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Message From The Organizing Committee

On behalf of all the members of the organizing and scientific committees, let me welcome you to the 2^{nd} Specialty Conference on Leadership and Management in Construction. Building on the momentum of the 2004 Hilton Head conference, the 2006 conference has expanded significantly. We are pleased to have CIB joining us as an official sponsor in addition to our ASCE sponsorship. The global focus of this year's conference is truly represented by delegates from Europe, Asia, Africa, North and South America. We are looking forward to great presentations, opportunities for discussion both formal in the conference and informal during afternoons on the beach. Our conference format is once again focused on providing maximum presentation, discussion, and interaction time.

Please take the opportunity to make new friends, renew old friendships, and develop new collaborations. The research community is small and collaboration is the key to advancing our agenda. We need everybody to help in this pursuit.

We look forward to a great conference and building a foundation for many more successful conferences. Thank you again for all of your participation and assistance.

Paul Chinowsky
Tony Songer
Patricia Carrillo
Conference Co-Chairs

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ASCE's Raise the Bar Effort: Forward Progress

American Society of Civil Engineers (ASCE)
Committee on Academic Prerequisites for Professional Practice (CAP^3)

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Abstract

In October 2001, American Society of Civil Engineers (ASCE) approved Policy Statement 465 entitled "Academic Prerequisites for Licensure and Professional Practice." The underlying purpose of ASCE Policy Statement 465 is to prepare the civil engineering professional of the future. The Committee on Academic Prerequisites for Professional Practice (CAP^3) has been working to implement the policy for the past four years. The purpose of this paper is to describe the progress over the last year and the next steps for the implementation of Policy Statement 465.

Introduction

In October 2001, the American Society of Civil Engineers (ASCE) Board of Direction unanimously approved Policy Statement 465, entitled "Academic Prerequisites for Licensure and Professional Practice." In October 2004, the policy was unanimously revised. This policy supports "the attainment of the Body of Knowledge (BOK) for the entry into the practice of civil engineering at the professional level." Under girding this policy is the belief that the BOK necessary to enter the practice of civil engineering at the professional level in the future will be beyond the scope of a traditional 4-year bachelor's degree and required practical experience. While ASCE recognizes that implementation of Policy Statement 465 will not occur overnight, this policy has the potential to transform the practice of civil engineering, and positively influence the safety, quality, efficiency, and sustainability of the built environment in the 21st Century. The purpose of this paper is to describe the progress over the last year and the next steps for the implementation of Policy Statement 465.

Background

The last four years have seen major progress in ASCE's "Raise the Bar" initiative, from the creation of a Civil Engineering Body of Knowledge (BOK), to a sea change in the reaction towards this initiative. The CAP ^3 Body of Knowledge committee formulated and published the first edition of the Civil Engineering Body of Knowledge for the 21st Century in early 2004. This effort moved the focus of ASCE's initiative from one principally referencing degrees to a new focus on the requisite areas of knowledge necessary for the professional practice of engineering in the future.

The overarching goal of CAP^3 is to develop, organize, and implement ASCE's "Raise the Bar" initiative. To accomplish this multi-phased objective, CAP^3 has spread its efforts over several fronts including curricula, accreditation, licensure, and BOK fulfillment and validation, and levels of achievement. Efforts in each of these five fronts were carried out by a constituent committee.

There were 9 face-to-face meetings and 93 conference calls during Fiscal Year 2005. Through these engagements, the overall efforts and accomplishments of the five committees in Fiscal Year 2005 were as follows:

The **Curricula Design Committee** has been working in earnest for the past two years. The Curriculum Committee is evaluating the BOK, mapping the BOK against the curricula of 25 participating undergraduate programs, and making suggestions on inconsistencies and how to improve the BOK. The Curriculum Committee regularly corresponds with a wide group of stakeholders, and is leading the charge to engage CEE faculty and administrators.

The **Accreditation Committee** has been formulating revised civil engineering program criteria, in concert with the ASCE accreditation community, for submission to the Engineering Accreditation Commission of ABET, Inc. The goal of this endeavor is to incorporate primary elements of the BOK into civil engineering curricula via the basic level civil engineering program criteria and the advanced level general criteria. In general, flexibility is being sought to allow universities to efficiently obtain accreditation of both undergraduate and graduate programs of the same engineering discipline. Such flexibility does not exist within current interpretations of ABET policies.

The **Licensure Committee** has continued to provide input to CAP^3 and to each of its committees from a licensure perspective. The Licensure Committee has closely monitored the activities of National Council of Examiners for Engineering and Surveying (NCEES) regarding proposed modifications to the Model Law. Additionally, the Licensure Committee continues to seek and identify states that may wish to consider early implementation of additional engineering education requirements as a prerequisite for licensure.

The **BOK Fulfillment and Validation Committee** began work in the fall of 2004 on two fronts. They explored concepts to allow alternative education providers other than universities to provide credible post-graduate engineering education. To become viable, such alternative education channels must be equivalent in academic rigor and individual performance assessment to upper level undergraduate and graduate level education at traditional universities. This committee also addressed how to assure that the requisite BOK is fulfilled through a combination of a bachelor's degree and approximately 30 credits of courses in technical and professional practice topics. The committee was "sunsetted" on May 1, 2005.

The **Levels of Achievement Committee** was formed as a result of input from the Curricula Design committee. The proposed 3 levels of competence (recognition, understanding, and ability) were difficult to apply in mapping the Body of Knowledge into existing curriculum. Thus, a committee was formed to address this issue. The committee completed their work in September 2005.

The **Second Edition of the Body of Knowledge Committee** was formed at the end of 2005 to develop the second edition of the ASCE BOK. Since the publication of the original BOK document in February 2004, there have been many papers written, talks presented and discussions held on the BOK. The purpose of the new BOK-2 committee is to review all that has transpired and to update the BOK, as necessary to reflect the new information. The expected date of completion of this effort is February 2007.

The remainder of the paper will address at greater length the efforts and accomplishments of the curricula design committee, the accreditation committee, and the levels of achievement committee.

Curricula Design Committee

The Curricula Design Committee has been working in earnest for the past year. The Curriculum committee's primary activities have been evaluating the BOK, mapping the BOK against the curricula of 25 participating undergraduate programs, drafting curricula on paper that would fulfill the BOK, and making suggestions on how to improve the BOK. The Curriculum Committee regularly corresponds with a wide group of stakeholders and is leading the effort to incorporate the BOK into the formal academic process (as applicable).

Activities and Accomplishments

- The committee conducted conference calls approximately every two weeks for the past year. The third face-to-face meeting of the committee was held on June 11, 2005 in Portland, Oregon.
- The committee formed a group of correspondents comprised of civil engineers and others interested in ASCE Policy Statement 465 and civil engineering education. This group reviews draft materials, responds to questions, and otherwise provides ideas and information for consideration by the committee.
- The committee has authored or co-authored articles and papers and made numerous presentations about its activities and progress for ASCE and other professional organizations such as the American Society for Engineering Education (ASEE). Currently, the committee is also compiling a bibliography of all published articles and reports related to education reform and "Raising the Bar."
- Currently, there are 25 universities that are assessing their curricula relative to the BOK. The committee has worked to assess how much of the BOK is covered in these 25 participating partner schools. This task—called program mapping—began in November 2003 and is expected to be completed in December 2005. Western Michigan University is actually implementing the BOK in its new undergraduate Civil Engineering degree program, as well as refocusing its graduate degree program. Norwich University is implementing a distance

education master's program to support the BOK. With time, other curriculum design partners are expected to implement BOK-based programs.

- The committee and its curricular design partners continue to review the outcomes and commentaries of the BOK. A related goal of this endeavor is to determine the appropriate location for the professional breadth outcomes (Outcomes 13, 14, and 15) in the curriculum as well as how they can be taught. At this point, it is assumed that Outcomes 13, 14, and 15 will be part of the undergraduate program.
- Work is being done to identify potential funding sources for BOK curricular development and implementation; to inform interested CE department heads, chairs, and faculty of such funding; and to encourage these parties to apply. One possible funding source is the U.S. Department of Education (DOE). The DOE solicits proposals annually. Although there are no substantive actions to report, the committee remains in communication with the DOE.
- The committee also established a subcommittee to re-examine the attitude section presented in the first edition of the BOK. The report is complete and will be forwarded to the Second Edition of the Body of Knowledge Committee for their consideration in preparing the next edition of the BOK.

Accreditation Committee

Thus far in 2005, the Accreditation Committee has drafted its primary work products, developed consensus for these documents within the civil engineering accreditation community, and has been communicating and coordinating with the Engineering Accreditation Commission (EAC) of ABET, Inc.

The Accreditation Committee, has drafted proposed revised ABET basic level civil engineering program criteria to incorporate the appropriate components of the BOK into the undergraduate civil engineering curricula -- and incorporate Bloom's taxonomy into the description of achievement levels. The Accreditation Committee has also been working with the EAC of ABET on modifications to the ABET advanced level general criteria, to provide assurance that holders of an accredited master's degree in civil engineering have satisfied the full civil engineering body of knowledge, and to facilitate the ABET accreditation of engineering master's programs in the U.S. To allow the latter, flexibility is being sought to allow universities to efficiently obtain accreditation of both undergraduate and graduate programs of the same engineering discipline. Such flexibility does not currently exist in engineering within current interpretations of ABET policies. Finally, the Accreditation Committee is working on modifications to a draft commentary on the proposed BOK-compliant accreditation criteria.

<u>*Activities and Accomplishments*</u>:

- The Accreditation Committee continued its internal communications activities with bi-weekly telephone conferences.
- The committee updated its membership in 2005 to maintain a roster that includes a key member(s) from each of the following groups:

  - CAP^3

- ABET Board of Directors
- Engineering Accreditation Commission (EAC)
- Committee on Curricula & Accreditation (CC&A) of ASCE's Educational Activities
    - Committee (EdAC)
- Department Heads Council Executive Committee (DHCEC) of ASCE's EdAC.
- Body of Knowledge Committee of CAP^3
- Curricula Committee of CAP^3
- Licensing Committee of CAP^3

- The committee regularly updated its draft Accreditation Master Plan to incorporate those changes needed in response to a changing environment. The Accreditation Master Plan lays out in detail how the committee will work to publish approved criteria in the Engineering Accreditation Commission (EAC)/ABET document titled Criteria for Accrediting Engineering Programs (effective for evaluations conducted during the 2008-2009 accreditation cycle) that fulfill the formal educational requirements for entry into the professional practice of civil engineering (i.e., licensure) as specified in the Civil Engineering Body of Knowledge for the 21st Century.
- The committee conducted a session dedicated to ASCE's accreditation effort at the 2005 ASEE Annual Conference & Exposition.
- The committee successfully worked to have the EAC of ABET withdraw its previous (July 2004) proposal for a new Advanced Level General Criteria. That version of the proposed Advanced Level General Criteria would have been detrimental to the ASCE Policy Statement 465 initiative. The Criteria Committee of EAC subsequently drafted a new proposal for modifying the Advanced Level General Criteria. This latest draft drew heavily from the committee's recommended language, but differs in one significant aspect from the proposal put forward by the accreditation committee. The committee is now working through ABET channels to seek further modification of EAC's latest draft criteria.
- The committee conducted telephone conferences of the entire "ASCE Accreditation Community" on a 6-week schedule throughout most of 2005. This community consists of ALL of the members of the following groups:

    - Accreditation Committee of CAP^3
    - CC&A of ASCE's Educational Activities Committee (EdAC)
    - ASCE Representatives on the EAC of ABET
    - ASCE Representatives on the ABET Board of Directors
    - Department Heads Council Executive Committee (DHCEC) of ASCE's EdAC

- The committee developed draft Basic Level Civil Engineering Program Criteria and draft advanced Level General Criteria that are aligned with the formal educational requirements for entry into the professional practice of civil engineering (i.e., licensure) consistent with the BOK.
- The committee developed a draft document entitled "Commentary on the ABET Engineering Criteria for Civil and Similarly Named Programs" to provide guidance to CE department heads and CE program evaluators. This document interprets the ABET/EAC criteria in the context of the BOK.

- On May 21, 2005, the committee presented its draft Basic Level Civil Engineering Program Criteria and its draft Advanced Level General Criteria at the ASCE National Department Heads' Meeting in Salt Lake City, UT. The outcome was very positive and generated support for implementation of the draft criteria.
- The committee met with the EAC Criteria Committee on July 13, 2005, and explained the committee's overall initiative and plans. The committee also provided crucial comment to the EAC on proposed Advanced Level General Criteria, leading to the probable adoption of much, but not all, of the committee's suggested language. Finally, the committee participated in EAC discussions leading up to a decision by the EAC to openly evaluate lifting of the prohibition against dual level accreditation.
- The committee met with the DHCEC, CTC&A, and the CC&A on October 1, 2005 and thoroughly briefed these key stakeholders on its draft accreditation products.

Levels of Achievement Committee

The Body of Knowledge (BOK) is defined in ASCE Policy Statement 465 as "the necessary depth and breadth of knowledge, skills, and attitudes required of an individual entering the practice of civil engineering at the professional level in the 21st Century." As noted earlier, the foundational role of the BOK in implementing ASCE PS 465 resulted in the 2004 publication by ASCE of the report Civil Engineering Body of Knowledge for the 21st Century. The BOK is presented in that
report in accordance with these three themes: 1) what should be taught to and learned by future civil engineering students; 2) how should it be taught and learned; and 3) who should teach and learn it. The Committee's primary focus was the what.

Implementation of ASCE PS 465 is a complex, long-term, and highly interdependent effort illustrated, in part, by the number of involved stakeholders within and outside of ASCE. Many of these stakeholders reviewed and began to work with the BOK in carrying out their responsibilities. As a result of reviewing and using the BOK report recommendations, stakeholders identified a problem and raised issues related to the BOK.

The problem revolved around the three principal words used to define competency levels, namely recognition, understanding, and ability. In particular, the CAP3 Curriculum Design Committee came to this conclusion: Until there were understandable and readily applicable competency definitions—including definitions that would be understood by those outside the committee—evaluation of existing curricula and development of example curricula would be difficult if not impossible.

Accordingly, CAP3 formed the Levels of Achievement Subcommittee in February 2005 and charged it with resolving the levels of competency problem. The Subcommittee, including members and corresponding members from academia and public and private practice, studied the problem. The Subcommittee's report, Levels of Achievement Applicable to the Body of Knowledge Required for Entry Into the Practice of Civil Engineering at the Professional Level --

- Recommends substituting achievement for competency in all future references to levels of demonstrated learning.
- Recommends using Bloom's Taxonomy as the framework for defining levels of achievement. Bloom's levels of the cognitive domain are widely known and understood across the education community. Furthermore, use of measurable, action-oriented verbs facilitates consistent curricula design and assessment.
- Recommends using a revised statement of the original 15 civil engineering outcomes using action verbs. This revision was prepared by the Subcommittee and appears in the report.
- Asks the CAP3 Curricula Design Committee to use the revised outcomes in the continued mapping and design of BOK-based curricula, suggest refinements, and comment on the usefulness of the BOK Outcome Rubric introduced in this report.

The Curricula Design Committee has begun that process and reports success. The Committee --

- Asked the CAP3 Accreditation Committee to use the revised outcomes as the basis for drafting Basic Level Civil Engineering Program Criteria and Advanced Level General Criteria. The Accreditation Committee is following this suggestion.
- Asked the recently formed second BOK Committee to consider adopting the 15 outcomes as stated in this report, using verbs based on Bloom's Taxonomy, and possibly to present them as a rubric. The Subcommittee also recommends that the second edition committee explore the possible application of refinements to Bloom's Taxonomy and more explicitly address the role of critical thinking in the BOK.
- Asked the American Academy of Water Resources Engineering to consider applying the achievement level concept in defining the requirements for Diplomate status. The AAWRE has indicated its willingness to follow this suggestion.
- Asked the new ABET Accreditation Council Task Force to proceed with refining ABET General Criteria using Bloom's Taxonomy, an approach that is likely to be applicable to other engineering disciplines, as well as the disciplines represented by the other ABET Commissions.
- Asked Civil and Environmental Engineering Departments to consider applying the 15 Civil Engineering Outcomes, as defined in the Subcommittee's report using verbs, in evaluating and designing baccalaureate and Master's degree curricula.
- Asked other engineering disciplines and organizations to comment on the approach used and recommendations presented in this report.

The Subcommittee's report was received by CAP^3 in September and, having completed its work, the Subcommittee was "sunsetted."

Summary

The ASCE Committee on Academic Prerequisites for Professional Practice has made significant progress in the last 4 years. The progress is encouraging but there remains considerable work in years to come to fully transform the profession.

An Integrated Construction Education Model at Virginia Tech

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Abstract

This paper looks at the process, the reasons, challenges and lessons learned in formulating a new model for construction education, research and outreach at Virginia Tech and, hopefully, across the nation. It details the steps taken to establish a cross college School of Construction between the College of Architecture and Urban Studies and the College of Engineering. The school and the relationships it creates will lead to a new degree in Construction Engineering and Management, an integrated set of capstone courses for undergraduate education between Building Construction and Construction Engineering and Management, a model for integrated coursework for MS in BC and CEM, a focused research agenda and a common PhD in Construction. The School of Construction was made possible by gifts from two alumni and commitments from the two Colleges, two Departments, and the University Provosts.

Introduction/ How Did We Get Here?

The authors of this paper have worked together for the past 20 years. They first worked to establish a program of Construction Engineering and Management (CEM) in the Department of Civil and Environment Engineering (CEE). That effort started in 1985 has lead to a nationally recognized CEM program with four full time faculty. The task in CEM was to create a high quality program within CEE curriculum that provided a construction concentration for undergraduate Civil Engineering students and formed the basis for a high level research and graduate program. This program currently has about 45 graduate students and regularly outputs civil engineering undergraduate students who take on roles in the construction industry. Of the 150 or so CE graduates per year about 33% go into construction.

In 1995 the first author left the CEM program to take on the Department Head position in Building Construction (BC). His tasked was to solidify a floundering department, add a research agenda, and increase the quality of a newly formed graduate degree in Construction Management. The department over the past 10 years has increased its visibility and quality as well as has grown from 85 students to 280 students; 45 of these are in the graduate program.

In fall of 2003 the authors began a discussion to explore the possibility of bringing the two programs together and benefit from obviously available but hard to achieve synergies. The programs had achieved substantial individual success but, the authors believed, much could be done if past success could be used as a springboard for the step change needed to establish an integrated school of construction and create a single community of industry leaders, students and faculty who have a passion for the construction industry.

These conversations were carried out in close contact with Ross Myers, an alumnus of CEE who joined and participated in the development of the vision for an Inter College School of construction and made a verbal commitment to support the initiative with the stipulation that a matching gift would be required from Building Construction.

The vision for a inter College School of Construction was discussed at the fall 04 BC advisory board meeting. The advisory board unanimously endorsed the idea and moved ahead to find a matching gift. This resulted in a verbal commitment from another alumnus, John Lawson. The two donors were keynote speakers at the April 05 at our Construction Awards Banquet, and confirmed their joint commitment to support the establishment of the Myers-Lawson School of Construction.

A contribution was requested from the university and a memorandum of understanding between the University President, the Provost the Deans of Architecture and Urban Studies and Engineering and the two department heads was agreed in March 2005.

During summer of 05 a strategic planning initiative was undertaken and a formal proposal for the establishment of a School of Construction at Virginia Tech was developed for approval through the University governance system. Working sessions with faculty from BC and CEM were undertaken to reach common vision and mission for the school and these, together with the strategic plan were accepted by the newly constituted School of Construction Advisory Board. at their Fall 05 meeting.

The formal proposal for the establishment and naming of the Myers-Lawson School of construction at Virginia Tech was approved by the University Board of Visitors on March 27th 2006.

Vision, Mission and Guiding Principles.

It is difficult to underestimate the importance of establishing a common vision, mission and set of guiding principles for a venture of this nature. Ross Myers and John Lawson provided the framework during their keynote address at the Construction Awards Banquet when they articulated their vision in the following five areas:

1. The School must strive to be the best – it must set the standard for and take a leadership role in construction education and define a construction community.
2. The School must be student centric – it must focus on students, build their commitment to construction and improve their ability to lesad in all sectors of the industry.
3. The School must be founded in values based leadership – it must emphasize ethics, people and community
4. The School must establish creative learning environments – it must rethink how people learn and emphasize learning above teaching.
5. The School must build a construction community – it must be the focus for a community of industry leaders, students and faculty who have a passion for the construction industry.

These five points guided the strategic planning process and became an integral part of the of the formal proposal to establish the School. Both documents articulate the vision, mission and guiding principles for the School as follows:

Vision:

The School of Construction at Virginia Tech will set the standard for innovation and excellence in construction education, research and outreach.

Mission:

The School will provide a unified identity for excellence in construction education, research and outreach within Virginia Tech, to the academic community and to the construction industry.

Our students will come first

- We will educate inquisitive values based leaders, thinkers, and integrators able to succeed in all sectors of our industry by providing an education founded on technical, managerial, and practical knowledge.

We will cross boundaries

- We will provide a critical mass of faculty and students to work across traditional boundaries and share learning environments, research, and academic life without the constraints and preconceptions of traditional departments.

We will value discovery

- Our learning environments and research will be based on the needs of our industry and communities, without compromise in creativity and technical quality.

We will grow a construction community

- We will partner with our industry to be the benchmark provider of knowledge and leadership and make construction a career of first choice.

Guiding Principle:

Our Guiding Principles are elaborated in three concepts that form our areas of excellence, underlying philosophy and reason for being:

- **Values Based Leadership** – The school will provide research and learning environments that exemplify Values Based Leadership. These leadership values are founded in the highest ethical standards and behavior that extend across the decisions that we as members of our construction community encounter in every day life including areas of: **1.) Human interactions/relationships** such as respect and empathy for a diverse population, safety, caring for people and the entities we work with, growth of the individual; and **2.) Society/community involvement** including local, regional, national and world involvement with an understanding of sustaining our society and communities for future generations.
- **Excellence in creative learning environments and research**– The school will concentrate on learning environments that promote academic inquiry, pursuit of discovery, and human enlightenment and that provide maximum learning for our students. The school will be known for developing and using creative learning environments that include case based, seminar based, project based and studio based learning integrated with E-learning technologies and classical learning modes to improve access, efficiency and quality.

The school will be known for rigorous research methodology and products. We will concentrate on doing the best quality research that will enrich academic thinking and benefit the construction community.

- **Integrating and Sustaining the Built Environment** – The school will address all the elements of the built environment that must come together in a unified and integrated way to provide the best value for owners and our society. We will embrace field operations, production and productivity management as a necessary element of project management. We will strive to lead the change towards facilities that produce a net contribution to our environment and society. The elements that need to be embraced include integration for livability, safety, performance, energy consumption, sustainability, operation, and salvage. The school will take a leading role in growing a construction community that will address the interface issues that are critical to the long term success of the built environment and our industry.

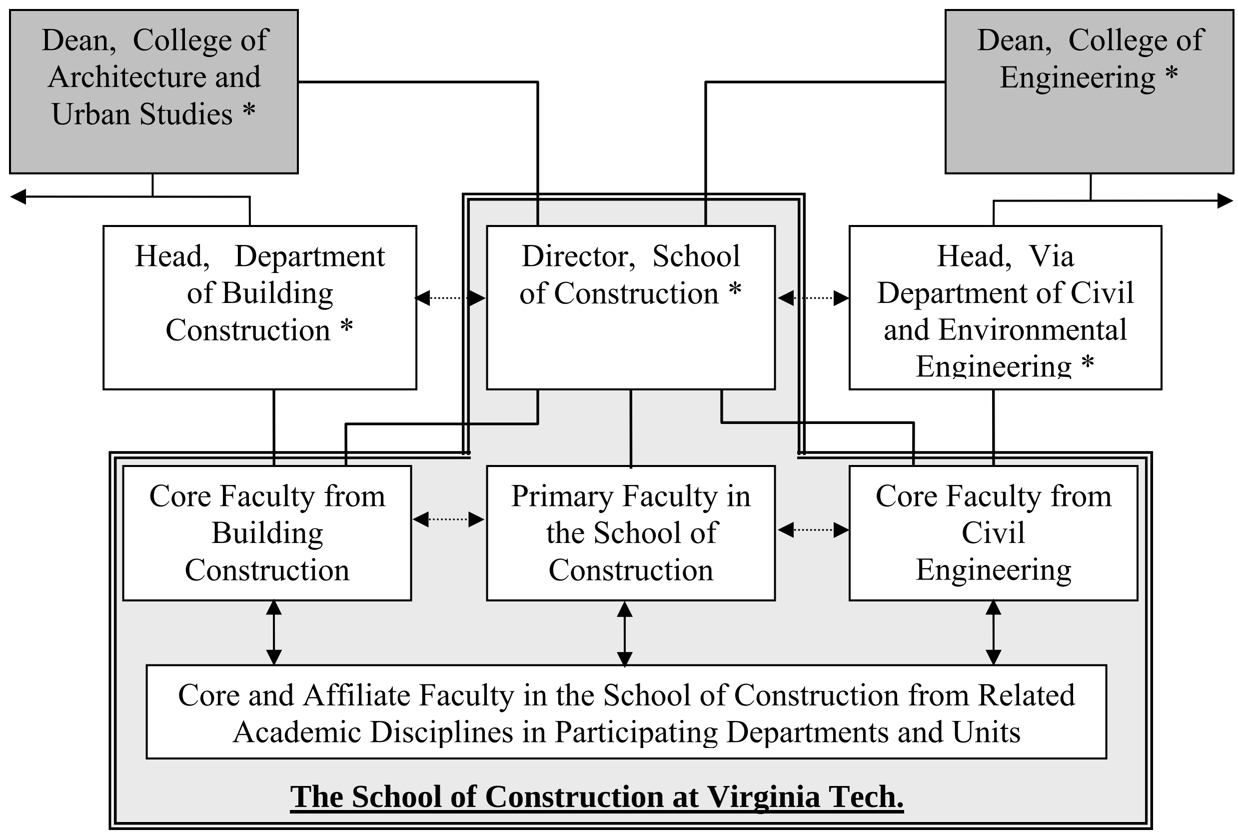
Structure and Operations

The School will be jointly housed in the College of Architecture and Urban Studies and the College of Engineering. The School will be administered by the Director who will have formal reporting ties to the deans of both colleges. Faculty will be comprised of Primary Faculty with positions and reporting responsibility in the School, Core Faculty with tenure lines in their respective departments and Affiliated Faculty from related academic disciplines. The organizational structure is given in Figure 1.

The School will be located in Bishop-Favro Hall that will open in fall of 07, and the school will be administered by a Director with support provided through an appointed Associate Director. The Director will have formal reporting ties to the deans of Architecture and Urban Studies and Engineering and will be responsible for the School's budget and all personnel matters relating to the primary faculty and staff in the school. The Director will liaise with the heads of the participating departments on all matters especially those pertaining to courses, curriculum and assignments for core faculty.

The School will have an Internal Advisory Committee that includes the deans of both colleges, the heads or designates of the participating departments, and selected representatives of other departments/schools /programs on the Virginia Tech campus that have significant ongoing activities related to construction. The director and associate director will be ex-officio members of the Internal Advisory Committee which will be chaired by one of the deans.

The establishment of the school will not change any of the existing personnel and budgetary responsibilities in the participating departments except in so far as the School's promotion and tenure advisory committee will provide input to departmental deliberations regarding annual reviews and the promotion and tenure of primary and core faculty.



* Member of Internal Advisory Committee.

Figure 1 – Organizational Structure for the School of Construction.
The School will be jointly housed in the Colleges of Architecture and Urban Studies and Engineering. It will include Primary, Core and

An operating budget equivalent to $750,000 made up of university commitments and cash operating funds contributions, and endowment buildup will be fully available each year starting in fall 06. These funds will be used for the following:

a. 3.5 Faculty positions including the partial support for the Director and Associate Director outlined in D.1 and D.2 above.
b. 5 Ph.D. level GTA positions
c. The program support technician and industry internship program coordinator positions described in D.4. above.
d. General operating and Student Support funds

The Department of Building Construction will remain as a department in the College of Architecture and Urban Studies, The Vecellio Construction Engineering and Management Program will remain as an integral part of the Via Department of Civil and Environmental Engineering. The establishment of the School of Construction will not require or lead to a change in the level of faculty, staff, student and other forms of support for these two programs.

Academic Priorities.

Faculty met as a group and sought input from a preliminary external advisory board to establish the following six priorities for the building and development phase for the School:

1. **Coordinate Existing graduate degrees in construction.**

Existing graduate degrees in construction are administered and students are advised separately by the Department of Building Construction and the Vecellio Construction Engineering and Management Program. The School will assume these responsibilities on behalf of the two units and will establish a uniform curriculum structure that matches student background and college affiliation and spans the traditional academic disciplines of Architecture and Engineering.

The student application review process for these two units will also be administered by the School and students will be admitted and advised by Primary and Core faculty according to research interests, degree requirements and undergraduate background. This process will provide a unified construction identity to graduate students, the campus community and the construction industry. It will leverage faculty resources, enhance the quality of graduate programs, improve Virginia Tech's ability to recruit outstanding graduate students and significantly increase the number of students graduating with advanced degrees in construction from Virginia Tech.

2. **Propose and establish a new BS degree in Construction Engineering and Management and coordinate undergraduate education in construction.**

Students wishing to obtain an undergraduate degree in construction at Virginia Tech currently register in the College of Architecture and Urban Studies and obtain a BS degree in Building Construction (BS BC) or in the College of Engineering where they use the flexibility in the civil engineering curriculum to obtain a BS degree in Civil Engineering with coursework in construction.

The School will seek to establish and obtain ABET accreditation for a new BS degree in Construction Engineering and Management (BS CEM) The existing BS BC degree will work in tandem with the proposed BS CEM degree and enable Virginia Tech to recruit engineering students who wish to focus their careers in construction. The two undergraduate degrees will ensure that Virginia Tech is able to prepare students for success in the construction industry regardless of whether their backgrounds are in building construction or engineering and will increase the number of graduates entering the industry.

Students seeking the BS BC degree will be admitted through the College of Architecture and Urban Studies as at present and will complete the established and well recognized BS BC curriculum. Students seeking the proposed BS CEM degree will be admitted through the College of Engineering and will complete a curriculum that includes the equivalent of five BC courses as capstone studio classes shared with BS Building Construction students. These capstone studio classes will use innovative methodologies to maximize learning, build appropriate skills in leadership, teamwork and communication and ensure that construction students at Virginia Tech are prepared for success in an industry that does not rely on one particular academic discipline for the development of technical and managerial leadership.

The administration of the BS CE degree and its various tracks remains in the Via Department of Civil and Environmental Engineering. The two undergraduate construction degrees - BS BC and BS CEM - will be administered by the School of Construction on behalf of their respective departments and colleges.

3. **Propose and establish a new interdisciplinary Ph.D. degree in Construction.**

There is no Ph.D. degree in Construction at Virginia Tech. Students entering the College of Engineering require a background in engineering and pursue a Ph.D. in Civil Engineering. Students entering the College of Architecture and Urban Studies have diverse educational backgrounds and typically pursue a Ph.D. in Environmental Design and Planning.

The establishment of the School will make possible, and the faculty will propose, the establishment of a new interdisciplinary Ph.D. degree in Construction. The proposed degree will cut across traditional boundaries and prepare graduates for professional and academic careers in a broad and diverse industry that does not rely on one particular academic discipline for the development of academic, technical and managerial leadership.

4. **Establish three centers of excellence that characterize and form the philosophical foundation for the School.**

The School of Construction makes it possible for faculty to work together and develop a focus on three initiatives that establish the philosophical foundation for the School, cut across teaching, research and outreach activities and provide a common ground for interaction between faculty. These are:

i. **Values Based Leadership** – The school will provide research and learning environments that exemplify Values Based Leadership. These leadership values are founded in the highest ethical standards and behavior that extend across the decisions that we as members of our construction community encounter in every day life.
ii. **Excellence in creative learning environments and research** – The School will concentrate on learning environments that promote academic inquiry, pursuit of discovery, and human enlightenment and that provide maximum learning for our students.
iii. **Integrating and Sustaining the Built Environment** – The school will address all the elements of the built environment that must come together in a unified and integrated way to provide the best value for owners and our society.

5. **Support and develop synergy with the Center for Innovation in Construction Safety and Health.**

   The Center for Innovation in Construction Safety and Health has recently been established as a College level center within the University and several faculty are actively involved in its activities. The School will seek to develop a formal relationship with the center to improve alignment and share expertise to the greatest extent possible. This will provide the School with a ready made opportunity to develop activity consistent with the emphasis on values based leadership and build synergy with an established center of growing reputation.

6. **Expand outreach activities in partnership with industry.**

   Faculty have maintained an active outreach program through advisory boards, a construction affiliates program and other initiatives that build and nurture relationships with industry. They have also been involved with short courses such as the Transportation Construction Management Institute, the Construction Affiliates Leadership series. The School will coordinate these activities and work in close association with Center for Innovation in Construction Safety and Health and other partners across the breadth of the industry to develop, maintain and promote an active outreach program including and advisory board and affiliates program.

Lessons/Wisdom?

There are several lessons or points of wisdom that the authors would like to share for anyone contemplating doing something like a cross college School of Construction. These are listed below:

1. There must, in the first place, be wise, committed and dedicated executive leadership from industry that is passionate about the venture, able to navigate through differences and maintain a course towards the final destination.
2. There must be an acknowledgement of the contribution and equality of the different entities entering into the relationship. There cannot be feelings of superiority/inferiority. It must be an inclusive group that believes in the value of each partner. This cannot be understated. A relationship/team cannot emerge without this first requirement.
3. The parties must agree on the benefits and end results before they get into the details. If the fundamental philosophy is not in place the details will always derail the process.
4. This end result of a school of construction is not about engineering, architecture, or building construction. It is about doing what is best for our students, our industry, and our university. ***It is about looking to create a construction community.***
5. Joining must be voluntary. Compulsory involvement will not work.
6. The leadership team must be accepting of all its children. There must be a feeling of ownership of all degrees and types of graduates that will be involved in the school of construction.
7. There must be a commitment to success with the tact, tenacity and patience needed to hear all points of view, find common ground and move forward.

8. There must be acceptance of the fact that it will take time, energy, effort and, above all, compromise.

It is hoped that this effort will lead to a sustainable construction educational model that will be adopted by other universities. We hope that through this effort we will be able to help develop and define a construction community. The community that represents this very large world and national economic sector need an identity; and we hope to contribute to that diverse and inclusive identity.

Benefits of Industry Involvement in Construction Education

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Abstract

Construction programs must have a symbiotic relationship with the construction industry. The construction industry can greatly benefit from the involvement of industry practitioners in the development, implementation, and improvement of construction education programs. Industry involvement provides construction programs with ideas and resources necessary to meet the challenge of continuously improving construction education. This paper will discuss the findings of a survey among construction programs members of the Associated Schools of Construction (ASC). The purpose of the study was to learn about construction programs and to identify factors that could promote mutually beneficial relationships between the construction industry and construction education programs. The results of the survey showed that general contractors and commercial building contractors have a higher level of involvement with construction programs. It was also found that internship programs and assistance in securing financial resources were factors that could promote mutually beneficial industry-education partnerships.

Introduction

The increasing complexity of today's construction industry requires continuous improvement of construction education programs. An important factor that has shown to be essential to the success of construction programs is the involvement of the construction industry (Badger, 1999). Construction programs must take the necessary steps to promote mutually beneficial industry-education partnerships.

Construction programs have the challenge of preparing professionals for a continuously changing industry. Construction faculty must meet this challenge by keeping up with the changes in the industry and incorporating these changes into the curriculum. Construction industry practitioners can be involved in construction education in many capacities. They can provide construction educators with ideas for topics to be included in courses, they can help researchers identify industry problems that need to be solved, and they can give feedback to construction programs on how effective the program is in educating students to succeed in today's construction industry.

The goal of the survey discussed in this paper is to determine the level of involvement of construction industry practitioners and the benefits to the programs with which they are involved. Characteristics of the construction programs surveyed are presented and factors that could contribute to successful industry-education partnerships are discussed. If construction education is to succeed in preparing the next generation of construction professionals, a concerted effort must be made to achieve the highest level of industry involvement possible.

Research Methodology

In order to learn about the factors that contribute to successful collaboration between the construction industry and construction education programs, a survey was conducted among members of the Associated Schools of Construction (ASC). The ASC is an organization established in 1965 which goal is to foster excellence in construction communication, scholarship, research, education, and practice. The membership of the ASC includes academic programs in disciplines such as architecture, engineering, management, technology, and others. The ASC is organized into seven geographic regions in the United States (Northeast, Southeast, Great Lakes, North Central, South Central, Rocky Mountain, and Far West) and two international regions, one for international institutions (Canada; Europe; Asia and the Pacific; and Caribbean/Central/South America) and one for industry professionals (ASC Website, 2005).

The use of the survey questionnaire is intended to provide results that are descriptive in nature and are intended to provide an understanding of what factors construction programs consider to promote successful industry-education partnerships. The questions included in this survey were divided into three groups: information about the programs, information about industry partners, and factors that contribute to successful industry involvement.

The survey was sent to construction programs members of the ASC across the United States. One hundred and nine (109) construction related programs were contacted from all regions of the ASC (ASC Website, 2005). The construction programs surveyed included programs that reside in civil engineering schools as well as programs in technology schools and architecture schools. A total of 19 programs from 5 regions of ASC completed the survey for a 17.4% response rate (see Table 1). The respondents included construction programs from fifteen (15) states across the United States.

Table 1. Surveyed programs by ASC region

ASC Region	Programs Surveyed
I - Northeast	5
II - Southeast	4
III – Great Lakes	2
VI – South Central	4
V1 & VII - Far West	4
Total	19

Data Analysis

The analysis of the survey to construction programs includes descriptive statistics and an analysis of responses related to the importance given to several factors that are believed to result in positive involvement of industry partners with construction education programs.

Descriptive statistics

Information on important characteristics (i.e., size of program, characteristics of student body and faculty, and program focus) of the surveyed construction programs can be obtained from the survey data. The information obtained can increase the understanding of the factors that contribute to the successful relationships between the construction industry and construction education programs. Learning about these factors can contribute to the improvement of construction education and ultimately the construction industry, which benefits from the increased quality of construction program graduates.

Program size and demographics

Table 2 includes information on the size, and demographics of the programs who responded to the survey. The largest programs were located in Region VI of ASC. From the survey it was also learned that 58% of the programs surveyed had a graduate program. The programs with a larger proportion of graduate students, female students, and international students were located in the Far West Region of ASC. There were notable differences in the sizes of the graduate programs. For example, Region II and the Far West Region had a combined 32% of the graduate programs but the Far West Region had a much higher percentage of graduate students. This shows that graduate programs in the Far West Region schools are larger. The data also shows that there are notable differences in the number of female and international students. The programs in Regions II and III of ASC reported the lowest number of female and international students in the programs surveyed.

Table 2. Program size and student body demographics

ASC Region	Average # of Total Students	Standard Deviation of Total Students	Average of % of Grads	% Female Students	International Students
I - Northeast	102	65.0	3.04	8.02	2.84
II - Southeast	218	118.8	6.80	5.03	2.25
III – Great Lakes	175	75.7	1.32	2.50	0.50
VI – South Central	299	164.6	4.88	10.13	4.40
VI & VII - Far West	176	125.9	21.08	16.82	14.18

Program focus

When asked about the proportion of time that faculty spends in teaching or research, most of the programs reported that faculty spends on average close to 80% of their time in teaching activities (see Table 3). This could be an indication of the difficulties that construction faculty face in obtaining funding for research activities. Tener (1996) noted that a lack of construction research funding is a factor that can limit the availability of construction faculty in the future. The role of industry partners is extremely important for securing the necessary resources to conduct construction research and ensure the availability of qualified faculty. Badger (1999) also discussed this issue when he noted that the educational and industrial communities both benefit from research in the construction field. The knowledge obtained for research is incorporated into the undergraduate curriculum and research findings also help industry to solve some of its technical problems (Badger, 1999).

Table 3. Faculty allocation of time (in percent)

ASC Region	Research	Teaching	Other
I - Northeast	22	78	0
II - Southeast	12	89	0
III – Great Lakes	18	83	0
VI – South Central	18	77	5
VI & VII - Far West	21	66	13

Faculty statistics

Figure 1 shows the compositions of the construction programs surveyed. There was no consistent proportion of faculty at the assistant or full professor levels. However, there were similar numbers of associate professors in many of the ASC regions surveyed. The survey results also showed that many of the regions surveyed had a large number of adjunct faculty. For example in Regions III and Far West, 60% or more of the faculty are adjunct faculty. This could be an indication of problems with availability of qualified faculty or the desire of many construction programs for faculty with practical experience. Tener (1996) discussed this issue when he indicated that the quality of construction education depends greatly on the industry experience of its faculty. Therefore, it is important that the construction industry recognizes this issue and provides opportunities for faculty to participate in activities that will enhance their practical knowledgebase. This assistance from industry could be in the form of faculty internships. According to the data reported from the ASC programs surveyed, only 15.8% had a formal faculty internship program.

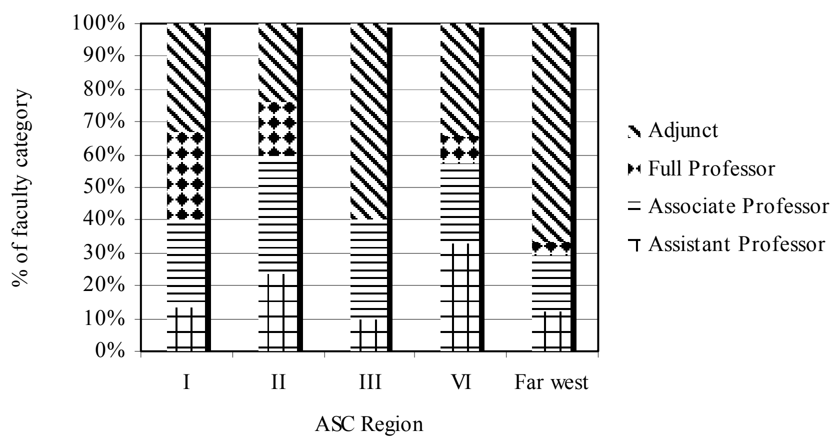

Figure 1. Faculty categories by region

Student internship programs

The opportunity for students to have industry experience before graduation is very important to their success in the construction industry. The internship experience provides students with the knowledge to better understand concepts taught in the classroom and also helps them to know what to expect when they go out into the "real world" of construction. Internships also provide employers with construction graduates that are better prepared to face the challenges of this dynamic industry. Commitment from construction programs is essential to the success of student internship programs. The resources devoted to the internship program can demonstrate this commitment. The survey results showed that 63% of the construction programs had an Internship Coordinator, which is evidence of commitment to the internship program.

Teaching techniques

The teaching techniques used by construction programs can be an important factor contributing to the quality of graduates and to the success they achieve in the construction industry. Respondents of the survey were asked to indicate what teaching techniques were used in their programs by indicating the frequency with which they were used. Respondents rated each of the techniques on a scale from 1 to 10, 1 being the least used and 10 being the most used. A summary of the responses is shown in Figure 2.

Traditional classroom teaching was the most used technique with an average rating of 9.3 and distance education was the least used with an average rating of 2. Case studies and field trips were moderately used with average ratings of 4.8 and 4.4 respectively. The results show that construction programs that responded to the survey rely mostly on traditional methods of instruction with only a small number employing innovative instructional methods.

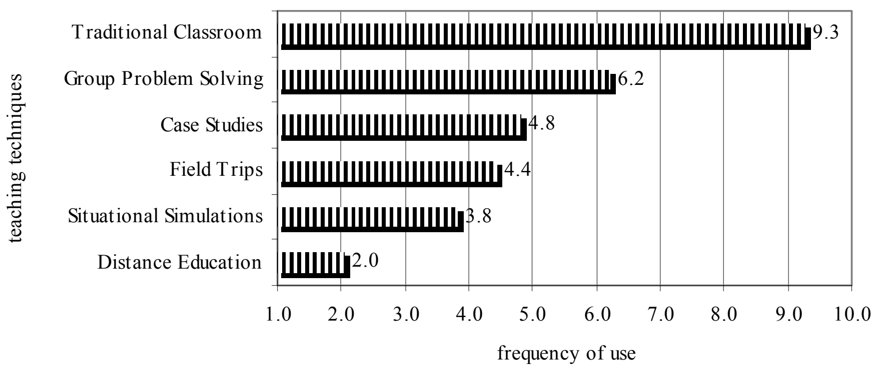

Figure 2. Teaching techniques used by construction programs

If construction education programs are to improve the quality of it graduates, increased efforts should be made to increase the use of technology in the classroom. Lindsey (2003) demonstrated the benefits of distance education technologies for a structural steel design course. He found that by using distributed education (DE) technology his students spent more time preparing for class and made better use of their time with the instructor. Benefits for the instructor included reduced lecture preparation time and increased quality of lecture materials.

Industry partners

There is great diversity in the type of companies that perform construction and construction related work as well as a wide range of company sizes. This diversity provides a great number of opportunities for industry-education collaboration in the construction field. The following sections explore the demographics of the industry in relation to their involvement with construction programs.

Types of companies

Figure 3 provides and indication of the types of companies that are involved with the construction programs surveyed. General contractors were the group with the greatest involvement. All the construction programs surveyed reported that general contractors were involved with their program. Equipment manufacturers were the group with the least involvement with construction programs with only 11% of the programs reporting that they had a relationship with such companies. Other types of companies with high level of involvement with construction programs were commercial building contractors, residential construction contractors, and heavy civil contractors. Specialty contractors such as electrical and mechanical contractors had a smaller level of involvement (58% and 53% respectively). It is important to increase the level of involvement of the specialty contractors if construction programs wish to produce graduates that will serve this sector of the industry.

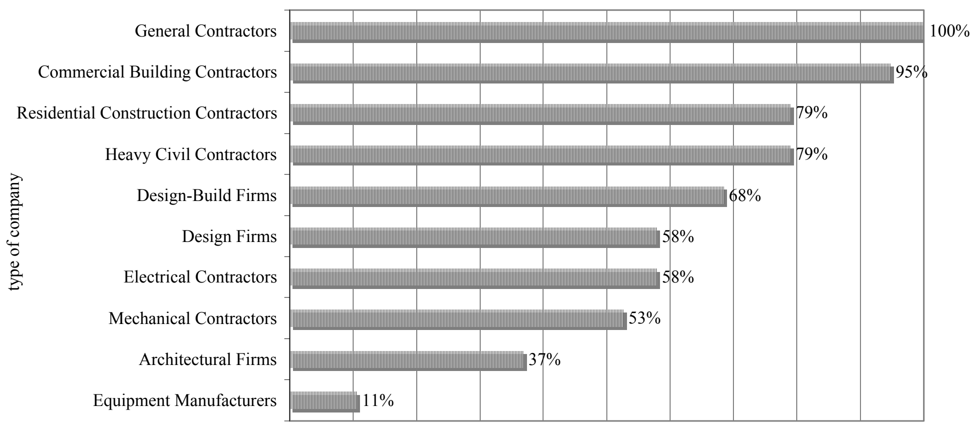

Figure 3. Types of companies involved with construction programs

Factors contributing to successful partnerships

The level of involvement of companies can provide an indication of the commitment that the companies have to their relationships with construction programs. From Figure 4 it can be observed that commercial building contractors are the group that shows the highest level of involvement with the construction programs surveyed closely followed by general contractors. Mechanical contractors and electrical contractors are again at the lower end on the scale with low level of involvement.

There are numerous ways in which industry can get involved with construction education programs. Tener (1996) outlined the elements for an effective industry-university partnership which include involvement in curriculum development, fundraising, internship program development, assistance to faculty in terms of research ideas and resources. Badger (1999) discusses similar elements of industry involvement in the success of industry advisory councils for construction programs. Survey respondents were asked to rate several types of involvement that industry partners could have, by how conductive they believed they were to a successful industry-education partnership. Respondents of the survey reported that providing internships for students and financial contributions were the types of involvement that could be most conducive to a successful industry-education partnership (see Figure 5). Other types of involvements that were rated highly were providing guest speakers for lectures and assistance in fundraising efforts.

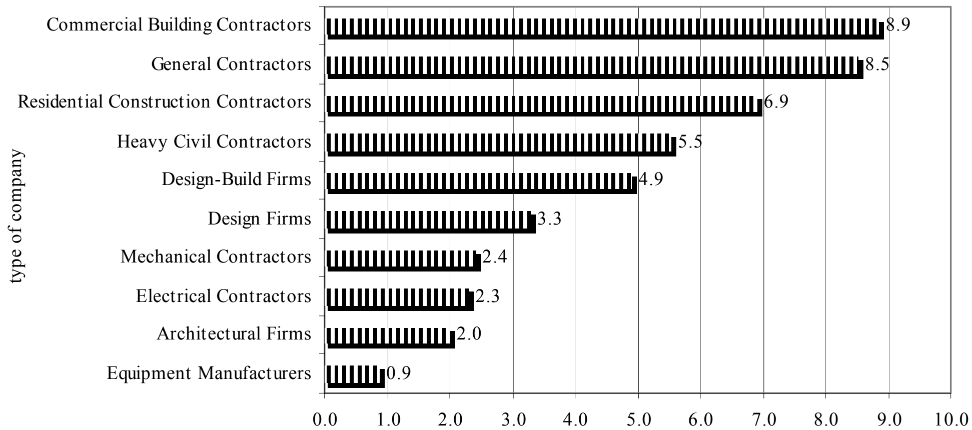

Figure 4. Level of company involvement

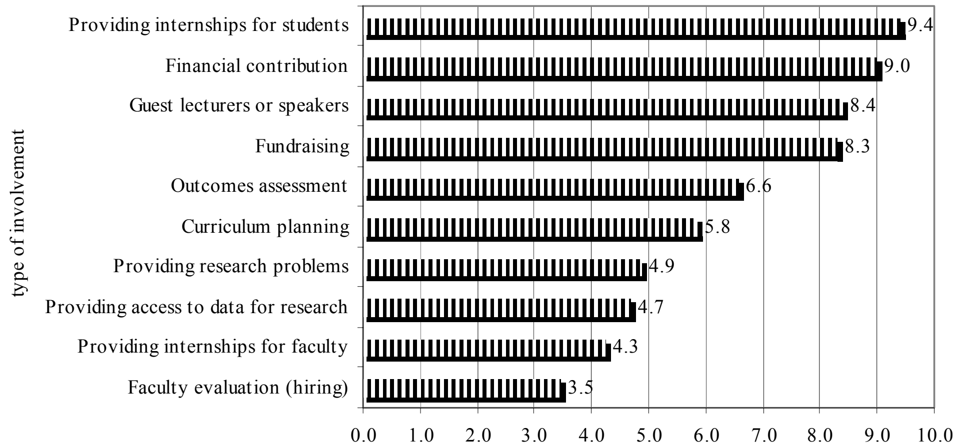

Figure 5. Types of industry involvement

Conclusions

The construction industry can play a vital role in the developing of its future leaders and its involvement has clear benefits for construction education programs. This paper evaluated the factors that can result in successful industry-education partnerships. A survey was conducted among construction programs members of the Associated Schools of Construction (ASC). Construction programs from five ASC regions responded to the survey (17.4% response rate). Important information was collected about the construction programs, the types of companies involved with the programs, and the types of involvement they had with the programs.

It was observed that faculty in the programs surveyed dedicate on average close to 80% of their time to teaching activities. It is important to determine if this high percentage is due to departmental goals or to issues with lack of funding for construction research. This is an important issue since research serves as a catalyst for the development of future faculty and the improvement process of construction programs. The data also showed that some of the regions surveyed had a significant number of adjunct faculty. This may be an indication of two issues, the shortage of faculty and the need for faculty with industry experience. The construction industry can have a significant role in addressing these issues by providing the opportunity for faculty to participate in internship programs that will enhance their practical knowledge.

General contractors and commercial building contractors were the types of companies most involved with construction programs, while design firms and specialty contractors were not as involved. This provides an indication that efforts should be made to increase the involvement of design and specialty contracting companies, especially when many programs are developing specialty contracting and design-build concentrations. For many construction programs, providing internships for students, financial support, and assistance from guest speakers or guest lecturers were the type of involvement most conducive to successful industry-education partnerships.

A limitation of the study was the low response rate from construction programs members of ASC. In the future, the study will be extended to include additional construction programs members of ASC as well as non member programs. In addition, the views of industry on this topic will be assessed and compared with the views of construction programs to determine if there is compatibility in goals and expectations for industry-education partnerships. A broader view of this topic is essential to the development of successful industry-education partnerships that can be mutually beneficial for all those involved. Only with a concerted team effort this goal can be accomplished.

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The Competitiveness of International Construction Majors: Managing the Evolution.

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Abstract

This paper clearly defines *capabilities*, *competencies* and *core competencies* within a strategic management context. It then goes on to argue that the ability of *international construction majors* (ICMs) to successfully manage their evolutionary path depends on: i) competencies and core competencies they already possess, ii) managerial comprehension of the corporate objectives to be achieved, the necessary competencies and core competencies to be deployed for the cause and where those can be obtained, iii) managerial entrepreneurial and administrative competence and, iv) the corporate infrastructure to facilitate managerial efforts and effective mobility of competencies and core competencies across the group. It is then proposed that by conceptualizing ICMs as companies managing through their corporate center portfolios of competencies existing at their constituent parts, rather than portfolios of market focused *business streams* (BSs), waste and duplication of resources when pursuing process and scale specialization can be reduced. The four focal points outlined above are brought forward as a framework that will allow researchers and practitioners a more realistic and holistic examination of the competence related evolutionary issues that ICMs face.

Introduction

Certain companies are more successful at managing their evolutionary path than their peers. The companies of primary concern to this paper are large international construction organizations, which we shall refer to as *international construction majors* (ICMs). Adopting the notion that while industry characteristics matter, they are not as important as organizational characteristics when accounting for prospects for growth (Wernerfelt, 1984; Schmalensee, 1985; Rumelt, 1991), the key challenge for any company becomes to preemptively build the capabilities, competencies and core competencies that provide gateways to tomorrow's opportunities, as well as to find novel applications of current capabilities, competencies and core competencies it possesses, by creating an organizational environment that can facilitate their effective mobility (Hamel and Prahalad, 1994; Teece et al., 1997; Langford and Male, 2001).

Capabilities, Competencies and Core Competencies

Following Nelson and Winter (1982), Helfat et al. (2003: 999) defined organizational capabilities as '*the ability of an organization to perform a coordinated set of tasks by utilizing* *organizational resources, for the purpose of achieving a particular end result*'. Winter (2003) described *operational capabilities* as those that permit a firm to make a living in the short term and *dynamic capabilities* as those that operate to extend, modify or create operational capabilities**.** McGrath et al. (1995: 251) define *competence* in operational terms as '*the degree to which a firm or its sub-units reliably and consistently meet or exceed objectives*' and have shown that it is positively associated with the level of comprehension and deftness of the responsible managerial group[1]. Hall, (1993) has further explained that organizational *competencies* constitute of *the know-how of employees (as well as suppliers, advisers and distributors) and the collective attributes*, *which add up to organizational culture.*

The difference between *capabilities* and *competencies* is not obvious from the literature. The confusion is worsened by the fact that those terms are almost always preceded by different adjectives (*dynamic, functional, operational, organizational* and *core*) and because of the fact that they are both based on the broader concept of organizational routines that a company has developed throughout its history of operation. However, there is a difference between the two that can be understood if we examine the words *capability* and *competence* through a number of lenses. First, we see that the Oxford Dictionary defines the terms as follows:

- *Capability* as the power or ability to do something.
- *Competence* as having the necessary ability or knowledge to do something successfully.

Second, we can observe that 'capability' has as a constituent the word *ability*, whereas 'competence' the word *petition*, which, combined with *com* (meaning "comes with" in Latin) suggests that a *competence* is something that comes through the intentional realization of a process towards specific objectives. Theoretically, having set and then met corporate objectives, a company should have developed at all hierarchical levels the human skills and organizational processes supporting its competitive superiority in the range of services it offers[2].

We could argue that it is the competence with which organizational capabilities are managed and deployed that distinguishes one competitor from the other. In the words of Helfat et al (2003: 999): "*Simply because a capability may have reached a threshold level of reliability, does not imply that the capability has attained the highest possible level of functionality. To say that an organization has a capability means only that it has reached a minimum level of functionality that permits repeated, reliable performance of an activity. Some versions of capability are better than others"*.

ICMs – or any diversified company for that matter – that manage through their corporate center portfolios of capabilities and competencies existing at their constituent parts, can develop *competencies* at the *core* (or corporate center) of the organization that we will refer to as *core competencies*, which can be applied to and support their competitiveness in a range of markets they are active in, while providing scope for further competence-related diversification (Wernerfelt, 1984; Hamel and Prahalad, 1990; 1994). Core competencies represent the collective learning of the organization. When applied to construction (Haan et al., 2002) the core

[1]Comprehension involves the processes by which management at all hierarchical levels develops a good understanding of what combinations of resources will allow it to meet business objectives. Deftness involves creating working relationships which enable management to execute effectively in light of comprehension (McGrath et al., 1995:251).

[2]In practice however, a company's realized strategy is a function of its *intended*, *deliberate* and *emergent* strategy- where patterns develop in the absence of intentions or in spite of them (Mintzberg et al., 2003) and where objectives might change before they have been met.

competence approach can enable organizations to achieve growth by building on their existing competencies, which exist as individual sets of skills and organizational processes in their individual market focused BSs and their constituent *business units* (BUs). We can thus understand *core competencies* for the purpose of this paper as *"the people skills and organizational processes facilitating them that have been developed at the core of the organization as a company specific set of strategic resources, supporting its competence to coordinate and manage efficiently, effectively and in a complementary and supplementary manner the individual competencies that exist at individual BSs and/or BUs in order to obtain or retain access to a wide variety of markets and make a significant contribution to perceived customer benefits of the end product/service, with the ultimate purpose being the sustainability of the competitive superiority of the firm"*.

It becomes clear at this stage that what is of key importance to the long term prosperity of ICMs is the full exploitation of the potential the competencies they offer, through their effective deployment on a corporate wide basis, as well as their competence in transforming capabilities to competencies and core competencies. Following the line of argument above, which derives from a review of strategic management, evolutionary economics and construction related literature, the authors believe that the ability of ICMs to successfully manage their evolutionary path depends upon and can be more realistically and holistically examined through a theoretical framework consisting of the following four focal points:

- **The competencies and core competencies:** that ICMs already possess.
- **Managerial comprehension:** of the corporate objectives to be achieved, the capabilities, competencies and core competencies that need to be deployed for the cause and where those are to be obtained or how they can be developed.
- **Managerial entrepreneurial and administrative competence:** to identify and push forward business opportunities to which the company's existing capabilities, competencies and core competencies are applicable and then to aggregate those business ventures within the existing organizational framework.
- **The corporate infrastructure:** that will efficiently facilitate managerial efforts in light of comprehension and will ensure effective mobility of capabilities, competencies and core competencies across the organization, as well as clear communication of corporate objectives across BSs, their constituent BUs and throughout hierarchical levels.

Competencies, Core Competencies and "Competence Management" in Construction

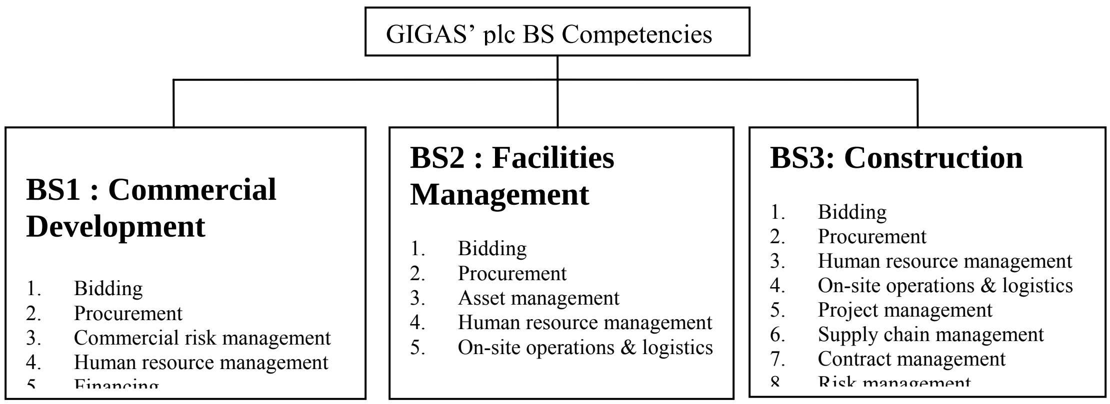
To understand competencies and core competencies within a construction specific context, let us present a hypothetical example. Imagine a company called GIGAS ltd, which started trading as a building contractor in its home country around fifty years ago. By deploying entrepreneurial and administrative skills while slowly embedding to the organization efficient processes facilitating their efforts, its founder(s) and employees made the company gradually competent in performing value-adding activities such as bidding, procurement, contract management, project management and on-site operations. This enabled the company to grow based on its strengths and to be able to set diversification and internationalization objectives for the near future. In time, GIGAS ltd diversified- in related markets to those it was active in that nevertheless had their market and local idiosyncrasies – to form BUs Stella ltd, a commercial developer and Yiannis Ltd, a facilities management company. It also internationalized to form Alex ltd, a general building contractor in a neighboring country. Each of these BUs developed gradually market specific competencies in a similar process like the one initially described for GIGAS ltd, less one fundamental difference: the new BUs were initiating their existence with endowments of human skills and established organizational processes that GIGAS ltd already possessed and could deploy to their favor.

Years down the line the BUs grew to a size where the group's operations had to be grouped under three market focused BSs. "Stella", comprising commercial development companies in a number of countries, "Yiannis", providing facilities management services internationally and "Alex", undertaking all construction operations. GIGAS, now a plc, continued to monitor, control and coordinate their efforts from the corporate center. A more elaborate corporate governance system had evolved and certain organizational aspects had become of critical importance. Clear communication of corporate objectives and how those were to be achieved was strongly pursued, to enable managers and decision makers to comprehend the sphere of ultimate potential purposes of any project that the company undertook[3] (Artto and Dietrich, 2004). Efficient communication channels had been set up to enable feedback to take place and senior management to take decisions based on timely and accurate information, so that emergent strategies could be more successfully integrated with the group's realized strategies. Managerial *entrepreneurial* and *administrative* competencies (Penrose, 1988) were also nurtured so that the human skills would exist for new initiatives that could contribute to the group's growth and prosperity to be identified and successfully pursued.

Currently, each business stream (BS) possesses a portfolio of competencies that underpin its competitive superiority in its chosen market. The competence portfolios of individual BSs of GIGAS plc are shown on Figure 1. Although not indicative but a simplification of reality, Figure 1 allows us to see that competencies possessed by different BSs can be either identical, similar, complementary or supplementary to

[3] Internally and/or externally generated.

Figure 1: Business Stream (BS) Competencies



competencies existing in other BSs. This provides scope for supra-divisional competence management and coordination. In that situation, the role of the corporate center becomes to nurture existing competencies of all three subsidiaries and observe which of these could be supplementary and/or complementary to each other, in order to create the appropriate organizational infrastructure for their effective mobility. By managing through the corporate center portfolios of competencies existing at its constituent parts, GIGAS plc has developed competencies at its "core" (i.e. its corporate center) that we can refer to as its core competencies. Core competencies have the dual nature of enabling GIGAS plc to obtain or retain access to a wide variety of markets and make a significant contribution to perceived customer benefits of the end product/service. Figure 2 shows the portfolio of competencies that GIGAS plc as a whole is in possession of, as well as the portfolio of core competencies it has developed through monitoring, coordinating and controlling the efforts of its constituent parts.

Alliancing and intra-group collaboration are core competencies that GIGAS plc has developed through years of coordinating, controlling and supporting the efforts of its constituent BUs that grew to become BSs and they too consist of a combination of managerial skills and organizational processes that facilitate managerial efforts. Financing and Asset Management might not be deployed at a supra-divisional level but constitute core competencies for the organization since they fulfill both criteria of enabling it to obtain or retain access to a wide variety of markets (such as PFI and development) and make a significant contribution to perceived customer benefits of the end product/service. The portfolio mapping shown on figures 1 and 2 could be extended to include capabilities, so that the potential for their transformation to competencies could be identified and examined further in a company specific context.

Discussion

We stated in the introduction that the key challenge for any company becomes to preemptively build the capabilities, competencies and core competencies that provide gateways to tomorrow's opportunities, as well as to find novel applications of current capabilities, competencies and core competencies it possesses by creating an environment

Figure 2: Portfolio of Competencies and Core Competencies

Portfolio of Competencies

- Bidding (BSs 1,2 and 3)
- Procurement (BSs 1, 2 and 3)
- Human Resource Management (BSs 1, 2 and 3)
- Risk Management (BSs 1(Commercial) and 3)
- Supply Chain Management (BSs 1 and 3)
- Contract Management (BSs 1 and 3)
- Project Management (BSs 1 and 3)
- On-site operations and logistics (BSs 2 and 3)
- Financing (BS 1)
- Asset Management (BS 2)

Portfolio of Competencies (Supra-divisional)

- Alliancing
- Intra-group collaboration
- Bidding (BSs 1,2 and 3)
- Procurement (BSs 1, 2 and 3)
- Human Resource Management (BSs 1, 2 and 3)
- Risk Management (BSs 1(Commercial) and 3)
- Supply Chain Management (BSs 1 and 3)
- Contract Management (BSs 1 and 3)
- Project Management (BSs 1 and 3)
- On-site operations and logistics (BSs 2 and 3)
- Financing (BS 1)
- Asset Management (BS 2)

that can facilitate their effective mobility. But *how* is that to be achieved? This paper proposes that the first step is for the mental shift from perceiving ICMs as a collection of BS to conceptualizing them as managing portfolios of competencies to take place. “Market grouping” has prevailed in construction because, as Mintzberg et al. (2003) would suggest, it favors mutual adjustment and direct supervision as coordination mechanisms in lower hierarchical tiers of the organization and because the simultaneous management of collections of projects as large entities under market focused BSs assists in managing more systematically the linkage between business and project strategy by linking the intent of the strategic apex with the intent of the operating core (Morris, 2004). However, it could be argued that this configuration hinders the scope for process and scale specialization across the group, by reducing the scope to perform specialized or repetitive tasks across BSs and across organizational parts operating in different geographic regions.

As part of an ongoing research, it has been observed that successful ICMs exhibit similarities in that they have formed temporary and semi-permanent internal functions in the form of initiatives and ongoing programs in areas such as risk management, project management, supply chain management and procurement – to name a few – whose purpose is to capture, nurture and transfer relevant competencies across the group. But is that enough? This paper advocates a more “hands-on” approach to the management of organizational competencies. After all, competencies *could be* supra-divisional intangible strategic resources and should be actively managed as such.

For any corporate center to develop “competence” in competence management and hence the organization to develop core competencies, an intentional focus towards that direction must occur. Perceiving ICMs as managing portfolios of competencies rather than portfolios of market focused BSs and BUs, a simple step can be taken to map their competencies as they exist at different parts of the organization in a manner similar to the one shown in figures 1 and 2. First, this can identify and bring to the forefront which competencies are truly supra-divisional. Second, it will allow competence interrelationships between the various parts of the company to emerge and hence identify where transfer channels for effective competence mobility have to be constructed, if they do not already exist. This process might also assist in setting up more efficient systems for intra-group collaboration. During that process, the four focal points framework brought forward in this paper can assist in categorizing "competence management" issues and plan a strategy to address them that will have a greater chance of success by being more structured and straightforward to manage. ICMs are appropriately structured to implement and exploit competence interrelationships, since they are companies whose competitive strength has come to depend on their ability to operate successfully a global network of interrelated activities across a number of BSs operating in various geographic regions (Langford ad Male, 2001).

Examining the most likely effects of its application could also support the appropriateness of a competence management approach for ICMs. Adopting such an approach will most probably lead to a focus on standardization of skills and norms. Those coordinating mechanisms are the ones Gareis (2004) suggests as being the most appropriate for project oriented companies – like ICMs – and those that Mintzberg et al. (2003) advocate as being the most appropriate for diversified companies, such as ICMs. ICMs could work towards standardizing skills and norms associated with competencies they possess, thus making them more easily transferable and deployable across their organization. This could help overcome duplication and waste of resources that obstruct them from achieving the full potential that process and scale specialization could offer on a corporate-wide scale. Adopting a competence management approach, ICMs could finally retain their ability to think globally but act locally (Flanagan, 1994) by making their internal strengths available at a corporate wide level, and developing the capability to proactively create a global market rather than merely international ones.

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Value-Based Management of Highly Dynamic Construction and Engineering Businesses

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Abstract

The highest client value as well as its creation, capturing, and distribution is one of the major challenges in managing highly dynamic construction and engineering (C&E) businesses. A new value-based concept is designed based on the principles of nine generic concepts that, in turn, have been originally designed for managing a versatile set of business contexts. Successful management of a highly dynamic C&E business can be based on six elements, i.e. (i) strategizing in these markets, (ii) pacing competitive strategies and tailoring offerings with the best value, (iii) managing processes that capture and carry the targeted value, (iv) investing in platforms that create new value streams and (re)placing development paths vis-à-vis core competitiveness, (v) enhancing a business' frame and its governance, and (vi) nurturing a collaborative net. Re-inventive business managers avoid target fixation and grasp opportunities in C&E markets with: instant or no communication, rapid evolution, and chaotic business and project cycles (e.g. those in Russia and China).

Introduction

The prior literature review (Huovinen 2003, 2004) revealed that no established tradition exists in **construction-focused business-management research** in any of the OECD countries. One of the "white" areas involves ways of creating, capturing, and distributing value (e.g. for money) among owners, investors, contractors, engineers, and other stakeholders in construction and engineering (C&E) businesses.

Thus, **the objectives** of this paper are as follows: (i) to introduce nine value-based concepts for managing highly dynamic businesses in general, (ii) to incorporate the selected value-based principles of these generic concepts into the proposed 6-element business system for managing a highly dynamic C&E business, and (iii) to discuss implications for both practitioners and related scholars.

The theoretical base of this concept-design effort is limited to a set of nine dynamism-based and value-based management concepts published between the years 1994-2003. The contexts of these concepts are non-C&E businesses. Nevertheless, it is assumed that their key ideas and ways of managing high business dynamism belong to the few invariants inherent in any highly dynamic (incl. C&E) business.

Herein, value is approached through those value chains and processes that **add value to clients** (owners, capital investors) in such terms as value for money to be invested in new construction objects or in the renovation of the existing stock. In reality, value is being created, captured, and shared (and destroyed) daily among stakeholders involved in C&E projects in various dynamic (inter)national markets.

The value of the organizations themselves involved is excluded. Originally, Rappaport (1986/1998) came out with the idea of maximizing **shareholder value,** i.e. corporate value minus debt or the economic value of the equity of a business based on forecast data, and shareholder value added, SVA (i.e. the amount of value created by a given scenario). Instead, client value is approached at the level of business management. This paper complements the value-management developments in both the UK and the USA at the level of C&E projects (Male et al. 2005).

The rationale of this paper unfolds through the introduction of nine generic management concepts and the design of a new 6-element concept. Each of the applied elements is initially defined by adopting the eligible principles of the generic concepts. Finally, both the practical and scholarly implications are discussed briefly.

Value Creation and Capturing in Nine Generic Business-Management Concepts

Since the mid-1990s, leading authors in generic business management have been designing new concepts to enable firms to manage their businesses successfully **in highly intense, fast-paced, unstable, even chaotic (inter)national and global markets**. The nine selected (sets of) concepts address value creation and capturing from **the three perspectives** of highly dynamic competition, competing firms, and targeted clients. The concepts are compiled in Table 1 in the order of publication, i.e. D'Aveni and Gunther's (1994) 7-S management in hypercompetition, Hamel and Prahalad's (1994) concepts for competing for the future, and Hamel's (1994) three core-competence types as well as Slywotzky's (1996) value migration, Slywotzky et al.'s (1998) profit zones, Slywotzky et al.'s (1999) profit patterns, and Bovet and Martha's (2000) value nets, Ramirez and Wallin's (2000) prime movership strategy, and Sanchez and Heene's (2003) virtuous management circle with its strategic logic in organizations. Many principles of these concepts are herein assumed to be applicable to managing a highly dynamic C&E business.

A New Concept for Value Creation and Capturing in C & E Businesses

Competition involves herein firms participating in the ownership, design, implementation, use, operations, maintenance, servicing, and life-cycle aspects of investments in natural resources usage, energy supply, telecommunications, transportation, infrastructure, manufacturing, and general building concerns in various (e.g. global) construction-investment markets.

Table 1. Nine generic management concepts for value creation and/or capturing in highly dynamic businesses (published between the years 1994-2003).

Reference	Management concept	Value-based approach
D'Aveni with Gunther (1994)	Hypercompetition (7-S)	Value disruptions
Hamel and Prahalad (1994)	Competition for the future	Customer-perceived value
Hamel (1994)	Core-competence types	Value creation/capturing
Slywotzky (1996)	Value migration	Value in-/outflow, stability
Slywotzky et al. (1998)	Profit zones	Customer priorities
Slywotzky et al. (1999)	Profit patterns	Value growth leadership
Bovet and Martha (2000)	Value nets	Value creation/capturing
Ramirez and Wallin (2000)	Prime movership	Customer/supplier value
Sanchez and Heene (2003)	Virtuous circle and logic	Value creation/distribution

C&E businesses include broadly eight business-scope groups: (i) technology-intensive contracting, (ii) construction-related contracting, (iii) process engineering, design, and consulting, (iv) construction-related design and consulting, (v) the supply of building products and materials, (vi) the supply of construction machinery, equipment, and tools, (vii) real estate ownership, development, and management as well as (viii) the supply of life-cycle services (Huovinen 2003). Dynamism varies a great deal across various (inter)national and global C&E businesses. Herein, the focus is on the ways of strategizing through the highly dynamic end of the spectrum.

For the task at hand, value creation and capturing is adopted as **the primary dimension** for re-designing one of the author's systemic concepts (Huovinen 2002). It is proposed that successful management of a highly dynamic C&E business can be based on **a 6-element value-based C&E business system**, i.e. the strategizing vis-à-vis: highly dynamic (e.g. global) C&E markets (Element 1), a firm's competitive strategies and value-providing offerings (Element 2), a firm's value-capturing business processes (Element 3), a firm's value-creating platforms and value-developing paths via its core technologies, competences, and offerings (Element 4), a value-enhancing business frame with a governance system (Element 5), and a focal firm's value-delivering net with internal competition among collaborative stakeholders (Element 6). These six elements are illustrated in Figure 1.

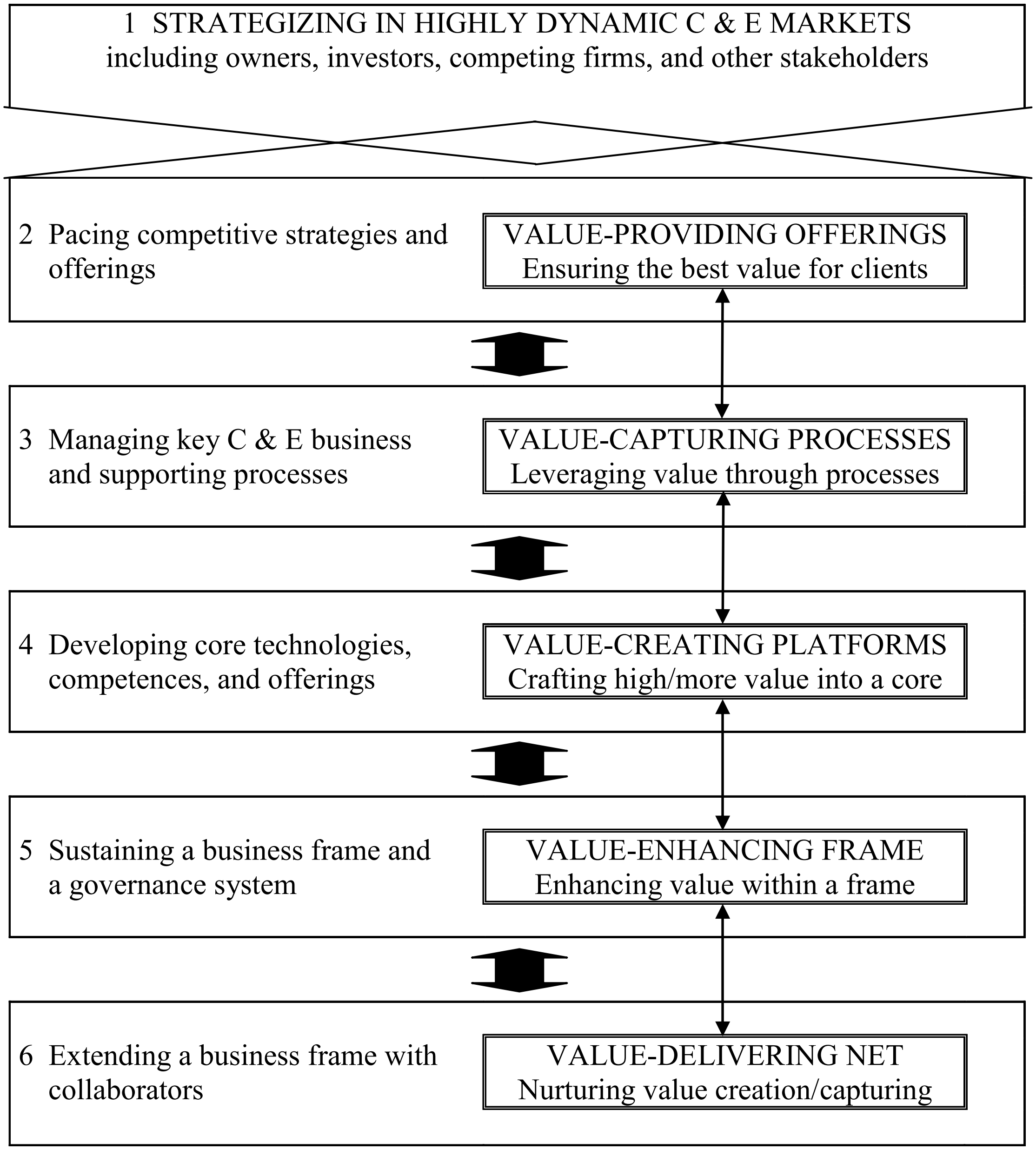

Figure 1. Managing a highly dynamic C&E business in value-based ways as a 6-element system (applying Huovinen 2002: 336).

Success in highly dynamic C&E markets (Element 1) can be based on a firm's integrated value-based business management through Elements 2-6. It is herein proposed that **the best client value** is created on the core platform and developed along the pioneering path, leveraged in terms of the contract fulfillment, captured by the project-specific processes, enhanced within the firm's organizational frame, and, in part, delivered by the value net. Each element is elaborated as follows.

Five Ways of Strategizing in a Highly Dynamic C&E Business

Element 1. Strategizing in highly dynamic C&E markets. Business managers may succeed by applying one or several of the generic ways of strategizing, i.e. through: hypercompetition, 4-level competition for competence, value migration, profit patterns, and/or prime movership. In each case, the choice of the future strategy to be used for competing depends on both the incumbents' current strategies and the managers' own perceptions on desired or avoidable future.

In **C&E hypercompetition**, competitors move quickly to build advantages and to erode their rivals' advantages when e.g. clients are changing their priorities, contractors are offering new solutions, or local authorities are giving ultimatums. The focal C&E firm may aim at value disruptions that create superior client satisfaction in terms of identifying new needs, finding unserved clients, creating new needs, and/or predicting changes. Strategic soothsaying allows the firm to see or create new needs that it can serve best, even if only temporarily (D'Aveni with Gunther 1994).

In **the 4-level C&E competition for core competence**, understanding the nature of the competition at each level is critical to establishing leadership: develop-ing and accessing constituent skills and technologies (level 1), synthesizing them into core competencies and products (level 2), competing for core-product share (level 3), and maximizing end-product shares (level 4) (Hamel and Prahalad 1994).

In **the value-migration process**, the focal C&E firm aims at inventing a business design with a prolonged value-creation power through three states, namely those of inflow, stability, and outflow. (i) In the inflow state, value moves (rapidly at times) toward (new) activities and skills, and also toward the focal firm's new business design whose superiority in meeting client priorities makes profit possible. (ii) In the stability state, the business design matches to the clients' priorities and the equilibrium among competing firms, but value may remain either over several years or for only some months. (iii) In the outflow state, value starts to move away from the firm to new business designs that more effectively meet evolving client priorities (Slywotzky 1996).

Profit patterns of change can be adopted to understand how the strategic C&E landscape is deforming itself toward tomorrow's topology. Often 3-4 patterns take place at the same time. The pattern-cycle time may vary. A pattern can have several variants, versions created by the differences in their development and the creativity with which they are exploited by C&E firms. Patterns describe those business designs that are becoming even client-compelling and extremely profitable. Patterns also describe which business designs are becoming economically obsolete. C&E firms that will become value growth leaders through pattern recognition also have the opportunity to become value polarization winners (Slywotzky et al. 1999).

Prime movers may succeed in moving C&E businesses by getting others to follow the way they (co-)design and reconfigure the business in terms of finding out new contractual, risk-allocating ways of doing business by reallocating project roles among actors that enhance value-creation (Ramirez and Wallin 2000).

Management of Five Business-System Elements for High Client Value

Element 2. Providing high client value by competitive moves and offerings. C&E firms may aim at offering the best value to the targeted clients and managing the contracts to be won profitably. Alternative competitive moves include hypercompetitive behavior, i.e. generating a flow of new advantages, moving faster than competitors, restarting new cycles, or entering new arenas, and destroying or neutralizing the opponent's advantage, thereby destroying perfect competition (D'Aveni and Gunther 1994). A firm's value-providing offerings enable it to pre-empt client needs, to excel among competitors, and to meet its own short-term aims. Client priorities provide insight into which business design will serve her/him best (Slywotzky 1996). In the form of an equation, client value = net satisfaction contribution (or how well the offering supports the clients' value creation minus purchasing price minus interface (purchasing) cost minus integration cost (as part of the client's system) minus life-cycle cost (cost-in-use) minus project-transaction risk plus learning/information transfer advantages. A 3-dimensional offering encompasses hardware (e.g. a building), software (e.g. client service support), and peopleware (Ramirez and Wallin 2000).

Element 3. Leveraging and capturing value through business processes. C&E firms may aim at integrating their global, local, and contract-specific business processes to ensure effectiveness. Processes and contracts can be managed as a matrix where teams play integrative roles. This matrix is based on a firm's market-access, integrity-related, and other competences (Hamel 1994). Future digital value nets or processes allow clients to self-design buildings, spaces, infrastructures, or products and choose the offering attributes they value most. Agile, digital, scalable, and fast-low sourcing, manufacturing, delivery, and associated services or processes are to be differentiated to match each client segment (Bovet and Martha 2000).

Element 4. Managing value-creating platforms and value-developing paths. C&E firms may aim at nurturing their core technologies, competences, and offerings in order to create new advantages and/or to prolong the current ones. Platforms are based on: opportunity perceptions, technology foresights, a core-competence architecture, a core-offering portfolio, and related value-developing paths. Generative and transformative competences are used for the imagination, the development, and the design of new offerings (Ramirez and Wallin 2000). Business-design innovations are managed through value-growth trajectories. Customer-centric thinking is a core skill of a business re-inventor to prevent today's profit zones from becoming tomorrow's no-profit zones (Slywotzky et al. 1998). Various races for future technology-based C&E businesses may occur in three overlapping stages, i.e. competition (a) for business foresight and intellectual leadership, (b) to foreshorten migration paths (preemptively building core competences), and (c) for market position/share. C&E firms need to nurture core competences, i.e. the bundles of skills and technologies that: (a) make a disproportionate contribution to client value, i.e. enable the delivery of fundamental client benefits over the life-cycles of buildings and/or infrastructure, (b) are competitively unique, (c) enable an array of new offerings to be issued, and/or (d) yield a cost advantage (Hamel and Prahalad 1994).

Element 5. Enhancing value within a firm frame and governance system. C&E firms may aim at governing their business-specific frames to optimize their existence and shareholding. Governance takes place along legal, financial, venturous, organizational, institutional, social, and environmental dimensions. A frame facilitates ownership, top management, business venturing, financing, and the preferred ways of firm-market interactions. Strategic logic can be defined for sustaining coordinated deployments of resources in ways that help the firm to achieve goals for value creation. The virtuous circle of value creation is managed through five processes, i.e. managers are self-guided to: (i) discover opportunities, (ii) define offerings, (iii) manage resources, (iv) manage uncertainties, and (v) distribute value created to all resource providers (Sanchez and Heene 2003).

Element 6. Delivering more value through value nets. C&E firms may aim at extending their business-specific frames by networking with local or foreign stakeholders. The nature of a given relationship varies according to stakeholder roles. Alternative forms include e.g. those of consortiums, joint ventures, subcontracting, partnerships, networks, and value nets. These value constellations provide new offerings and they are linked to clients' value-creation processes (Ramirez and Wallin 2000). Virtual value nets are fast, flexible supply systems aligned with and driven by new client-choice mechanisms. The focal firm may control client-touch points through digitally integrated service and support. Clients' choices are transmitted in real time to net participants through seamless webs of client choices and delivery competences (Bovet and Martha 2000).

Discussion

The initial implications for C&E business managers are discussed as follows. On the one hand, it is argued that most business managers find it vital to determine the current degree of business dynamism and foresee its future levels. This understanding is a prerequisite for any (team of) business managers who consider adopting one or several dynamism and value-based ways of managing. On the other hand, avoiding target fixation and leading the firm toward new opportunities seems to be **re-inventive managers'** single most important role in a highly dynamic C&E business with instant or no communication, rapidly evolving markets, and short business-design cycles. For this, a firm's collective mind needs to be open and on the lookout for the next major changes (aligning with Slywotzky et al. 1998: 287).

The validity of nine generic references can be readily questioned in the context of C&E businesses. However, it is proposed herein that **a set of invariant-like ways of managing a highly dynamic business** turn out to be applicable in most specific business contexts. These invariants may include introducing the new inter-locked ways of creating, capturing, and distributing the highest client value (Element 1), generating (and destroying) new (existing) sub-offerings and competitive advantages continuously (Element 2), integrating transparent end-to-end business processes (Element 3), investing in both core competitiveness platforms and their irreversible but replaceable development paths (Element 4), enhancing a business-focused frame and governance system (Element 5), and managing one or several value nets with internal competition among replaceable stakeholders (Element 6).

Finally, some promising ways of **advancing and testing dynamism and value-based concepts** are put forth to scholars related to C&E businesses as follows. (i) Many scholars find value-based ways of managing C&E businesses to be a challenging research area. Indeed, it is relevant to couple future endeavors with a particular C&E business context in order to grasp its evolution, preferably during a longitudinal investigation. (ii) The internet based search among databases will turn out to be very useful for finding theoretical building blocks and, thus, conceptualizing the value-based management of C & E businesses. The eligible search words include at least those of business value, buyer/client/customer value, value-based management, and value appropriation/capture/capturing/configuration/ creation/proposition. (iii) Between the years 1990-2002, six authors have readily published their C&E related dynamic business-management concepts as the departure point for those interested in the matter (Huovinen 2003).

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Embeddedness, Emergent Uncertainty and Strategies for Foreign Markets[4]

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Abstract

This inductive study investigates the challenges that entrant firms face on large global development projects — e.g., airports, oil refineries, resorts, etc. — in foreign market environments, and the strategies that they evolve to cope with these challenges. It uses a multi-case research design with interview data from four types of firms—Systems Contractors who sell, test and deliver integrated technical systems; Project Consultants who plan, manage and control large projects on behalf of a client; General Contractors who undertake responsibility for overall project delivery; and Developers who finance, acquire land and develop a facility for commercial use. The research design invokes two logics: a theoretical replication logic, i.e. the level of embeddedness varies across the four types of firms; and a two-way literal replication logic, i.e. there are two firms of each type. The findings indicate that with increasing embeddedness in a new market, firms face greater emergent uncertainty. This affects strategic decisions such as entry mode, staffing and centralization. The findings also articulate three general strategies of entrant firms: increasing the supply of local knowledge, decreasing the demand for local knowledge, and reducing the impact of a local knowledge deficit. These strategies refute the myth that entrant performance is tied to climbing a "country learning curve", but, instead imply that dodging the need to learn and avoiding the costs of not learning can be equally effective.

Introduction

In this article, we begin the empirical analysis of the link between level of embeddedness in an unfamiliar market context, level of need for local knowledge and strategies to cope with a local knowledge deficit. In doing so, we seek to develop a grounded theory by integrating the experiences of managers engaged in the planning, design and management of large engineering projects situated in overseas markets.

Despite differing aims and the use of a variety of terms and nuanced definitions, scholars who write about entering foreign markets repeatedly employ key terms that are conceptually similar. The terms "liability of foreignness" (Hymer, 1976), "cultural distance" (Kogut & Singh, 1989), "institutional distance" (Kostova, 1999), "psychic distance" (Johanson & Vahlne, 1977) and "political risk" (Kobrin, 1979) each have a long and rich history in the international business literature. Yet all imply a common assumption: that foreign firms face challenges and, perhaps, even outsider disadvantages, when they enter new or unfamiliar markets.

[4] This article summarizes a 50 page manuscript; please contact the authors to request the manuscript.

Although there are many variances in these views, none deals with a key reality. As noted by Melin (1992), they entirely ignore the entrant's embeddedness in the local context. Most studies suggest, albeit implicitly, that two firms from Country A who enter Country B will suffer equally from "liabilities of foreignness", "cultural distance", "psychic distance", "institutional distance" and other forms of "risk". For example, many scholars have discussed the concept of "foreignness" in a language that implies an amorphous disadvantage or liability that trickles down and touches all entrants evenly (eg. Luo & Peng, 1999). Likewise, many discussions of "country risk" or "political risk" imply a halo of misfortune that floats down to plague every venture within the boundary of a given nation-state uniformly (eg. Kobrin, 1979). But is it really true that all entrants face the same outsider disadvantage?

Methods

Table 1 portrays the eight firms studied. All eight are involved in some aspect of the business of planning, engineering or constructing large infrastructure projects.

Firm ID	Firm Name	Firm Type	Employ-ees	Revenue (mil.)[a]	Home Country	Firm Age	Global Diversity[b]	Number of Interviews
1	Kelso	Systems Contractor	33,000	6,800	Finland	90+	36/110	7
2	Archer	Systems Contractor	76,000	21,000	France	100+	55/150	4
3	Duke	Developer	1,800	400	US	50+	5/5	5
4	Heroic	Developer	2,800	750	US	40+	12/16	13
5	Marengo	Project Consultant	7,000	800	UK	100+	35/120	5
6	Phantom	Project Consultant	1,300	200	Japan	50+	17/120	11
7	Boomerang	General Contractor	44,000	16,000	US	100+	26/140	8
8	Forester	General Contractor	35,000	9000	US	80+	25/95	7

[a] The revenue and employee figures aggregate international operations, across several corporate divisions, for the calendar year 2003.

[b] Number of countries with corporate headquarters as of May 2005. / Number of countries with project site offices, both past and present.

Table 1. Firm descriptions.

Case Study Design. The study invokes a multiple case study design. The logic underlying the use of multiple cases is replication. As Yin (2001) explains, "Each case must be carefully selected so that it either…predicts similar results to enhance reliability of the findings (a literal replication) or…produces contrasting results but for predictable reasons (a theoretical replication)." The eight-firm sample was designed to create four instances of theoretical replication (i.e., four types of firm each with different embeddedness); and to generate several literal replications (i.e., two instances of each firm type, each with two or more projects).

Research Setting. Large global projects provide a setting where many international firms congregate, each with different roles, responsibilities and home country affiliations. Literature related to large engineering projects includes studies of temporary organizations that undergo simultaneous structuring and operations (eg. Thompson, 1967); the quasi-firm (eg. Eccles, 1981); construction projects as hierarchies of contracts (eg. Stinchcombe, 1990); and projects as high-stakes, real-options games (eg. Miller & Lessard, 2000).

Project ID	Project Description	Firms Present	Region	Project Duration	Project Value	Site Visit by 1st Author
1	Mass Transit System	Kelso, Archer, Boomerang, Phantom	Asia	61 mo.	$700M	yes
2	International Airport	Kelso, Phantom	SE. Asia	36 mo.	$1.1B	yes
3	Water Treatment Plant	Archer, Marengo	Asia	54 mo.	$160M	yes
4	Rail Transit System	Marengo, Boomerang	Asia	78 mo.	$13B	yes
5	Resort Complex	Duke	Asia	36 mo.	$1.7B	no
6	High End Housing Development	Heroic	E. Europe	24 mo.	$30M	no
7	High End Housing Development	Heroic	E. Europe	40 mo.	$45M	no
8	Commercial Office Development	Heroic	W. Europe	28 mo.	$100M	no
9	Commercial Office Development	Heroic	E. Europe	48 mo.	$50M	no
10	Motor Way	Boomerang	E. Europe	42 mo.	$260M	no
11	Petro Chemical Refinery	Forester	Asia	48 mo.	$1.2B	no
12	Petro Chemical Refinery	Forester	Middle East	48 mo.	$900M	no

Table 2. Project descriptions.

Data Sources & Analysis. Data collection involved project visits and interviews: open-ended interviews in the early stages, and structured interviews towards the end of the study (Spradly, 1979). As is typical in building a grounded theory, data analysis followed three distinct, yet iterative phases. As Glaser and Strauss explain (1967: 105): "first, coding each incident in the data into as many categories of analysis as possible and comparing incidents [in] each category; second, integrating categories and their properties…resulting in a unified … theory; and third, delimiting the theory…and reformulating it with a smaller set of high level concepts."

Challenges in Foreign Markets

Many studies in international business suggest a link between the performance of foreign entrants and measures of "cultural distance" (Kogut & Singh, 1989), "institutional distance" (Kostova, 1999) and "psychic distance" (Johanson & Vahlne, 1977). Studies that take this perspective make the implicit assumption that cultural, institutional and psychic distance encumber all foreign entrants *equally*.

Embeddedness. The data from this research suggests that this assumption is mistaken. Certainly, as extant theories well predict, firms that enter foreign markets face unexpected conditions and incur unforeseen costs when they misjudge and misunderstand local cultures and institutions. However, these conditions and costs are not *uniformly* distributed across all entrants, as previously had been assumed. Instead, our findings suggest that each type of firm faces a distinct level of *embeddedness* in the host country context. Our evidence reveals that the level of embeddedness is different for every entrant, because every type of entrant has specialized objectives, resource needs, activities, regulatory requirements, levels of exposure to civil society and industry affiliations. Our results are suggestive of the fact that as entrants become more heavily embedded in the local context, they need more local knowledge in order to anticipate, assess and adapt to the locally determined ideas, interests and institutions. Consequently, when they fail to acquire this local knowledge, they face a greater likelihood of unanticipated relational friction. More formally,

Proposition 1: The more deeply an entrant is embedded in an unfamiliar market setting, the more local knowledge is needed to achieve objectives and avoid unforeseen costs.

Table 3 displays evidence to show that embeddedness varies significantly for different types of global project entrants. *Embeddedness* is defined as a measure of the total number of relations between a global project entrant and local organizations. Relations with local organizations are grouped into four categories: formal regulatory, formal market, informal community and informal project.[5]

Table 3 reveals that, as a class, General Contractors face by far the greatest level of embeddedness, with a low of 669, a high of 1680 and a mean of 1172 total relations with local entities. On the other end of the spectrum, Table 3 shows that the Systems Contractors face the lowest level of embeddedness, with a low of 18, a high of 78 and a mean of 52 relations with local entities. Thus, the level of embeddedness is not uniform, although past studies have assumed uniformity of embeddedness or have ignored its effects. Rather, different types of firms, with different kinds of work and activities, face dramatically different levels of engagement with organizations and institutions in the host environment.

Consequences of embeddedness. The consequence of embeddedness is that for every activity associated with local actors or institutions, an entrant requires a certain basic level of local knowledge about those elements. If the relevant elements are well understood prior to performing the task, much of the activity can be planned in advance and the task is accomplished in the most efficient fashion at a minimum level of effort to the responsible manager (Galbraith, 1973). If these elements are not well understood, then institutional exceptions—misjudgments, misunderstandings and conflict— arise that lead to changes in priorities, plans and strategies. Our evidence, which is presented in our longer article, suggests that all of these changes require sense-making, trial-and-error learning, adaptation and a high likelihood of relational

Type of Relation	**Project Consultants**			**Systems Contractors**			**Developers**			**General Contractors**		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Formal Regulatory Relations	9	24	**17**	3	5	**4**	8	29	**14**	12	21	16.75
Formal Market Relations	12	220	**78**	9	55	**36**	50	95	**64**	640	1600	1123
Informal Community Relations	3	55	**22**	0	0	**0**	5	15	**10**	5	28	12
Informal Project Relations	12	380	**166**	6	18	**12**	0	5	**2**	12	31	20.75
Total Number of Relations	**36**	**679**	**282**	**18**	**78**	**52**	**63**	**144**	**90**	**669**	**1680**	**1172**

[a]N = 17. Project details are described in Table 2.

Table 3. Overall embeddedness[a]

[5] *Formal regulatory relations* include interfaces with local arms and agencies of government that grant approvals, permits and licenses (e.g., Transport, Fire Department, Police, Building Department). *Formal market relations* include transactions with local firms in the marketplace that provide products and services (e.g., tool suppliers, materials vendors, sub-contractors). *Informal community relations* include interactions with community groups and stakeholders that provide legitimacy to a project (e.g., NGOs, school board, shopkeeper's guild). *Informal project relations* include non-contractual dealings with other firms on a project that arise by virtue of working side-by-side and sharing limited project resources and physical workspace (e.g., foundation, electrical or elevator subcontractors).

friction (Orr, 2005). Therefore, the greater an entrant's knowledge deficit at the outset of a task, the greater the likelihood that sense-making, trial-and-error learning, and adaptation will be necessary during task execution. Thus, the central effect of an actor's local knowledge deficit is a limited ability to anticipate issues, set priorities, develop strategies or make decisions about activities in advance of their execution.

Emergent Uncertainty. Recently, a number of authors (eg. Han & Diekmann, 2001; Chua, Wang & Tan, 2003; Chan & Tse, 2003; Wade, 2005) have written about political, cultural and social "risks" in foreign markets in tones that imply *a priori* predictability. Similarly, many software vendors and consultants[6] suggest in their marketing materials that political instabilities, cultural conflicts and social uprisings can be assessed and predicted with probabilistic tools and techniques.

Our findings contradict this view. We find that these approaches, which rely on subjective probability assessments, are largely unreliable without recent and relevant in-country experience. We also find that relational interactions with host entities often lead to critical incident scenarios that are extremely difficult to predict *a priori*, and, can only be managed as they occur. Thus, we conclude that as entrants face greater levels of embeddedness, they also face more frequent situations of emergent uncertainty, where unexpected factors and dynamics arise. Thus,

> *Proposition 2: The more an entrant is embedded in an unfamiliar market setting: 2a) the less likely that a priori risk analysis approaches will help to prevent unforeseen costs; and 2b) the more likely that emergent relational dynamics will generate unforeseen costs.*

Firm-Specific Strategies

Many studies have examined the process of organizations learning to succeed in foreign markets (Johanson & Vahlne, 1977; Eriksson et. al., 1997). Other related studies have emphasized one or another specific aspect of this process, such as, mode or sequence of foreign market entry (eg. Brouthers, 2002; Pan, Li & Tse, 1999).

These studies tend to have two key limitations. First, in empirical analyses, there is typically a high degree of aggregation of data across industry sub-groups (eg. Erramilli, 1991; Brouthers, 2002), usually to ensure a statistically significant sample size, but at the cost of ignoring unique drivers and dynamics that characterize each sub-group. Second, embeddedness has not been seriously considered as a determinant of the level of need for organizational learning or strategic decisions.

In contrast, our study explores the effects of variance along the embeddedness dimension and finds that it plays an important role in how different types of organizations perceive and learn about the challenges in foreign markets. Moreover, our data confirm that embeddedness is a primary determinant of entry strategy, staffing policy and organization structure. This confirms Melin's (1992) observation, that "when studying internationalization within a strategy process framework, it is crucial to focus on 'organizations in their sectors (Child, 1988).'" Our evidence, which is discussed in depth in our longer article, suggests several propositions,

[6] For example: Control Risks Group (http://www.crg.com/), Pegasus Consulting Inc. (http://www.pegasusconsultinginc.com/), and Pertmaster Project Risk (http://www.pertmaster.com).

Proposition 3: The more an entrant is embedded in an unfamiliar market setting, the more it needs local knowledge and hence: 3a) the greater the unforeseen costs associated with a start-up or "green field" entry strategy; 3b) the greater the benefit of an acquisition strategy or partnering entry strategy; 3c) the greater the advantages of local staff over expatriate staff; and 3d) the greater the benefit of decentralizing control to the project office.

General Strategies

There have been many fruitful efforts to investigate the linkage between international experience and performance in foreign markets (eg. Luo & Peng, 1999). Yet, despite these advances, there has been little effort to describe what firms actually learn as they accumulate global experience or to unpack the black box of "general internationalization knowledge" that has been alluded to by prior scholars (eg. Petersen & Pedersen, 2002). Specifically, what types of general strategies do firms devise in order to combat the challenges of embeddedness and emergent uncertainty?

In response to this question, our evidence suggests that firms evolve multiple variants of three general strategies: *learning, avoiding learning, and avoiding the costs of not learning.* Instances of these general strategies are explained in detail in our longer manuscript and were observed repeatedly across all eight firms, across all observed market and project settings. In formal terms,

Proposition 4: When firms face a knowledge deficit in a foreign market, they can improve performance by: 4a) increasing the supply of local knowledge; 4b) decreasing the need for local knowledge; and 4c) reducing the consequence of a local knowledge deficit.

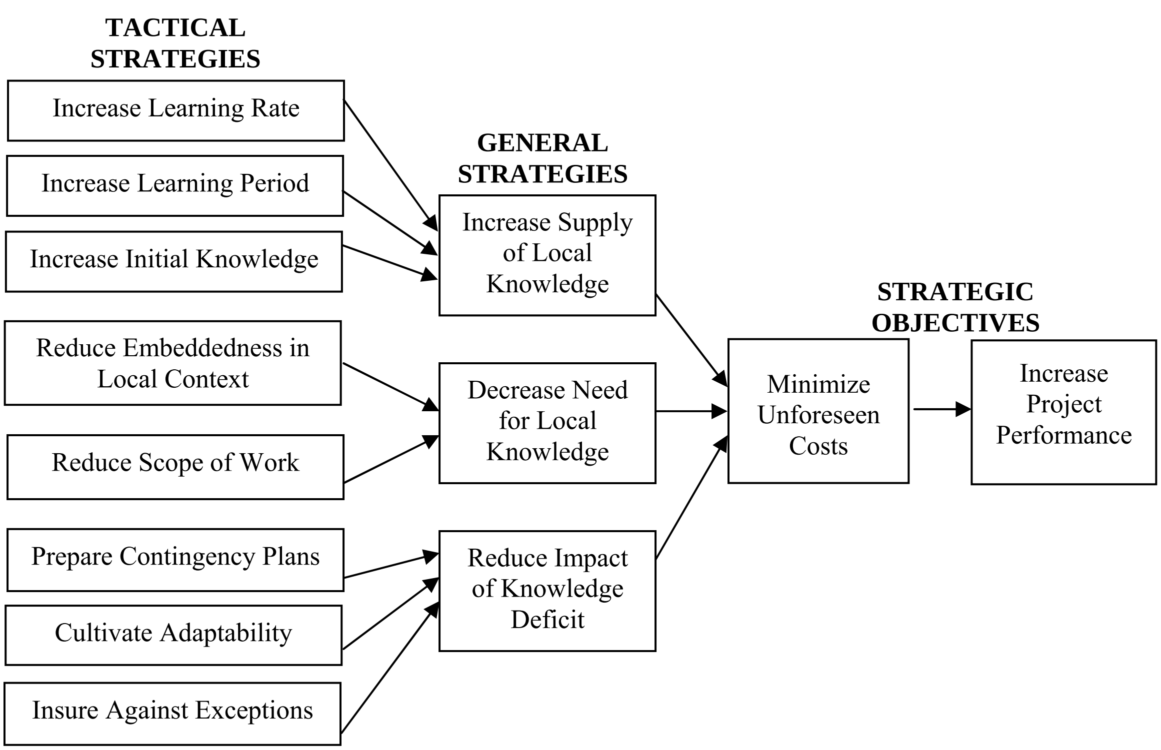

Figure 1. Strategies to succeed in foreign environments.

Figure 1 illustrates the general strategies. The figure also depicts an array of tactical strategies, each of which converge on one of the general strategies, representing different pathways for an entrant can to minimize unforeseen costs and maximize project performance. We hypothesize that these three general strategies are exhaustive from a knowledge-based perspective. Yet, while each offers a theoretically distinct means to cost minimization, they are not always separable when observed in the field, nor do they come for free. On the contrary, they often come bundled together, and firms select them in order of decreasing cost-effectiveness until diminishing marginal returns discount further strategic action (North, 1990).

Learning How to Circumvent the "Country Learning Curve"

A number of studies have presented theoretical arguments to suggest a "learning-curve" or "experience curve" relationship between the time spent in a given host country and operational performance (Luo & Peng, 1999).

Our evidence contradicts this view. What we find, in our sample of highly experienced international firms, is a deft ability to circumvent the learning curve. That is, entrants are able to succeed with only minimal learning about the local business and institutional environment in a new host country. More formally,

> *Proposition 5: As firms internationalize, they learn to circumvent the country learning curve, by "ingesting" locals, reducing the need to learn about local institutions, and reducing the consequences of not learning.*

Three main "circumvention strategies" were observed. First, strategies to avoid learning—e.g., hiring locals, partnering, and acquiring local firms. Second, strategies to decrease exposure to local actors and institutions—e.g., off-shoring and outsourcing. Finally, strategies to reduce the severity of unforeseen conditions or events—e.g., planning for contingencies and designing adaptive organizations.

Conclusion

This article has explored the link between an entrant's embeddedness in an unfamiliar market environment, level of need for germane local knowledge, and strategies to cope with a local knowledge deficit. Overall, this research proposes a new, grounded-theoretic view of the strategies firms actually develop as they learn to cope with embeddedness and emergent uncertainty in foreign markets and it identifies a clear link between these strategies and firm performance. For international business managers, this article offers a "toolkit" of strategic options to improve overseas performance. For a more complete discussion of contributions and areas for future research, please request a copy of our longer manuscript.

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Project Information Management for Construction: Organizational Configurations

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Abstract

Project performance could be improved through a more explicit and well-defined ***Project Information Management*** function, particularly in the face of emerging advances in information and communication technologies. This paper summaries a framework for project information management and discussed some of the organizational issues relating to its implementation.

Introduction

Project performance in the architecture, engineering, construction and facilities management industries (collectively referred to simply as "construction" here) could be improved through a more explicit and well-defined ***Project Information Management*** function. This is especially important in the face of current trends in ***information and communication technologies (ICT)*** that are yielding a wide range of new computer-based tools—everything from project collaboration web sites to virtual building environments—which promise great increases in the effectiveness and efficiency of designing and managing construction projects. Yet these systems are often complex and the improvements come at a cost in terms of required changes to skill sets, work practices, and organizational structure.

We are interested in contributing to the development of project information management as a well-defined sub-discipline of project management. To date, this work represents early-phase research in which we are developing conceptual models and approaches (prior to field-based research and implementation of the techniques). Elsewhere (Froese 2004, 2005), we have discussed conceptual models that aid in the understanding of the role and context for ICT in construction, developed a conceptual framework for project information management, discussed some of the organization implications (including the role of a ***Project Information Officer,*** or ***PIO***), and explored the impact on project management as a whole. This paper summarizes our proposed approach to project information management and then further explores alternative organizational configurations that might be appropriate for implementing project information management in various construction contexts.

Information Management as a Sub-Discipline of Project Management

Information and information management have always been recognized as important aspects of project management. But they have not been well-formalized—wide variations exist in the level and techniques used for managing project information. Some perspectives argue against an explicit project information management function: for example, suggestions that project management is inherently *all about* information and communication and cannot be sub-divided into a distinct information function sub-function; that information management is largely a technical support (staff) function rather than a project management (line) function; or that information management is a corporate, rather than a project-centric, function. However, we contend that the necessity, on one hand, for management tasks and technical expertise related specifically to information and ICT, while on the other hand, for tight integration with the all aspects of project management, demands that project information management be treated as a critical, explicit function within the overall project management process.

This could be considered as very analogous to functions such as safety, risk, or quality, which have also been long recognized as important to project management in the construction industry; yet over time, these areas have evolved from loosely-defined project management objectives to distinct sub-disciplines with well-understood requirements, procedures, bodies of knowledge, and roles within the overall project management process. The same can be said for information management. For example, one chapter of the Project Management Institute's Project Management Body of Knowledge (PMI 2000) defines a communications planning framework, yet this falls well short of a comprehensive approach to project information management. Information management seems far behind the areas of cost, schedule, scope, safety, risk, or quality as a well defined and understood sub-discipline of project management.

We contend that improved project information management could improve performance on any construction project today. Yet it becomes much more significant as projects adopt more advanced, emerging ICT, such as building information models (BIM's). Indeed, we contend that a careful consideration of how information management practices could adopt new ICT provides the essential bridge to move new ICT from development into industrial practice.

A Framework for Project Information Management

A comprehensive list of all of the issues involved in the management of information systems for construction can grow very long indeed. To provide some structure to these issues, we propose that project information management be defined as ***the management of information systems to meet project objectives***. Though simple, this definition suggests a breakdown of project information management into four main topic dimensions: a *management process*, *project elements*, *information system elements*, and *objectives*. The following sections examine each of these topics.

A Management Process for Information Management

The management of information systems should follow general management processes:

- *Plan* all aspects of information system. This includes analyzing the requirements and alternatives, designing a suitable solution taking into account all objectives and constraints, and adequately documenting the plan so that it can be communicated to all.
- *Implement* the plan, including issues such as securing the necessary authority and resources for the plan, implementing communication, training, etc.
- *Monitor* the results, including appropriate data collection relative to established performance measures and taking necessary corrective action.

Other generic management processes such as scope definition, initiating and closing the project, iterating through increasingly detailed cycles of the plan-implementation-monitoring sequence, etc. are all equally applicable.

These generic management processes should be applied in the form of specific management practices tailored to the needs of individual projects. In the field of quality management, as a comparison, generic management and quality principles can be implemented in the form of a specific ISO9001 process, in which a project's quality plan is documented in a quality manual that includes a collection of specific work methods statements. Similarly, a project's information management plan can be documented in an information management manual that includes, among other things, a collection of *information management methods statements*, which describe how particular pieces of ICT (a software tool, a particular data set, a type of electronic transaction, etc.) will be used for particular functions on the project, thereby acting as the atomic units of the information management practices.

Project Elements

The information management actions of planning, implementing and monitoring an information system should be applied to all parts of a project. This can involve the same project work breakdown structures used for other aspects of project management (e.g., breaking the project down by discipline, work package, etc.). However, there are perspectives on decomposing the work that are of particular relevance to information systems. Adopting the processes view of the project as a basis for structuring information management, the approach should focus on three aspects: project tasks, information transactions, and overall integration issues. The process should define these elements, including identifying participants, project phase, etc. (this should correspond largely to an overall project plan and schedule, and thus it may not need to be done as a distinct activity). Then, for each of these elements, the information management process should analyze information requirements, design information management solutions, and produce specific information management deliverables (this is generally at the level that various work packages must interact with each other, not into the details of how each participant performs their own work packages).

The model considers these elements across all project participants (spanning all participating companies, not just internal to one company), and the information management tasks should be carried out for each of these project elements.

Information System Elements

For each of the project elements to which we are applying our information management processes, there are a number of different elements of an information system that must be considered:

- *Information*: Foremost, we must consider the information involved in each of the project elements. First, the process should assess the significant information input requirements for each element, determining the type of information required for carrying out the tasks, the information communicated in the transactions, or the requirements for integration issues. With traditional information technologies, information requirements generally correspond to specific paper or electronic documents. With building information models and other newer information technologies, however, information requirements can involve access to specific data sources (such as specific application data files or shared databases) that do not correspond to traditional documents. Second, we must assess tool requirements by determining the key software applications used in carrying out tasks, communication technologies used for transactions, or standards used to support integration. Third, we must assess the significant information outputs produced by each task. This typically corresponds to information required as inputs to other tasks. After analysis, these results should be formalized in the information systems plan as the information required as inputs for each task, and the information that each task must commit to producing.
- *Resources:* the information management process should analyze the requirements, investigate alternatives, and design specific solutions for all related resources. These include hardware, software, networking and other infrastructure, human resources, authority, and third party (contracted) resources.

- *Work methods and roles:* the solution must focus not only on technical solutions, but equally on the corresponding work processes, roles and responsibilities to put the information system to proper use.
- *Performance metrics, specified objectives, and quality of service standards:* the information systems plan should include the specification of specific performance metrics that can be assessed during the project and used to specify and monitor information systems objectives and standards of service quality.
- *Knowledge and training:* the information systems require certain levels of expertise of people within the project organization, often requiring training.
- *Communications:* implementing the information systems plan will require various communications relating to the information system itself, such as making people aware of the plan, training opportunities, procedures, etc.
- *Support:* information system solutions often have high support requirements, which should be incorporated as part of the information management plan.
- *Change:* the information management plan should include explicit consideration of change—how to minimize its impact, how to address un-authorized changes by individual parties, etc.

Information Systems Objectives

Solutions should be sought that meet the general project objectives of cost, time, scope, etc. However, there are a number of objectives that are more specific to the information system that should be taken into account:

- *System performance* is of primary concern, including issues such as efficiency, capacity, functionality, scalability, etc.
- *Reliability, security, and risks* form critical objectives for information systems.
- *Satisfaction of external constraints:* we have placed the emphasis on the project perspective, but the information management must also be responsive to a number of external influences. Of particular significance in alignment with organization strategies and information management solutions, including appropriate degrees of centralized vs. decentralized information management. Other external influence include client or regulatory requirements, industry standards
- *Life-cycle* issues should be considered. These include both the life cycle of the information (how to ensure adequate longevity to the project data), and of the information system (e.g., life-cycle cost analysis of hardware and software).
- *Interoperability* is key objective for many aspects of the information system.

Maturity Models

The permutations of all of the issues listed under the previous four dimensions leaves a monumental range of issues to be addressed in a project information management program. Not all projects will be able to do a thorough job of addressing all of these. Indeed, an organization could be assessed in terms of the degree to which it addresses each issue. For example, Mourshed (2005) uses a maturity model scale for assessing organizations' performance on information management tasks, ranging from non-existent to optimized.

The Technical Body of Knowledge: Project Systems and Areas of Expertise

The previous section outlines a very generic framework for information management. While this focus on the conceptual frameworks and management processes provides one leg to the practice of project information management, the other leg consists of the technical body of knowledge that underpins the information systems used throughout the construction industry. Ideally, there would be a well developed and widely understood body of knowledge for this discipline—but this does not seem to exist. At present, technical expertise is built up mainly through extensive industry experience with little in the way of unifying underlying theory or frameworks. Recent developments such as Master degree programs focusing on construction ICT (e.g., the European Masters program in Construction ICT, Rebolj and Menzel, 2004) are helping to contribute to a more formalize body of knowledge for both traditional and emerging construction ICT. A further consideration of the technical body of knowledge is outside the scope of this paper.

Organizational Roles: The Project Information Officer

Organizational Issues for Information Management

The following challenging criteria must be considered in defining the organizational responsibility for information management:

- *Project focus:* information management should be project-focused and organized as a project management function, as opposed to centralized within a corporate ICT department. The information management process, as described above, is tightly coupled to the project processes and, inversely, the project processes should be strongly influenced by the ICT perspective. Furthermore, the information management must be responsive to project objectives and the needs of all project participants, rather than being driven by the corporate objectives and the needs of one company alone. This does not imply that a centralized ICT group is not needed: the depth of ICT expertise and resources required may be well-served through some centralized resources. Thus, a matrix organizational structure may be suitable, with primary organizational responsibility for information management residing in a project position supported by a centralized information management group (although matrix organizational structures are generally not ideal, their use here would be similar to other common applications in the construction industry such as estimating or field engineering services).
- *High level:* since information management is central to the overall project management, it should not be relegated to a low level within the project organizational structure (e.g., as might be found with typical ICT support personnel), but should be the primary responsibility of someone within the senior project management team.
- *Separate function:* Although the responsibility for information management should lie within the senior project management team, it would often be a poor fit with other project management functions and current senior project management staff. It requires a depth of specialized knowledge in areas of technology that are rapidly evolving. It may also be overshadowed by traditional practices if it is added as a new, additional responsibility to someone that already handles other aspects of the project management, such as a contracts manager, a project controls engineer, or the overall project manager. Therefore, project information management should be clearly defined as a distinct project management function and, where possible, assigned to personnel dedicated specifically to that role.

Information Management Functions and Roles: Organizational Configurations

The above criteria suggest that, where possible, information management requires a new, senior-level position with the project management team. We call such a position the ***Project Information Officer (PIO).*** The overall responsibility of the PIO is to implement the information management as described previously. However, no single solution for implementing project information management will be ideal for all projects. Rather, ideal organizational solutions will depend on a number of factors, not the least of which are the size of the project and the relative complexity of the information systems to be used. A number of factors contribute to the level of ICT complexity—a project may be considered to have low ICT complexity only if all of the information management process and key ICT software systems are mature implementations that have previously been successfully used by the key project participants (i.e., no innovation), and there is nothing extraordinary in the information requirements or organization makeup of the project. The following suggest some possible organizational configurations that may be appropriate:

- *Small projects/low ICT complexity:* For small, simple projects, it may be sufficient for the project manager(s) to include information management as one of the responsibilities that they must carry out on the project. It may be treated quite informally, but it must still be considered as an explicit responsibility. In this configuration, the project manager(s) must have some expertise in project information management appropriate to the systems being used. There would be no formal PIO position.
- *Medium-sized projects/low ICT complexity:* For larger projects with no unusual ICT requirements (e.g., no major innovations), it may be appropriate to formally define a project information management function and to assign the position of PIO as one of the duties of someone on the project management team. For example, a project controls manager may responsible for scheduling and cost control in addition to being the PIO. This person should have good expertise in project information management.
- *Large projects/high ICT complexity:* For large projects, or any projects with challenging ICT requirements (e.g., the introduction of innovative, advanced ICT systems), project information management should be a well-defined, distinct project management function assigned to a full-time PIO individual or group. Here, the PIO would have a high level of expertise in the practice of project information management and in the specific technologies to be used.

The Project Information Officer

There are also various alternatives for staffing the PIO position. The PIO may be an employee of the project owner, lead designer, or lead contractor organizations, or may work as an independent consultant/contractor. Regardless of employer, the PIO should be considered to be a resource to the project as a whole, not to an individual project participant organization. The PIO should be a senior management-level position within the project organization (i.e., not a junior technology support position). The PIO should report to the owner's project representative and work with an information management committee consisting of project managers and information specialists from key project participants. Depending upon the size of the project, the PIO may have an independent staff. In addition to the information management committee, liaison positions should be assigned within each project participant organization. As in the medium-size project example above, the PIO could be combined with other areas of expertise, such as project controls or quality management. The PIO position could also be supplemented with a specialist consultant to add specific expertise and/or to assist with certain information management tasks (although the overall information management function should not be "outsourced" to someone that is not a part of the project management team.

Skills and Qualifications

Candidates for the position of PIO must have a thorough understanding of the AEC/FM industry, information management and organizational issues, data interoperability issues, and best practices for software tools and procedures for all of the major project systems described previously. Preference would be for candidates with a master's degree relating to construction ICT and experience with information management on at least one similar project.

Compensation and Evaluation

Advanced construction ICT offers great promise for improving the project effectiveness and efficiency while reducing risk. Not all of these benefits directly reduce costs, yet the overall assumption is that the costs of the PIO position will be fully realized through project cost savings. This will not be a direct measure, but will be assessed on an overall qualitative basis through an information management review processes that examines the following questions of the information management and technology for the project:

- To what degree was waste (any non-value-adding activity) reduced?
- What new functionality was available?
- How efficient and problem-free was the information management and technology relative to projects with similar levels of ICT in the past?
- What was the level of service and management effectiveness offered by the PIO?
- What is the potential for future improvements gained by the information management practices on this project (i.e., recognizing the long learning curve that may be associated with new ICT)?

There is a need for the development of good metrics and data about industry norms related to these issues.

Conclusion

In summary, emerging ICT offer great potential to improve project outcomes, but they come at a cost. They involve complex systems with high technical and organizational requirements. Current practices for managing project information and ICT need to evolve and current skills need to improve. This paper gave a framework for project information management as a distinct sub-discipline of project management and defined the role of the project information officer as the central organizational focal point for information management. It explored some of the organizational configurations and considerations for project information management.

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A Comprehensive Approach to Implement Simulation in Construction Sites

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Abstract

This paper describes a new approach, which depicts the potential of simulation to be used in construction management. Not only technical, but also organizational aspects are taken into consideration. The developed innovation planning matrix helps identifying the chance of simulation to become an innovation, i.e. a marketable product in a specified application field. The use case 'Material flow in buildings projects' demonstrates the perspectives of this approach.

Introduction

A great deal of research efforts during the last two decades considers simulation as a very promising project planning and controlling method for construction management. These studies demonstrated how simulation can be successfully applied to improve planning and analyzing processes in construction. The benefits of simulation are well known for the industrial engineering in view of the fact that a lot of applications and software products were successfully developed. Simulation enables stochastic and dynamic analysis of a system and helps consequently designing and describing its behavior over time. So, the process of making and justifying a decision is significantly simplified. Implementing simulation technology in construction management promises even more potentials than just modeling system operations and utilizing resources efficiently. Simulation constrains transparency and structure at process as well as at project level and can therefore be an excellent communication instrument. Nevertheless only a negligible transfer into the practice can be observed and simulation is not yet acknowledged as a method for planning and controlling of construction sites (AbouRizk et. al. 1992). The complex nature of both structure and progress of construction operations restricts the use of simulation in practice. Applying simulation consumes therefore a lot of costs and time for collecting data and training the staff to work with a simulation tool. This fact might be the reason, why responsible managers are not motivated to implement simulation in their every day work.

Many researches believed to find the solution for this problem in developing the technical capabilities of simulation tools and making them user-friendly. The results of these research efforts led to develop special approaches for construction simulation like CYCLONE (Halpin 1977), CIPROS (Odeh et.al. 1992), STROPOSCOPE (Martinez 1996). Additional approaches followed the same aspect and focused on simplifying the modeling process by developing special purpose simulation tools (SPS) (Hajjar, AbouRizk 1998). Other papers dealt with general simulation concepts and their application to construction industry (Petri nets, block-oriented tools) (Franz 1989), (Franz, Chahrour 2002). These concepts are successfully used in other industries, and can also be applied to the construction industry, as these works approved.

While the former contributions mainly concentrated on technical aspects, this paper is searching for new aspects, and takes also organizational developments into consideration, which convert the simulation as a method for construction management into an innovation.

Simulation as an innovation in construction management

New developments should change the fact that simulation as a method of construction management is still a technical invention without considerable application in the practice. The first step is to define relevant factors that help transforming the simulation technology from just being a technical invention to be an innovation for construction management. In this sense an innovation is a market- and user- oriented product. Construction firms should be able to integrate it with other management systems. That is why identifying the demands of construction management, both technical and organizational ones, and the contributions of simulation to these demands are very essential in defining the previously mentioned factors.

The demands of the construction management depend on the complexity of the systems to be

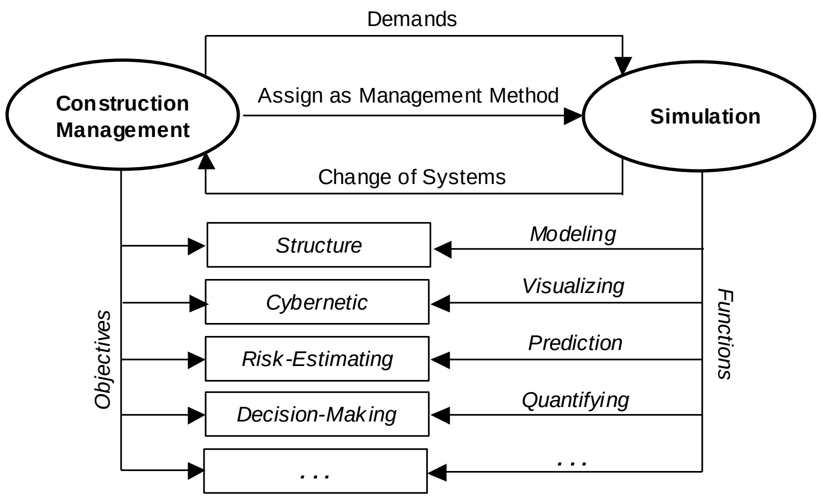

Figure 1. Support of the management by simulation.

managed. Not only the ‘project organization’ itself, but also parts of relating national and international economy were characterized by significant changes during the last decade. For instance an increasing number of participants, like subcontractors, suppliers, etc., more price dumping, tighter scheduled construction time are counted to the significant changes concerning construction management in Germany. These make coordination and organization more complicated. To overcome this increasing complexity a better know-how and innovative methods, like simulation, are more and more recommended. Taking these developments into account, the main question turns into: how can simulation improve and support the construction management to master the increasing challenges?

To answer this question it is essential to realize the role, the simulation can play within the whole construction management framework. The upper part of Fig. 1 shows that simulation should fulfill the demands of construction management mentioned above. In the case that innovators within the construction firm - which are at best the user of conventional management methods - assign simulation as a management method and use it consequently to support the decision making process, construction management is supposed to experience a systematic change as a result for this innovation. The reason is that simulation in turn demands more systematic and transparency from construction management. Furthermore the figure demonstrates how simulation - with its multiple functions - can support achieving diverse management aims at the same time. With the functions of visualizing and dynamic modeling simulation can improve structuring construction projects and support cybernetic in the system. Moreover, risks can be better estimated with the help of simulation because of its ability to predict future work progress. The consequences of a decision can not only be predicted but also quantified by simulation, so that variant decisions can be better compared. The role of simulation in management systems is accordingly exposed to have an intersection function among construction management systems. Therefore the potential of simulation does better than just supporting an individual planning process to become a common planning as well as controlling method for construction management and a communication instrument for all involved parties.

The innovation planning matrix

The innovation planning matrix is developed to help depicting the potential of simulation to be used in construction management. This matrix defines many factor categories for different application fields. Evaluating these categories for a possible application field leads to take into consideration probable structural changes, or even innovations, in construction operations, such as outsourcing, specializing etc. Thus technical and organizational demands can be efficiently defined for simulation technique to be used in construction sites and to suit the requirements of practitioners. The categories can simply be clarified by answering five essential “W-questions” for each possible application field:

- “Who-question”: intensive observation of the application field leads to identify the best user, who is supposed to promote simulation implementation.
- “Which-question”: a more detailed observation can define the process of interest for the simulation within a specific application field.
- “When-question”: after answering the two previous questions the phase in which the simulation can be economically implemented has to be determined.
- “Why-question”: making the objectives of simulation explicitly clear is one of the main tasks in this context.
- “What-question”: also describing the benefits of simulation in this specified use case are essential, especially to animate the user to use simulation.

The “5W-Matrix”, i.e. innovation planning matrix, is generated after selecting a specific field of application. It also helps deriving new application fields, like the Fig. 2 shows. Originally the supposed application field was ‘planning of earthwork in road construction’. After dealing with the “5W-Matrix”, a specific and for the practice even more interesting application field could be identified, i.e. “claim management in earthwork”. With this perception according to the related application field simulation has more innovation potential as a tool to enhance the analysis process in resolving disputes caused by changed conditions.

Furthermore an intensive study of a possible application field should trace other innovations that can be efficiently integrated with simulation and thus function as a ‘driving spin’ to help it achieving an innovation per se. The following is dealing with this point with reference to the application field ‘logistics in construction management’.

Application field: Construction Logistics

In this context an interesting innovation can be observed in the application field ‘logistics in construction management’ that is the offered ‘construction logistics service’ of few specialized German firms. Logistics processes conventionally represent secondary works that should be carried out parallel to the main construction process. These firms define logistics as their profession which includes services like: coordination of all supply-processes to the site, management of storage places on site, transport activities to and within the construction site and disposal of construction waste.

		Application-Fields		
		Planning of earthworks in road construction	**Claim management in earthworks**	**Coordination of Logsitics in construction management**
W-Questions / Categories	„Who ?“ (Users)	Cost-estimator, Methods-engineer	Projectmanager, Site-manager	Logistics coordinator
	„Which ?“ (Process to simulate)	Earthmoving-operations	Earthmoving-operations	Material flow on site
	„When ?“ (Phase of process)	Planning	Planning & Controlling, Resolving disputes	Scheduling
	„Why ?“ (Objectives of simulation)	Comparing alternative operations	Visualize the claimed operatoins, documentation	Analyze productivities and waiting time of ressources
	„What ?“ (Benefits of Simulation)	Duration- & Cost-estimation, Ressource-analyzes	Dynamic modeling of realized and planned operations	Efficiency in coordina-ting the ressources

Figure 2. The “5W-Matrix”.

An example of a concept practiced by one of these construction logistics firms is characterized by innovative developments and also new organizational structures. This firm was engaged by a general contractor to coordinate construction waste disposal. All concerned subcontractors should sign a contract to cooperate with this logistics firm. The progress of logistics processes on the construction site was controlled by a logistics coordinator from the firm itself. More over the construction logistics firm utilized its patented mobile container system “rolco”® and one forklift truck. These wheeled containers have also stirrups to be easily picked up by a forklift truck. All subcontractors were ordered to throw construction waste into these containers, separated into different fractions. They also had to move these containers to a determined central place near the entrance of the building, ready to be picked up by the forklift truck and uploaded into central waste-containers. Furthermore all deliveries, ordered by subcontractors, must be declared to the logistics coordinator. This information flow enables him to coordinate deliveries to construction site. These both logistics services insure a better coordination performance and improve the safety at work.

Such an innovative development represents a great chance for simulation to be intensively used in the practice and perhaps become an innovation. The discussed use case demonstrates the benefits of applying the “5W-Matrix” to plan such an innovative use of simulation in another exemplary use case in the same application field.

The main scope of the following use case - and in the same time the answer of the “Which” and “When” questions - is logistics coordination of interior works in high building projects. Many subcontractors are usually involved in finishing a building project. Each subcontractor is responsible for organizing his own work inclusive logistics processes. The new practice in this field engages a specialized logistics contractor to coordinate diverse logistics processes on the construction site. This logistics coordinator - “Who” question - is supposed to be the one, who should be definitely more interested in possessing a new technology like simulation.

Consequently logistics processes are not integrated in construction works anymore but carried out by this expert, who offers many services in a professional way. One important service is to organize the material flow to and within the construction site which is the subject of the specific use case below. This problem can be identified as an answer of the “Why” question. “What” benefits simulation can offer to solve this problem, should be represented by a special system to improve the decision making process. The developed matrix shows the advantages of developing a special purpose simulation system to analyse material transport to and within a construction site. Both technical and organisational demands on this simulation system should be the results of intensive communication with the potential user identified by the “5W-Matrix”, i.e. the logistics coordinator.

Use Case: Material flow in building projects

This use case covers two logistics tasks related to interior works of high building projects which are the coordination of material deliveries to the site and their transport to the right floor by elevators. It demonstrates how simulation can improve scheduling material deliveries achieving economical utilization of available resources. The modelled building project consists of 30 floors. A snapshot situation shows that 6 different works are being carried out at once, each paralleled in 5 floors. These are bottom up: floor, ceiling, wall, tiles, air conditioning and electrical works, respectively. Materials are delivered by trucks to the site, whereas one truck for each work is supposed to come during the simulation time. There are two standard lifts and one goods lift in the high building that can be used to convey delivered materials to where they have to be installed. A forklift truck is used to transport materials from truck into lift directly, because the spatial conditions nearby the unload place and the lifts do not allow any puffer places.

Two assumptions were met in order to simplify the modelling effort: the delivered materials come in standardized containers; we call it transport units (TU), so that two TU go in standard lift and three in goods lift. The second assumption is related to the decomposition of the building project; we assume that it contains of 6 sections, 5 floors and one work each. That is why the transport time to each section is modelled stochastically.

Simulation represents an excellent method to analyse productivities and waiting time of each resource to choose the most economical alternative. This alternative should determine the number of lifts to be utilized and schedule the delivery time of each truck. A proto type instrument is developed to simulate the situation described above, with which also a free parameterization of the resources is possible. This makes it easily usable for other building projects. The model is done with the help of a Petri nets based simulation system and described later on. First an overview on the Petri nets theory and its applications in construction management are discussed.

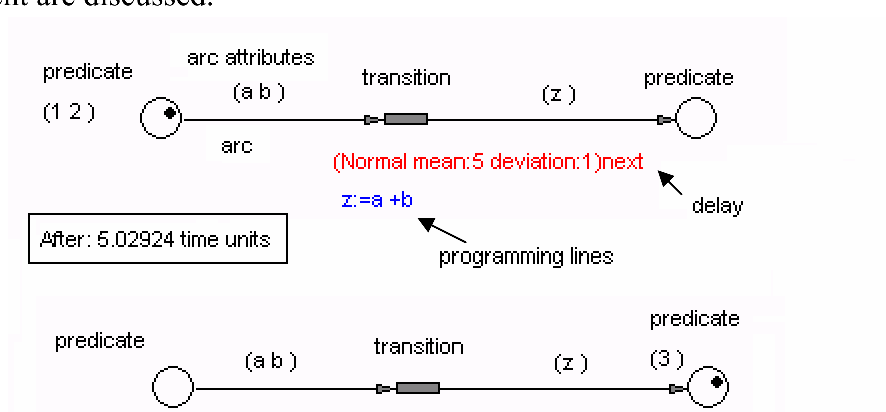

Figure 3. A simple Petri net before and after firing.

Petri nets. The history of Petri nets started 1962 with the dissertation thesis of Carl Adam Petri (Petri 1962). With these nets complex processes can be statically and dynamically ana-lysed. The basic net theoretical model was also proposed by Petri as condition/event systems. Since then the theory of Petri nets was continuously developed. In general a Petri net consists of three elements that model the statistical state of a system. A place - denoted by a circle – represents a condition, such as resource availability, buffer, input or output data. A transition – denoted by a solid bar – represents an event or activity. The third element, a directed and at-tributed arc, connects a place with a transition and vice versa. The dynamic state of the system is represented by tokens – denoted by a small solid circle – which are initialized at places and usually model the entities or the flow units of a system, such material, resource, vehicle, etc.

High level predicate/transition Petri nets (PrT) enable defining individual tokens with changing properties (Genrich, Lautenbach 1981). This enhancement allows the modeller to define different types of tokens by assigning more attributes to each type. To manipulate these attributes during the simulation alphanumeric code can be integrated in transitions and executed when they are activated (fired), Fig.3. Modern Petri nets tools based on PrT nets theory and can also model timed, stochastic, hierarchic operations even in an object oriented manner. Only few studies dealt with the use of Petri nets to model complex construction systems (Wakefield, Sears 1997), (Sawhney et al. 1999). PrT nets were especially proven to be appropriate for construction planning and control (Franz 1989).

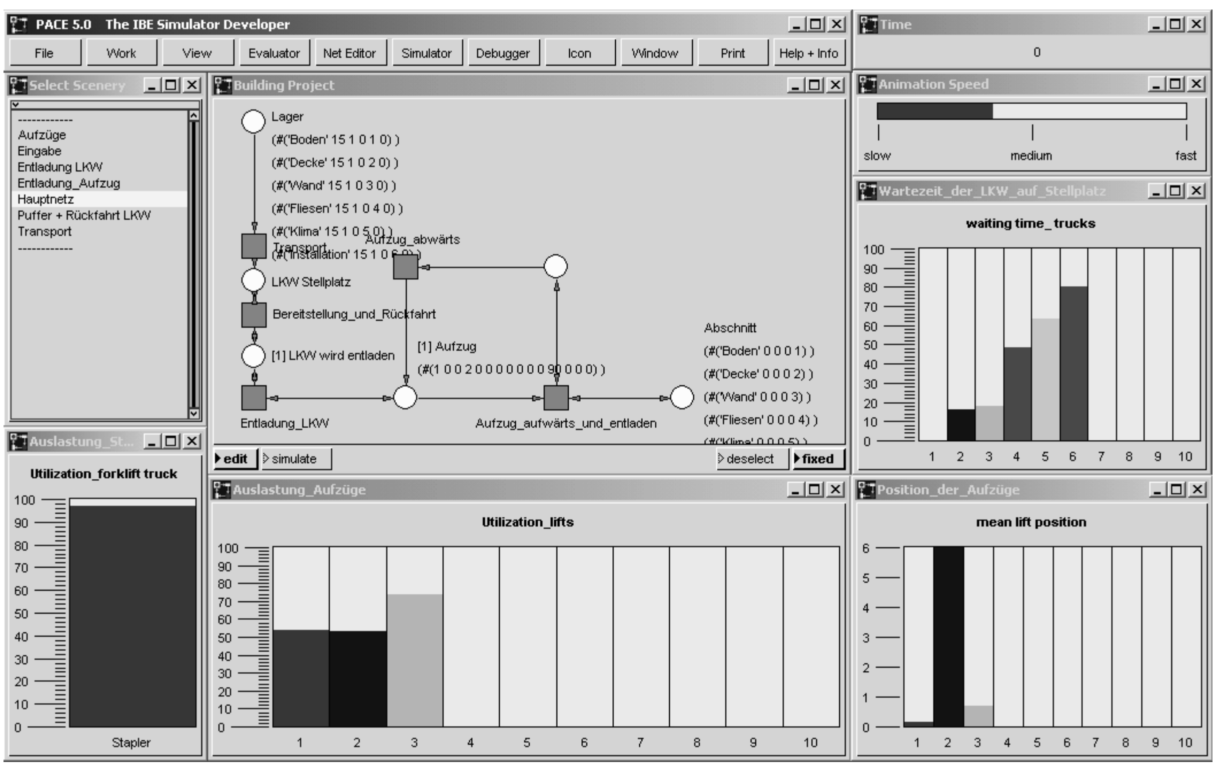

Figure 4. The Petri nets model with monitoring tools.

Model analysis. The objectives of the simulation study are to determine the intervals between material deliveries at the construction site and the number of lifts to be utilized under the defined site conditions. In order to achieve these objectives a flexible and user-friendly simulation model should be developed. Keeping in mind that this model has to satisfy both technical and organisational demands and taking the previous analysis of logistics processes into consideration an intensive communication should be made with the logistics coordinator to identify all technical properties required. Fig. 4 shows the highest net hierarchy with many monitoring tools that display some important results during simulation time progress and can stand for a model that meets practice requirements. The net is developed using the Petri nets based simulation system PACE and the integrated programming language Smalltalk, (Eichenauer 2002). Modelling with high level predicate/transition Petri nets mainly depends on data modelling, i.e. the data structure of tokens which consists of many attributes. These attributes indicate to technical and simulation related data like capacity, duration, productivity etc. While simulation runs, the user can observe waiting time for each truck in order to be able to estimate the queue length of trucks at the construction site. In addition the mean position of the lifts, their utilization and the utilization of the used forklift trucks can also be observed during simulation time.

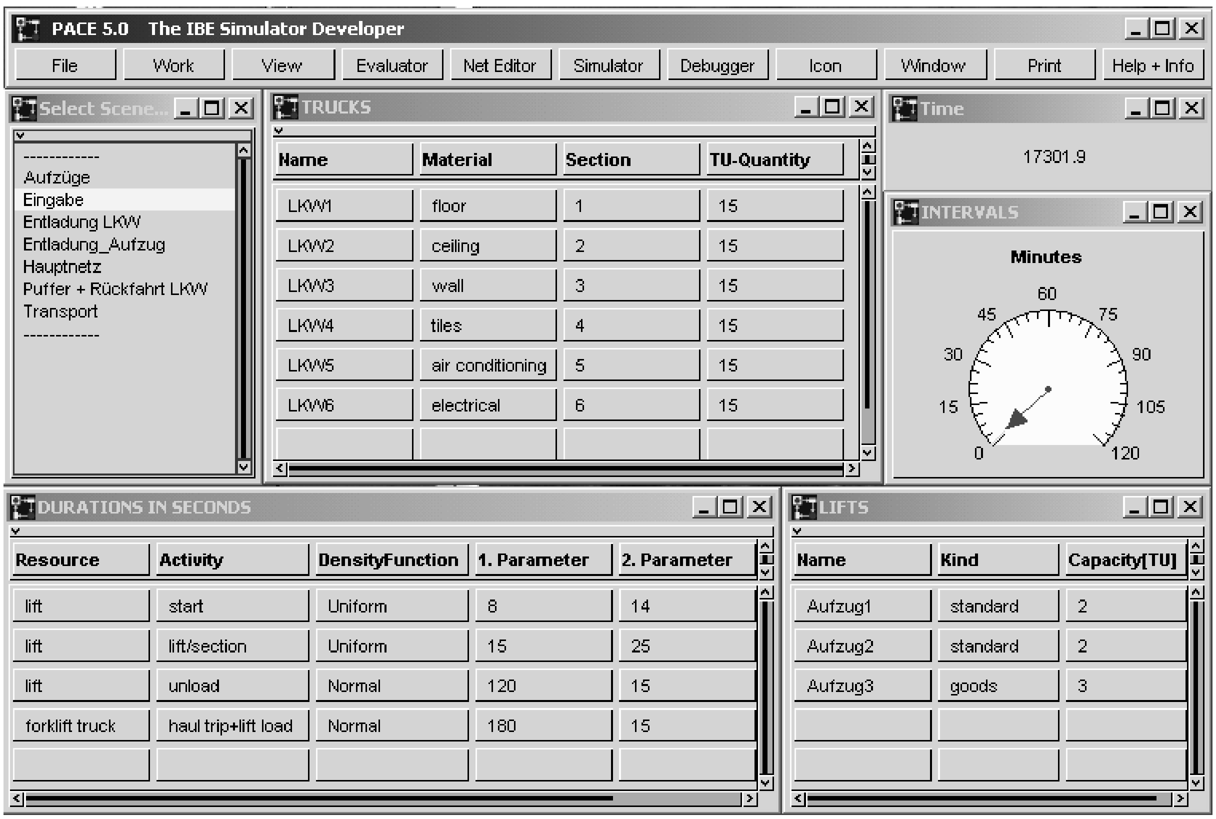

Figure 5. The Petri nets model with user interface.

Fig. 5 includes tables in which resources availability and some of their attributes, like capacities and durations, are listed for the described example building project. All these values can be changed by the user, so that the simulation system can also be used for other building projects with similar conditions. In addition this table helps initializing alternative resource combinations in order to choose the best and the most economic one to be utilized in the real system. The system can be linked to Excel in order to compare average results of each alternative. The dynamic of the simulation system and the required information exchange among participants extend the scope of simulation objectives to include being a communication instrument.

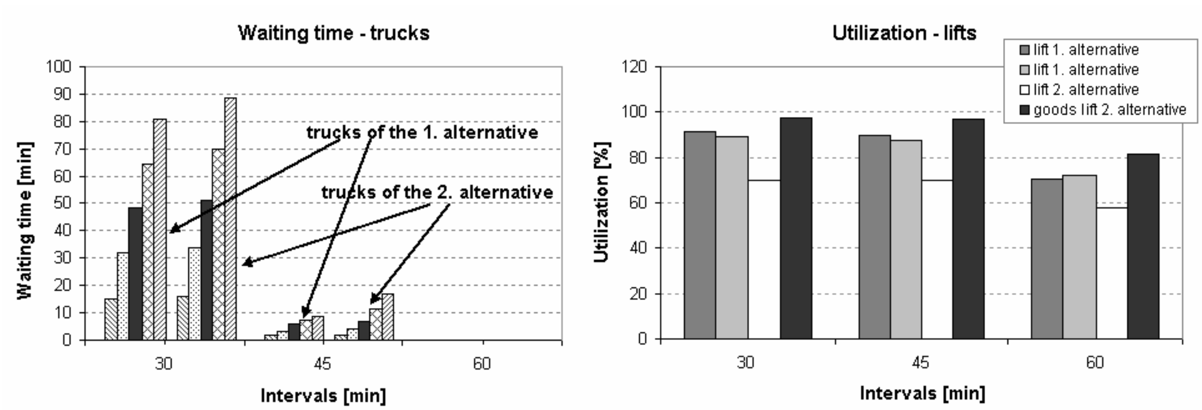

Figure 6. Some simulation results.

A parameter study of the presented example showed that the best interval between material deliveries is 45 min. Two resources combinations led to close results relating to time, i.e. using two standard lifts or one standard and one goods lift. In this case a decision can be better made after analysing the costs of each alternative. Assuming that utilizing a goods lift causes more costs than a standard one makes the first alternative represent the best resource combination. These results are illustrated by diagrams in Fig. 6.

Conclusions

This paper introduces a comprehensive approach to implement simulation in construction management. Not only technical aspects, but also organisational aspects were taken into consideration to analyse the chances of simulation technology to be intensively applied in the practice. The paper recommends the use of the developed “5W-Matrix” to analyse a proposed application field thoroughly and then define the required specifications of a simulation system. Detecting structural changes and other innovative methods can also help simulation to become an innovation itself, i.e. a marketable product. Furthermore the paper suggests predicate/transition Petri nets to be used to analyse construction management problems. These nets did not find wide application yet. However, they provide a very flexible and feasible alternative to other existing construction simulation systems.

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Project Management and Collaboration Tools on the Internet – Where Are We After The Bubble?

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Abstract

An initiative is underway at the University of Washington to investigate the means and methods for overcoming barriers to the implementation of web-based project management systems, (WPMS), and to develop a set of best practices in both the U.S. and Japanese construction industries. This paper reports on the preliminary findings of this ongoing research. Both the U.S. and Japanese economies are high-tech intensive and both cultures have embraced technology. However, a relatively small sector of the construction industry in each country has implemented WPMS. This research seeks to broaden our understanding of implementation barriers that are limiting the use of WPMS tools as well as means and methods of overcoming those barriers based on successful implementation in both countries.

Introduction

In November 1999, 60 top executives from major engineering and software companies met in Chicago at CounterEntropy Strategies' Summit on Software. The firms agreed that "the Internet will change how engineering software is used by facilitating collaborative efforts involving large numbers of people." Additionally, they forecasted that "project Web sites will proliferate rapidly, that e-commerce will come to dominate all aspects of sales and marking in architecture, engineering, and construction industry, that the computer interface needs a major overhaul, and that application servers will grow and spread quickly." (ASCE, 2000) Has the industry yet realized this prediction?

During the dot-com bubble, innovators' enthusiasm swept the investor economy. High-tech products captured the nation's imagination, and the construction industry, ("industry") was not immune; indeed, at the turn of the millennium, many observed that the use of WPMS and e-Commerce applications was on the rise (Anumba and Ruikar, 2002, O'Brien, 2000, ASCE, 2000). WPMS and e-Commerce start up companies emerged and attempted to establish themselves as the leaders in the industry (Kraker, 2000). However, by mid 2002 many of these startups had closed their e-doors, merged with larger firms, or transformed themselves to serve niche markets. (Laiserin, 2002; Sawyer, 2004)

Current State of the Industry

It is clear why the industry once hailed this new technology as a revolution (ASCE, 2000). Those who have studied this area agree that there is a need to replace redundant paper-based systems with centralized WPMS where project data are held until the project team member needs to use them (Thorpe and Mead, 2001). Given this potential, how many companies in the construction industry are currently using WPMS?

United States

In June, 2005 ENR reported on the results of an A/E/C survey sponsored by Adobe Systems Inc., San Jose, California (a technology vendor), and conducted by Harris Interactive of Rochester, New York. The Document Exchange Study included survey results from November, 2004. There were 965 architects, engineers, contractors, owners, operators or facilities managers who did not know the sponsor of the study at the time they responded to the 15-minute internet survey. When asked the means of document and information exchange with project team members outside of their own firm, only 17% of the respondents listed WPMS as a means of exchanging data. (Schriener, 2005)

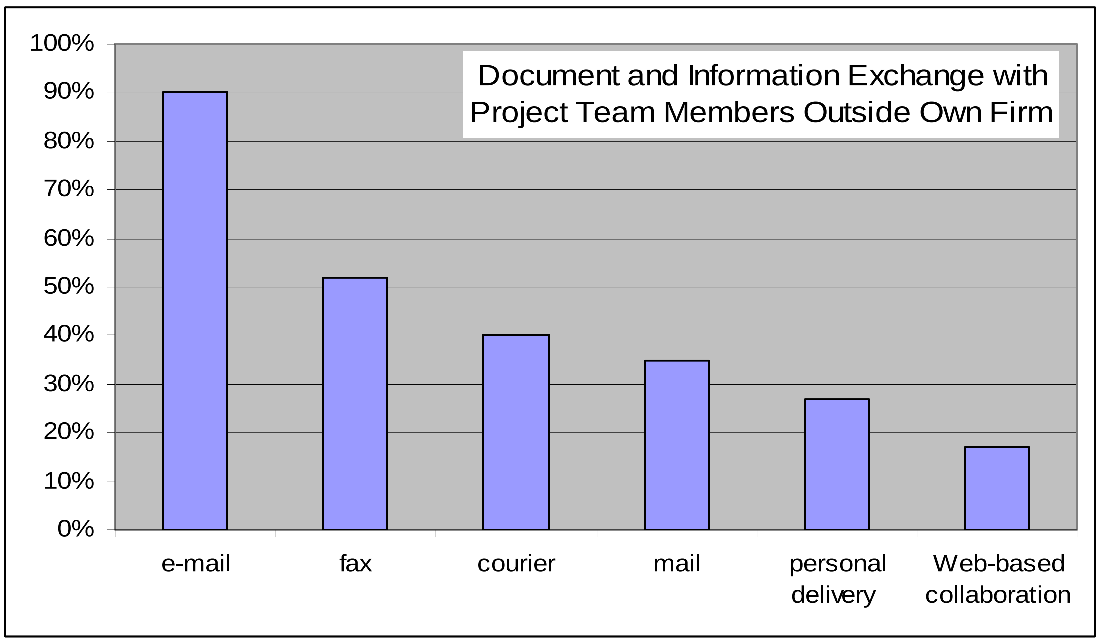

Figure 1. Responses from survey respondents measuring various means of document and information exchange with project team members outside their own firm (Schriener, 2005)

Concurrently, in their 2004 Information and Technology Survey of General, Highway and Specialty Contractors, the Construction Financial Management Association reported that approximately 17 percent of all construction firms use WPMS. Of this 17 percent, 5.7 percent are using in-house or custom-built project collaboration software, while 12.2 percent are using commercial products.

While many firms have reported great savings using WPSM, there still seems to be reluctance in the construction industry to utilize this technology. In November 2004, ENR reported that owner organizations realize the efficiency gains from WPMS; it is also reported that owners find contractors and subcontractors reluctant and unprepared to use WPMS. (Tulacz and Rubin, 2004)

This owner-driven adoption of WPMS was echoed by ConstructWare, (one of the most widely used web-based project management tools available today). ConstructWare reports that their current market focus is on owners. Having started in 1994, and having had a presence on the internet since 1997, ConstructWare has found that contractors are reluctant adopters of this technology; in contrast, it has found that the owners seem to immediately perceive the value that WPMS offers by streamlining communication between project participants, and by enabling anyone on the project team to view project documents and status from their office. Consequently, ConstructWare clients who are owners have started to specify the use of ConstructWare in the specifications for their projects (Spadoni, 2006).

Japan

Adoption of WPMS in Japan appears to be partly driven by government policy and practice. As a strategy to recover from long-term recession, the Japanese government and those in industry have identified information technology (IT) as a way to make conventional systems more efficient. (Pena-Mora & Tanaka 2002). This drive for efficiency and globalization in business encourages IT innovation in all Japanese industries including construction. The Japanese government developed an IT policy in the 1990s with the goal of constructing systems for e-commerce and e-government in all sectors of the economy. Concurrently, in the U.S., the Department of Defense developed a procurement system called Continuous Acquisition and Life-cycle Support, or CALS. European and Japanese industries then adopted CALS as a means of creating more efficient and effective business transactions. In Japan, the concept of Electric Commerce was added to CALS, and the system is presently called CALS/EC. (Takasaki et al 2002, DoD 1997)

In 1994, the Japanese government established the “Government Information Promotion Plan” as a policy. The government’s Ministry of Construction adopted “Construction CALS/EC Maintenance Basic Framework” in 1996 with a goal of applying this framework to all public works projects by 2010. Furthermore, in 1997, the Ministry of Construction mandated that all Ministry projects must use Construction CALS/EC by 2004. Based on this government policy, Construction CALS/EC has been developed and integrated into the Japanese construction industry. Construction CALS/EC includes e-procurement, e-bidding, and collaboration functionality for the design and construction phases of a project (JACIC 2005).

Pena-Mora & Tanaka (2002) describe the nature of Japanese general contractors in their study. According to the paper, the top five Japanese general contractors, so-called Super General Contractors, have over 1,000 architects and engineers on staff. Generally speaking, large Japanese general contractors tend to provide not only construction services but also the design aspects of projects. Just as some vertically integrated U.S. companies, these Super General Contractors can offer a diverse set of services, and an owner can hire one construction company to design and build a project.

WPMS can bring together several organizations that have different roles on a construction project to create one incorporated team (Rojas and Songer 1999). JACIC (2004) reported that 42% of large Japanese companies (over 1,000 employees) are using Application Service Providers (ASPs) that offer WPMS; by comparision, less than 10 % of all Japanese companies are using these systems. Furthermore, JACIC (2005) reports that large general contractors have developed in-house systems and are developing WPMS to share project information with other stakeholders (JACIC 2005). However, smaller firms in the industry have not yet adopted this technology.

Barriers to Implementation in the U.S. and Japan

Many in the construction industry envision seamless data sharing networks with virtual teams working together from around the globe (Brandon, 2005). In studying responses to new technology, Moore (2002) identifies three types of people with very different reactions: *Innovators* celebrate change, are enthusiastic users of new technology, set the trends, and define new systems and processes that incorporate the new technology. *Pragmatists* are more wary of change, but are open-minded users of proven technology, will follow trends established by others, and incorporate new technology into their work processes only after it has been proven to have a positive effect on the bottom line. *Skeptics* resist change on principle, will not accept technologies even when proven, and go out of their way to avoid new systems or processes while stubbornly continuing to work the old way. (Moore, 2002) Consequently, it is not surprising to find that team attitudes towards the WPMS systems are one of the top success or failure factors for implementing web-based project management systems (Nitithamyong and Skibniewski, 2006).

Researchers at Purdue University have identified some of the main factors found to affect the success and failure of WPMS usage both in the U.S. and abroad (Table 1).

Table 1. List of leading factors for success and failure of WPMS (Nithamyong and Skibniewski, 2006)

US Respondents	**International Respondents**
Starting stage of WPMS development	Project Size
Type of owner	Complexity related to construction tasks
Internet access availability	Team attitudes towards IT
Team attitudes toward PM-ASP	Team attitudes toward PM-ASP
Level of support from top management	Presence of champions
Promptness of customer service response	Promptness of customer service response
Ease of use	Ease of use
Data quality and reliability	System reliability

These results match the experiences of others who have worked on implementation of web-based project management systems. For instance, William O'Brien discusses implementation issues based on his experience with Collaborative Structures, Inc., in Boston (O'Brien, 2000). O'Brien's implementation issues include:

1. Resistance to change and the need for a new job description
2. Password barrier and the problems with boundary spanning
3. Communication density and the problem of yet another channel
4. Team tools and the problem of something for everyone
5. Collaborative maturity – knowledge is power
6. Related legal issues – review burden under the new regime

Takamoto et al (2003) observes that there are four barriers to spread the usage of US-built WPMS IT systems in the Japanese construction industry. These include:

1) Most systems currently used by Japanese construction companies are based on American off-the-shelf software and are not customized for the Japanese construction industry.
2) An element of Japan's conventional characteristic culture (ambiguity) does not fit the nature of IT systems, which create transparency and inclusiveness.
3) Poor skills of users for IT system
4) Different representation/indications of project information, such as schedule chart, between the Japanese and the American style

Paul Spadoni of ConstructWare agreed that in his experience the barriers listed by Takamoto, with the exception of language, representation and cultural issues, are applicable to U.S. companies as well. Spadoni also identified seven recommendations to overcome what he sees as the general implementation barriers the construction industry faces for web-based collaboration. Those include:

1. Secure Executive buy-in
2. Develop a comprehensive roadmap
3. Select initial implementation team wisely
4. Create a change map for the implementation program
5. Make the implementation an IT priority
6. Define a ramp-up period
7. Insure effective training

Preliminary Findings

Based on the research to date, it seems that there are three main categories that need to be addressed when implementing web-based collaboration systems: People, Program, and Process.

People: For successful implementation, there needs to be support from upper management and the leaders of the primary user organizations. Owners are particularly instrumental in championing the utilization of these systems. However, it is also imperative that project team level champions also be cultivated to use the system and integrate it into their daily work lives.

Program: From a user interface and customer service perspective, the software and hardware tools have to be easy to implement. It has been observed that if the project team members do not feel comfortable using the system within 4 hours, they will abandon the software to revert back to the old way of doing things (Spadoni, 2006). The technology also has to be reliable. If the internet connection is intermittent or the software frequently crashes, users will abandon the system for the older process that is more reliable. The goal then is to make the new system the *easiest* way to get things done. Why is change so difficult? People are like water: they find the path of least resistance. With regards to web-based project management systems, construction engineering and managers have little time on the job to learn new systems or processes, and will default to the easiest and fastest way to get the job done. So the best way to implement technology is to make it the easiest and fastest way to get things done.

Process: For successful implementation, the new technology must be integrated into the daily work processes of the users. If the software tool becomes an add-on to existing processes, it will be the last on the list and infrequently utilized. However, if the software tool is integral to the daily work processes of the management team, it will become instrumental. In a recent case study at Polytechnic University in Brooklyn New York, the project team used ConstructWare for RFIs, change documents, contract information, drawings, and daily reports. However, the web-based tool was not the first place the team went for information. The project managers found that since the email was not integrated with the ConstructWare system, the project managers would open their email, answer and address questions, and not open ConstructWare. If, on the other hand, the email was incorporated into ConstructWare, the users might open ConstructWare from the start of their day and it could thus become the information and communications hub. (Griffis, 2006).

Future Research

This ongoing research initiative includes a case-study analysis of U.S.-based and Japan-based companies who are currently implementing WPMS. An effort will be made to verify and validate that these barriers accurately reflect the resistance of the Japanese construction industry to implement WPMS through the use of case study analysis. The second phase of this research is designed to define means and methods for overcoming the barriers identified in this paper. Third, this research will culminate in a best-practices guide for those seeking to implement WPMS both in the U.S. and in Japan. The best practices will include approaches for overcoming people, program and process barriers to successful implementation and use of WPMS.

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ROAD CONSTRUCTION PLANNING (ROADSIM): A KNOWLEDGE-BASED SIMULATION SYSTEM

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ABSTRACT

Road construction projects are characterised by the use of heavy and expensive equipment and machinery. They are highly influenced by weather and geological risk factors, changes in working condition, environmental regulations and other risk factors. Accuracy of construction planning in road projects is highly dependent on the experience of construction planners to understand and incorporate risk factors. The prime objective of this paper is to discuss the creation of a knowledge-based/simulation system that assist project managers to generate sound construction schedules using knowledge and information which were developed by extracting construction and resources behaviour knowledge from 124 current and previous road projects.
Knowledge-base/simulation is an approach which can applied to model construction operations and in particular at the construction planning stage. It can provide the necessary information to ensure that resource allocation and construction methodology are appropriate to obtain the best possible project performance in terms of cost and time efficiency. The system is designed to allow a thorough evaluation of all possible and feasible construction alternatives and provide analysis related to the compatibility between resources used in different activities. The paper describes briefly the respective features and capabilities of the system and uses an international contract as a case study to verify the system.

Keywords: Road construction, knowledge-based simulation, automation of planning.

1. INTRODUCTION

Almost all road construction planners use only their own experience and 'gut' felling to plan and schedule road construction project and often use 'subjective judgment' to deal to uncertainty that characterise road construction. This approach has a very high margin of error, time consuming and hence increase the chance of risky and unsound plans. Whilst experience is important and crucial to make complicated planning decisions, a more systematic and knowledge-based DSS systems are needed to give planners tools and facilities to clearly develop objective plans and identify and quantify the effect risk factors.

The use of knowledge-base/simulation as modelling tools and DDS systems have revealed to be very powerful in designing complex construction operations [Kamat and Martinez (01)]. Simulation has been utilised as modelling tools for automating construction planning processes and assisting in the process of selection of resources, determination of construction methods which include construction cost and time.

The aim of this research project is to capture and re-use road construction knowledge. A knowledge-base/simulator DSS system (dubbed RoadSIM) was developed to encapsulate such knowledge and assist project planners to develop sound road construction plans.

The next sections introduce simulation techniques and the knowledge based approach used in the development of RoadSim.

2. SIMULATION MODELLING AND ROADSIM

The degree of complications and uncertainties associated with road construction made the application of current simulation tools (research and commercial) not practical. Frequent and unpredictable changes in construction working conditions can introduce a high degree of uncertainty that cannot be adequately modelled and predicted by existing simulation tools developed for construction purposes. These tools are, in many cases, implementations of CYCLONE developed by [Halpin (1976)] for the simulation modelling of construction operations. CYCLONE stands for CYCLic Operations NEtwork and, as suggested by the name, is purely network based. Many CYCLONE-based simulation systems have been developed, deserving special mention INSIGHT [Paulson 1978], UM-CYCLONE [Ioannou (1989)], Micro-CYCLONE [Halpin (1990)] and DISCO [Huang and Halpin (1994)]. These tools revealed to be adequate for certain types of constructions, namely concrete batching plant operations [Woods and Harris (1980), Lluch and Halpin (1982)] or tunnelling [Touran and Asai (1987)]. RESQUE [Chang (1986)] recognises the differences between resources and constitutes an important implementation of CYCLONE. COOPS [Liu (1991)] was designed in an object oriented language and builds the simulation by picking the construction objects from a library and placing them directly on the screen. CIPROS [Odeh (1992)] uses hierarchical object oriented representation of the resources and combines both process level and project level. STROBOSCOPE [Martinez (1996)] provides access to the state of the simulation process.

The main elements that underpin the above mentioned simulation models are the theoretical rules that drive the simulation engine. Such rules needs to be more practical and knowledge based if road construction activities can be modelled effectively and efficiently.

The rules should therefore be acquired from experienced planners and analysis of current and historical real projects case studies.

Based on a through review of existing simulation system, the research concluded that existing simulation systems are not capable to efficiently and effectively model the uncertainty associated with road construction and are unable to represent accurately the road construction project. In response to the industrial needs of a more robust and practical DSS to assist planners to develop sound construction plans, RoadSim was developed and presented in this paper.

RoadSim is a knowledge-based system that incorporates expert rules of the road construction. As widely recognised, the incorporation of expert rules allows better error detection, provides a natural framework for the simulation and treats adequately the tedious tasks related with the modelling process. The introduction into the system of a specific set of realistic working conditions provides a more reliable prediction of the behaviour of the construction system, since the solutions have been previously studied and verified. This system uses the concept of “atomic model” in order to simplify the modelling building and allow the introduction of modularity in the process. The concept of “atomic model” was introduced by [Ziegler (1987)] and developed by [Luna (1992)] and [Odeh (1992)].

The following section deals with the knowledge base part of the system.

3. ROADSIM DEVELOPMENT: KNOWLEDGE BASED APPROACH

The development of RoadSim followed the steps indicated in fig.1. The three stages indicated in the figure form the knowledge-based part of the system and are discussed in this section.

Stage1: At this stage, a data collection process was undertaken involving 124 road construction projects [Castro (2002)]. The data included BoQ, method statements, resources involved, cost, time for each activity and site diaries and accounts. The analysis of the data identified (50) common construction operations that usually form the main part of any road project, their possible execution methods and respective resources. Resources' behaviour and analysis were identified and detailed. This included technical information about heavy machinery, performance under different weather and other risk factors and basic production rates. The key road construction materials were identified, grouped and characterised. The same process was used for labour.

Stage 2: The evaluation of the construction performances constitutes stage 2 of the knowledge development process. For each construction operation, all possible combination groups of resources (equipment, materials and labour) were defined and their average production rate was determined using equipment manufacturer's information and mainly the experience of road construction managers who participated in the knowledge elicitation process. The changes in working conditions, and the constraints related with the interactions between/among resources have also been analysed. The same was done for other risk factors like weather, soil condition and quality of heavy machinery and equipment drivers. Efficiency coefficients have been established to reflect the impacts of working conditions and job efficiency. The deliverables of this stage was a series of productivity equation that calculates productivities and costs under a wide range of resource combinations and project conditions.

Stage 3: The third and final stage of the knowledge-based part of the system was constituted by the definition of the logical relationship between/among resources and between the resources and existing working conditions. The relationship between/among resources- especially equipment - refers to the interactions that are only conditioned by the capability of the equipment units. The productivity of the defined combinations can be considered as the aggregation of the inherent characteristics of the equipment unit and the interactions that are part of the construction operation and can be estimated through a mathematical formula that was established at this stage using historical work performances.

These three stages that constitute the knowledge-based part of the RoadSim which have been used to define and populate the RoadSim database.

The database was populated with three different elements:

- The collection of work packages or construction operations identified in the road construction analysis that resulted from the data collection process;
- The possible and feasible construction methods for the execution of activities with the corresponding combinations of equipment units; and

- The mathematical formulae defining the relationship between resources and interactions with the working conditions.

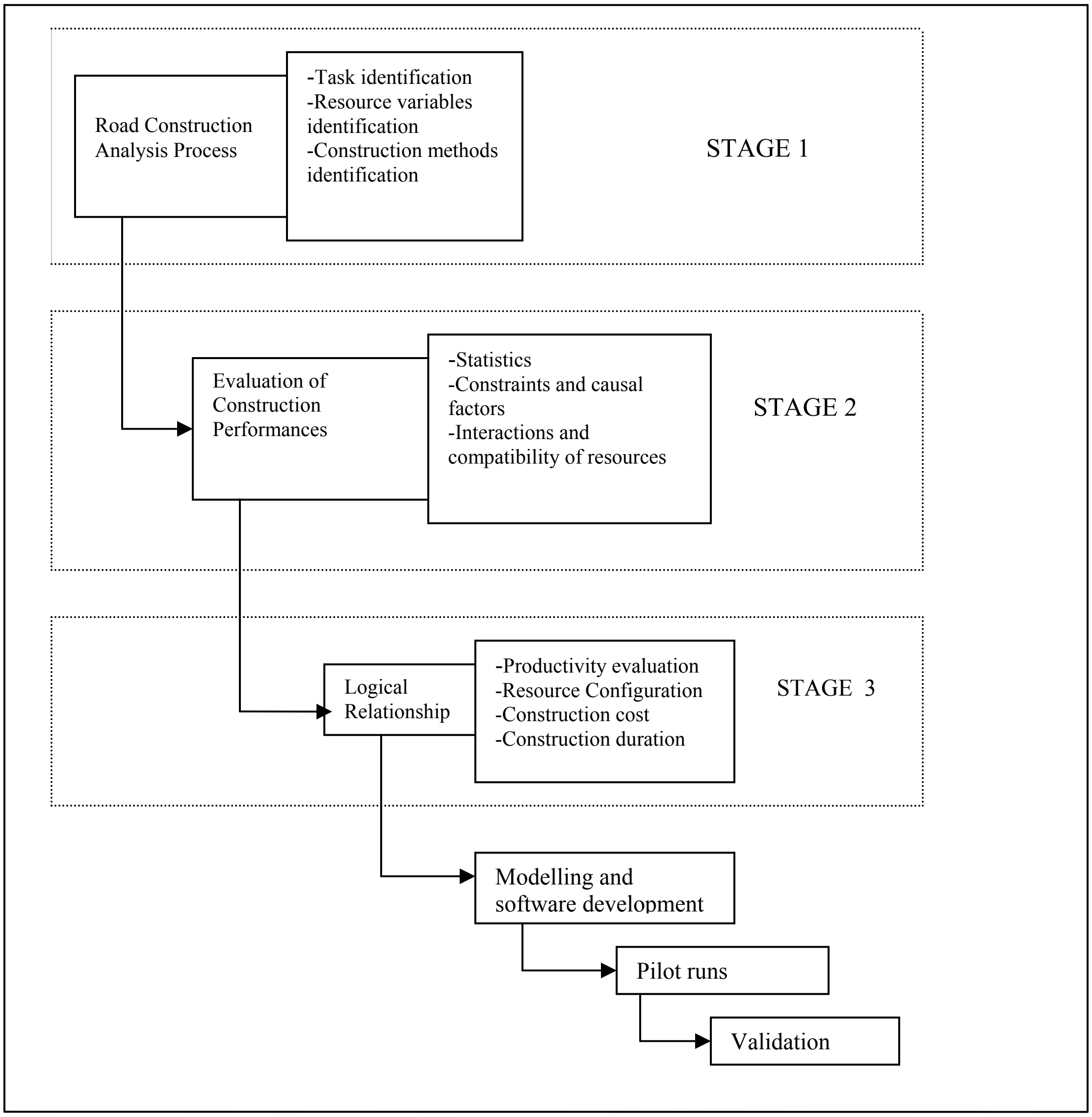

Fig.1- Steps in the RoadSim Development Process

The database contains also the unit cost of the resources to be utilised with the identification of the respective consumption rate per unit of work and a guideline for the calculation of the equipment cost.

The RoadSim software was developed to encapsulate the knowledge rules and equation mentioned above and its output was expressed in terms of cost and time that is needed to execute new project activates. Fig.2, shows RoadSim system components. As can be seen the system recognises the activities/operations from the inputs (new road project), and asks for the details concerning the actual working conditions, which are to be given by planners. Then, the simulator retrieves the information from the database, generates all possible equipment combinations and performs a set of programming calculations to output – for each feasible construction combination – the productivity of the system and the corresponding cost and duration.

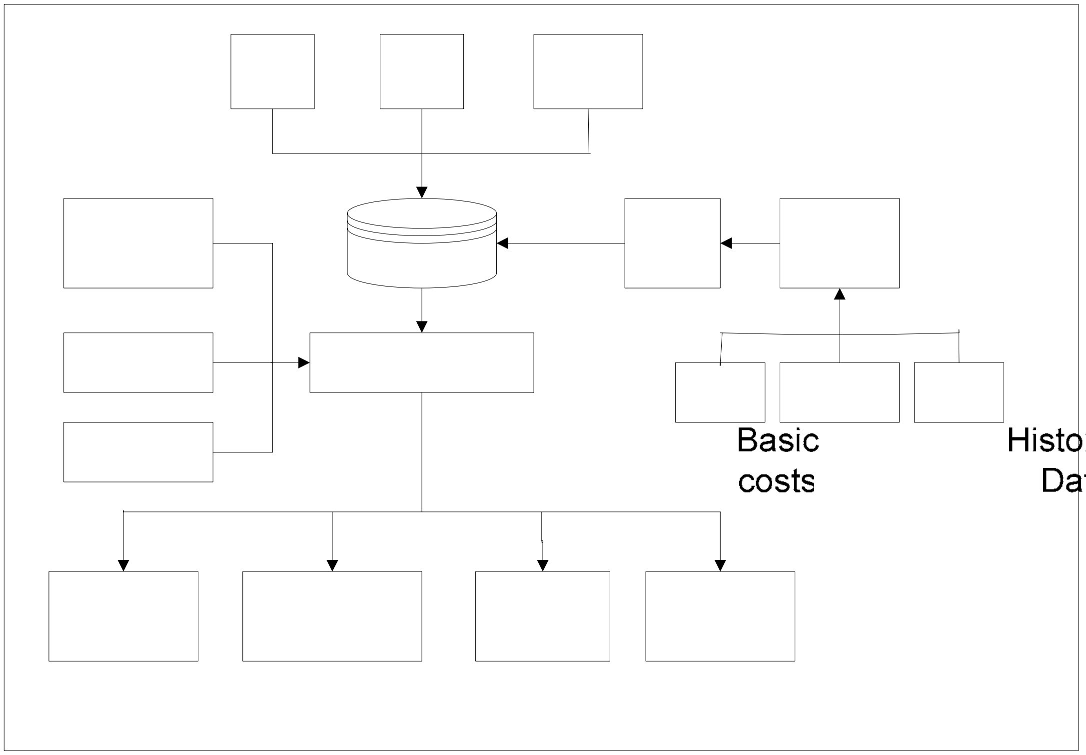

Fig.2 – RoadSim software overview

4. EVALUATION OF ROADSIM PERFORMANCE

After successful pilot runs, RoadSim was tested in field conditions and showed that the system was able to represent accurately the simulated construction operations. But RoadSim can also support a decision making process if the selection of resources should be regarded in terms of the optimisation of the whole project means. In this paper we verify RoadSim using a real-world case, constituted by the Msulira – Nkhotakota road project in Malawi. The project is an 80km road funded by the African Development Bank in a total cost of € 30 million. The main work quantities are shown in table 1. The road is surfaced (double chip seal) in two sections of 33km and 14 km, separated by 33 km within a game reserve, being the latter only gravelled.

Table 1. Msulira-Nkhotakota project quantities

Description	Unit	Quantity	Average Hauling Distance
Cut to spoil	m3	976 845	3500 meters
Cut to fill (mass earthworks)	m3	743 040	300 meters
Common fill from borrow pit	m3	459 250	4 000 meters
Sub-base in laterite	m3	170 000	10 000 meters
Crushed stone base+chippings	m3	128 120	38 200 meters

Malawi is a hinterland country, served (poorly) by the ports of Nacala (Mozambique, and distant 800km by railway) and Dar-as-Salaam (Tanzania, 600km by road). As the ship lines do not frequently serve these two ports, the port of Durban (South Africa and 3000km) is commonly utilised. In these circumstances, the selection of resources should be optimised since demobilisations and/or mobilisations are very difficult and expensive. Possibilities of subcontracting and equipment hire are almost impossible and unattainable. The mobilisation operation is logistically difficult and should preferable be done once and involving all equipment. In these cases, the optimisation of the resources should be studied more carefully, since corrective measures can be expensive and difficult to implement.

RoadSim was used for the optimisation of the resource allocation through the evaluation of the project performance. It was used for the determination of the resource allocation, cost and execution duration of every main construction operations. Similar process was undertaken for all relevant construction operations.

The elements obtained from RoadSim and referring the productivity of the main construction operations which was summarized in the table 2. As can be seen for each operation (example cut-to-spoil, fill-from-cut, etc) there are two options that can be generated from RoadSim and users can select the most coats and time effective option. In table 2, the 'bold' number were selected as most effective options.

Table 2-Elements for the project performance evaluation

	Cut to spoil		Fill from cut			Fill from borrow		Laterite	Base+chippings
Resource	OP 1	OP 2	OP 1	OP 2	OP 3	OP 1	OP 2		
Pay loader						2		1	1
Excavator	3	2	2		3		2		
Motor scraper				3					
Bulldozer (D8)	1	1	1			1			
Bulldozer (D7)					2	2	1	2	
Bulldozer (D9)				1					
Dumper		8	6						
Tipper truck	14				12	14	14	10	10
Cost (€/m3)	**2.38**	2.65	1.63	**1.25**	1.96	2.95	**2.87**	**3.40**	**13.60**
Duration (month)	**17**	17	13.5	**15**	15	15	**15**	**7.5**	**8.5**

The contract has a total duration of 27 months. The mobilisation operation will take 3 month and 2 rain seasons are expected in which a total of 4 months will be lost. Therefore, the working period is reduced to 20 months. The utilisation rate of the resources should therefore be *actual expected working time/27 months.* Analysing both cost and duration, it can be seen that a good resource selection could be obtained by the choice indicated in bold characters.

5. MANAGEMENT AND LEADERSHIP ISSUES

The use of knowledge based/simulation systems to assist construction managers in developing sound plans by the industry is very limited. Amongst the reasons for such low use are:

- Lack for strong evidence regarding the value of such systems in the industry. The value is related to the amount of saving that such system can achieve.
- Lack of innovative leaders in the industry who will question current practice and invest in the next generation systems.
- Current systems are complicated, information hungry and very cumbersome to run.

Taking the above points into consideration, RoadSim has been developed and tested by one of the top construction companies in the EU, MotaEngil. The production managers have provided resources, funds and commitments to develop the system. The company is committed to run pilot studies in a number of their road construction projects around the world and to establish the value of RoadSim. This is critical to the successful proliferation of RoadSim in the construction industry. The IT component of RoadSim is simple and use standard software that the industry currently use and therefore utilisation will be easer than stand alone system.

6. CONCLUSIONS

The objective of this paper was to present and discuss a knowledge based/simulation designed for the automation of the road construction planning process dubbed RoadSim. The system simulates road construction operations by integrating knowledge-based approach with simulation capabilities.
The paper presented a brief description of the RoadSim and focused on its ability to assist in the optimisation of resources allocation. A case study of the use of RoadSim in an international contract concluded that RoadSim is a very important tools that can assist planners in the evaluation of the project performance, saving time in the planning process, allowing the optimisation of the resource allocation and reducing costs.

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Knowledge Management Systems: their benefits and obstacles from an industry's perspective

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Abstract

In an increasingly knowledge-driven environment, the management of knowledge is crucial in maintaining the competitive advantage of organisations. This is more so in industries with low profit margins such as the construction industry. In such industries, a systematic approach fostering continuous learning, sharing and efficient diffusion of knowledge is vital for a sustained and profitable business performance. Much research has been conducted to evaluate the benefits of knowledge management systems. This research differs in the fact that it registers the industry's perspective on the worthiness of knowledge management systems in practice.

This paper presents findings of a postal survey of contractors, consultants and quantity surveyors operating within the UK construction industry to ascertain the extent of adoption and effective implementation of formal knowledge management systems. The purpose of the survey is to investigate the benefits of implementing such systems within project-based organisations. It also examines potential obstacles hindering effective implementation and maintenance of such systems. Only 20% of the companies surveyed have a formal knowledge management system in place. The vast majority, 80% of respondents don't have such systems.

Keywords: Knowledge management, factors ranking, severity index

Introduction

The view that knowledge is a valuable organisational resource has become widely recognised and accepted in the business community. Although it is difficult to quantify and value knowledge, it is recognised as one of the most important organisational assets. Schwandt and Marquardt [2000] argue that knowledge has become the most important asset for organisations even more so than financial resources, market position, technology, or any other company asset. They believe that knowledge is the core of an organisation's existence. Everything that an organisation stands for, does, utilises, produces and provides is essentially based on knowledge. This has led to their strong belief that knowledge is what conveys a competitive edge in the marketplace.

As a result managing knowledge has become a critical factor to business success and indeed survival [Davenport and Prusak, 2000]. This is more so in industries with low profit margin which operate in an increasingly knowledge-driven economy. In such industries, continuous learning, knowledge sharing and efficient transfer of knowledge in a structured and systematic manner is vital for a sustained and profitable business performance.

Since the early 1990 there has been a surge in the number of literature addressing the definitions, concepts and processes of knowledge and its management [Davenport and Prusak, 2000; Schwandt and Marquardt, 2000; Trautmann, 2000; Wigg, 1999; Nonaka and Takeuchi, 1995]. A number of researchers have also looked at the concept of knowledge management and its implementation in the construction industry [AlGhassani, et. al. 2002, Elhag, et. al. 2003, Egbu, 2004]. This paper focuses on the perceived benefits and obstacles of implementing knowledge management systems in UK construction organisations.

Knowledge management tools (techniques – technologies)

The concept of knowledge management tools is one that is very broad and tricky to define. This is because tools such as computers, phones, paper and pen can be useful in facilitating knowledge. Generally, KM tools have been grouped into two main categories: technologies which are IT based tools and techniques which are non-IT based [AlGhassani et. al., 2002]. Some of these are useful in enabling people within organisations to transfer knowledge, such as phones, while others are designed to capture, store and distribute it such as knowledge repositories.

The difference between techniques and technologies was well explained by Egbu [2004]. Knowledge management tools may have very different functions depending on the context within which they are used [Despres and Chauvel, 2000]. This was further highlighted by Elhag et.al. [2002] who classified IT-based tools according to various needs at different stages of the knowledge management process. Egbu [2004] suggested some points which organisations should consider when selecting appropriate tools: clear identification of needs, awareness of available technologies and having an understanding of their functional capabilities, and the nature and location of knowledge.

In this study, techniques and technologies identified in the literature as suitable for capturing, storing and distributing knowledge are investigated. These include on the one hand, human-based techniques such as brainstorming, post project review meetings, and face-to-face sharing of knowledge and on the other hand, technologies such as case-based reasoning, groupware software and the use of intranet/internet.

The construction organisations surveyed in this study were presented with a list of 16 knowledge management tools to identify those that are most likely to be used in these organisations. The following section presents the analysis and discussion on the findings of the study.

The Study

This study is based on a postal questionnaire survey distributed to three different types of construction organisations operating within the UK construction industry: contractors; engineering consultants; and quantity surveyors. A total of 200 companies were contacted and 48 responses were received with a response rate of 24%.

The questionnaire was designed to provide three categories of information. The first section concentrated on gathering information on the general background of the company including the type of projects the company was engaged in, the size of the organisation measured by the annual turnover and the number of employees, and the level of experience of the respondent measured by the number of years in practice.

The second part of the questionnaire was subdivided into two sections. The first was designed to gather information on the processes, techniques and tools used by the company to obtain and manage knowledge whilst the second section focused on the perceived benefits and obstacles of knowledge management systems.

Background Statistics

The majority of respondents were based in organisations dealing with general building works (90%) with some of these (43%) involved in other projects including maintenance and civil engineering works. The size of organisations participating in the survey in terms of turnover and number of employees is shown in Table 1 below.

Table 1: Size of Organisation

Range of Turnover (£m)	% of Respondents	Number of Employees	% of Respondents
< 50	73	1 - 50	40
50 - 200	3	50 - 250	33
200 - 500	7	250 - 500	3
500 - 1 billion	17	500 - 1000	14
		> 1000	10

Knowledge management within the organisation - processes, techniques and tools

The companies surveyed were requested to indicate whether they implement a KM system within their practices. The majority of respondents did not have at the time a formal KM system in place. These accounted for 80% of the respondents. The remaining 20% who did have a system in place also confirmed they had between 1 and 4 people employed specifically to manage it. In addition, half of these companies [with a KM system] also employed a knowledge management consultant.

Respondents were asked to indicate whether their respective organisations employed a systematised process of learning from experience. For those companies who had a KM system in place, 67% confirmed the existence of a systematic learning process. The survey also revealed that almost 63% of companies with no KM systems learn from experience using a systematic process.

The study also intended to understand the means by which knowledge is created and controlled within construction organisations. The survey included three approaches to gathering knowledge which were presented to respondents: top-down, bottom-up and middle-up-down techniques. The survey revealed that the majority of companies – 93% - use the middle-up-down model developed by Nonaka and Takeuchi [1995]. Only 7% of the respondents indicated the use of the top-down approach. All of these were respondents in companies that did not have a formal knowledge management system in place. No respondent indicated the use of the bottom-up method in creating knowledge and filtering that through the organisations.

Another question in this section of the survey aimed to understand the learning processes and critical learning milestones for construction companies. The question whether learning reviews took place in the companies and at what stage in a project's life was addressed. Respondents were asked to rank in terms of importance four stages on a 5-point likert scale. Four learning milestones were presented: before a project starts, during the life of a project, before a key professional retires from a project and after a project is completed. The survey revealed some interesting results [Table 2].

Table 2: Points of Learning Reviews

	Most Insignificant (%)	Insignificant (%)	Neutral (%)	Significant (%)	Most Significant (%)
Before the start of a project	15	15	11	52	7
During the life of a project	15	0	22	43	15
Before someone retires	25	29	17	13	17
After the completion of a project	7	7	57	18	11

The statistics showed that almost 60% of respondents agreed on the significance of a learning review exercise before a project is started. During the life of a project, about 58% of respondents agreed on the importance of undertaking learning reviews. The most worrying statistics is concerned with conducting a learning review before a key professional retires from a project. About 54% of respondents did not find it important to conduct a learning review at this point. The implication of this issue will be discussed in the following paragraph. Finally, only 29% of respondents indicated the significance of undertaking a learning review after the completion of a project.

The results demonstrated that a large number of the companies surveyed 54% do not see the significance of undertaking a learning review before a key professional or team member leaves a project or the organisation as a whole. Indeed, only 30% indicated that this process is significant. The reality is that much of organisational knowledge is lost through retirement, abandonment, restructuring and/or lack of employee commitment. This is particularly so with tacit knowledge which ultimately lead to the reduction of the organisation's competitiveness. As Schwandt and Marquardt (2000) point out, organisational learning is critical to the survival of an organisation in the 21st century.

The final question in this section aimed to identify the tools used in the learning process as well as in sharing and transferring knowledge within construction companies. A list of 16 tools identified from the literature survey was presented to the respondents. They were then asked to indicate the significance of each of these on a 5-point likert scale. These responses were then converted into percentages and a Severity Index was calculated for each factor. The severity indices were then used to rank the factors in terms of importance. Table 3 shows the statistical analysis generated from all responses.

Table 3: Ranking of Learning Tools

Factor	Rank	Severity Index
Face to Face Sharing	1	84.82
Training/Apprenticeships	2	76.14
Work teams/groups	3	74.62
Intranet/Internet	4	74.48
Post Project Reviews	5	68.56
Brainstorming Sessions	6	68.46
Learning History	7	66.40
Benchmarking	8	64.80
Customer Surveys	9	60.80
Employee Suggestion	10	57.84
Process Re-engineering	11	55.44
Case-based Reasoning	12	51.58
External Advisory	13	50.40
Groupware software	14	46.30
Recruitment	15	45.92
Knowledge Mapping Tools	16	43.16

The findings revealed that 'face-to-face' ranked the top as a tool used for sharing and transferring knowledge within companies. This is followed by 'training' and 'work teams/groups'. Results also showed that more formalised tools such as 'knowledge mapping' and 'recruitment' do not feature high in the ranking.

Face-to-face sharing of knowledge could take place in a number of different settings. Formal meetings, workshops and seminars are the most popular means. These are often conducted under formalised conditions. However, companies should also recognise the value of informal face-to-face meetings as effective channels for knowledge creation, transfer and innovation diffusion (Larsen and Ballal 2005). Although the term 'knowledge management' implies a systematic, structured and formalised creation and transfer of knowledge, a good knowledge management system is also one which encourages spontaneous unstructured knowledge transfer. Davenport and Prusak [2000] argued that this less formalised means of knowledge transfer is vital to a company's success.

The survey also revealed that more formal means of learning tools feature low in the ranking by construction companies. This implied that respondents appreciated that although formal tools such as documents, databases, groupware and internet/intranet are necessary for learning and effective management of knowledge, by far human interaction is more important in learning and knowledge transfer.

Benefits of the implementation of KMS

The final part of the survey was concerned with the benefits and obstacles associated with the use of knowledge management systems as perceived by respondents. They were presented with a list of 20 possible advantages of implementing a knowledge management system which were all identified from the literature. Respondents were asked to indicate the significance of each factor on a 5-point likert scale.

The information obtained from the questionnaire was used to calculate severity indices for all the factors so that these could be ranked according to their relative importance. For comparative purposes the responses of companies with KMS systems were analysed independently from those without such systems. Tables 4 and 5 present the results of these analyses respectively.

Table 4: Advantages of KMS (companies with)

Factor	Rank	Severity Index
Increase Profit	1	95.00
Improve Processes	1	95.00
Risk Reduction	3	93.34
Improve Quality	4	90.00
Improve Teamwork	4	90.00
Improve Efficiency	4	90.00
Disseminate Best Practice	4	90.00
Problem Solving	8	85.00
Staff Empowerment	9	80.00
Improve Trust	9	80.00
Increase Competitiveness	9	80.00
Enable Innovation	9	80.00
Enhance Project Success	9	80.00
Increase Capability	14	75.00
Support Planning	14	75.00
Cost Reduction	16	73.34
Customer Satisfaction	16	73.34
Improve Sustainability	18	66.66
Re-work Reduction	19	60.00

Waste Reduction	20	26.66

Table 5: Advantages of KMS (companies without)

Factor	Rank	Severity Index
Increase Competitiveness	1	73.32
Improve Teamwork	1	73.32
Enhance Project Success	1	73.32
Disseminate Best Practice	4	69.98
Re-work Reduction	5	66.66
Customer Satisfaction	5	66.66
Improve Trust	5	66.66
Increase Profit	5	66.66
Increase Capability	5	66.66
Improve Quality	5	66.66
Problem Solving	5	66.66
Improve Efficiency	12	65.72
Cost Reduction	13	60.00
Risk Reduction	13	60.00
Waste Reduction	13	60.00
Staff Empowerment	13	60.00
Improve Processes	13	60.00
Support Planning	18	59.98
Improve Sustainability	19	56.66
Enable Innovation	20	54.30

Generally, Tables 4 and 5 show a clear division in terms of the awareness of the advantages of KMS between companies that implement them and companies that don't. For the former, severity indices range between 80-95% for the top ten factors whilst ones calculated for the latter group range between 67-73%. Companies with existing KM systems rank increased profits, improved processes and risk reduction as the top factors respectively. These are followed by four equally rated factors namely: improved quality, improved teamwork, improved efficiency and dissemination of best practice. On the other hand, benefits such as cost reduction, customer satisfaction and waste reduction all featured low in the ranking.

It is somewhat surprising that cost reduction is not one of the benefits that construction companies reap from knowledge management systems. According to Dixon [2000], many organisations that have been on the leading edge of knowledge management activities have demonstrated tremendous cost savings that can be achieved through knowledge sharing. For the companies participating in this questionnaire one reason could be that the KM systems they use are unsuitable for the kind of knowledge they handle. This leads to the deduction that unless the transfer system is fit for the kind of knowledge and task in hand, it may end up being ineffective in managing knowledge.

Companies with no KM system in place ranked increased competitiveness, improved teamwork and enhanced project success as the most important factors. There is a clear lack of agreement between the two groups surveyed regarding KM system benefits. It is believed that one reason for not implementing such systems within construction companies is that the true benefit of these systems particularly related to their contribution to achieving company objectives are not fully understood and realised. This is supported by the analysis of perceived obstacles of implementing KM systems.

Obstacles to the implementation of KMS

The obstacles facing the implementation of KMS were investigated. They were ranked independently according to the responses from companies with and without KM systems for the purpose of comparisons, Tables 6 and 7 respectively.

Table 6 reveals that, for companies with KM systems, unwillingness to share knowledge is the greatest obstacle to effective implementation of such systems. This factor obtained 93% severity index. Also, time pressures and corporate culture are among the main factors. On the other hand, it is seen that the size of an organisation and its structure bear little effect on implementing KM systems.

Table 6: Ranking of Obstacles by companies with KMS

Factor	Rank	Severity Index
Unwillingness to Share Knowledge	1	93.34
Time Pressures	2	86.66
Corporate Culture	3	83.34
Unawareness of KM Benefits	4	73.34
Scarce Project Resources	5	66.66
Lack of Senior Management Support	6	63.34
Lack of Motivation	6	63.34
Language	8	56.68
Nomadic Nature of Team Members	9	56.66
Project Complexity	10	53.34
Geographical Dispersion	11	43.34
Low Level of IT Use	11	43.34
Increased Paperwork	11	43.34
Ineffective Team Composition	11	43.34
Hierarchical Depth of Organisation	15	36.66
Size of Organisation	16	33.34

In contrast, companies with no experience in implementing KMS - Table 7 - ranked low level of IT use as the least important factor with only 20% severity index. The severity index calculated for size of organisation is much higher at 73% than that obtained by companies with KM system (33%) again indicating a sharp contrast between the two groups. On the other hand, there was general agreement between the two company types regarding time pressures and unawareness of KM benefits as in both cases high severity indices were achieved.

Table 7: Ranking of Obstacles by companies without KMS

Factor	Rank	Severity Index
Time Pressures	1	100.00
Scarce Project Resources	2	93.34
Unawareness of KM Benefits	3	90.00
Project Complexity	4	75.00
Size of Organisation	5	73.34
Increased Paperwork	6	70.00
Corporate Culture	7	66.66
Language	8	65.00
Hierarchical Depth of Organisation	9	55.00
Ineffective Team Composition	9	55.00
Nomadic Nature of Team Members	9	55.00

Unwillingness to Share Knowledge	12	50.00
Geographical Dispersion	12	50.00
Lack of Senior Management Support	14	45.00
Lack of Motivation	15	35.00
Low Level of IT Use	16	20.00

Conclusions

Knowledge is recognised as one of the most important assets, though it is difficult to value. There are a variety of tools for managing knowledge. From this study, it was found that construction organisations fostered non-IT based techniques for knowledge sharing such as face-to-face sharing, brainstorming and post project reviews.

The survey revealed that companies, which do have formal KM systems in place ranked increased profit, improved processes and risk reduction as the most important advantages of its implementation. This was followed by improving quality, improving teamwork, improving efficiency and spreading of best practice. Furthermore, these companies regarded unwillingness to share, corporate culture and time pressures as the most important obstacles for effective and efficient implementation of knowledge management systems.

On the other hand, companies, which do not have a KM system ranked increased competitiveness, improved teamwork and enhanced project success as the most significant advantages. These companies indicated that time pressures, scarce project resources and unawareness of real benefits of KMS were the main obstacles to adopting such systems.

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Capturing Construction Project Knowledge

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Abstract
Knowledge gleaned from completed projects can be a tremendous asset to a construction organisation. However, there are several challenges associated with providing such an asset. These may be considered to fall within the three categories of: (a) how to capture relevant project knowledge in a timely fashion; (b) how to store the captured knowledge in an easy to access manner; and (c) how to disseminate the knowledge captured to potential users in a convenient manner.

This paper describes the development of a framework to capture construction project knowledge on a 'live' basis. The framework comprises of three main components: (a) a web-based Project Knowledge File that stores the project knowledge captured; (b) a Project Knowledge Manager who is responsible for managing the inputs and outputs of the Project Knowledge File; and (c) an Integrated Workflow System that determines how the knowledge captured should be captured, validated and disseminated. The advantage of the framework is that it encourages organisations to systematically collate project knowledge that can be exploited by all team members.

Keywords: construction project, knowledge, capture, reuse, framework

Introduction

"*Most activities or tasks are not one-time events. .. Our philosophy is fairly simple: Every time we do something again, we should do it better than the last time*" (BP's Group Chief Executive John Brown in Prokesch,1997). Snider *et al.* (2002) also state "*though the idea of learning from experience is timeless, formalized systems for capturing and disseminating lessons within an organisation have received increased attention in recent years*". The construction industry has also recognised that although each project is unique, there are some processes that are repeatable and thus there is scope to capture and transfer knowledge from previous projects. This is vital to prevent the 're-invention of the wheel' and to avoid repetition of previous mistakes. However, whilst companies recognise that the capture and dissemination of project knowledge is important, it appears to be a 'holy grail' for many organisations because of other commercial pressures that inhibit the capture and dissemination of knowledge.

A challenge would be to capture project knowledge as soon as it is recognized, i.e. in a 'live' context so that the impact of the event does not diminish with time and also to maximize the potential reuse within the project lifecycle. This paper therefore describes a research project aimed at capturing construction project knowledge in a 'live' format that will enable re-use. It uses case studies determine the types of knowledge considered important to capture and re-use and typical user-requirements and presents a framework to capture construction project knowledge.

Importance of Capturing Knowledge

The imperative of 'live' capture of knowledge is supported by the recent survey of organisations involved in PFI (Private Finance Initiative) projects where the 'live' capture of knowledge is noted as crucial by 76% of construction organisations and 70% of client organisations (Robinson *et al*., 2004). Furthermore, the need for 'live' capture of knowledge is also being indirectly addressed by Whetherill *et al*. (2002). They assert that a construction organisation's only sustainable advantage lies in its capability to learn faster than its competitors and the rate of change imposed by the external environment, and that there is a need to 'integrate learning within day-to-day work processes'. Kamara *et al*. (2003) have outlined the potential benefits of 'live' capture and reuse of project knowledge as follows:

- Facilitates the reuse of collective learning on a project by individual firms and teams involved in its delivery. More insights are likely to be captured in the collaborative environment, as each of the members in the project team knows only bits of the whole story about the project (Kerth, 2000);
- Provides knowledge that can be utilised at the operation and maintenance stages of the assets' lifecycle;
- The 'live' methodology for knowledge capture could involve the members of the supply chain in a collaborative effort to capture learning in tandem with project implementation, irrespective of the contract type used to procure the project from the basis of both ongoing and post-project evaluation;
- Benefits the client organisations with enriched knowledge about the development, construction and management of their assets; and
- Benefits the construction industry as a whole. Project teams would be enabled to manage better the subsequent phases of a project, to better plan future projects and to collaborate better with other organisations through the capture and transfer of learning from a previous phase or projects.
- Prevents knowledge loss due to time lapse in capturing the knowledge. This is supported by Linton's (1975) findings which reveal that the percentage of human memory retained on a set of data depletes over time and that the probability of forgetting an event (and knowledge) increases as time elapses;
- Maximises the value of reusing the knowledge captured through 'live' reuse. The true benefit of capturing knowledge comes only when the knowledge is being used (McGee, 2004), particularly if the knowledge is being reused 'live' after it has been captured.; and
- Enables the knowledge to be disseminated for reuse as soon as possible (i.e. 'live') before the opportunities for reusing the knowledge diminish. This helps to seize every knowledge reuse opportunity.

Tools for Capturing Project Knowledge

The most common approach used in the industry to capture the learning from projects is the post-project evaluation (Orange et al. 1999). This is usually conducted individually by participating organizations to a project. Post project evaluation can be useful in consolidating the learning of people involved in the project under review, but there are indications that current practice does not provide an effective framework for the capture and reuse of learning. A common problem is that of insufficient time for post-project evaluation to be conducted effectively (if conducted at all), as relevant personnel would have moved to other projects (Orange et al, 1999). Furthermore, it does not allow the current project to be improved by incorporating the lessons being learnt as the project progresses. There is also the problem of loss of important information or insights due to the time lapse in capturing the learning. Moreover, in consolidating the learning of people involved, post project evaluation is a not very effective mechanism for the transfer of knowledge to non-project participants. It is also limited in scope, in that the perspective is that of members within only one of the participating organizations to the project.

The reliance on people is based on the assumption that the knowledge acquired from one project can be transferred by that individual when s/he is reassigned to another project. The use of long-standing (framework) agreements (e.g. within a partnering contract) with suppliers to maintain continuity in the delivery of projects for a specific client is also designed to ensure that the learning by individuals and firms is reused on future projects. However the reliance on people, even within a framework agreement, makes organisations vulnerable when there is a high staff turnover. The use of framework agreements also cannot guarantee that the learning of individual firms participating in the agreement is shared to other participants for the benefit of the project, since these firms can be in competition elsewhere (e.g. on other projects) and may not want to divulge 'secrets' that might weaken their competitive advantage.

A study conducted by Tan et. al (2005) indicated that other popular tools used for capturing and transferring project knowledge include groupware, communities of practice, expert directories.

Limitations of Existing Practice

Busby (1999: 23) concluded that "post-project reviews were important learning mechanisms and their value seems to be underestimated by individuals who do not appreciate the need to disseminate insights throughout the organization". Weiser and Morrison (1998) also noted that very few firms systematically identified, captured and transferred project information for future use. They recognised the importance of sound project management where explicit knowledge in the form of drawings, standard, specifications, etc. are documented. However, they stressed that there was a need to capture knowledge on tools and methods used and stressed the importance of lessons learned to outline precise problems, describe successful and unsuccessful solutions, relevant people to contact, etc. The main problems with capturing project knowledge can be summarized as follows Carrillo (2005):

Ad hoc Capture: Whilst companies aim to capture and transfer project knowledge, this tends to be done on an ad hoc basis with little or no structure regarding which projects are examined and how the knowledge is captured (Carrillo, 2005);

Tick Box Mentality: Some companies that attempt to capture knowledge appear to be doing this as part of a quality a management exercise that is more interested in ticking boxes, rather than the resulting learning processes

Lack of Dissemination: Even if project knowledge is captured, one of the main weaknesses is the storage and dissemination of lessons learned. This stems from the lack of a structured way of disseminating the knowledge in a pro-active manner. Thus these potentially useful snippets of knowledge tend to reside, unused and buried in reports.

The CAPRIKON Project

In order to overcome the limitations in current industry practice regarding the capture and reuse of knowledge, it is necessary that project knowledge is captured *while it is being executed*, and presented in a format that will facilitate its reuse during and after the project. However, the 'live' capture and reuse of construction project knowledge poses a number of questions:

1. What knowledge from a project is reusable in other projects?
2. How can this knowledge be captured (during and after project implementation) in a cost-effective way, given the temporary nature of construction projects, and given the various facets (e.g. organisational, human and technology issues) that need to be considered?
3. How can project knowledge be captured without causing unnecessary knowledge overload for project participants who already have to cope with huge amounts of project information?
4. In what ways can captured knowledge be made available for reuse during (and after) project execution?

With this in mind, the CAPRIKON research project was undertaken. The aim of this research project was to develop a methodology for the 'live' capture of reusable project knowledge that will reflect both the organisational and human dimensions of knowledge capture and reuse, as well as exploit the benefits of technology. The specific objectives were as follows:

- To investigate the current practice of knowledge capture and identify the requirements for knowledge reuse by various end users of project knowledge;
- To explore various concepts and techniques that would facilitate the 'live' capture of reusable project knowledge in construction;
- To develop a methodology for the live capture of reusable knowledge on construction projects; and
- To test the methodology on a web-hosted project environment (for easy access to all project participants) and evaluate its effectiveness using live projects.

Methodology and Findings

In line with the above objectives, the following was methodologies were selected:

Current Practice

A case study approach was selected because it provided (a) an in-depth insight into the current approaches for the capture and reuse of project knowledge within the case study companies and (b) the end-users' requirements for knowledge capture and reuse. The case studies involved semi-structured interviews with 18 senior staff from six companies. The composition of the case study companies is shown in Table 1. The interviewees consisted of Group Knowledge Manager, Director of Business Development, Knowledge Researcher, IT Manager, Procurement Manager, Head of Research and Development, Company Partner and Managing Director.

Table 1: Case Study Companies' background

Company	Company background	Number of employees	Annual revenue (£)
A	Design Consultant	80	£4.3M
B	Group of Development, Design and Construction Companies	850	£250M
C	Engineering Consultant	7000	£403M
D	Management Consultant	1200	£61M
E	Project Extranet Service Provider	31	£2M
F	Water Company	18000	£1860M

Through the case studies, various types of reusable project knowledge were identified. These include process knowledge, knowledge about clients, costing knowledge, knowledge about legal and statutory requirements, knowledge about reusable details, knowledge of best practices and lessons learned, knowledge of performance of suppliers, and knowledge of who knows what.

The end-users' requirements for the development of the 'live' methodology identified were as follows:

- The methodology should not create significant additional cost and workload to the companies. This requirement can be addressed by building the ‘live’ methodology on existing practices such as project reviews and meetings;
- An appropriate legal framework is required to overcome the client’s potential restriction or copyrights problem on the sharing of knowledge;
- A validation mechanism is required to ensure the accuracy and correctness of knowledge before it is shared; and
- A standard format for representing the knowledge which contains the background information on the project, abstract, details, conditions for reuse and reference is required.

The types of reusable project knowledge in construction, shortcomings of current practices and end-users’ requirements identified were then analysed to formulate the methodology for the ‘live’ capture and reuse of project knowledge in construction.

Relevant Concepts and Technologies

A literature review explored various concepts and techniques that would facilitate the ‘live’ capture of reusable project knowledge. Focus was on the concepts of “collaborative learning” (Digenti, 1999) since the intention was to involve members of the supply chain in the live capture of project knowledge. The concept of “learning histories” (Kleiner and Roth, 1996), which was developed to capture and transfer useful knowledge from one team to another team operating in a different context, was also explored. Both these concepts provided insights on the live capture of project knowledge. For example, collaborative learning is best facilitated by clear guidance, safeguards and opportunities for mutual benefits for members of the supply chain who are requested to contribute their learning. The idea of soliciting multiple perspectives of a learning event (as advocated in learning history) to build a holistic picture of the learning that took place, was also found to be helpful as this corresponds to the reality in construction projects which require the expertise of the supply chain for their success.

Various web-based and related technologies, such as ASP.NET, PHP and data mining were also investigated to ensure that the most appropriate solution could be found that will facilitate the live capture of project knowledge.

Development of the Methodology

The methodology developed was embodied in a web-based application, CAPRI.NET. It focused on two interrelated problems: *what* learning is to be captured, and *how* it is captured, represented (i.e. *content* and *process*) and shared. The *content* is embodied in a Project Knowledge File (PKF) and the *process* is defined in an Integrated Workflow System (IWS) which is administered by a Project Knowledge Manager (PKM). The details of these components are described in the next section.

Testing of the Methodology

The methodology was tested at a workshop consisting of industry partners and academics. A series of evaluations were also conducted in a company environment. This is described in detail in a later session.

The CAPRI.NET Methodology

The components of the CAPRI.NET application are described below.

The Project Knowledge File (PKF)

This is where the reusable project knowledge captured from a project is stored. The PKF also provides access to this knowledge for subsequent reuse. The case study findings were used to specify contents of the PKF and the format in which learning is to be captured. A one-page template was designed to capture details about the person entering the knowledge (Member Details) and of the knowledge being captured (Knowledge Details). "Member Details" include information about the name, position, background, company and contact details of the user. "Knowledge Details" include information about the category of knowledge (i.e. whether it is about: a 'process' or the 'client', or 'cost', etc.), the source of learning being captured (e.g. either from an individual, a meeting, or from a document), the topic that the knowledge relates to, details of the learning being captured (i.e. what has been learnt), conditions for its reuse (e.g. the specific context of this knowledge which should be taken into consideration during reuse), and links to other knowledge and documents on the project.

The Integrated Workflow System (IWS)

The IWS delineates, executes and monitors the mechanism for the capture, validation and dissemination of the project knowledge captured. The methodology allows for the collaborative capture of reusable project knowledge generated from the various learning situations such as project reviews and meetings, and from individuals. It was also intended that knowledge should be 'mined' from various project documents to ensure comprehensive coverage of the learning on a project. The learning from meetings will be captured as a formal agenda item and this is later inputted in the PKF.

Project Knowledge Manager

The Project Knowledge Manager (PKM) configures the Integrated Workflow System to suit the individual requirements of the project e.g. the project team with access to the Project Knowledge File, type of validation required, members of the validation team, etc. The PKM is also responsible for logging the knowledge captured from project meetings. With this in mind, it makes sense that the project manager adopts the role of PKM.

The Project Knowledge File (PKF) is validated by a group of designated people before it can be shared and reused. Knowledge submitted by individuals is flagged as 'Draft Knowledge' until it is validated. The 'Draft Knowledge' is rated by other members of the project team, on a scale of 1 to 5 stars. If the item submitted does not obtain an averaged pre-determined score, it will be removed from the database. Knowledge captured from project meetings/reviews is deemed to have been validated and will be instantly shared through the PKF. This is because the capture of the knowledge in project reviews/meetings should have involved some discussion and review, which can be regarded as a validation process of the knowledge. They are also notified via email whenever new knowledge is added to the PKF. All project team members can retain a copy of the PKF at the end of a project.

Evaluation of CAPRI.NET

The evaluation of CAPRI.NET involved eleven industrial partners. It was conducted to investigate whether the framework suited industry's needs. The results of the evaluation revealed that the users were very satisfied with:

- The simplicity and ease of use of the system;
- The idea of capturing and sharing knowledge 'live' once it is created or identified; and
- The way knowledge is represented in the system where the author is linked to the knowledge submitted.

The users also suggested that some areas in the system could be improved. These include mainly the aesthetic of the interface design, the need for a more robust search function, and the provision of functions for uploading relevant documents and facilities that would allow users to submit comments on knowledge added.

Whilst the authors believe CAPRI.NET fulfilled the aim of providing a methodology for the 'live' capture of construction project knowledge, they also recognise the limitations of the final product The main limitations are as follows:

- It does not take into consideration the soft side such as socio-cultural aspect of capturing knowledge;
- It does imply additional resources although this has been minimised. The most onerous will be the responsibility of the PKM to set up the system according to the project's requirements and to log the learning outcome of regular project meetings; and
- A more detailed evaluation will have to be undertaken to judge the long-term benefits of CAPRI.NET.

Conclusions

This paper set out to describe the development of a framework to capture construction project knowledge on a 'live' basis that avoids the pitfalls described . A CAPRI.NET application was proposed that comprises three main components: (a) a web-based Project Knowledge File that stores the project knowledge captured; (b) an Integrated Workflow System that determines how the knowledge captured should be captured, validated and disseminated; and (c) a Project Knowledge Manager who is responsible for managing the inputs and outputs of the Project Knowledge File. It is envisaged that this will help to support companies in their knowledge capture activities and the Project Knowledge File will provide a central store for vital aspects that can be re-used on future projects.

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Sharing Knowledge in a Contractor's Team: A Case Study of Disney's Adventureland Project

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Abstract

Knowledge sharing has become more popular in the construction industry recently. Construction projects involve many interfaces where communication is essential for the production of high quality work. As professionals recognize that they can gain new knowledge and reduce misunderstanding through communication, knowledge sharing is becoming ever more essential in the modern world. The main focus of this research is to explore the channels used to share knowledge in the contractor's in-house team for Disney's Adventureland Project. The effectiveness of the knowledge sharing media is also evaluated, and the facilitators of and barriers to knowledge sharing are examined. Semi-structured interviews were conducted to achieve the objective of what knowledge is shared and how it is shared within a contracting team. Findings indicate that the thickness of the communication media is more important for diffusing personal and complex knowledge than general one. In this study, face-to-face communication is most valued by professionals over telephone or e-mail for sharing complex and personal knowledge. The success of knowledge sharing in this project depends on the work environment, friendships and social networks. However, the lack of commitment of team members, diverse multi-disciplinary views and the culture of the organization are barriers to knowledge sharing.

Introduction

The construction industry in Hong Kong is highly fragmented as projects are broken down into many parts and distributed among many players. Communication among the various parties may become inefficient due to the presence of many tiers and specialisations. The sharing of experience, skills and knowledge between different participants on a construction project team is essential in order to improve the performance of the project as well as to meet the project goals. Professionals can learn from each other's expertise or from past projects, and this can prevent them from making similar mistakes.

Construction project team members can share knowledge in both formal and informal ways. These include meetings, telephone calls, databases, intranets, e-mail, forums and documentation. Although technology supports knowledge sharing, the most important factors are how team members apply their knowledge and the motivation behind the sharing of knowledge. This research examines the channels and effectiveness of knowledge sharing in the contractor's in-house team of the Adventureland project, which is part of Hong Kong Disneyland. In addition, it explores the potential facilitators of and barriers to knowledge sharing in this project. The Adventureland project is chosen as a case study in this research as it is unique and complex, involving diverse expertise: it is thus essential to exercise knowledge sharing amongst the project team members in order to achieve success.

Knowledge Sharing

Knowledge sharing is defined as team members mutually sharing their experiences and ideas. Knowledge sharing is not confined to large organizations only. It also occurs in small and medium-sized enterprises

(Kelleher & Levene, 2001). Fong (2003) recognizes that multidisciplinary project teams are essential in creating new knowledge, as they help to solve problems and disseminate knowledge.

Knowledge-sharing channels include face-to-face meetings, and verbal and written communications. In addition, people may use different types of meetings designed to promote the socialization of shared values and goals in order to enhance knowledge sharing (Hakanson, 1995). The frequency of applying different sharing channels depends on the types of knowledge being shared and who the senders are. Face-to-face communication is especially suitable for complex knowledge. The more complex the knowledge, the greater the need for face-to-face interaction, as complex knowledge is difficult to describe fully in writing (Daft & Lengel, 1986).

E-mail and databases are good for transferring less complex knowledge such as rules, forms and procedures that can easily be written down (Daft & Lengel, 1986). In addition, the effectiveness of technology-assisted communication such as databases and e-mail depends on speed and accuracy (Bakos & Treacy, 1986). Kelleher & Levene (2001) agree that knowledge can be shared through various technological systems such as computer databases and intranets. Explicit knowledge can be shared verbally, while tacit knowledge can only be shared through socialization. Knowledge sharing is necessary to an organization's success and thus has become the focal point of strategy and the strategic planning process (Liebeskind, 1996). While many factors are involved in sharing knowledge, one that is of particular importance is media selection (Carlson & Davis, 1998). Managers can improve performance by matching media characteristics to the needs of the organization (Daft & Lengel, 1986).

Knowledge sharing establishes a good managerial technique in organizations, enabling individuals on various levels to participate in the joint production (Kalling & Styhre, 2003). Managers must communicate the importance of knowledge sharing by both their verbal and nonverbal behaviour. Dent & Montague (2004) state that senior management was able to communicate the concept of knowledge sharing across teams by emphasizing its importance through workshops and forums. Managers must play an active role in developing an organization that will transfer knowledge, as they help define and implement the organizational culture (Datta, 1991). Leaders should motivate their team members to share knowledge. According to Matsui et al. (1987), team members should develop a sense of shared responsibility for the group goals. The success of knowledge sharing depends on the commitment of the whole company instead of part of it.

Activities related to knowledge sharing depend heavily on the participation and motivation of the people involved (Rajan et al., 1998). Knowledge sharing becomes more efficient with an open company culture (Kelleher & Levene, 2001). A relaxed environment enhances knowledge sharing. Team members give more ideas in participative decision making (Yukl, 1998). Trust reduces the resistance to knowledge sharing. Coleman (1988) observed that knowledge sharing is successful if a relationship of trust exists between the contributors and users of knowledge. Shafritz & Ott (2001) studied an organization that conducted weekly Monday morning meetings. Although these meetings were designed to share knowledge, team members failed to voice their opinions as they were under the false impression that they were supposed to agree with the discussion and not offer a conflicting opinion. Thus it is necessary for a company to establish knowledge sharing as a cultural norm. If the culture does not embrace continuous learning, team members will not fully understand the need for additional training and development (Wise, 1996) that could help in knowledge sharing.

Knowledge sharing depends on the ease of communication and the relationship between the source and recipient units. Close ties lead to a higher level of motivation to share more information, according to the opinions of Cross et al. (2001). They explain that if an organization wants to create relationships, it is important to increase the opportunity for face-to-face interactions among people.

Research Methodology

This study used a case study approach to explore knowledge sharing within the contractor's in-house team in the Adventureland project. According to Scholz (2002), case studies are considered an appropriate approach to real, complex, current problems that cannot be treated simply by one of the known analytical methods, such as experiment, proof, or survey.

Interviews were conducted in order to yield a deeper understanding of the current situation of knowledge sharing in the Adventureland project. Every interview was conducted on a one-to-one basis in the form of an in-depth discussion to collect information in order to meet the objective of the study. Ten face-to-face semi-structured interviews were conducted on site in December 2004, with interviews lasting from 30 to 90 minutes. The information collected was used to form a detailed picture of the topic area. The questions asked in the interviews could be classified into several types: a) background of the interviewee, b) effectiveness of knowledge sharing, and c) facilitators of and barriers to knowledge sharing. All questions were of the open-ended type. The interviewees were encouraged to express their opinions freely. Interviewees were carefully chosen based on their positions and experience in the contractor's firm. In addition, interviewees had to stay in the site office at least one full day during the week. This provided a more consistent result as they had a better understanding of operation of the site office than those working exclusively off-site. Ten interviewees from different departments of the project team were deemed sufficient to reflect knowledge-sharing activities in the contractor's team.

On-site observations were conducted by attending site meetings and also informally conversing with Adventureland site personnel and listening to them telling each other site stories. Visual impressions were gained by walking around the Adventureland construction site. Observations offer opportunities to validate the information collected through interviews by comparing what people say and how they actually behave, thus minimizing the chance of misunderstanding and misinterpretation. Document analysis was used as it provides more comprehensive data. Minutes and correspondence were collected and analysed in order to interpret the types of knowledge shared and the effectiveness of knowledge sharing in the Adventureland project. Through these documents, information about the history and background of the project, the legal and policy environment, the objectives and other issues related to the project was tracked. Answers from interviewees could be cross-checked by studying documents to see whether they were being honest or not. This allowed a full and real picture of knowledge sharing within the in-house project team being generated.

Results

The main contractor, CW, was awarded the contract for the Adventureland project in 2003. Adventureland is an escape into the remote jungles of Asia and Africa, and includes a jungle river cruise, two cafes, the "Lion King" theatre and "Tarzan's Treehouse". It is a huge and complex project which involves many interfaces. Quality requirements are extremely high. Nearly all materials are imported from overseas so as to satisfy the client's requirements. To further meet these requirements, some of the most experienced staff of CW have been assembled to achieve the task, including a director assuming the duties of project manager, 6 project managers taking on the role of facilities agents, 7 department managers, and a supporting work force of around 130 members covering the structural, builder's and E&M work.

Frequency of using different sharing channels

The face-to-face meeting was the most mentioned knowledge-sharing channel. All interviewees spent about half a day meeting with other in-house team members every day. The main feature of this project was that the project team of contractors, client and sub-contractors saw each other on site everyday, making it easier to call meetings. In addition, telephone communication was rated more popular than written communication on site.

There were two types of meetings: internal and external. Internal meetings were usually informal and conducted within the contractor's in-house team. There were generally three kinds of meetings: 1) meetings between the PM and department heads every morning, 2) meetings among the contractor's in-house team to solve problems and report its progress every Saturday afternoon. This was similar to the above meeting but generally involved a wider range of people, and 3) meetings within each department among their own team members. The first two tend to be more formal than the last one. External meetings between the client and CW were formal, while those between CW and its sub-contractors were informal. In general, external meetings were more formal than internal meetings. There were usually more participants in external meetings than internal ones and more expatriates were involved.

Telephone conversation is one of the communication types which is used for less complex issues in this project. The results of the interviews indicate that the contractor's in-house team usually used the telephone to confirm the times of meetings with the client or sub-contractors. Moreover, CW used the telephone to confirm whether or not the receiver had received e-mails, faxes and RFIs. In addition, CW's in-house team on site always communicated with the head office by telephone. Apart from face-to-face and telephone communication, the alternative approach was to use the written form. Based on the observations on site and from analysing documents, it is evident that the written communication method was the least frequently used on site. There were generally 7 types of written communication. Letters were more formal than memos, Requests for Interpretation **(**RFI), Requests for Substitution **(**RFS), e-mails, faxes, or databases. E-mail was mainly used for external communication. Daft & Lengel (1984) pointed out that information of low complexity would be shared using e-mail. Interviewees confirmed that CW shared knowledge with the client on minor issues via e-mail. This finding is consistent with those of Daft & Lengel (1984).

Effectiveness of knowledge sharing channels

The study revealed that the face-to-face meeting/discussion was the most effective sharing medium as suggested by interviewees: this is supported by Nonaka & Takeuchi (1995), who found that individuals share knowledge with each other effectively through face-to-face dialogues. Face-to-face communication allows immediate feedback between the sender and the receiver. This feedback may be verbal or a signal, such as a facial expression showing frustration. Eye contact allows participants to monitor one another's mutual perceptions. Body language and tone of voice can be observed too. This alleviates problems of misunderstanding since it allows for the immediate exchange of information. Goffman (1963) pointed out that eye contact maximizes the opportunity for participants to monitor one another's mutual perceiving. This reduces misunderstanding between sender and receiver. As a result, all parties can get confirmation of common understanding and agreement on what is being said. Problems can be solved easily and quickly. In addition, the effectiveness of communication media depends on the receiver's perception and the nature of the knowledge shared. It is important to choose the correct medium for the kind of knowledge the team members are attempting to share (Gnyawali et al., 1997).

Informal meetings are more effective than formal meetings according to the interviewees. Informal meetings facilitate knowledge sharing, as participants are more willing to express their ideas and problems can be resolved more quickly. As pointed out by the building services manager, consultants discussed changes of materials with the contractor. They reached a consensus during a meeting, which shortened the time needed for approval by the client. They immediately submitted shop drawings for the Buildings Department's approval. It can be seen that better solutions could be reached as different views were integrated.

Face-to-face meeting was also the best way to share personal and complex knowledge. Site meetings were organized to ensure that the various design disciplines' offices kept up with the necessary design coordination work in progress. According to site observation, CW and the client came across technical problems in construction during a meeting. At first, no decision from the client was forthcoming. Due to time constraints, CW suggested their own solutions to the client as the client's engineers were not present in the meeting. Once the client agreed with CW, problems were resolved quickly.

Some of the periodic site meetings were followed by site walks, where participants went out on site to discuss among themselves the daily progress of the construction, and to review design compliance and appraise workmanship. In this project, the client and CW met on Mondays, Wednesdays and Fridays. They then had site walks on Tuesdays and Thursdays. This schedule had been in place for a few months and interviewees considered it to be successful. During a meeting, CW claimed that they had finished the door installation but the client was not so sure. Proof of completion of the work could only be revealed on site. Both parties could evaluate for themselves, as seen on site, that the installation of doors had been finished.

Interviews also showed that site walks and meetings were effective for problem solving for the contractor's in-house team. Site walks allowed direct communication between site agents and foremen. A closer relationship was maintained and knowledge of construction methods was shared more effectively. The area development team usually discussed construction problems on site. Each member had a better understanding of the practical work as it was clearly visible on site, as opposed to trying to foresee problems from oral description or drawings. It was easier for them to locate problems and solve them more efficiently.

The findings indicate that e-mail was the least effective method of communication in this project. The lack of signals in an e-mail leaves much ambiguity. People often misinterpret the information received through e-mail, as the communicator cannot see the target's reaction (Cramton, 1997). Some interviewees commented that e-mail increased the workload of staff, as they needed to check it regularly. In addition, the sender needed to confirm whether the e-mail had reached the receiver or not. Follow-up action such as a telephone call was needed in order not to miss the message, and this was time-consuming. However, e-mail is still in use as it can remind staff to take action on some issue after telephone communication.

Facilitators of knowledge sharing

The presence of knowledge sharing activities does not necessary mean that the knowledge sharing activities are performed effectively. The effectiveness of knowledge sharing activities is determined not only by media selection, but also by several other factors. Thus, team members will not use knowledge sharing activities effectively if the implementation factors do not encourage participation. From analysis of the interviews, work environment, capability and personality of receivers and social relationships were the key determinants of the success of knowledge sharing in this project.

A relaxed work environment is more effective than a forced one. Team members are more willing to share knowledge and experience in a relaxed climate. Knowledge sharing is effective in an open culture with a high degree of trust and support at senior corporate levels (Dent & Montague, 2004). As explained by the project QS, they always held informal meetings with their own QS team in a relaxed environment. As team members were more open with one another, they even shared knowledge during lunch or in their leisure time through general conversation. From observations, team members dropped in and out, stepped behind the partitions, or walked over to the workstations of the Lion King Theatre representatives in order to share their experience on construction methods. Informal meetings can provide the type of relaxed work environment that might motivate individuals to express their views and share their knowledge more readily.

The responsibility and power of receivers are key to the success of knowledge sharing. Hirokawa & Poole (1996) considered the ability to communicate meaningfully to be one of the key factors that affected the extent to which knowledge was shared among team members. The assistant planning manager explained that the role of the receiver affected the effectiveness of knowledge sharing. If the receiver was the client's QS, the issues discussed would be contractual or financial issues. No consensus could be reached if technical construction problems were discussed, as the QS was not experienced in this area. If the receiver was the client's construction director, then the issues of labour, strategy and general direction could be discussed in depth. It is evident from interviews and observation that personality affected the volume of knowledge shared. The effectiveness of channels of knowledge sharing depends on personality, working style and a person's propensities. Individual characteristics such as being helpful, generous, courteous and reliable (McCrae & Costa, 1987) and open to others' experience affect knowledge sharing. The PM explained that a person who was more open shared more knowledge with others. They even shared knowledge when having lunch together, travelling back to the site office on buses or during after-work social events. By contrast, if the receiver was closed, less knowledge would be shared and it would be limited to work issues.

Likewise, relationships affect the volume of information shared. All the interviewees agreed that the better two people know each other, the more they share as trust is built up. There are fewer hidden problems, and problems can be better foreseen. This allows better planning for the future. Cross et al. (2001) found that relationships are critical for obtaining information, solving problems, and learning how to do your work. The project QS mentioned that some materials imported from the Chinese mainland were delivered by air in order to complete work on time. The QS needed to know the reason behind this decision, as it was cheaper to transport materials by ship. Since the QS had a good working relationship with the project coordinator of the sub-contractor, he could easily find out the reason which was delayed submission of the purchasing order by the sub-contractor. Friendships are definitely needed for the exchange of personal knowledge. Knowing the receiver's expectations and methods of communication leads to the ability to predict and explain their actions. However, it is time-intensive.

Barriers to Knowledge Sharing

People with different demographic backgrounds have different communication styles. The motivation and commitment of a person to share knowledge are important. If the staff is more active, it is easier to share knowledge. The contractor's team needed to deal with different levels of people daily. The BS manager mentioned that the sender needed to adjust to the receiver's personality when sharing knowledge. It is difficult to change other people's attitudes. He used an example to illustrate this point: in the case of a person who had 30 to 40 years' experience in the construction industry, it was difficult to change his attitude to adapt to advanced technology. Even though databases are more environmentally friendly, he would not accept them as he believed keeping hard copies was safer and more secure. He claimed that information would be lost once a computer hard disk crashed.

Sharing knowledge with different experts may lead to conflicts, as they have different intentions. The project QS and the site engineer from the Lion King Theatre agreed that conflicts arose easily due to people having different opinions and perceptions. The operations department might object to commercial advice from the QS although it was essential for the project. In addition, not everyone was willing to give opinions, as they were afraid that their ideas would be rejected by others.

Conclusions

The study revealed that knowledge sharing was fully applied in the Adventureland project, as it was highly complex. The quality requirements of the client were extremely high and involved interfaces with many different parties. The separation of design and construction and the lack of communication may have led to poor quality. Knowledge sharing was essential in this project in order to satisfy the client's project requirements.

The findings illustrate that face-to-face communication was the most popular channel in this project. When the contractor's in-house team came across any problems, they discussed them with the team and attempted to get a solution by formal or informal meetings. Site walks were scheduled after meetings to reduce misunderstandings between parties. Written communication was the least popular method on site, as everyone could meet daily in any case. There was no need to waste time on drafting letters or e-mails. Likewise, sharing channels varied with the nature of knowledge shared and types of receivers. For more complex knowledge, face-to-face communication was preferred. For less complex knowledge, telephone communication, e-mail or memos were preferred.

The success of knowledge sharing depends on the work environment, capability and personality of receivers and social relationships. If these are appropriate, knowledge sharing will be more effective. A relaxed environment helps to build a good relationship between team members and makes them more willing to share their opinions. Friendships positively influence effectiveness because friends have a greater ability to communicate with each other than with non-friends. Social networks built up in the project help with the sharing of knowledge in the future.

Knowledge sharing enhances problem solving, saves time, helps in the acquisition of new knowledge, reduces misunderstandings and ultimately achieves a better quality of work. Although knowledge sharing offers several advantages, a few obstacles needed to be overcome. The barriers included the difficulty of changing organizational culture, conflicts arising due to different views from different experts and the lack of commitment of team members to knowledge sharing.

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Network Organizations: Structural and Strategic Implications

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Abstract

Previous research has demonstrated that there exists an organizational structure referred to as network organization and that this structure has been shown to be an archetypal structure in the AEC industry. This categorization of AEC industry organizations as network organization provides a model for studying the interfirm relationships and affords a typology in terms of temporal relations that transcend project lifecycles. Using such a model affords a high degree of clarity with respect to structural attributes of networks and it allows a greater insight into the strategic implications of structure. This paper examines the relations of strategy and structure at a broad conceptual level. At this level questions of performance amplification can be addressed and strategies can be established in terms of their amplification capacity.

The research presented in this paper expands on the work of management theorists who have posited that significant strategic amplifications can be attained through appropriate selection of strategy and structure and have offered examples in a variety of setting to demonstrate this amplification. In this paper, structural relationships drawn from cases in the AEC industry are examined at a variety of levels that demonstrate progressive amplification.

Concepts traditionally used in the fields of cybernetics and systems theory, are employed to create a synthesis of systems towards optimization of performance in AEC industry organizations. The ensuing synthesis points to the archetypal network organization as an appropriate model for optimizing both performance and output in AEC industry organizations.

Keywords

Organization, Structure, Strategy, Performance.

Introduction

The type of organizational structure known as network organization has been presented as an archetypal structure endogenous to AEC firms. This structure is endogenous by virtue of environmental necessity that arises form the complexity of the undertakings and the environmental turbulence. Furthermore, the assertion: “Self-awareness is a prerequisite to self actualization” was stated in order to emphasize the necessity for further study that will deepen understanding of the nexus of strategy, structure and performance as a potent instrument of amplification of performance. (Katsanis, 2004). This paper builds on these concepts by presenting first the underlying concepts of organization as a system in the context of the complexity of the AEC and then by exploring the use of the system concepts as viewed by researchers in other fields. This cross-boundary exploration related to the AEC was previously identified in Katsanis (2005) and it reveals exciting and promising findings.

To explore the potential of cross-disciplinary knowledge derived from the domain of systems theory, the AEC industry and its attributes are presented in the systems context. In this context the interdependence of structure, strategy and performance are examined in the light of relevant antecedents that bear on issues of performance in AEC firms. Finally, a set of strategies form settings other that the AEC Industry is presented and the performance of these strategies is quantified and contrasted. An analogous set of strategies employed in the AEC are then juxtaposed and their performance is assessed. This juxtaposition provides a platform for exploring questions for future research in this area.

The AEC as a System

In order to appreciate the usefulness and suitability of the systems theory an overview of the AEC in the context of systems follows.

The complexities of the AEC processes make it apparent that the organizational design of the principal firms cannot be properly addressed without considering the building industry as a system within which such firms are components (Davidson, 1988). A model of such a system is essential for understanding the broader process and the ensuing influences that come to bear upon these firms as well as the counterforce that the firms produce that 'reshape' the system and its environment. While often the emphasis is on the individual organizations rather than on the AEC industry as a whole, an accurate view of the influences that shape the organization could not be established without the guidance of a holistic frame of reference. Such a frame of reference is afforded through the application of the systems approach. Morris (1973) described the systems approach as follows: 'The primary concern of the systems approach is that any system should be treated as a whole. It is recognized, however, that the individual interests should not go unrecognized." It is this 'individual interest' of the firm that gives rise to the construct of the firm's performance as a distinct aspect that needs to be differentiated from the project's performance.

Extant models of the industry (Katsanis and Davidson, 1995) confirm the view that the AEC industry is a system within a larger system - that of Society and that each enterprise is also a system within the AEC industry system. The AEC industry is therefore subject to prevailing forces in Society, and consequently is under pressure to change as Society itself changes. These system dynamics models try to identify and account for the influences of such forces and hence deduce the direction of change in building. Thus, they become powerful instruments in identifying the impact such changes are likely to have on the organizational design of the firm.

The AEC Industry and its undertakings constitute systems of immense complexity. Consider the Industry's ultimate physical output: the Building. It takes considerable time to conceive, design and physically produce and it consumes significant amounts of resources. Major projects are the result of collaborative contributions of dozens of professionals and hundreds of commercial firms. In terms of contribution to GDP, the AEC industry accounts for 12-15% in direct output and 30-40% in related industries. Any effort to increase the performance of the industry has a significant impact on the national economy. Yet, Statistics Canada data show that in recent years there is a widening gap between aggregate productivity increases in the overall economy and the AEC.

Efforts to increase performance have primarily been technology driven and are often at the trade level. A higher potential for productivity gains exists through organizational process innovation, however, the fragmented nature of the AEC industry acts as inhibitor to the adoption of processes innovation. Considering that the industry has been entrenched in its constraints and traditions, the broader question is: *Can the AEC industry be liberated from the shackles of such constraints and traditions?* Posing the following targeted questions may identify the way to some answers. What strategies are available that can facilitate innovation at a scale that can make a difference? Can strategies that have proved successful in other settings be considered analogous and thus appropriate for the AEC industry?

To consider these questions, this paper proposes a set of concepts, adapted from cybernetics and systems, for dealing with complexity in large systems by developing appropriate strategies. Before proceeding with the discussion of these concepts it is necessary to briefly discuss network organizations and performance in the AEC industry.

Organizational Structure and Networks

According to Maturana and Varela (1987): *"Organization* denotes those relations that must exist among the components of a system for it to be a member of a specific class. *Structure* denotes the components and relations that actually constitute a particular unity and make its organization real.

The purpose of the structure of the organization is to attain efficient utilization of physical and intellectual resources. A variety of definitions of structure are found in literature: A concise definition of structure offered by Mintzberg (1979) is: "The structure of an organization can be defined simply as the sum total of the ways in which labor is divided into distinct tasks and then its coordination is achieved among these tasks". Chandler (1962) defines structure as the design of organization through which the enterprise is administered. Essential to this design are the lines of authority and communication, and the information and data that flow through these lines. These lines are essential for "knitting together the total resources of the enterprise". Another descriptive definition may be formulated as follows: The structure of an organization encompasses the conceptual and physical elements that constitute the ways and means for accomplishing key tasks such as information gathering and transmission, resource distribution and assignment, performance measurement and compensation, and decision making.

Thus, during a century of industrialization and organizational studies, only four broad organizational structures have emerged. These structures are: The Functional; the Divisionalized; the Matrix; and the Network Organization. The shifts from functional to divizionalized and subsequently to matrix may be viewed as variations on what one might call the original theme, the functional form, whereas the latest shift – to network configuration – is a radical revolutionary change from the traditional organizational form. What distinguishes the first three forms from the network form is the fact that all three sought to accumulate resources including personnel and through efficient utilization under the general, hierarchical oversight of a central office improve overall organizational performance.

However, network organizations differ from the previous structures in that they espouse a heterarchical, distributed approach to management of not necessarily their own resources, at least not to the same extent of ownership previously sought by the organizations of traditional structure. This differentiation along with attributes described in Katsanis (2004) lends the network structure the potential to effect strategic changes at a higher amplification level. To appreciate the relationship between structure and amplifications consider a simple system of lever and fulcrum. Changes to the structure of the system, i.e., the ratio of the lengths on either side of the fulcrum changes the amplification capacity of such a system and consequently the relationship between input and output and the ensuing performance or amplification capacity of the system. This analogy applies equally to the structure of the organizations with regard to output and input, the ratio of which defines performance.

Performance in the AEC Industry

With respect to performance, the product of the building industry is a project that culminates in a building. Therefore, it is important to look specifically at project performance, and this has received extensive attention by various researchers (Mohsini and Davidson, 1992, 1987, 1986; Mohsini, 1984; Davidson, 1989). These studies have focused on the organization and management of the building process and the interorganizational conflicts among the participating task-organizations that inevitably affect performance in a negative way.

Mohsini and Davidson (1992) correlate key structural variables (measures of conflict) of the task organization to the performance variables of the project. In building their model, through critical examination of the building process, they identify disparities between two levels of organizational objectives that the multi-organization is continuously confronted with: (1) Level I objectives – the temporary objectives of the project and the organization that is set up to build it, and (2) Level II – the permanent objectives of the participating task organizations. The second level of objectives includes those that are typical of all permanent organizations, namely, their survival in the marketplace, the enhancement of their domains, and their position in it and so on.

The same concern is echoed by Mohsini (1989) when he charges that project performance evaluation has traditionally been biased toward the Level I. The importance of task-organization performance has been recognized by numerous other researchers as a key factor in achieving project performance as shown in the following passage from Mohsini (1989): "But to secure his project level goals [the decision maker] must also ensure that all task organizations are able to achieve their economic efficiency objectives without any one of them ending up a net loser".

Systems Theory and the AEC Industry

How can performance amplification be achieved so that it is inclusive of Level I and II performance objectives in a complex organizational system? An answer is suggested by a set of strategies that have been proposed by Umpleby (1990) using underlying assumption and theories embedded in the domain of cybernetics and systems.

Various researchers have invoked the application of systems and systems thinking in the quest for amplification of performance. According to Senge (1990), the essence of Systems Thinking lies in the ability to shift from lower to higher level strategies as the circumstances require. In doing so one must be able to discern the underlying circular interrelations rather than focus on the more obvious linear cause-effect chains. In effect, Systems Thinking shifts the focus of attention from symptomatic action to systemic action. It is in this shift that amplification is achieved. The amplifying power of strategy shifts is well documented in the literature by authors such as Senge (1990) and Beer (1972). Umpleby (1990) proposed a theory of regulation based on the law of requisite variety which states that the capacity in the regulator must be at least equal to the capacity in the system to be regulated. One of the implications of this statement is that it addresses structural issues of the system. Umpleby (1990) was the first to attach quantitative values to such amplifications. He has identified four levels of strategies shown in Table 1. In the one-to-one regulation of variety each side must match each of its opponent’s moves with its own. In the one-to-one regulation of disturbance amplification is achieved because most citizens are law abiding and it is only necessary to control criminals. In ecological regulation, the constituents of the set exercise self-policing and compliance with regulations. Finally, in epistemological regulation amplification is achieved through a conceptual shift that changes the game itself. The last strategy example refers to the report to the Club of Rome *The Limits to Growth*. Every time there is a shift to a higher level strategy a gain in amplification results by a factor of approximately a thousand. Umpleby points out that these strategies can be used at any level of analysis.

These four strategies of regulation can be easily applied to the AEC industry. Table 2 shows the proposed analogy of these strategies applied to the AEC industry. In the one-to-one regulation of variety an example analogous to the football game one can see the coordination of trade- persons by a general contractor. In the one-to-one regulation of disturbance the variety is reduced by delegating the coordination of trade-persons to several sub-contractors. Ecological regulation is achieved by changing the rules of the game through partnering. In the partnering paradigm, the aim is to redefine the norms that govern business relations thus establishing new a conduct for business. (Katsanis and Davidson, 1995). The fourth strategy, Epistemological Regulation, requires changing the game itself. Umpleby’s example demonstrates the potency of this strategy but it is also indicative of the magnitude and circumstances of such undertaking. Has the AEC seen an analogous example? Is it currently happening? Or will it happen in the future? At what scale? These are critical questions that require exploration beyond the space afforded herein. However, previous research (Katsanis and Davidson 1995, and Katsanis 2004) indicates that the network structure has the potential to be the platform for introducing epistemological change. How can this potential be verified?

Umpleby (1990) has successfully quantified the amplification achieved by shifting to a higher level strategy in the case studies considered. Are these rations generalizable? Would they hold true for other cases, including the AEC example? These constitute research propositions that require further exploration. However, while amplification data is not available for the AEC industry examples, the literature cited earlier under *Performance in the AEC Industry* provides information that indicates amplification is achieved at the level of performance as one goes from regulation of disturbance to ecological regulation by addressing performance objectives for both Levels I and II.

Table 1. Four Strategies of Regulation per Umpleby (1990)

Strategy	**Example**	**Amplification**
One-to-one Regulation of Variety	Football game	1/1
One-to-one Regulation of Disturbance	Crime Control	2/1000
Ecological Regulation	Antitrust Regulation	1/640,000
Epistemological Regulation	The Club of Rome	12/4 billion

Table 2. Four Strategies of Regulation. Proposed Analogy in the AEC Industry

Strategy	**AEC Analogy**	**Levels of Performance**
One-to-one Regulation of Variety	Trades	I
One-to-one Regulation of Disturbance	Sub-Contracting	I
Ecological Regulation	Partnering	I and II
Epistemological Regulation	Network Structure	I and II

Summary and Conclusion

The preceding discussion demonstrates that principles of cybernetics and systems hold promise in exploring higher level strategies that are appropriate for the idiosyncratic nature and structure of the AEC industry. Furthermore, the proposed analogy appears to follow the pattern established by Umpleby (1990) and based on literature, the performance amplification is consistent with expectations. The network organization structure is an area of research that appears to hold great potential for introducing changes in the industry and similarly it provides a fertile ground for research as articulated in the research questions presented in this paper.

Thus, it can be reasonably concluded that further research to pursue the questions postulated herein would be appropriate.

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What Makes An Effective Project Manager: Findings Of A Four-Year Program Of Research

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Abstract

There is a growing awareness within construction of the relationship between project performance and the competencies of project managers as evidenced in terms of key behaviors. By ensuring that managers possess those competencies upon which performance is predicated, the overall performance of the sector can be improved in the future. This paper reflects on the cumulative findings of an award-winning, four-year program of research comprising three complimentary projects. These have: identified the competencies of leading construction project managers; developed them into performance management tools, and refined an associated set of tailored learning interventions to enable managers to undergo the behavioral change necessary to achieve managerial excellence. Together, the research projects have developed a set of practicable tools proven to develop high performance leaders of the construction process. This research demonstrates, *inter alia*, how it is practically possible to use behavioral competencies, in combination with other performance measures, to ensure the professional development of this key management group.

Keywords: project managers, competencies, behaviors, performance management, professional development.

Introduction

In recent years there has been a growing emphasis within research and practice on the need to develop and improve the competence of contractors' project managers in order to meet the increasing demands being placed on the industry. This emphasis stems from a growing recognition of the centrality of the project manager's competency and authority to the performance of projects (Jaselskis and Ashley 1991). Construction project managers now operate with a significant degree of power and autonomy in return for increased responsibility for the operational performance of their projects. They must fulfill a number of roles including those of facilitator, coordinator, motivator and politician (Briner *et al* 1996). This demanding and multifaceted role has necessitated the development of more sophisticated approaches to managing their development and performance in a way which supports both specific project objectives and the wider business goals of the organization. Clearly, if the industry is to be successful in developing leaders which can positively shape the performance and achievements of its organizations in the future, an understanding of the skills, knowledge and characteristics that an effective project manager should possess is crucial. To this end, the authors of this paper have collaborated over the past four years in a program of empirical research aimed at revealing what makes a successful construction project manager. The aim of this paper is to summarize the cumulative outputs of this research program and to discuss a possible way forward with relation to future research into project manager competence and development.

Project Management Competence

Establishing the competence or competency of an individual or occupational role has been seen as an increasingly versatile and powerful tool in contemporary human resource management (HRM) practice (Collin 1997). Such assessments can help to define job-role characteristics and desired levels of performance and hence, can provide a basis for many aspects of the human resource development (HRD) function. However, although the use of the terms ‘competence’ and ‘competency’ is fairly indiscriminate, there are important conceptual and practical distinctions to be made that fundamentally effect their application within modern organizations. *Competence* relates to a person’s ability to comply to a range of externally agreed standards, whereas *competency* refers to personal attributes that a person draws upon as part of their work activities (Roberts 1997). Thus, whereas competence is a work-related concept that defines the areas of work at which a person needs to be competent, ‘competency’ is a person-related concept that refers to the dimensions of *behavior* underlying competent performance (Woodruffe 1991). Thus, displaying competency is not about demonstrating an ability to comply with minimum standards of functional performance, but relates to underlying behavioral characteristics that tend to result in effective performance (Mansfield 1999). These are variously defined in terms of those essential personal traits, skills, knowledge and motives of the employee that have been causally related to superior managerial performance.

Within the UK, measuring performance against competence standards has formed the dominant paradigm for both performance measurement and performance management. This is rooted in the Employment Department’s Standards program, which defines competence as a description of something that a person who works in a given occupational area should be able to do. This model expresses competence in terms of the job purpose and the standards of performance expected to be achieved (i.e. actions and outcomes that a person should be able to demonstrate). This approach has been widely criticized for the inappropriate and inflexible standards that it promotes, particularly for higher-level and managerial positions (Cole 2002: 368). Such a model cannot take account of the complex and dynamic context in which managerial behaviors may be carried out; high performing managers do not simply apply required actions, but are conscious of how they manage, reflect on their actions, experiment, and in so doing learn and develop (Kolb & Fry 1984).

The Case for Competency-Based Performance Thinking in Construction

Most companies now accept the importance of utilizing and developing the potential of employees in order to enhance their competitive and dynamic capabilities (Bratton & Gold 1999). As such, performance management has replaced performance appraisal as the way to manage employee performance (Torrington and Hall 1995). It is based on a cyclical and continuous process of performance planning, employee assessment and corrective action (Ainsworth and Smith 1993). In recent years it has received considerable attention in both the academic and practitioner-oriented HRM literature, largely because performance management systems encompass the support, development and reward of employees, set within the context of organizational objectives (Williams 1998). This acknowledges the centrality of the development of people to the achievement of strategic business objectives, which is better aligned with the tenets of the HRM new orthodoxy. Thus, it is crucial that the competencies which form the basis of a performance management system accord with the abilities required by managers if they are to achieve managerial excellence. Traditionally, such measures have typically relied upon appraising managers against a range of job-role requirements and output-based performance criteria. Known as 'lagging' indicators, these measures are often linked to traditional measures of out-turn performance of projects such as time, cost and quality (Kagioglou et al 2001). However, using such measures is problematic within the construction project management (CPM) context given that there are many variables that could impact on the achievement of program, financial and quality targets which lie outside of the control of the project manager. Accordingly, the construction context presents a *prima facie* case for the adoption of competency-based performance approaches, where managerial behavioral *inputs* are appraised and managed, in order to engender performance excellence.

Research Program and Methodology

The research summarized within this paper comprised a series of conjoined research projects designed as an integrated four-year program of research. The methodology used to support this program of research took its lead from the established McBer job competency assessment process initially developed for industrial psychology by David McClelland (1973). This comprises the following steps (the related stage of this research program is stated in parentheses): the identification of criteria defining effective performance (*Phase 1*); the identification of a criterion sample group of superior performers and a comparison group of average employees (*Phase 2*); data collection through behavioral event interviews (*Phase 2*); the identification of competencies that distinguish superior from average performers (*Phase 2*); the validation of the competency model (*Phase 2*); and the application of the model to a range of HRM functions (*Phase 3*) (see Spencer and Spencer, 1993). In addition, the research program also undertook an additional stage (*Phase 4*), which aimed to identify the types of training interventions required to induce the kinds of behavioral change necessary for managerial development within the project management role. All four phases of the research were carried out with a range of leading industrial collaborators. These included two contractors (both of which were in the UK's top 20 by turnover) and a leading project management consultancy which acted as a control to ensure that the competencies identified were also applicable to those working on behalf of construction clients as well as contractors. Clearly, it is not possible to detail the findings of all four phases of the research in a single paper of this size. Rather, the aim of this paper is to draw together the principal findings of the research program and to reflect on their significance for the industry.

Phase 1 – Defining a 'successful' construction project manager: An important initial step in this research was to identify the criteria or metrics that define superior or effective performance in the job role to be studied. Without such a framework it would not be possible to identify the superior performers from whom key leadership and management behaviors could be identified. The approach adopted was to use a series of focus groups to bring together senior managers, HRM specialists, project managers and project team members to discuss the criteria that project managers' performance should be measured against. These were run in different partner organizations and comprised a stratified sample of managers ranging from first line supervisors to senior head office based managers. Participants were encouraged to discuss openly their views of the criteria of performance excellence against which construction project managers should be evaluated. The full range of criteria was then listed and the original participants asked to rank the importance of each criterion on a seven point Likert scale on an individual basis. Factor analysis was used as the data reduction tool to reduce the number of success indicators to a manageable and meaningful number of criteria expressed as factors. Details of this phase of the research can be found in Dainty *et al* (2003).

In total, nine performance indicators emerged as being of principal importance to the construction project management role. Factors 1, 2 and 3 embodied what could be described as the basic management abilities required within the project-based environment. The *team building* indicators grouped under Factor 1 suggested that a key performance measure should be their effectiveness in managing team socio-dynamics in order to create a teamwork environment that encouraged low staff turnover and stability. Factor 2, labeled *leadership*, included abilities of delegation directing, assertiveness and monitoring, which were joined with those of planning ahead and taking responsibility. Factor 3, labeled *decision-making*, encompassed several production-related indicators as well as more general management attributes. Factor 4 was interpreted as representing *mutuality and approachability*. This category embodied the need for the project manager to engender individual trust and mutual respect between themselves and their subordinates in order to create an appropriate workplace culture. Factor 5 focused on the need for the manager to be *honest* and to show *integrity*, both in terms of the management of internal team relations, but also externally to the client and other project stakeholders. *Communication* issues were embodied under Factor 6, where the ability to transfer knowledge effectively both within the team and to external stakeholders were seen as crucially important. Factor 7 focused on the manager's abilities and performance in *learning* and *understanding* situations and then in *applying* their skills rapidly within the project environment. The issues embodied within *self-efficacy* were all contained within Factor 8. This category contained aspects related to self-motivation, enthusiasm, self-discipline and ambition, along with time management and initiative. The final factor 9, *maintenance of external relations*, incorporated most of the measures that related to the project manager's interface with those outside of their immediate workgroup. It is notable that the traditional outturn measures of time, cost and quality were not defined as key criteria by the focus groups.

Phase 2 – Identification of core behaviors of successful project managers: The second research phase aimed to utilize the success criteria identified in Phase 1 to select a group of superior performing managers from whom core competencies could be identified. These core competencies and behaviors of such managers formed the basis of the performance management tools developed in Phase 3. In order to facilitate the selection of such managers, an 'expert panel' of HRM specialists, senior managers, project managers and other site-based managers from the two participating construction companies were invited to identify a total of 40 'superior' performers and 20 'average' performers against the criteria emerging in phase 1. The expert panel carefully assessed managers' performance against the nine criteria and discussed each candidate until a collective agreement was formed as to the 'superior' and 'average' performers. Following this, a variety of data were collected from the managers selected. Initially, they were asked to describe their job tasks and key responsibilities in order to identify competence requirements of their roles. Next, behavioral event interviews were used to assess the behaviors underlying effective performance in their role. Interviewees were asked to recount an occasion where they had to manage a complex or problematic situation or event. The behavioral event interviews were transcribed verbatim and then coded in accordance with the McBer Competency Dictionary (Spencer and Spencer 1993). Forward stepwise logistic regression analysis was then carried out to create a parsimonious model to predict job performance based on the results emerging from the study. The model was validated by using the model to predict the performance of a second criterion sample (see Dainty *et al* 2004).

The results revealed that 12 competencies distinguished superior managers from average performers as follows. *Achievement orientation* refers to the manager's concern for working towards a standard of excellence. A conceptually related trait is that of using *initiative*. This is demonstrated by taking proactive actions to avert problems in order to enhance job results and avoid problems. Another interrelated competency concerns the need for *flexibility* in terms of the ability to adapt to and work effectively with a variety of situations. This additionally requires that the project manager understands and appreciates different and opposing perspectives on an issue, and is able to adapt their approach as the requirements of a situation changes. *Information seeking* refers to an underlying curiosity or desire to know more about things, people, or issues. This competency can be seen to underpin others within the framework, such as *focusing on client needs*, a self-explanatory competency relating to efforts to meet their client's requirements, coupled with a desire to help or serve others. *Impact and influence* refers to the intention to persuade, convince, influence or impress others in order to support their agenda, or the desire to have a specific impact or effect on others. However, success in influencing the team can also be seen to be dependent upon the manager's *directiveness/assertiveness* in terms of ensuring that subordinates comply with his/her wishes in the way that was intended. Similarly, *teamwork and cooperation*, the intention to work cooperatively with others as opposed to separately or competitively, is a pre-requisite for influencing the team to perform in a desirable manner. *Team leadership* is perhaps the most obvious managerial ability linked to working within the construction project environment. It is closely related to the other categories here in that it refers to the intention to take a role as leader of a team or other group. Two competencies refer to the ability of the project manager to conceive, analyze and reason in order to make appropriate management decisions; *analytical thinking* refers to the need to develop understanding of a situation or problem by breaking it down into component parts, and *conceptual thinking* relates to developing an understanding of a situation or problem through the identification of patterns or connections between situations that are not obviously apparent. Together these abilities can be seen to support reasoned and considered decision-making, embodied within the behavior labeled *composure*. This refers to the self-control of the individual manager and their ability to control emotions inappropriate to a particular environment or situation. The logistic regression revealed that superior performance can be predicted with a high level of confidence on the basis of only two key management behaviors; 'composure' and 'team leadership'. Possession of these attributes suggests that an individual is likely to be endowed with a degree of competency in the others.

Phase 3 – Applications for the competency framework: The emergence of two predictive competencies for identifying construction project manager's likely performance is that they provide a basis for a range of HRM functions linked to the recruitment, selection and development of managers within organizations. These applications are discussed in detail in Cheng *et al* (2005) and are summarized below:

- *Performance management* - competency profiles arguably offer an improved benchmark against which managers' performance can be assessed. Examples were extracted from the behavioral event interviews and then used as benchmarks against which other managers can self-rate their performance. These are refined through discussions with line managers.
- *Team deployment and job-matching* – by identifying an individual manager's competency profile and reconciling this against the competency profile for a particular role or position, the degree of fit can be established; the better the fit, the higher the probability of an individual achieving job satisfaction and the better their performance and likelihood of being retained. This is being applied to team selection.
- *Recruitment and selection* - The effective use of the model in the recruitment process demands that the characteristics of the various behaviors (and particularly the two predictive competencies) are clearly identifiable through that process. Both composure and team leadership behaviors are tested using standard psychometrics.

- *Career development and succession planning* - the competencies have been used to assess the managerial potential of young and inexperienced managers, as well as to identify deficiencies in the profile of experienced managers who, with further development, could be groomed for senior management positions.
- *Reward management* – competency-based pay schemes are being used to reward managers for developing their competencies in line with organizational requirements.

Phase 4 – Training interventions to propagate the adoption of key behaviors: Developing the applications outlined above revealed a level of reluctance on the part of some managers to adopt the behaviors empirically shown to underpin superior performance within the construction project management role. Successfully inducing behavioral change at the level of the individual within an organizational setting demands a sensitive approach to HRD which must reconcile the individual manager's change requirements with the performance needs of the organization. The fourth phase of the research aimed to achieve this through several interrelated research stages to be undertaken as part of a longitudinal study. This enabled the impacts and effects of the learning and intervention strategies to be monitored, evaluated and refined in order that they induced tangible benefits for the participating businesses. The approach adopted was to use the *Transtheoretical Model* (TTM) to measure the readiness for change of individual managers in relation to each of the behaviors shown to underpin performance excellence. This model is the most influential approach to the integration of behavior change theories and practices within the healthcare sphere, and recent development of the TTM has applied it to the development of tailored change management programs for businesses (Prochaska, 2000). The TTM approach suggests that, for people to elicit a positive behavioral change, they must go through a process of improving their *readiness* to change. In other words, before a new behavior or action can occur, the individual must have the right attitude and beliefs to embrace it, or receive appropriate intervention strategies to induce such a change.

All 600 project-based employees of the participating organization were surveyed. The results showed that only people in the precontemplation stage (around 10% of the respondents) believed that the advantages of adopting the identified competencies did not outweigh the disadvantages. Belief in the advantages of adopting the competencies increased substantially between the precontemplation and contemplation stages. As such, maximizing the benefits of developing learning interventions suggested that the company should target those most skeptical of the value of the competencies embodied within the performance management tool. The detailed results from this group were used to refine a set of strategies to shift their decisional balance in favor of the adoption of the competencies. This was achieved through a dual strategy of increasing employees' understanding of how adopting the behaviors would benefit both themselves and the company combined with efforts to make them more simple and easy to understand (i.e. through raising consciousness, line management reinforcement and supporting relationships). The results revealed that different forms of intervention will be required depending upon the individual's profile with regard to managerial behaviors, stage of change, readiness to change and learning styles. By establishing bespoke change strategies, the objective is to engender a more participative employee-centered change strategy that should enhance the well-being of both the individual and the organization.

Discussion and Directions for Future Research

The four-year program of research alluded to above presents *prima facie* evidence for the use of competency-based approaches to project manager development within the construction industry. Through its various phases, the research program has revealed the importance of key managerial behaviors in identifying successful project managers and has provided a basis for inducing the necessary behavioral change for managers reluctant to adopt these progressive leadership attributes. Whilst their utilization is by no means unproblematic (as the resistance of some of the managers suggests), the approach could have far-reaching implications for the ways in which construction organizations measure and manage the performance of their management employees. Notably, the strength of the results calls into question the primacy of normative micro-competency based approaches which rely upon the assessment of minimum standards of performance. These traditional approaches arguably do little to engender performance excellence amongst the industry's key managers. In contrast, the competency framework presented here has a variety of applications ranging from recruitment and reward management to succession planning. Thus, it is suitable for promoting behaviors that enable managers to develop independently within their role.

Despite the significance of the findings, the outcomes of the study also raise other questions relating to the future measurement of managers' performance within the sector. A first question concerns the definition of what we mean by project management in a construction context. Many definitions of the function exist, but almost all are founded on the premise that their primary objective is to achieve time, cost and quality targets. Another issue concerns the applicability of standard performance frameworks within construction. Whilst there are some important generic criteria appropriate to project managers in all industries, it is also arguable that the choice of performance measures is influenced by project type and industry classification (see Tukel and Rom, 2001). The findings of this study suggest that construction has some specific characteristics which demand bespoke performance measures. In terms of future directions for this research it is clear that there is a need to examine the role-based (context bound) nature of competency within the construction workplace. Crawford (2005) asserts that there is, in fact, no statistically significant relationship between performance against the widely used competency standards and senior management perceptions of project management performance. This suggests that another dimension of competence exists which is rooted in the ability of managers to capitalize on their socio-political understanding of the project and its stakeholders in a way which utilizes their attributes effectively. This 'third dimension' of project management competence requires further investigation.

Conclusions

There is a growing awareness within construction of the relationship between project performance and the competencies of project managers as evidenced in terms of key behaviors. This paper has summarized the cumulative findings of a four-year program of research comprising three complimentary projects. It has briefly explained the various phases of the research, summarizing the key outcomes of each stage, which have: identified the competencies of leading construction project managers; developed them into performance management/HRD tools, and refined an associated set of learning interventions to enable managers to undergo the behavioral change necessary to achieve managerial excellence. Together, the research projects have developed a set of practicable tools proven to develop high performance leaders of the construction process and have shown the potential of competency-based approaches to act as a basis for management development programs.

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Leadership Development of Construction Project Managers

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ABSTRACT

Current construction research initiatives explore procedures, processes, materials, equipment, computer applications, safety, and other improvements that will enhance the management skills of construction project managers. Although research toward improvements in management areas is important, the authors believe the corresponding need for leadership skills development has not been adequately researched. The construction industry is dominated by engineers of various disciplines who initially entered the field because of their interest in, and academic aptitude for, hard technical skills. There is increasingly a need for engineers in project management positions to also have people oriented skills, i.e. leadership skills, to complement their technical skills.

The research summarized in this paper compared two groups of construction project managers within a major, international, United States based construction company. A top performer group was selected by corporate executives, while the control group was selected at random. Project managers were administered a 360-degree leadership analysis, and also completed a supplementary questionnaire to provide demographic and leadership causal influence data. The research data were analyzed using standard statistical analysis techniques. The research found statistically significant differences between the two groups both in leadership behaviors and causal influences. The top performer managers were judged better at such leadership skills as aligning organizational actions with shared visions, enlisting others into a common vision, and seeking ways to change, grow and improve. Both groups valued job experience and observing as important causal influences for leadership development, but the top performers placed relatively higher emphasis on the importance of mentoring and coaching, and reading and self study.

KEYWORDS: Leadership, management, training, mentoring, culture

INTRODUCTION

There is a growing recognition of the importance of and need for improved leadership skills in the engineering and construction industry. For example, in 2000, the Accreditation Board for Engineering and Technology instituted new Engineering Criteria standards, requiring engineering schools to ensure a more balanced education program. This program would incorporate courses in non-technical skills such as communications and the economic and societal constraints on engineering. The goal is to produce engineers capable of excelling in a world that combines technological, scientific, and social issues with problems that cannot be solved solely with a technical approach (Williams 2003). Other publications (Powell 2002; Bergeron 2001; Grose 2004) have documented the need for engineers to develop leadership skills to accompany their technical skills. The American Society of Civil Engineers has made several efforts to revise the academic standards required for professional licensing. The latest initiative requires three new categories of expertise before licenses are awarded: understanding of professional practice issues, leadership and public policy, and technical depth in a specialized area of civil engineering (Civil 2004).

John P. Kotter (Kotter 1990) explained that management is about planning, budgeting, organization, staffing, controlling, and problem-solving, whereas leadership is about establishing direction, aligning people, and motivating and inspiring others. This definition was the one utilized in the research.

This paper summarizes a research project that was undertaken in 2003-04 at Clemson University with the cooperation of, and funding from, a major international construction company. The authors' premise was that all construction managers require leadership skills. The research analyzed the leadership differences between a top performing group of construction project managers and a control group of similarly assigned managers, as measured by a 360-degree evaluation tool. The research also identified the causal influences that may have generated the differences in leadership performance between the two groups.

RESEARCH METHODOLOGY

The Clemson University research initiative summarized herein assumed the following principles: 1) leadership behaviors are taught and learned, rather than being inherent characteristics; 2) the validated instrument used to measure leadership behaviors, the Kouzes-Posner Leadership Practices Inventory, or LPI (Kouzes and Posner 2002a), is applicable to construction project managers; and 3) the participants in this study trusted the well-advertised condition that this research was anonymous and not being used for individual personnel evaluation, and therefore provided truthful answers to all questions on the questionnaires.

This paper addresses two hypotheses, the first being that a group of top performing construction project managers has different, and better, leadership behaviors than a control group of randomly selected construction project managers, as measured by the Kouzes-Posner LPI. The null hypothesis was stated as: "the leadership behaviors of top performing construction project managers are equal to or less than the leadership behaviors of a control group of construction project managers." The alternate hypothesis was stated as: "the leadership behaviors of top performing construction project managers are greater (better) than the leadership behaviors of a control group of construction project managers."

The second research hypothesis adopted was that the same group of top performing construction project managers has different causal influences from the control group of construction project managers, as measured by data from a supplementary questionnaire. The null hypothesis was stated as, "the causal influences of top performing construction project managers are equal to the causal influences of a control group of construction project managers." The alternate hypothesis was stated as: "the causal influences of top performing construction project managers are not equal to the causal influences of the control group of construction project managers."

Study Population

The authors selected for study and analysis a large and diverse United States based international construction company, with revenue of more than $3.7 billion in 2003. The company has more than 25,000 employees, 335 of whom are construction project managers. For study purposes, a construction project manager: 1) oversees the operation of a project, including safeguarding company funds, property, and employees; 2) represents the company with respect to the client; 3) completes projects to the satisfaction of the client, consistent with cost, schedule, and contractual requirements; 4) ensures that established company goals are realized while maintaining client relations that will enhance future business; and 5) has authority for independent action, exercise of judgment, and discretion within the limits of company policy. This definition clearly applies to project managers involved in engineer/procure/construct (EPC) projects. Typically, EPC projects are built from a bare or near-bare base, where no or only limited facilities exist. On the other hand, many construction project managers also are involved in operations and maintenance (O&M) projects, in which existing facilities are operated, improved, upgraded, or modified for safety, production, or efficiency reasons. Because the study company had a substantial number of managers involved in O&M projects, it was decided to include both EPC and O&M construction project managers in the research.

The project sponsor identified an alphabetical listing of 335 construction project managers. To generate statistically significant results from this analysis, two groups of 40 project managers were selected. The first group consisted of 40 top performers, as identified by corporate senior executives. The determination of top performance was based on consistent performance in exceeding company objectives in areas such as quality, safety, cost, communications, and client relations. The control group consisted of 40 construction project managers, selected by using an Excel random number generator. The control group was selected by removing the 40 top performers from the list of 335 eligible construction project managers, and then selecting 40 other construction project managers at random from the remaining 295 personnel. This analysis of 80 leaders could have potentially resulted in a sample of 80 of the 335 construction project managers, for a sample size of approximately 24% of the total available. The number of participants in each group was set at 40 to allow for possible non-completions while maintaining at least 30 responses in each group. Because each individual response required a supplementary questionnaire and completion of seven to 10 questionnaires for the 360-degree analysis, obtaining two groups of 30 was considered to be a substantial undertaking. The desire for a minimum size of 30 samples in each group was based on the generally accepted rule that the central limit theorem holds true when sample size is equal to or greater than 30 it provides statistically significant results (Ott and Longnecker 2001). A supplementary questionnaire was used to capture demographic data, including age, gender, EPC versus O&M experience, and type and amount of formal education, as well as opinions related to leadership development experience.

Measurement Tools

In the leadership research community, the 360-degree measurement process is generally accepted as a viable tool for quantitatively measuring varying levels of leadership behavior (Goleman et. al. 2002; Kouzes and Posner 2002a; Welch 2001; Zenger and Folkman 2002). The term "360-degree" derives from the analysis methodology: the individuals involved evaluate themselves and also are evaluated by managers, co-workers, direct reports, and customers or other constituents. This methodology is in contrast to the traditional approach in which an individual is evaluated only by his or her supervisor. The strengths of the 360-degree approach are that it provides a more complete evaluation, penalizes an individual who focuses on only one constituency (e.g., the boss), and has the potential to result in a more balanced and accurate assessment.

The Leadership Practices Inventory, or LPI, was used to quantify the leadership behaviors of construction project managers in this research. The LPI has been validated internally and externally, and it has been reported as providing consistently reliable and valid findings across people, gender, ethnicity, cultural backgrounds, and related organizations. As a validated research tool, it has been used for more than 15 years to evaluate more than 350,000 managers and non-managers across a wide variety of disciplines, organizations, and demographic populations. Additionally, more than 200 published masters' degree theses and doctoral dissertations have used the LPI as a leadership analysis and data collection tool (Kouzes and Posner 2000a).

The LPI questionnaire consists of 30 questions, six for each of the five basic leadership practices (Kouzes and Posner, 2002, pg 13):

- Model The Way
- Inspire A Shared Vision
- Challenge The Process
- Enable Others To Act
- Encourage The Heart.

The responder answers each query on a scale of 1 (almost never) to 10 (almost always), thus generating a score of 6 to 60 for each of the five categories. For each category, an individual received three scores: a self-score (LPI-Self), his or her manager's score (LPI-Manager), and an average score of all evaluations completed, regardless of type (LPI-Average), resulting in 15 scores for analysis for each participant. Because at least seven separate evaluations were used to generate the LPI-Average scores (the true 360-degree evaluation) for each individual, the LPI-Average values were deemed to be a more accurate representation of an individual's true leadership performance than the LPI-Self or LPI-Manager values. For that reason, the authors focused on the LPI-Average scores to prove or disprove the hypotheses.

A Supplementary Questionnaire was also developed by the authors to enable analysis of causal influences. The first part of the questionnaire requested general information with respect to age and education along with questions addressing the casual influences such as: job experience, project management experience, formal management training, formal leadership training, and job assignments. The second part of the questionnaire solicited information related to the respondent's perceptions as to the importance of various leadership influences on their career development. These leadership influences included observing, mentoring or coaching by others, reading and self study, education, training, and job experience. The respondents were asked to rate the importance of these influences on a scale of 1 to 10, with 1 indicating "absolutely not", and 10 indicating "absolutely yes". A rating of 8 indicated that the survey influence "usually" impacted their career development.

Data Analysis Process

The data from the LPI questionnaires were entered into an LPI Scoring Software program (Pfeiffer & Company at John Wiley & Sons, Inc., Indianapolis, IN; or online at www.LeadershipChallenge.com). This program produced a feedback sheet of numerical data for each participant, identifying areas that needed improvement. The supplementary questionnaire also generated numerical data. Both sets of data were entered into excel sheets. The Statistical Analysis System (SAS) Process Means (SAS Institute, Inc., Cary, NC) was used to generate descriptive statistics of the LPI results and supplementary questionnaire results for the two groups of construction project managers. The results then were analyzed using two-sample *t*-Tests.

An important decision in this analysis was the level selected for the type-I error. Based on a literature review, it was determined that setting the type-I error α value at 0.10, and having 90% confidence in the resulting analysis, would be acceptable. The reasons for this decision were: 1) because many researchers have failed to find statistically significant results in leadership research, setting the type-I error at 0.10 would provide a more generous opportunity for success; 2) the results of this research would not result in catastrophe or loss of human life if they were inaccurate, so a larger α value is acceptable; and 3) a value of 0.10 provides a larger chance of a type-I error (rejecting the null hypothesis when the null hypothesis is true), which is preferable to making a type-II error (accepting the null hypothesis when the null hypothesis is false). A type-II error would accept the null hypotheses as true, and offer no assistance to the construction industry in leadership development. Given the choices, making a type-I error is preferable because at least some direction can be provided to the construction industry for leadership development options.

DATA ANALYSIS

Response Rate

Table 1 identifies the total number of potential participants in the research, as well as the actual number of participants in each group who were selected, and ultimately responded. As reported in the table, the response rate for each group of construction project managers selected for this dissertation research was approximately the same. The top performers responded at a rate of 87.50 percent, while the control group responded at a rate of 82.50 percent.

Table 1: Construction Project Manager Research Participants

Construction Project Manager Category	# Selected	# Responses	Response %
Total Population	335	68	20.30 %
Selected for Research	80	68	85.00 %
Top Performers	40	35	87.50 %
Control Group	40	33	82.50 %

The overall response rate for the research equaled 85%. This is an extremely high response rate for any voluntary survey; personal interviews and telephone interviews typically yield a response rate of 60% to 75%, while mailed questionnaires response rates are much lower (Ott and Longnecker, 2001). The outstanding response rate is indicative of the strong corporate support provided for the research. As depicted in Table 1, sample sizes of 35 top performers and 33 control group construction project managers were obtained, exceeding the target research sample size of 30 responses per group. A total of 719 questionnaires, including both the Leadership Practices Inventory Questionnaires and the Supplementary Project Manager Questionnaires, were incorporated into this research. One of the 68 respondents did not submit a supplementary questionnaire, but data from that individual was still utilized in the LPI analysis. Demographically speaking, a significant difference was not found between the two study groups with regard to age, gender, or type of construction project being performed. In fact, the researcher would have had a difficult time finding a more evenly distributed sample. These data seem to indicate that age, gender, and type construction project being performed are not relevant to achieving top performer status.

Leadership Behavior Differences

The Kouzes-Posner Leadership Practices Inventory (LPI) (Kouzes-Posner 2002) was used to quantify the leadership behaviors of construction project managers. The data used for this research were the following three values; LPI (Self), LPI (Average), and LPI (Manager). The average score is generated by the 360-degree analysis, and is produced by calculating the mean of all evaluations submitted on the participant; to include evaluations by self, manager(s), direct reports, co-workers, and others. These three scores; self, manager, and average, were provided for each of the 5 LPI measurable leadership practices. For the purpose of this research then, 15 scores were analyzed from each construction project manager; self, manager, and average, in each of the 5 LPI leadership practices. The 5 LPI areas analyzed in this research are as follows:

- Model The Way,
- Inspire A Shared Vision,
- Challenge The Process,
- Enable Others To Act,
- Encourage The Heart.

The LPI requests participants to answer 30 questions regarding observed leadership practices. Responses are answered on a scale ranging from one (Almost Never) to 10 (Almost Always). Each measured LPI area generates a score from 6 to 60 based on the answers to six corresponding questions. The self score is the score the individual assigns himself. The manager score is the score assigned by the individual's manager(s). Both of these scores are interesting, but provide a somewhat limited evaluation of leadership for a researcher attempting to compare group performance. The average scores are a 360-degree observation, and include observations of self, manager, co-workers, direct reports, and others. A minimum of seven separate evaluations were employed to generate the LPI average scores for each individual considered in this research. Table 2 provides a comparison of the LPI (Average) scores for construction project managers in the five evaluated leadership practices areas. Areas of significant statistical difference are annotated by the asterisk (*) symbol placed in the P value column of the matrix.

Table 2: LPI (Average) Comparison

LPI Area	Group	n	Mean	Std Dev	df	t	P
Model The Way	TP	35	46.409	4.1150	66	2.31	*0.0369
	CG	33	44.333	3.9060			
Inspire A Shared Vision	TP	35	40.926	4.2671	66	1.72	*0.0902
	CG	33	39.045	4.7472			
Challenge The Process	TP	35	44.280	4.1485	66	2.31	*0.0238
	CG	33	42.000	3.9671			
Enable Others To Act	TP	35	48.066	3.9114	66	-0.39	0.6999
	CG	33	48.430	3.8496			
Encourage The Heart	TP	35	45.260	5.2908	66	1.61	0.1112
	CG	33	43.336	4.4723			

The following notation is utilized in Table 2:

"n" represents the number of samples in the analysis;
"Mean" represents the mean score;
"Std. Dev." represents the standard deviation;
"df" represents degrees of freedom;
"t" represents the test statistic;
"P" represents the probability of accepting or rejecting the test statistic.

Table 2 shows a statistically significant difference in three of the five measured LPI (Average) areas; Model The Way, Inspire A Shared Vision, and Challenge The Process. The P values for those 3 leadership practices are less than the .10 value established for level of significance, and reject the null hypothesis. Data in Table 2 indicates top performers are significantly better at; clarifying their personal values, setting the example, and aligning organizational actions with shared values (Model the Way), imagining exciting possibilities and developments and then enlisting others into a common vision by appealing to shared inspirations (Inspiring a Shared Vision), and searching for new opportunities by seeking out innovative ways to change, grow, and improve as well as taking risks by constantly generating small wins and learning from their mistakes (Challenging The Process), (Kouzes-Posner 2002).

There was not a significant difference in leadership practices between the two groups in the LPI areas of; Enable Others To Act, and Encourage The Heart. This implies that there is not a significant difference between the two groups in their ability to; foster collaboration by promoting cooperative goals and building trust and strengthening others by sharing power and discretion (Enable Others To Act), or in recognizing the contributions of others, showing appreciation for individual excellence, celebrating values and victories, and creating a sprit of community (Encouraging The Heart), (Kouzes-Posner 2002).

Leadership Career Development Influences

The research Supplementary Survey solicited opinions from both groups as to the importance of various leadership influences on their career development. The seven leadership influences cited on the survey were observing, mentoring or coaching by seniors, reading or self study, education courses during college, education courses since college, company training, and job experience. The purpose of this section of the survey was to determine if top performers assigned significantly different values of importance to these potential sources of leadership development than the control group. It was anticipated that the results of the analysis would identify strategies for the development of project manager leadership skills.

A portion of the survey data analysis is illustrated in Table 3. Two leadership influences indicated statistical differences between the groups: mentoring and coaching by seniors, and reading and self- study. It is interesting to note that mentoring and coaching requires the support of others whereas reading and self-study requires the initiative of the individual. This particular finding is in agreement with the literature, which states that learning leadership is very personal, and usually requires the initiative of the individual for self-improvement (Bennis 2003; Kotter 1990; Tichy 1997).

The mean values shown in Table 3 should also be carefully examined. Both groups strongly believed that observing and job experience were the primary influences. This is consistent with the literature that states you learn leadership best by leading or observing someone else lead (Kotter 1990; Bennis 2003; Cohen 2000). Both groups indicated that formal education courses taken in and since college were lesser influences in leadership career path development. This finding agrees with the literature that challenges colleges and universities to make their curriculums more responsive to the leadership and management needs of today's engineer (Bergeron 2001; Rubin 2002; Badger and Kashiwagi, 2004).

Table 3: Comparison of PM Opinions on the Development of Leadership Skills

How Leadership Skills Were Developed	Group	n	Mean	Std Dev	df	t	P
Observing	TP	35	8.486	1.246	65	0.58	0.5613
	CG	32	8.313	1.176			
Mentoring/Coaching By Seniors	TP	35	6.200	2.483	65	1.86	*0.0667
	CG	32	5.125	2.211			
Reading & Self- Study	TP	35	6.371	2.414	65	1.76	*0.0830
	CG	32	5.313	2.507			
Educational Courses During College	TP	35	3.743	2.582	65	0.70	0.4879
	CG	32	3.313	2.455			
Educational Courses Since College	TP	35	4.057	2.700	65	1.24	0.2199
	CG	32	3.281	2.300			
Training Offered By The Company	TP	35	5.171	2.572	65	0.24	0.8073
	CG	32	5.031	2.055			
Job Experience	TP	35	9.086	1.011	65	1.15	0.2545
	CG	32	8.781	1.157			

Although not addressed in this paper (the reader is referred to Skipper 2004), the research also examined such causal influences as formal education, years of job experience, extent of formal training, and the mix of initial job assignments. In general, there were no statistically significant differences among the two groups for these influences.

CONCLUSION

The Clemson University research project described in this paper utilized the Kouzes-Posner Leadership Practices Inventory (LPI), to generate data that found statistically significant differences in three of the five measured areas for LPI (Average). The research null hypothesis was rejected, and the authors accepted the alternate hypothesis; "The leadership behaviors of top performing construction project managers are greater (better) than the leadership behaviors of control group construction project managers." The top performing construction project managers were assessed to be significantly different (better) at leadership traits that included the ability to align organizational actions with shared visions, enlist others into a common vision, and seek ways to change, grow, and improve. The general leadership literature supports this contention. This finding implies that organizations should strive to establish a leadership culture from top to bottom throughout the organization to have a sustained positive impact at every level.

Both the top performer and control groups valued the importance of job experience and observing as major causal influences on leadership development, but the top performer group placed statistically significant higher emphasis on the importance of mentoring and coaching, and reading and self study. The literature review also supports this position. This finding implies that leaders at all levels need to realize the significant importance of setting the example, coaching, and mentoring for the enhanced development of present and future construction project managers.

In summary, this research determined that there are significant differences in leadership behavior and causal influences between top performers and a control group. Attention to causal influences may help in the development of improved leadership skills in construction project managers. Revising college curriculums and teaching techniques can be done, but the results will take years to become apparent. However, many of the required actions by industry and individuals are comparatively inexpensive, and simply require a new focus on leadership. Organizations can develop a culture of teaching, mentoring, self study, and frequent job changes to develop improved leadership and management skills. Organizations can also use their own highly qualified personnel to offer formal in-house leadership and management training. Individuals can show initiative in self study, reading, observing, and attempting to practice proportionately more leadership than in the past. For too long the construction industry has focused on management, to the exclusion of leadership. More research, as well as determined application, may make a difference to the future competitiveness of the construction industry.

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Incorporating Leadership Skill Development in Construction Training Programs

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Abstract

Leadership is important at all levels of construction administration from field supervision to company management. Leadership has two key components – social skills (associated with influencing people to act) and problem-solving skills (associated with developing a plan of action or goal to work towards). Incorporating leadership skill development in construction training programs requires that both types of skills (social and problem-solving) be addressed. This paper suggests a Skills-Based Model for development of leadership skills in construction organizations. This model recognizes that leaders move from a novice level to an expert level by acquiring skills through progressively more complex work assignments. A practical implication of this model in construction organizations is that mangers need to expose workers to different work experiences and provide them with opportunities to solve progressively more complex problems.

Introduction

Leadership is of fundamental importance to effective management of construction projects, independent of size, sector or location (Dainty et al. 2005; Odusami 2002). It is important at all levels of construction administration from field supervision to company management. Given the importance of leadership to the success of an organization, it is surprising how few construction organizations take an active role in leadership development. One of the reasons for this lack of action may be associated with the fact that people define leadership differently. Even with different definitions of leadership, there are many commonalities. Farr et al. (1997) identified the following commonalities among several definitions of leadership – "leadership is an interpersonal influence process that is goal directed and purposive." McCuen (1999) takes a similar approach in stating that "leadership consists of the knowledge and skills that the individual possesses and employs to persuade others to enthusiastically work toward the completion of the plan of action that the leader has established." Based on these definitions, leadership has two key components – social skills (associated with influencing people to act) and problem-solving skills (associated with developing a plan of action or goal to work towards).

Incorporating leadership skill development in construction training programs requires that both types of skills (social and problem-solving) be addressed. Complicating the creation of leadership development programs in construction organizations is the difficulty in differentiating between management and leadership. Management is generally defined by the skills necessary to complete a task. For construction projects these skills may include technical skills (e.g., planning, scheduling, cost estimating, or craft skills) as well as basic social skills (e.g., communication skills). These are the skills that many construction organizations focus on when developing training programs. Management is the application of these skills using rules, such as management-by-exception (Clough *et al.* 2000). The application of management rules can ensure that tasks are completed; however, the success of a construction organization rests not only on completing tasks, but completing them successfully (i.e., profitably, safely, and with consideration for human resources). The difference between completing a task and completing a task successfully relies on employees evolving from a management role to a leadership role. Leadership skills build on basic management skills by adding motivation and advanced problem-solving skills.

As a starting point for developing leadership training programs in construction organizations, this paper presents a Skills-Based Model for leadership development and recommends how this model can be incorporated into construction training programs.

Skills-Based Model of Leadership Development

Mumford *et al.* (2000c) presents a skills-based model of leadership development based on observations of officers in the United States Army. This skills-based model contends that leadership ultimately depends on the ability to solve novel, ill-defined problems. The skills needed to solve these types of problems include problem-solving skills, social judgment skills, and social skills. Problem-solving skills include being able to identify and understand a problem and develop potential solutions. Social judgment skills relate to the refinement of potential solutions and the creation of frameworks for implementing solutions. Social skills are associated with motivating and directing others during the implementation of solutions. These skills are acquired over time as levels of experience increase, which means that the evolution from mere manager to leader occurs over the course of a career.

In addition, the model assumes that certain types of knowledge are necessary to effectively apply these leadership skills – knowledge of the job, knowledge of the organization, knowledge of the business, and knowledge of the people (Mumford et al. 2000c). Therefore, even the most charismatic and talented leaders are considered novices when they enter a new organization, because they lack a true understanding of the people in the organization and how to accomplish work within the organization (Mumford et al. 2000a). Leaders progress from a novice level through an intermediate level to an expert level by gaining organizational knowledge and acquiring increased competency in the three key leadership skills (problem-solving, social judgment, and social).

The development of leadership skills from novice to expert is achieved through real life experience. It is assumed that novice leaders have a basic set of technical and social skills from prior education or work experience that can be relied on to solve simple problems that are highly structured and well defined (Figure 1). As novices gain organizational knowledge, they also need to work on developing their leadership skills to reach the intermediate level. A key element in progressing from novice to intermediate is the integration of real-world experience along with independent, supervisory assignments, which expose novices to more ill-defined problems. The move from the intermediate to expert level occurs when a leader can solve novel challenging problems that require working with others who may have different perspectives. This progression from novice to expert may take up to 20 years; however, one would expect the time frame to be significantly less for people with many years of work experience. (Mumford et al. 2000a)

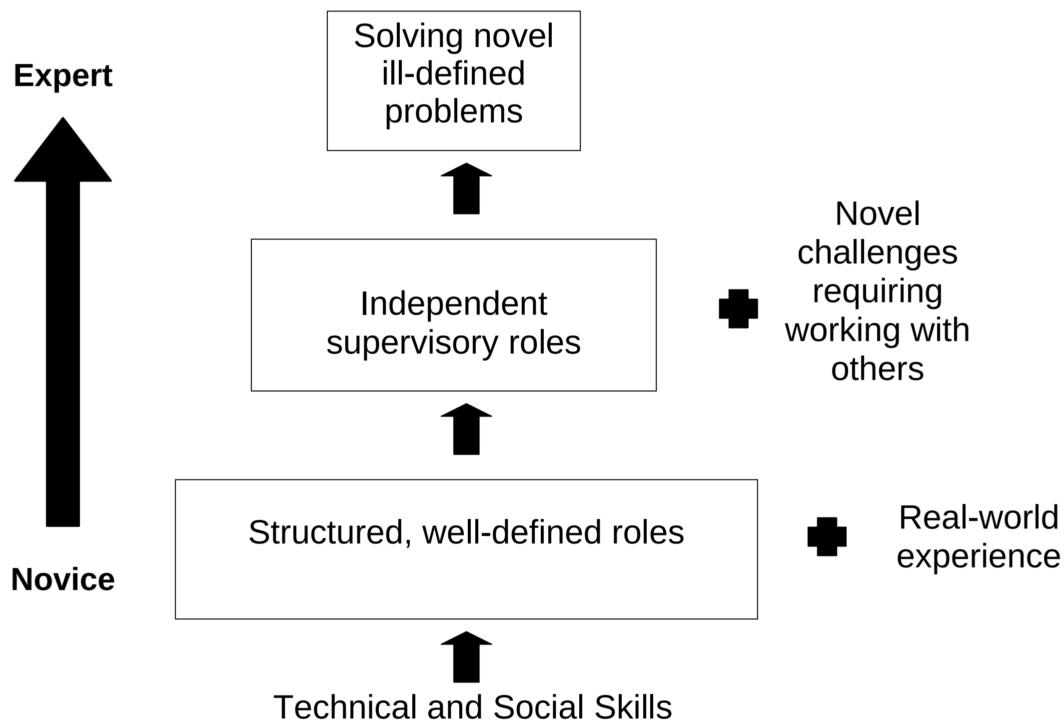

Figure 1. Skills-Based Model of Leadership Development.

The advantage of the skills-based model proposed by Mumford *et al*. (2000c) is that it provides a framework for creating leadership development programs that are based on the capabilities, skills and knowledge shown to develop leaders from novices into experts (Mumford et al. 2000b). According to the skills-based model presented in Figure 1, there are several areas on which to focus leadership development programs. Initial training on technical and social skills is the first step in developing leaders. These skills are often gained in educational environments, and several researchers have addressed the issues surrounding leadership development in engineering education (Bowman and Farr 2000; Farr et al. 1997; McCuen 1999). What is less well defined is the role of leadership development programs within a construction organization. These types of programs are critical to the advancement of leaders from the novice to the expert stage and are best offered within the organization in order to build up knowledge of the organization and the people in the organization.

Current State of Leadership Development Programs

A recent survey of business leaders and human resource representatives from 42 countries indicates that leadership development programs are often misdirected. The most common leadership development practice is formal training programs; however, the study showed that giving workers special projects or assignments as part of their normal job is more effective in developing successful leaders. Another missing element to leadership development in many companies is a mentoring program. (Weinstein 2006)

Apprenticeship programs are another successful approach to leadership development. Apprenticeship programs combine technical education with increasingly advanced work experiences, which allow workers to gradually assume greater leadership roles. Although apprenticeship programs have declined in recent years, some companies are reviving them as a means to develop future leaders. (Waxer 2006)

The focus of leadership development research can generally be grouped into one of two areas – developing individual skills that are associated with leaders (e.g., charisma, motivation, intellectual stimulation) or developing interpersonal social relationships to encourage cooperation (Day 2000). The first approach focuses on developing individuals as "leaders" and includes research on transformational leadership and charismatic leadership. These types of individual skills are hard to learn. The second approach focuses on developing "leadership" opportunities through relationships. The skill-based model developed by Mumford *et al.* (2000c), and described previously, focuses mostly on social skills as well as on individual problem-solving skills, both of which can be learned. For this reason, the skills-based model of leadership development has been adopted for this study as the initial framework for leadership development programs in construction organizations.

A Preliminary Training Model for Developing Construction Leaders

Development of leaders in construction organizations has traditionally followed an apprenticeship model where leadership skills are acquired through experiences gained in the construction workplace. Some companies augment apprenticeship programs to some extent by training. Recent labor shortages and economic pressures have forced some companies to abandon formal apprenticeship programs in exchange for on-the-job training. Apprenticeship programs provide a good structure within which to develop leadership skills. However, in the absence of a formal apprenticeship program, an alternative approach is described in the following paragraphs.

A training model for developing construction leaders should include creation of a well-defined plan to shape the work experience of the employee by ensuring that the employee gains appropriate learning opportunities supported by formal training. Leadership development should be based upon a well-defined plan starting at the level where an individual is. The plan should be designed to shape both the experience and the training to take the learner from a novice level through a series of steps, achieving the outcomes desired in the expert leader. A mentor will help the novice move through the leadership plan by providing direction and securing resources necessary for development.

Upon entry into the leadership development program, the novice should work with the mentor (often the novice's immediate supervisor) to define where the novice is at that point in their career and where they want to be. Based on the Skills-Based Model, a key element of the program is to provide clearly defined job descriptions and rolls for each step along the way. Next, technical skills can be defined as the tools that the learner will need to effectively execute the defined job at each step. Technical training can then be developed to provide the desired technical skills. Within the context of the technical training, social skills such as oral communication, problem solving and critical thinking can be integrated through workshop activities and practical exercises. These skills would then be reinforced and applied through work experiences. A unique characteristic of leadership skills is that they are difficult to teach in a vacuum, but can often be incorporated into technical training and through work experience.

Conclusion

The preliminary training model for developing construction leaders presented in this paper is based on a Skills-Based Model of leadership development. This model is presented as a starting point for discussion and further study on this topic. The key to the presented training model is to provide an employee with increasingly complex work assignments that will aid in developing problem-solving skills as well as social skills. These work assignments can be supplemented by technical training to ensure that the employee has the required technical skills. The goal of the training program is to move the employee from a novice leader state to an expert leader state.

Further definition of the model for leadership development programs in construction organizations is currently underway. The authors are conducting a survey of entry-level employees in construction organizations to identify what type of work environment they are exposed to and whether that environment is consistent with the Skills-Based Model presented in this paper. After the survey and subsequent refinement of the training model, the authors plan to conduct a demonstration case study to evaluate the training model in an actual construction organization. Based on observations from the case study, a final framework will be developed.

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Building Leadership Skills and Traits: The Critical Faculty Enabler

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Traditionally faculties resist the concept of being evaluated, profiled, and/or ranked, and yet in the processes of being recruited and hired, faculty candidates are constantly being measured and compared. The candidates' "paper credentials" play central roles in each candidate's success in being hired. However, individual core values, people skills, competencies, and leadership traits of the candidates are usually not addressed directly, and in many cases, not indirectly, in the hiring process. The faculty member's leadership ability and leadership experiences play central roles in each faculty's member's career successes. In reviewing evaluation processes and forms, leadership is seldom mentioned and if leadership is mentioned it is undervalued.

Key Words: Construction Education, Faculty Hiring, Faculty Profiling, Faculty Ranking and Faculty Evaluations, Leadership

Introduction

To quote an old management saying, "You are hired for your technical skills, fired for your lack of people skills, and promoted for your leadership and management skills." The purpose of this paper is to address how important leadership skills are to faculty recruitment and career success.

This paper uses the term "construction programs" to include all programs of construction in higher education, including construction management, construction science, building construction, construction engineering, etc. The authors realize this is a very controversial topic and anticipate that this paper will be a vehicle to initiate and conduct academic debates.

The academic discipline of construction is a blend of technology, engineering, management, and construction. Construction programs of higher education evolved during the last century; however, academia has been slow in realigning supporting programs to meet the growth of construction programs which reflect the needs of the construction industry. The transformation is underway, but the pipeline of qualified construction faculty has not yet been established. Faculty members are being recruited from the crossover disciplines—engineering, architecture, education, etc. The ability of multi-disciplined faculty to deliver a construction curriculum creates both a richness of diversity and a forum for conflict.

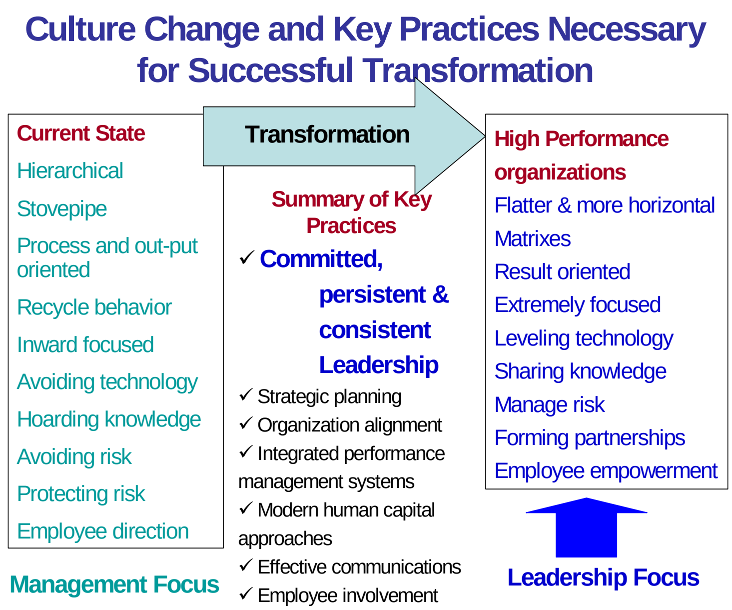
A few years ago one of the author's academic programs had a consultant/facilitator assess the faculty and senior staff in profiling their preferred work style. The results were interesting in that the majority of the faculty were classed as independent workers/creative types with great affinity for task and details. Only six of the 40 were in the leader/manager category with a big picture focus with an affinity for leadership over management. All were successful faculty and knew themselves, and were content with the academic careers. The authors recognize that the academic career may be a superb choice for the independent worker, but are concerned about creating a pipeline of future program leaders from this group. The concern was that the super-independent work style may produce micro-managers and not leaders if these faculty members become program administrators.

Consequently, in succession planning, leadership became a priority in one author's school. One training phase, the "identify future program leaders" phase helped the faculty better understand themselves. A series of leadership development discussions and seminars were conducted. Leadership books were introduced and discussions of principles of leadership were held. Additionally, an investment in annual faculty development education and training on leadership was incorporated.

In this paper, the authors will suggest ways to profile and evaluate the leadership competencies in the academic setting and increase the weightings universities use in evaluating the leadership area.

Literature Search--Background

The literature search will target leadership, competencies, hiring practices, profiling, ranking, and faculty evaluations.



The Federal Government

Walker, David (2005) promotes leadership at the highest levels of government a better appreciation of leadership over management has surfaced. Walker (2006) presented the culture change and key practices necessary for successful transformation. In his summary of key practices, his first transformational factor was committed, persistent, consistent leadership. He stated that leadership must set the direction, pace and tone for the transformation and should provide sustained and focused attention over the long term. The authors believe that the transformation in government agencies is also happening, and needs to be happening in academia.

A Shift to a Leadership Model

Badger and Kashiwagi (2004) state that the nature of work may be radically shifting from a management focus to a leadership-based framework and a better appreciation of leadership will be needed at every level within the organization.

Introducing Competency

In a Project Manager Competency Model (Waller, 1997), competence refers to some observable evidence of performance by individuals. Competency can be defined as having the minimum knowledge and skill to satisfactorily perform. The Waller paper describes a competence model for project managers that attempts to include not only knowledge and skill, but further expands the model to include intellectual and moral behaviors in concert with the project manager's style. The authors feel that construction education has to move to a competency model for faculty members.

As written by (Bigelow 2003), putting the right project manager on the right job is what competency assessment is all about! Competency is a buzzword in the new millennium, but what does it mean? Why would an organization want to evaluate project manager competency? Projects are only as successful as the people who manage them. Evaluating project manager competency enables organizations to identify individuals who are, or have the potential to become, superior project managers and determine what is needed in the way of coaching and development to raise performance.

According to (Dainty 2004), the role of competency-based performance management is growing in significance in many industries and sectors. The research identifies 12 core behavioral competencies that underpin effective project management performance, of which, two – 'composure' and 'team leadership' – were the most predictive. The authors believe this is true in academia.

Hiring the Right People

"Good to Great" (Collins, 2003) is a well read management book and is based on solid research regarding how a good company can become a great company. The authors feel that Collins has captured some of the concepts in his book for making academic programs great. In chapter 4, Collins emphasizes that level-5 leadership, the top leadership which he identifies, first gets the right people on the bus in the right seats and once the right team is in place, then they figure out the best path to greatness. One Jim Collins quote that stands out is: "Those who build great companies understand that the ultimate throttle on growth for any great company is not market or technology or competition or product. It is one thing above all others; the ability to get and keep enough of the right people."

Badger and Smith (2005) state that the first guiding principle in creating a world-class academic program is to hire and keep highly qualified and motivated faculty. In some academic circles deans will decide what direction the department will go and will only authorize hiring faculty with targeted skill sets. This seems to be especially true in deans who have a priority on research and a lower priority on teaching. The customers, the construction industry, value teaching more than research, and in most hiring cases, administrators have to face the dilemma of finding candidates with a Ph.D. and an affinity for research or a candidate with good construction experience and a desire and capability to teach.

Badger and Smith (2004) contend that the true measure of any construction program is the quality of the individual faculty members. World class instruction is not singularly driven by curriculum, but the quality of the individual faculty member. Great faculty members have outstanding classes and their students become outstanding alumni. The challenge is that the faculty members do not generally want to be evaluated and compared with their peers or peer programs. There are many metrics--student teaching evaluations, the chair's exit interviews, publication records, research dollar expenditures, and results of the CPC exams assessments--which could be used to rank faculty members, but few programs, have the desire, capability, or data to do this type of evaluation and ranking, nor can they stand the heat if they do.

Faculty Competence

According to one study (Walsh 1996), formal interviews are the best opportunity for a candidate to demonstrate their oral skills. Is the interviewee poised doing the interview? Were they articulate and confident? The oral communication abilities of faculty candidates become evident during the interview visits and the typically required presentation of a construction topic to the faculty.

Values

The Walsh study states: "…most people are aware of their own value system; however, many people deceive themselves and try to convince themselves that their values lie elsewhere". A person's value system is one of the most difficult things to change. Therefore, knowing your own values and the values of others working with you can be advantageous in developing personal and team relationships.

Professional Testing

Bernstein & Kaye (1993) have created an instrument to evaluate an individual's values. This instrument asked the person being tested 35 questions. Values give meaning to life and work and provide personal development. Knowing the values that are most essential is an enabler in making the good choices. The good news is there a wide variety of values to choose from; the bad news is that you can't have them all. The instrument asked the person being evaluated to select the seven values that are most meaningful to them out of 35. It forces the individual to "value" profile themselves.

The authors realize that determining core values will probably be accomplished in discussions with the candidate's references. Additionally, more discussions with the candidate's industry colleagues about core values and reputation are critical.

Work Style Profile

Everyone has a tendency to work according to a preferred work pattern or work style. For example, one person may be task-oriented, while another is only concerned with the big picture. One person may be result-oriented, while another may wish to investigate issues thoroughly. These two examples are rather diverse pairs. However, there is no reason they cannot work together on a project or as a faculty team. By knowing how each member of a team prefers to work, compromises can be made to work effectively as a team without destructive conflict.

Furthermore, assessing a person's work style preference may be as important as assessing their qualification for the job. Misalignment of a person's work style preference to the work style requirement of their position may result in personal and organizational stress. It may be unwise for an employer to select a task-oriented person for a big picture job.

Several inventories are available in a self-graded format for individuals to determine their preferred work styles. Two such surveys, McFlechor's Work Style preference inventory and Padgett Thompson's personal profile systems are available. The McFlecher instrument has been successfully administered and correlated with construction professionals by Badger and Warner (1991).

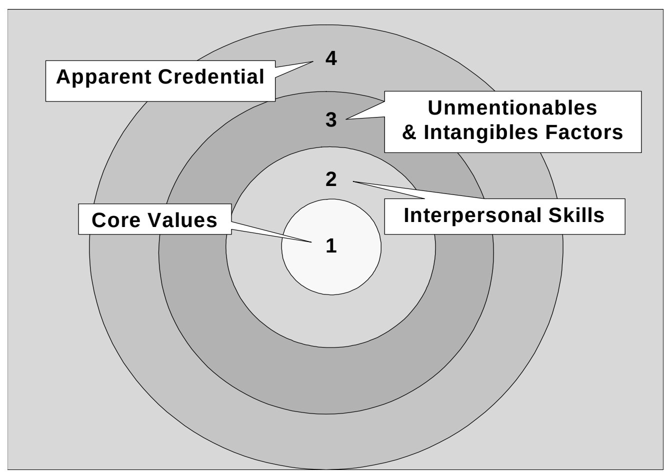
Myers-Briggs

The use of the Myers-Briggs Type Indicator ® instrument and the Strong Interest Inventory ® instrument or other similar tests can help both organizations and individuals make better decisions regarding suitable careers and job placement.

Hiring New Faculty

The Process

Most faculty searches are accomplished by casting a big net—the bigger the better—and hoping that something swims in. Once positions are approved by the institution, an advertisement is broadcast widely, usually on the ASC and ASCE web site, the obligatory EEO outlets, and frequently in ENR. Applications are received and evaluated or ranked and visits are offered to the best candidates. Visits are brief and perfunctory, references may or may not be checked, and a hiring decision is made. Usually a faculty search committee administers this process, making hiring recommendations to program leaders or the deans.



The Four Circle Model

The Four Circle Model was developed by the authors in a previous work (Badger and Smith, 2006). The authors realized that in the academic hiring process, faculty candidates are profiled and ranked by faculty and administrators. By developing a Four Circle Model to display the three layers of an individual's credentials that surrounds their core values, it is hoped that a better framework for the hiring process can be described. The authors have designated the center, Circle One, as the candidate's core values; Circle Two represents the candidate's interpersonal skills; Circle Three identifies the hidden, invisible, and unmentionable topics that come into play; and the outer Circle Four includes the apparent credentials—degrees and experience—usually found in a resume. Usually faculty hiring decisions only focus on Circle Four, the outer ring, to develop the selection and hiring criteria. The authors feel that hiring should be done from the core outward and not just in Circle Four.

Inner Circle One--Core Values

1 Is moral and ethical
2 Will be a positive role model
3 Has good leadership ability
4 Is sensitive to people
5 Seeks a higher purpose in life
6 Is a nice person—a lady or a gentleman
7 Is bright
8 Is entertaining
9 Is a humble person with ego under control
10 Keeps physically fit
11 Has internal discipline
12 Is visionary with commitment to construction higher education

Circle Two--Interpersonal Skills

1 Has interpersonal skills
2 Has people skills, a team builder
3 Is a trust builder
4 Is a good communicator
5 Has high energy level
6 Believes in life long learning
7 Has a vision, goals, and objectives
8 Practices leadership
9 Skilled in management
10 Superb communicator

Circle Three--Unmentionable and Intangible Factors

These are crucial factors in the hiring process that are used but never explicitly recognized.

1. Age: The faculty lines are so difficult to obtain we may not use one to hire an older candidate who will only be available for a few years.
2. Health: The candidate that is overweight, smokes, or has health problems is usually avoided as a poor return on investment.
3. Reputation: The un-programmed phone calls to determine the ability of a candidate to work within the team, moral and ethical behavior, and legal profiles are critical but never talked about.
4. Ability to be a role model component in the program: the stability, capability, and successful track record to work in close proximity with students without crossing the boundary is important but, again, never talked about.
5. Failure on previous jobs: any faculty that was not tenured at one university will not be a serious candidate at the next university.
6. Misconceptions: the idea and perception that an industry professional can retire, tell war stories, and play golf needs to be ferreted out, and the brutal fact of how difficult being a full-time university educator can be must be communicated. The true reason for the transition into academia needs to be determined and discussed.

Circle Four—Apparent Credentials

1. Education background comes in the form of the standard résumé or vita.
2. Industry experience may be the least understood hiring criteria, the hardest to verify, and most often is poorly evaluated.

3. University degrees are required, and over the years the bar has continues to be raised by universities to a PhD level.
4. Professional licenses are a clear demonstration of experience and ability but are seldom mandatory in the hiring process.
5. Publications are sometimes used to measure scholarship.
6. References seem to always be required, but it is unclear how extensively they are used.
7. Awards would be a great indicator of performance, recognition, and achievement but, in some cases are seldom used.

Discussion

The realism of the hiring system is that administrators usually advertise the requirements from the outer Circle Four when what is needed are the skills identified in Circle Two and the core values of the candidates in the inner circle, all considered in the context of Circle Three. It is unsettling to have the paradox of being politically correct but unable to state what is really wanted. In public, the faculty members work on Circle Four, when what is really needed is the recognition that the really important things are in Circles One, Two, and Three.

Badger and Smith (2006) state that clearly, hiring construction faculty is very difficult and is becoming more so as universities raise the minimum credentials. Additionally, fewer and fewer faculty hires are from U.S. graduate programs, which indicate that U.S. schools are not meeting the faculty needs of domestic construction programs. The absence of a pool of young, PhD holding applicants indicates a severe problem filling construction positions in the future. While international hires and hires from outside the discipline can fill some of the positions, the inability to hire PhD's in the specific field debilitates construction programs drastically, which negatively affects future recruitment of both students and faculty. Leadership or leadership potential, as a "skills-set" is missing in most hiring discussions.

Proposed Hiring Scorecard

Badger and Smith (2006) developed a hiring score card, see Appendix A. It is expected that there will not be agreement with the scored items or the scoring weights; however, the authors contend that the scorecard will assist programs in an analysis of candidates and reduce the likelihood that key discriminators will be overlooked. Programs may want to develop their own scorecards and weights; the candidate scorecard in the Appendix can be used as a point of departure.

The importance of faculty hires mandates that universities use as many screens and filters as possible. Investigative background checks, personality profile testing, extensive verification of work experiences, and complete profiling and ranking should be required. With the shortage of qualified faculty candidates, some programs will feel that they need to 'lower the bar' to fill the position. The dilemma that programs face is: Hire someone with imperfect credentials and try and force-fit that individual into the program, or do not hire, struggle through an interim situation for a year, and begin the search again next year? The demand for faculty is growing, the desired faculty credentials are becoming more demanding, and the faculty candidate pool is extremely limited.

The academic hiring process is fraught with difficulty. Growing demand, continuously elevated desired credentials, and very limited candidate development all combine to make hiring a significant challenge.

Current Faculty Ranking Systems

Today, most universities use a number of faculty ranking or evaluation systems [faculty prefer to be ‘evaluated’ rather than ‘ranked’]. These systems include—

- **Student Course Evaluations.** Most universities require that student evaluations be completed for every course, every semester. These evaluations are typically reduced to a ‘score’ which enable comparison with other faculty teaching similar courses.
- **Student Exit Surveys.** A survey of graduating seniors is a normal assessment instrument for most universities. One component of this survey is an assessment or ranking of faculty performance. Again this enables administrators to get a relative ranking of faculty performance.
- **Annual Faculty Reviews.** Most universities require some form of periodic faculty performance appraisal by administrators. This performance appraisal is normally an annual review and tells the faculty member where he/she stands against peers and/or performance expectations.
- **Promotion and Tenure.** The process of tenure and promotion is perhaps the most rigorous of faculty ranking systems. It includes an evaluation of performance over time with the evaluation being accomplished by colleagues in the university, by peers from outside the university and by administrators.
- **Peer Review.** Peer review is an important component of the Tenure and Promotion process and is also evident elsewhere when the professional work of a faculty member is evaluated in peer review of their teaching and research—particularly when they publish in peer-reviewed journals and conferences.

Proposed Ranking System--Faculty Scorecard

Using 10 Guiding Principles and multiple verification measures, Badger and Smith (2006) proposed a faculty scorecard (see Appendix B) which could be used as a component of the Annual Review process. The scorecard might be completed as a self-evaluation by the faculty member, or it might be completed by the administrator and used as a discussion vehicle to guide the faculty member toward professional growth. The authors’ preferred approach would be for the faculty member to complete a self-evaluation of the scorecard, and then in a face-to-face review session with the administrator, go over each metric and agree on a final score and then set goals for the future to enhance the faculty member’s scores. The assignment of weights is arbitrary and is meant to convey a sense of the relative importance as perceived by the program; it is expected that programs that adopt this process will choose to assign their own weights.

The purpose of the Professional Growth section is to address the leadership capability of the faculty member. This category has four metrics. Rankings in this area are often not included in other scoring systems. The authors feel these metrics are perhaps the most important and have more potential for impacting the faculty member’s performance and growth than the metrics in the teaching, research and service categories.

- **Self-improvement.** For a faculty member to achieve world class status, the faculty member needs to practice lifelong learning or self-improvement annually. Faculty internships have been a superb instrument to update faculty member's industry experience. Some programs feel that this industry experience should be updated every four years. On the engineer side, the academic discipline feels that doing research is all the updating needed. Attending industry classes and seminars in construction, estimating, scheduling, contracting, construction law, management, and leadership should be encouraged. Each faculty member should develop a career training and education plan. At one university, faculty members at the start of the year prepare three-page annual work plans. The director then allocates education and training developmental funds once the plan has been reviewed.
- **Mentorship** Whether faculty members like being role models and mentors to students does not matter. It seems to automatically be part of the job, and this should be recognized and rewarded. Great teachers become the leaders in the classroom. Good people skills and positive relationships are needed between faculty members and students, faculty members and industry, and faculty members and university administrators. Usually when surveys within the university address the issue of advising students, the faculty member's ability as a role model and mentor surfaces. Construction faculty members have to be advisers on academic matters, career planning, and during the job search time frame upon graduation. It appears that construction faculty members perform better than the average university professor in teaching and advising.
- **Collegiality.** Getting along in a friendly and collegial fashion is the hallmark of an excellent faculty member. Tolerance for the views and opinions of others is essential. A critical component of any construction program achieving excellence is the ability of the faculty members to work together as a team. The greatest problem any program can have is when the faculty members are divided into cliques and fight among themselves. To achieve world class status requires that faculty members to become team players. It is very difficult to measure loyalty, the ability to work within the team, and how to be a supportive colleague. Faculties need to conduct "think tank" sessions on how to make this happen within the program.
- **Participation.** Faculty members have responsibilities to participate in department, college and university activities. Attending and participating in activities such as graduation, social events, faculty meetings, committee meetings, and student activities are all part of a faculty member's obligations. The best faculty members will always participate actively.

Whether we realize it or not, faculty members are ranked continuously and leadership is a hidden metric. Students evaluate them each semester when they teach. They are evaluated annually when raises are allocated. However, the major ranking occurs when faculty apply for tenure and promotion.

As the academic discipline of construction matures, faculty should understand the profiling and ranking systems. The administrators need to develop skills in profiling and ranking. There are human resources professionals that have developed techniques and methods that we in academia need to study.

Professors do develop skills in evaluating and ranking students and in most cases use some type of tests or exams each semester. The students' work is actually graded by points established and an official grade is awarded. Academic administrators do not seem to use any type of testing or exams for their faculty. One program has encouraged their faculty to take the Certified Professional Contractor Level II exam. Others award credit for faculty members who obtain their Professional Engineer license. In most cases the PE license requires a written exam and a commitment to lifelong learning.

Leadership Development

Leadership Development is a journey which needs constant attention. Despite the age old debate as to whether leaders are born, or whether leaders can be taught, today's leaders must be constantly preparing tomorrow's leaders. Leadership scholars advocate leadership training, blended with leadership opportunity, to better enable tomorrow's leaders.

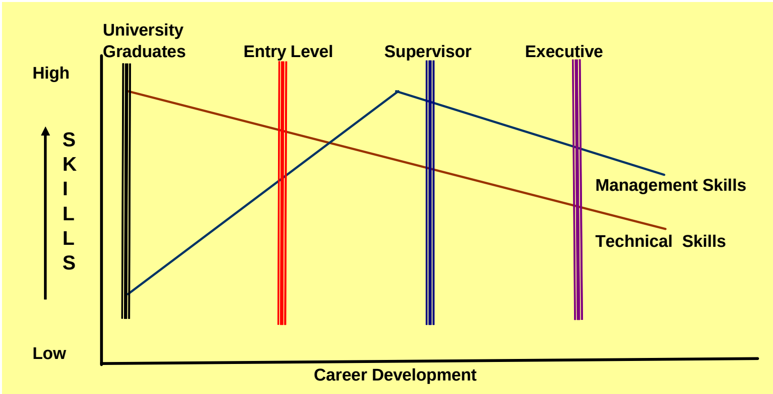
Military Leadership Model

In general, the military has tiered training where entry-level, mid-level, and senior-level officers are screened and the better performers are selected to attend additional schooling. Military and civilian school selection is performance based. The military uses both its own schools run by the military and other opportunity, outsourced to civilian universities. Approximately one-third of the military engineering officers are selected and funded for attendance at a civilian university to obtain a Master's Degree. There is strong encouragement to obtain a Professional Engineering License. Officers may serve a number of tours within the Facility Management area. The combination of the education investment and re-occurring job experience builds professionalism.

Technical Skills

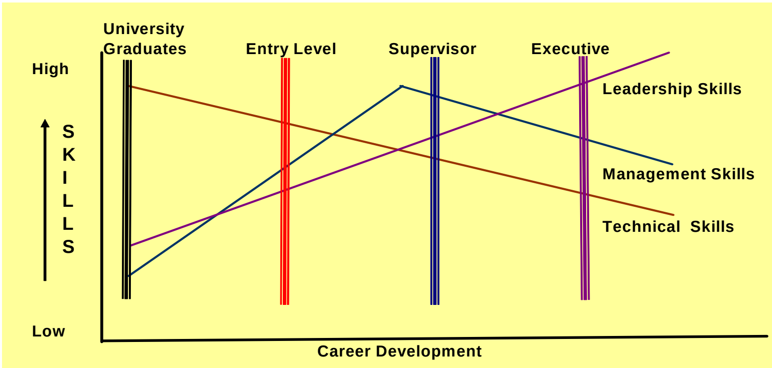
Obtaining a Bachelor of Science degree usually focuses on the technical aspects of the academic discipline. The graduate is hired to work in the functional area of the degree. The challenge may be how graduates can keep the technical skills from decreasing over a career? To maintain proficiency of technical skills, the professional is encouraged to adopt a concept of "life-long learning" and renew and refresh the technical knowledge. Without this refreshing, the proficiency will decrease over a career. A real professional will read, study, do in-house classes, seminars, and on-line technical assisted learning. Many organizational training programs only focus on the technical skill subjects and do not properly address management and leadership. Organization's can adopt the philosophy of "life-long learning", encouraging or requiring employees to join professional societies, practice on-the-job training, and obtaining certifications. When employees practice life-long learning they can keep the technical skill line slope relatively level and not continuing to decrease. See the figure below that has skills on the vertical axis and career development on the horizontal.

Management



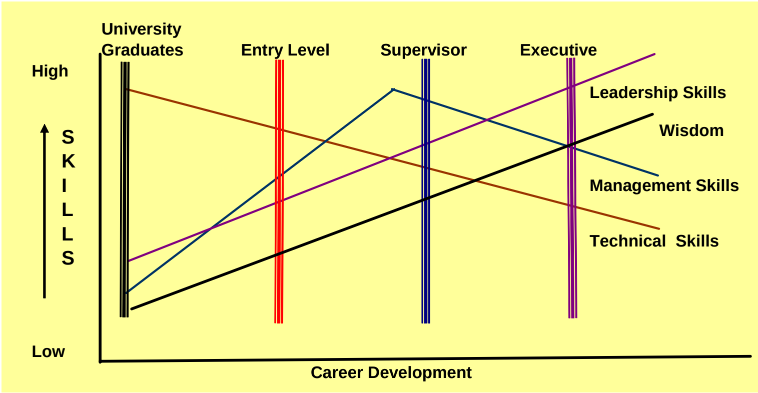
The challenge is how do employees increase their management skills over a career when their initial degree is in a different discipline? Some organizations recommend that the employees get an MBA degree, join professional societies, attend management seminars, and obtain the proper work experiences. Many companies feel it is a good investment to reimburse employees for their university tuition. The importance of providing a series of personal development opportunities builds professionalism within the organization. All these training activities and job experiences should increase the employee's management skill-set. When management is added to the technical skills set, during a career, the balance between technical skills and management skills keep changing. The peak on the management element seems to appear at mid-career before leadership becomes dominant.

Leadership



Employees can become better leaders from self-education, attending seminars, reading, watching, experience, and from having active organizational mentors. Mentoring seems to be the most critical component. It appears that it is relatively easy to train a manager, but extremely difficult to educate a leader. Consequently, organizations appear to have ten times more managers than leaders. It is important to note that leadership skills increase over a career as the employee moves up the career ladder. Additionally, the balance between the other types of skills change and the professional education, training, and development programs need to appreciate this trend and incorporate it into the development program.

Wisdom



Few professionals seem to find operational wisdom during the career process and may be housed in some senior position. To capture this wisdom an organization should initiate a knowledge transfer program. Wisdom seems to be gained from reading, life experiences, listening, observing, learning from mistakes and experimenting. When wisdom is added, successful professionals will be balancing the different skills sets.

Organizations value these skill-sets differently. Yet, they "Profile" the professor and help determine how successful they will be in the future. Professional development programs should address all four elements of technical, management, leadership, and wisdom, and the balance at different levels in the career development and to understand and appreciate the balancing differences.

Summary

The leadership skills of faculty members are important in getting hired, in achieving tenure and promotions, and moving into a leadership role. Academic programs do not seem to recognize, or invest significantly in the professional development of faculty. The profiling and ranking using leadership as a key indicator seems to be missing. However, academic programs need to make the transition in to a leadership model and away from the management focus only. The balance between technical, management, and leadership varies as faculty advance in careers. The management and leadership percentage increase in mid-career and leadership begin to dominate in senior level positions. It is realized that some of the data, analysis, and conclusions are pre-mature and additional research is needed. However, the paper should provide a platform for further academic discussion.

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Appendix A -- Candidate Scorecard

1. Circle 1: Core Values [Maximum score 150 points]
    a. Role model
    b. Gentleman/Lady
    c. Ethical
    d. Great Reputation
    e. Sensitive to people

2. Circle 2: Interpersonal Skills [Maximum score 150 points.]
    a. Leadership skills
    b. People skills
    c. Communicator
    d. Trust builder
    e. Team player
    f.

3. Circle 3: Unmentionable and Intangible Factors [Maximum score 150 points]
    a. Age
    b. Health
    c. Failure on previous jobs
    d. Misconceptions
    e. Poor reputation

4. Circle 4: Academic Record [Maximum score 150 points]
    a. Terminal degree
        1) Has a Master's degree in Construction Management, Construction Engineering, Architecture, or Related Fields
        2) Has a PhD in Construction Management, Construction Engineering, Architecture, or Related Fields
    b. Transcript analysis
        1) Evaluation of the University transcripts of the faculty candidate

5. Circle 4: Industry Experience [Maximum Score 150 points]
    a. Duration
    b. Level
    c. Variety
    d. Continuing education

    Factors to be considered

    - Has three to five years experience in the Construction Industry. (The four sectors factor into the scorecard as do the levels of experience: 1) entry-level, 2) mid-level, and 3) senior-level.)
    - Mapping experience by sectors of Construction (heavy civil, commercial, residential, and industrial) and identifying where the experience was generated.
    - Evaluating at project level, office level, or executive level or in the areas of estimating, scheduling, contracting, and in leading or managing..
    - Individual worker versus supervisor and alignment in a career path should be included.
    - It may be on the design side or construction.
    - It may be local, national, or international.
    - Experience may be gained or weighted by working on the owner side versus contractor and/or civilian versus military.
    - Has 3 to 5 years of experience in the US Construction Industry.
    - Job history, the number of companies worked, and geographic location.

6. Circle 4: Academic Experience – post graduation [Maximum score 50 points]
    a. Teaching experience
    b. Publication record
    c. Research record

   d. Service record
   e. Continuing education

7. Circle 4: Special Credentials [Maximum score 50 points]
   a. Earned credential [P.E., CPC, AIA, etc.]
   b. Honorary credential [NAC, Fellow, etc.]

8. Circle 4: Awards/Recognition [Maximum score 50 points]
   a. Teaching
   b. Research/Service
   c. Other

9. Circle 4: Professional Activities [Maximum score 50 points]
   a. Member
   b. Officer
   c. Continuing education credits and listing of seminars attended.

10. Circle 4: Personal Activities [Maximum score 50 points]
    a. Service activity
    b. Professional society's membership and participation.
    c. Awards, recognition, and letter of commendation.

Experience Ranking Scorecard Ideas

The authors anticipate heated discussions on where the 1000 points are allocated or should be allocated, but if academia could agree on a reasonable methodology to rank experience, this in itself would be a major accomplishment.

Appendix B -- Sample Faculty Scorecard

1. **TEACHING [300 points]**
    a. **Student Course Evaluations [100 points]** The metric used would be the faculty member's average score for all courses taught during the most recent academic year. This average score would be benchmarked against a perfect score and points awarded as follows:
        i. 90-100 percent of benchmark—100 points
        ii. 80-90 percent of benchmark—80 points
        iii. 70-80 percent of benchmark—60 points
        iv. Less than 70 percent of benchmark—no points
    b. **Graduate Committee Leadership [50 points]** This metric would assess the faculty member's participation in the critical role as a member and chair of graduate committees. For the purpose of scoring, three committee memberships would equate to one committee chairmanship.
        i. Committee chair, five committees—50 points
        ii. Committee chair, 3-4 committees—25 points
        iii. Committee chair, 1-2 committees—10 points
    c. **Student Exit Surveys [50 points]** The metric used would be the faculty member's average rating for the most recent academic year. The average score would be benchmarked against a perfect score and points awarded as follows:
        i. 90-100 percent of benchmark—100 points
        ii. 80-90 percent of benchmark—80 points
        iii. 70-80 percent of benchmark—60 points
        iv. Less than 70 percent of benchmark—no points
    d. **Teaching Awards [50 points]** The metric used would be any teaching awards received during the most recent academic year. The total awards could not exceed 50 points.
        i. National teaching award—50 points
        ii. College/University teaching award—25 points each award
        iii. Department/program teaching award—10 points each award
    e. **Peer Ranking [50 points]** This metric would depend on the peer ranking system used by the program. Outside reviewers might be asked to provide a score which could be used in awarding points.
2. **RESEARCH [300 points]**
    a. **Proposals [100 points]** The metric used would be the number of grant proposals submitted with recognition of grants awarded. Only grant proposals in excess of $50,000 could be counted. Total points awarded could not exceed 100 points.
        i. Grant proposals submitted—25 points each proposal
        ii. Grant awards received—up to 100 points, as follows:
            1. Grant awarded $50,000-100,000—50 points each award
            2. Grant awarded $100,000-500,000—75 points each award
            3. Grant awarded >$500,000—100 points
    b. **Expenditures [100 points]** Research expenditure records are normally maintained by the university and are a measure of the faculty member's research productivity. The metric would be the research expenditure for the most recent academic year. The benchmark would be $200,000.
        i. Research expenditure > $200,000—100 points
        ii. Research expenditure $150,000-200,000—75 points
        iii. Research expenditure $100,000-150,000—50 points
        iv. Research expenditure $50,000-100,000—25 points
        v. Research expenditure < $50,000—no points
    c. **Publications [100 points]** The metric would be refereed publications (journal articles and conference proceedings) for the most recent academic year. The benchmark would be five. Single author publications would receive 5 bonus points. Total points awarded could not exceed 100.
        i. Five or more publications—100 points

ii. Four publications—80 points
iii. Three publications—60 points
iv. Two publications—40 points
v. Less than two publications—no points
vi. Textbook published—100 points

3. **SERVICE [200 points]**
   a. **Local Service [100 points]** Each of the scoring points below would be counted with the total not to exceed 100 points. These service activities could be for the program, the college, and/or the university.
      i. Committee Chair—25 points each chair, up to 50 points
      ii. Committee Member—5 points each committee, up to 15 points
      iii. Competition Team Coach—25 points each team
      iv. Student chapter advisor—25 points
   b. **State/National Service [100 points]** The scoring points below would be counted with the total not to exceed 100 points. These service activities would be with state or national organizations.
      i. Senior Leadership position [President, Board, Executive committee, etc.]—50 points
      ii. Committee Chair—25 points
      iii. Committee Member—5 points up to 15 points
      iv. Journal Editor—50 points
      v. Journal/Proceedings reviewer—5 points each up to 15 points
4. **PROFESSIONAL GROWTH [200 points]**
   a. **Self Improvement [50 points]** This metric would indicate the faculty member's commitment to life-long learning. Scoring is for activities in the most recent academic year and may not total more than 50 points.
      i. Faculty internship with industry [three-month minimum]—50 points
      ii. Courses completed [on-line or in person, 15-hour minimum]—10 points each course
      iii. Attendance at seminars [8-hour minimum in construction topic]—5 points each seminar
      iv. Delivery of continuing education courses—1 point per delivery hour
      v. Attainment of CPC, PE, or similar—50 points
   b. **Mentorship [50 points]**
   c. **Collegiality [50 points]** This metric measures the faculty member's ability to get along with colleagues and students in a way that is cordial, constructive, and loyal. It measures the faculty member's ability to argue for a position, yet accept and support the decision of the faculty at large.
      i. Almost always collegial—30 points
      ii. Usually collegial—20 points
      iii. Frequently not collegial—no points
   d. **Participation [50 points]** The metric used would be the faculty member's participation at expected events. The metric would be scored :
      i. Always attends—50 points
      ii. Usually attends—40 points
      iii. Sometimes attends—20 points
      iv. Rarely attends—no points

ASCE's Raise the Bar Effort: Fulfillment and Validation of the Attainment of the Civil Engineering Body of Knowledge

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Abstract

In 2001, ASCE initiated an effort to "Raise the Bar" in educational requirements for practice of engineering at the professional level (licensing). As part of this initiative, in 2004, ASCE defined the *Body of Knowledge (BOK)* required of civil engineers as a prerequisite for licensing and defined two paths to attainment of the BOK: one requiring the future engineer to obtain a bachelor's and a master's degree in engineering or related disciplines (B+M), and the other by obtaining an ABET accredited bachelors in civil engineering and 30 credit hours of upper level undergraduate or graduate course work (B+30). Examination of the second path raised the challenge of determining how the quality of the courses obtained through the B+30 path and fulfillment of the BOK though this same path could be assured. This paper reviews the alternative approaches that could be taken to carry out this validation and details the approach currently being examined by ASCE.

A Civil Engineering Body of Knowledge (BOK)

Today's world is fundamentally challenging the way civil engineering is practiced. Complexity arises in every aspect of projects, from pre-project planning with varied stakeholders to building with minimum environmental and community disturbance. Addressing this increased complexity will require understanding and solving problems at the boundaries of traditional disciplines. At the same time, reductions in credit hours required for graduation are making the current four-year bachelor's degree inadequate formal academic preparation for the practice of civil engineering at a professional level in the 21st century. (BOK Report 2004)

In keeping with the leadership role of civil engineers in the infrastructure and environmental arena and in protecting public health, safety, and welfare, the Board of Direction of the American Society of Civil Engineers (ASCE) in 2004 adopted Policy Statement 465 supporting "*the attainment of a Body of Knowledge* for entry into the practice of civil engineering at a professional level."

The concept of a body of knowledge stems from the definitions of what constitutes a profession. Scholars have found that a profession, at its base, requires its members to possess a specialized body of knowledge. In 2004, the ASCE Committee on the Academic Prerequisites for Professional Practice (CAP[3)] defined the civil engineering BOK for the 21st century through 15 outcomes. The outcomes collectively prescribe a substantially greater depth and breadth of knowledge, skills, and attitudes for an individual aspiring to the practice of civil engineering at the professional level (licensure) in the 21st century. The 15 outcomes shown below include the 11 ABET outcomes and prescribe more technical depth and additional breadth (italicized). It is the belief of the Committee that the 21st century civil engineer must be able to:

TECHNICAL

- Apply knowledge of math, science and engineering.
- Design and conduct experiments as well as to analyze and interpret data.
- Design a system, component or process to meet desired needs.
- Identify, formulate and solve engineering problems.
- Use techniques, skills and modern engineering tools necessary for engineering practice.
- *Apply knowledge in a specialized area related to civil engineering.*
- *Understand the elements of project, construction and asset management*.

PROFESSIONAL

- Function on multidisciplinary teams.
- Understand professional and ethical responsibilities.
- Communicate effectively.
- Know contemporary issues.
- Understand the impact of engineering solutions in a global and societal context.
- Recognize the need for and engage in lifelong learning.
- *Understand business, public policy and administration fundamentals.*
- *Understand the role of a leader and leadership principles & attitudes.*

Those seeking to practice at the professional level therefore must obtain the BOK though a combination of a baccalaureate educational experience, additional education beyond that obtained in the baccalaureate degree, and progressive engineering experience that leavens the formal education (Figure 1). Licensure and initiation of practice at the professional level must be followed by life long learning. In some cases professional engineers may also seek higher-level certification in their technical specialties.

The Paths to Licensure

CAP[3] was established to "develop, organize, and execute a detailed plan for full realization of Policy Statement 465." As a first step, the Committee prepared an

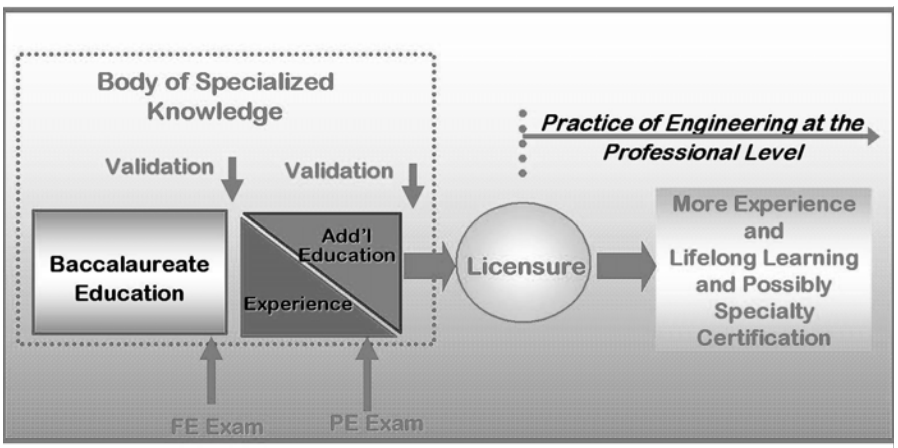

Figure 1. Moving to the Professional Level of Practice

implementation master plan with development of the Body of Knowledge (BOK) as the foundation. The initial definition of the BOK was accomplished with the release of the 2004 BOK Report.

The report, *Civil Engineering Body of Knowledge for the 21st Century,* identified several paths to attainment of the BOK. The BOK could be fulfilled by obtaining a Bachelor's degree plus either a Master's or approximately 30 acceptable credits & experience ("B + M/30 & E") (Figure 2). The "E" in "B + M/30 & E" refers to progressive, structured engineering experience which, when combined with the educational requirements, *results in attainment of the requisite Body of Knowledge.* The "$(B + M)^{ABET}$" method provides a formal educational program consisting of an acceptable combination of baccalaureate and master's degrees. If the baccalaureate degree is not ABET/Engineering Accreditation Commission (EAC) accredited, the master's degree must be ABET/EAC accredited. (Since, at this time, a program cannot have both a Bachelors and Masters accredited, the committee anticipates that this will change in the future.)

In a "B^{ABET} + 30" path, the additional education consists of an ABET/EAC accredited baccalaureate degree and 30 semester credits of acceptable upper-level undergraduate and graduate-level courses in professional practice and/or technical topic areas. The "+30" program does not have to lead to a master's degree. Some or all of the courses taken as part of a master's program in a related professional practice topic area may be acceptable towards the fulfillment of the "+30." *Because of the complexity of matching a non-ABET accredited bachelor's degree plus 30 credits to the BOK, the CAP[3] Committee has indicated that such a path is not viable.*

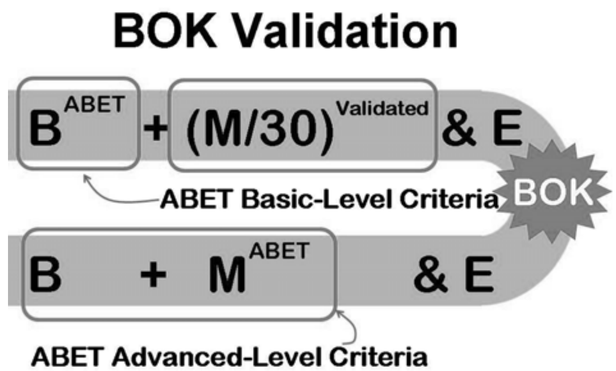

Figure 2. Alternative Paths to BOK Validation

The committee believes that most of those seeking the BOK likely will follow the traditional path of matriculation at institutions of higher learning, or through distance learning programs from those institutions. Others may choose to attain the BOK through a combination of campus-based education and courses offered by non-traditional providers.

Non-Traditional Providers

There are many organizations offering post-graduate professional education. Universities offer non-degree and certificate programs that include a large number of courses that would be relevant to attainment of the BOK. As the requirements for continuing professional development (CPD) have been mandated for re-licensing of engineers and the profession in general has encouraged life-long learning, many for-profit and non-profit organizations, government agencies and engineering firms are offering both CPD and the equivalent of upper level undergraduate and graduate level professional practice and/or technical courses. As an example, the US Army Corps of Engineers (USACE) offers extensive professional development opportunities through its Proponent-Sponsored Engineer Corps Training (PROSPECT) Program. For over 30 years the PROSPECT program has been offering courses worldwide to federal, state, or local government employees. Its instructors and course developers are drawn from USACE headquarters, divisions, districts, laboratories, the PROSPECT Center and from universities and private firms and many of the courses offered are in advanced technical and professional and professional practice areas. A recent survey of 2,000 members of USACE science and engineering professionals indicated that more than 80% of them have taken PROSPECT courses and believed that all or some of the courses matched college and university courses in quality and rigor. In the future, these programs will play an important role in providing post-baccalaureate education for civil engineers who pursue the B^{ABET} + 30 path. There are others private organizations who offer similar type classes via a corporate university like CDM, Earth Tech, Inc., and others. Other professional organizations such as The American Council of Engineering Companies (ACEC) have created an Institute for Business Management (IBM). The institute focuses on the following topics: business management/quality, contract and risk management, finance, human resources, information technology, leadership and ethics, marketing ad business development, and project management and project delivery systems.

Fulfillment and Validation

A critical challenge in including non-traditional approaches to completing fulfillment of the BOK is ensuring that the education provided by these organizations meets the standards of learning assessment, quality, and rigor found in and expected of engineering programs at colleges and universities and that the additional courses taken fulfill the educational component of the BOK. Courses that are taken to obtain the 30 additional credits would be limited to technical courses and to non-technical courses relating to professional practice. Confining the courses to the types that most practitioners are familiar with would, the committee reasoned, greatly ease the challenge of reviewing the courses to determine if they are consistent with the BOK. The committee then sought to identify means to validate the fulfillment of the post-baccalaureate educational requirements attained through these alternative education providers.

Meeting Prerequisites for Licensing

The current licensure system in most of the 56 US jurisdictions requires the possession of a Bachelor of Science in Engineering degree from a program accredited by the EAC of ABET, or its equivalent, as a prerequisite for licensure. Special procedures have been established with engineers with degrees from foreign universities. As additional engineering education requirements are adopted by licensing boards, they will have to develop means of validating the full attainment of the requisite educational requirements. The B+M^{ABET} approach will not be substantially different than the current procedure which requires only an ABET bachelors. The challenge becomes how do Boards validate the programs of individuals who obtain an ABET bachelor's and complete 30 credit hours of work beyond the standard bachelor's either from a university or from some other provider or from a combination of the two. In the latter two cases, not only must the quality of the education be validated, but since such programs, by their nature, are tailored to an individual's needs and time availability, there will be a need to ensure that, taken together, the post-graduate courses and the undergraduate program fulfills the requisite BOK.

Validating Providers and BOK Fulfillment

Licensing boards need assurances that the courses offered by non-university organizations are of a quality comparable to universities and to ensure that the 30 credit hour equivalents taken, as a group, fulfill the required educational component. Education's long history in accreditation clearly indicates that accrediting bodies do not accredit courses; rather, they accredit the programs that provide the courses and expect that the organizations offering these programs and their faculties will provide courses that fully meet the required standards. Believing that it would be neither feasible nor wise to attempt to 'accredit' individual courses being offered to satisfy the needs of the +30 program, the committee focused on developing methods to accredit /approve entities that might offer such courses. The committee reviewed a variety of organizations capable of either validating the credentials of +30 program providers and/or reviewing courses taken to complete fulfillment of the BOK. These organizations included:

- **Universities or professional organizations.** They could carry out both tasks but such activity would divert their attention from their primary function of education.

- The **International Association for Continuing Education and Training (IACET)**. IACET is a non-profit entity that evaluates and approves organizations to be “Authorized Providers” of continuing education and special courses. IACET has an established process for carrying out this mission and requires not only initial approval but also continuing review of programs being offered. IACET, however, has limited experience in dealing with college engineering programs.

- The **American Council on Education (ACE).** ACE, a non-profit association**,** is a major coordinating body of the nation's higher education institutions. ACE provides a valued and respected third-party validation of quality training providers thus supporting colleges, universities, and other higher education and adult learner organizations.

- **ABET**. ABET, has a long history of accrediting engineering programs and is known world-wide for this activity. Through its Engineering Credential Evaluation International (ECEI) subsidiary, it also reviews academic programs of individual foreign applicants for engineering licensing. and in the process deals with evaluation of the quality of the offering colleges and universities.

- **The National Council of Examiners for Engineering and Surveying (NCEES).** It has considerable experience in evaluating the educational qualifications required of individuals seeking engineering licensing and works closely with licensing boards in carrying out its mission.

- **ASCE and other engineering societies.** These organizations are significant participants in the current accreditation and licensing processes. It also has been the catalyst for educational change within the civil engineering community. ASCE, alone or in collaboration with other societies, is in a position to both evaluate potential providers and to review the programs of individuals seeking to fulfill the BOK though the +30 alternative.

- **Licensing boards.** Boards could assume either or both of the roles (provider and courses); however, the core competency of licensing boards is the regulation of the practice of engineering and the review of the qualifications of applicants for licensing. While licensing boards technically could make the determination as to whether or not the additional credits are valid in professional practice and/or technical topic areas, the administrative burden associated with such activity would argue against such a mission for the boards.

Committee Conclusions

After careful review of the potential methods of validating both the programs of course providers and the fulfillment of the BOK of those taking the B+30 path, the committee concluded that:

- Effective methods could be developed to carry out this validation activity

- The B^{ABET} +30 path is a viable option for attainment of the Body of Knowledge.

- ASCE should support establishment of a process to approve the programs of alternative providers of upper level undergraduate and graduate level technical and professional practice courses that would be included in the post-bachelor, +30, component of the individual's civil engineering education.

- ABET is most capable and experienced in this area and would be an appropriate provider of program review services, for a fee, for alternative education providers and to evaluate, for licensing boards, the fulfillment of the BOK by those participating in +30 programs.

To move ahead with this approach, the committee is working with ABET to ascertain its ability and willingness to take on these new missions. If ABET agrees to participate, as next steps, ABET and the committee will develop the criteria to be used in both program assessment and in judging BOK fulfillment. On completion of this work, ABET would conduct trial evaluations of selected volunteer non-traditional provider programs and would evaluate the academic records of volunteers who have completed or are in the process of completing graduate studies.

While such trials will take time, they will further demonstrate the feasibility of the +30 approach and will be another step in enhancing civil engineering education and opening the provision of graduate education to a wide variety of new providers. They are part of carefully designed Master Plan developed to accomplish full implementation of Policy 465 (Figure 3.)

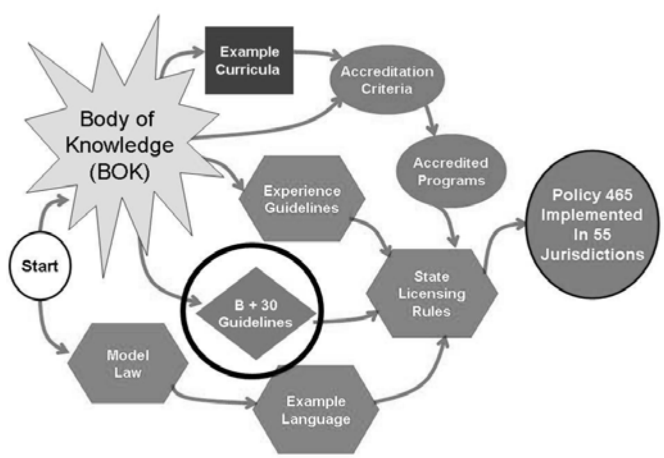

Figure 3. Master Plan – Implementation of Policy 465

A Path to the Future

ASCE Policy 465 supports a significant step forward in the education of civil engineering professionals. Its implementation, already underway, will open new opportunities to meet the growing challenges that will face tomorrow's engineers. Former president of ASCE, Bill Henry noted that:

> …in traveling around the country and meeting with our members—both young and seasoned—I have seen growing support for this [465] concept. I find that the focus within the membership has shifted from debating the efficacy of Policy 465 to discussing how we are going to make it all happen between now and 2020. ASCE believes this to be of great importance to the practice of our profession in the 21st century.

ASCE seeks to raise the bar for education of its professionals and to offer them a variety of methods to obtain this education. The work of the CAP^3 Committee is turning concept into reality.

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Highlighting Workforce Issues in the Classroom: The Impact of Race, Gender, and Culture in the Construction Industry

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Abstract

Understanding the complex interaction of people present on a typical construction worksite is a concept that most construction management and engineering curriculums address from a management or labor issues perspective only. While management and leadership classes highlight the importance of knowing your workforce, fostering team environments and empowering subordinates, few curriculums address the importance that race, gender and culture play in the workplace. These factors are critical for construction mangers entering the workforce today in supervisory roles, especially as graduates from US colleges and universities begin to perform an increasing amount of work in the global arena. Couple this factor with the dramatic change in the composition of the skilled labor pool, as more minority groups enter the industry and it becomes even more critical that the next generation of construction managers and engineers possess the skills required to interact, communicate and relate to the changing demographics of the workforce. Recognizing this need, an elective course was developed within the Del E. Webb School of Construction that highlights the importance of these characteristics. The course examines those issues and forces that have shaped today's construction workforce including the diversity of experiences and relations among gender, race, and culture. Students explore the construction workforce throughout history including the roles of women and immigrant labor forces. Goals of the class include shaping more aware students that have developed a respect for those who build and an awareness of the difficulties associated with the social and political issues surrounding today's construction workforce. Additionally, students determine the forces at work that will shape and impact the future construction workforce and establish a life-long appreciation for the workers who constructed the projects that created and sustain the fabric of society. The focus of this paper is to define the need for a course of this nature and highlight the course content and implementation. It illustrates how understanding the race, gender and culture behind a workforce can serve to improve leadership and management skills.

Introduction

Regardless of which icon of leadership and management theory you subscribe to, Maxwell, Covey, Collins, or Abraham Lincoln each emphasize the importance of knowing what your customers want, circulating amongst your employees, while seeking and incorporating feedback in your processes. These actions ensure your stakeholders have buy-in to the mission and feel part of the team. To accomplish these goals a leader must comprehend the culture of the people that comprise their team. As the demographics of the construction workforce continues to change, students graduating from construction programs will be required to work with diverse cultures. Providing students with the knowledge, skills and abilities to effectively lead and manage the workforce of today is a responsibility of the education they receive. Comprehending the history and culture of a workforce is critical to effective leadership, as it provides a basis for communication, the cornerstone of trust amongst a team. Incorporating these skills into current construction curriculum is difficult. With university demands of shrinking program hours, accompanied by increasing industry pressures to offer more construction related courses, faculty are facing a difficult challenge to provide students with such basics as estimating, planning and scheduling, let alone the softer interpersonal skills. This paper describes the development and implementation of an elective course that seeks to meet the desires of students and industry, while meeting accreditation and university requirements.

Needs assessment

To begin the development of the course entitled, “Workforce Issues: Race, Gender and Culture in the Construction Industry” the course creators first assessed the need for such a course. The areas investigated included those identified by students attempting to meet the University criteria and construction industry leaders.

The first area investigated was the request of students faced with meeting the university requirements. The Del E. Webb School of Construction (DEWSC) curriculum includes a lower level (100 or 200) and an upper level (300 or 400) humanities course to meet Arizona State University general studies course requirements. These two courses must satisfy three awareness areas: (1) Cultural Diversity in the United States, (2) Global Awareness and (3) Historical Awareness.

Each semester students request a construction related class to fulfill these requirements. The course developers, while appreciating student demands for a construction based course, also appreciate the importance of gaining a perspective of cultural diversity.

The reoccurring theme from industry leaders indicated that the communication skills of students were lacking. The feedback indicated that students were experiencing difficulties working with labor forces on site, specifically related to their interpersonal skills. Industry felt that construction managers of the future must possess the skills required to interact, communicate and relate to the changing demographics of the workforce. Combining this information, along with the request of the students, the developers felt the need for a course that addressed the importance of race, gender and culture in the workforce was apparent and justified. Comprehending the issues, concerns and motivational driving forces of the workforce leads to better communication and improved leadership abilities.

Course Development

When entering the construction industry as a new graduate from a construction engineering or management program, students are faced with issues that are unique to their discipline. How they relate to the individuals completing the work in the field is critical to success. Realizing this fact, the intent of the course is to provide students with a greater understanding of the workforce concerns, which can lead to changes and a greater awareness of the problems in the industry.

To begin the course, a history of the construction industry is discussed. The historical references include case studies to highlight problems, issues and the establishment of how successful projects were lead by individuals who understood the needs of the workforce. The historical approach is used to illustrate the fact that issues within the workforce and the characteristics of a successful leader have not changed much over time. With these examples under their belts, the course moves to a social and cultural based approach focusing upon the specific concerns facing the workforce and how comprehension of these issues can lead to better management.

To develop the culture of construction workers portion of the course, two ethnographic studies, *Royal Blue, The Culture of Construction Workers*, by Herbert Applebaum and *Hard Hats, The Work World of Construction Workers*, by Jeffrey W. Riemer are referenced. These books highlight how workers function on site, the unique nature of construction work, the autonomy within the workplace and how construction workers view job satisfaction. Emphasis is placed upon the fact that construction workers are bound to one another in work and family networks that are exclusive, and they project relationships, values, and norms from their work into their non-work lives. Other cultural studies included, *High Steel – the Daring Men Who Built the World's Greatest Skyline*,by Jim Rasenberger and *We'll Call You If We Need You-Experiences of Women Working in Construction,* by Susan Eisenberg. *High Steel* depicts the lives of Ironworkers in New York City and the contributions of different ethnic groups to include the Irish, Swedes, Norwegians, and the Mohawk Indians from the Kahnawake Reservation. *We'll Call You If We Need You* is an account of 29 women who entered construction trade unions across the US during the Affirmative Action Era of the late 1970's early 1980's. Other published literature, journal articles, trades publications and government publications are also referenced.

Another major area of focus for the course includes the changing demographics of the labor force of the future. Students receive US Census Bureau information regarding the influx of immigrant workers into construction and information on how to attract and retain workers between the ages of 16 and 24, the largest growing age bracket in the workforce. Specific issues of discussion include Hispanic culture, language barrier issues and illegal immigration, based upon the major demographics of the local workforce.

Personal experiences are drawn upon in course implementation. The developers each worked in the trades or with the trades in both non-union and union settings at various levels of leadership. One developer owned their own electrical contracting business in the Southwest and worked as an electrician in the Midwest. The other, a daughter of Italian immigrants whose father and grandfather were both union carpenters, worked as a field project manager on heavy-civil jobs throughout the Northeast and served as a civil engineering officer in the Air Force.

Course Content

While it is not the intent of this paper to cover the entire course content, specific sections where students are given tools to assist in their progression into the construction industry are presented.

History of Construction in the United States

To comprehend the functioning of a culture, be it of a certain race, tribe, religion or workforce, you must understand the history that drives that culture. The course begins with a discussion of the Carpenters' Company of Philadelphia. The study of this group focuses upon the role of the Master Builder in colonial times, and sets the stage for the structure of the building trades and practices still in place today. Issues included formation of guilds, development of legislation to protect local workers from foreign and domestic immigrant workers and the ancient tradition of sons following the trade of their fathers. Discussion revolves around the development of political associations with provincial leaders to influence work trends, early forms of price fixing, and the first labor strike in the United States. The intent is to highlight the fact that issues students will be facing as they enter the industry today, have roots dating back to colonial times.

Case Studies

The course uses monumental construction projects completed over the past century to highlight different working conditions, the treatment of the labor force, the contribution of immigrant labor to the building of this country and the roles that each of these variables plays in the completion of a project. Each project chosen highlights a particular workforce issue faced by the project leadership and how the lessons learned can be implemented on the jobsites of today.

The Transcontinental Railroad offers insight into the use of immigrant labor to solve labor shortages problems and how different cultures played a major role in the completion of the railroad. The class addresses issues of how labor problems were solved by contracting with Irishmen from New York where labor was scarce, using captive Native American Indians for the grading operations, the employment of men from the Union and Confederate Armies, and the experimental usage of the Chinese coolies. The project demonstrates how managers and leaders must be willing to try new approaches to recruiting and retaining labor forces. The Panama Canal illustrated the disparity in the treatment of workers based upon social status. The project highlights the concepts of non-stop work schedules, lack of concern for life, use of new innovations and the concept of the work camp, with special attention paid to the building of the Canal Zone. The Canal Zone was a development of communities to house workers and their families whose focus was to maintain a happy and productive workforce. The class explores the hierarchy of the Canal Zone and the exploitation and segregation of the African-American workforce. Other projects used to illustrate cultural issues among labor forces are the Alaska Highway and the Roosevelt Dam.

Culture of the Construction Worker

Occupational socialization is a process through which a newcomer becomes a regular member of the group. In order to successfully manage and lead individuals, one must comprehend their concerns, how they view their work and what motivates them to perform. The culture of a construction worker is unique and the next phase of the course deals with the comprehension of that culture. The focus is on key concepts that will aid new graduates in becoming better leaders and successful, respected managers. This includes race and gender issues within all levels of the construction workforce.

Construction projects are work environments where people work amongst equals – those who have mastered the tools, materials and techniques of their trades. The course discusses the importance of respecting the knowledge, skills and abilities of the worker. Questioning the knowledge and abilities of a worker in a demeaning manner or in front of an entire crew is a sure way to alienate yourself from your workforce. New graduates, leaders and management should never pass up the opportunity to listen to the worker's approach to work and respect their level of experience. The class enforces that respecting this concept will also help to improve relationships between management and trades.

In construction, people work in teams, gangs, or pairs. One must not only cooperate with one's immediate gang, but must coordinate with other trades. Each craftsperson has a sense of the totality of the structure and the part that each plays in creating it. Therefore, all trades share in the pride of creating something new and the part that each played. The course discusses this concept with a focus on allowing superintendents to select their crews and how careful consideration must be given when integrating new employees into the system, especially women and minorities.

Discussion of the core values within the construction worker culture revolves around the pride they take in their work. Construction workers believe they work hard, contribute to society and earn an honest living. They feel they produce something real and tangible. They see physical evidence of what they accomplish and that gives testimony to the integrity of their work. Self-respect is quite important among construction workers. The class emphasizes this concept and discussion is centered upon how these characteristics drive the construction worker to perform.

Leadership on construction sites has nothing to do with formal leadership positions. The individuals on construction projects who occupy formal leadership positions may command little respect if they are willing to manipulate and lie to protect their own personal positions. Those who enjoy their own self-respect and that of others exercise leadership for the benefit of others. The course discusses that as a manager, being willing to run the risk of failure and criticism by taking personal charge of a difficult situation will earn more respect than any title on a business card. The real leaders, in the eyes of the construction worker, are on the job solving construction problems (Applebaum, 1981)

Construction workers traditionally enjoy physical sports and socialization off the job is important. They like to tell stories, to kid around and comic stunts are regular occurrences on projects. They also enjoy jobsite lunches and off-site picnics during which they can socialize in a more informal manner. These activities contribute to group cohesion and produce in the workers feelings of fellowship and affinity. The course discusses these activities as important areas where a manager can influence the attitude, quality and performance of work, by supporting these events. Monthly jobsite luncheons are great motivational tools and can serve as a time to recognize safety, exceptional performance and as a time for controlled “horseplay.” A manager who shuns these actions as non-productive, ultimately disrupts the core of what makes the worker perform.

A critical area the course address is the language of the jobsite. A manager must comprehend the jargon used on the sites as it binds the workforce culture. Not comprehending this is a critical flaw of many new graduates, managers and apprentices alike. If you can talk the talk, you will be more easily accepted amongst the group.

Other issues of discussion relate to worker performance and the sense of job security. Construction workers are aware that their careers and the longevity of their employment depend on their performance. Feedback is important to workers, but must be accomplished in a respectful manner. Managers must also realize that the sense of insecurity that surrounds the entire industry is one of the basic elements of the way of life of construction workers. While most managers will move back to a home office or to another job, construction workers facing a lay off may be left unemployed, without a source of income to provide for their families. The class discusses ways managers can schedule work to allow for optimum employment and how to provide motivation to maintain productivity until job completion.

Race and Gender

This section of the course highlights issues that face women and minorities and how by comprehending these concerns, mangers can more successfully help these individuals succeed while completing their projects. A large number of construction projects require the hiring of a certain percentage of women and minorities and meeting these goals is a pressure that leaders will face. At times, the discussion in the classroom while addressing these issues becomes heated, but these topics are critical for managers to comprehend.

Both women and ethnic minorities face many of the same issues when entering the construction workforce. Based upon the culture discussed above, one of the key elements in construction is the pattern of personal relationships in the work process. The use of small crews and the familiarity amongst the workers, does not openly invite outsiders into the work process. Managers must strategically introduce these minorities into work crews and understand that they may not be welcome.

Ethnic minorities and woman experience issues within the construction workforce that traditionally white males do not encounter. They feel a sense of alienation when first arriving on the jobsite. They must earn the respect of the individuals on the jobsite and feel an intense pressure to perform. This visibility of race minorities and women within the construction field is a critical issue that leaders must comprehend. While the industry is apt to accept a mediocre performance from a white male as a reflection of the individual, when a female or minority fails it is a reflection upon their whole gender or race (Bilbo and White, 1999).

While Asians are the fastest growing ethnic minority in the US, the Hispanic population is represented to a larger degree in the construction industry (BLS, 2003). Construction managers working with Hispanic labor forces not only face a language barrier, but a cultural one as well. The course specifically addresses the issues that are valued by Hispanic workers. These include the importance of family and providing for them, the intense work ethic they demonstrate, the male machismo, and the manner in which they display loyalty and respect to each other. It is not uncommon for an entire crew of Hispanic workers to leave a job if a member of their crew is laid off.

Women in construction face a number of issues that managers can help alleviate by comprehending their importance. The course addresses issues of sexual harassment, the importance of family, equal pay for equal work, physical ability to perform work, and the glass ceiling concept. The class discussions centered upon the inclusion of women and how to embrace their skills, ideas and contributions as positives, versus a confrontational approach. Issues commonly raised by women such as safety and jobsite hygiene are discussed with an emphasis placed upon the fact that these are concerns of all construction workers, not just women.

Implementation of the Course

The course was conducted in a discussion based style. Students were responsible for reading information relating to the topic prior to class and expected to come to class ready to discuss the information. Some students found this method intimidating at first and quizzes were often required to stimulate student interaction. As the semester progressed, students began to participate in lively discussions relating the class topic to their personal experiences on worksites. By far the most heated discussions within the class arose when discussing the inclusion of minorities and women in the construction workforce, the roles of labor unions and language barriers faced on site.

Their grade in the class was comprised of three components, classroom discussion/quiz participation, a research paper and an oral presentation of the findings of their research. The research paper was to be an ethnographic study of a facet of the construction industry workforce. Examples of topics that students chose included: The Role of Unions in the US Construction Industry; Construction Labor Force of the Hoover Dam, Italian Immigrants in the US construction workforce; The Culture of Ironworkers and Recruiting Woman into the Construction Workforce.

Assessment/Feedback – Course ratings

The course was piloted in the Fall 2005 semester to a class of 28 students and 33 students in the Winter 2005 session. In order to evaluate the class, the developers used the standard Ira A. Fulton School of Engineering online course evaluation system. Thirteen students completed the online survey for the Fall 2005 semester resulting in a 46.43% response rate, while the winter session course feedback had an 85% feedback rate. The overall rating received was a 4.46. Based upon the feedback received the course developers feel it was successful and will continue to refine content and offer the course in upcoming semesters.

Conclusions

Comprehending the issues and underlying values that drive a labor force are important to maintaining productive and efficient job sites. Construction leaders of the future must understand these issues and gain an appreciation of the history that created these values. This course accomplishes that goal, along with aiding the development of leadership and management skills, verbal and written communication skills, while meeting the requirements of the university and the requests of the industry and students. Overall the developers feel it was successful and will continue to offer the course.

The purpose of this paper was not only to share some of the efforts that the DEWSC has taken to help produce better leaders, but to also seek input and feedback from the construction community. Please contact the authors if you have suggestions or would like to offer feedback.

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INTEGRATED CONSTRUCTION LABOUR MARKET PLANNING USING GIS

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ABSTRACT

The fluctuations in the demand for construction work have often resulted in skills shortages. This has led to the need for effective construction labour market planning strategies, which enable the construction industry to meet its skills requirements, particularly in periods of peak demand. Existing approaches to construction labour market planning have several limitations. In particular, they are inadequate in providing the construction industry with data on the spatial distribution of skilled workers, demand spots, and training facilities. This paper presents the implementation and evaluation of a GIS-based system for proactive construction labour market planning. It starts with a brief review of the nature of labour market planning in construction, introduces geographic information systems, and highlights the opportunities they offer for overcoming the limitations of existing approaches to construction labour market planning. The implementation of the GIS-based system and its application to a specific labour market planning initiative are then presented. The evaluation of the system by prospective end-users is also covered in the paper, with details of the enablers, barriers and benefits of the system implementation. Organisational issues that had a bearing on the implementation are highlighted. The concluding part of the paper explores the potential for deployment of the system to address a wider range of labour market planning issues.

1. Introduction

Labour Market Planning (LMP) is a reference planning for the future needs of an organisation or an industry's workforce. Lynch (1982) identifies two aims of corporate labour market planning, namely to ensure the optimum use of the personnel currently employed, and to provide for the future staffing needs of the enterprise in terms of skills, numbers and ages. The United Kingdom construction industry due to the boom of the past years is facing many challenges in trying to plan for its labour market and ensure that there are enough skilled workers to meet its future needs. Some of these challenges include locating where construction activity is growing, establishing what skills will be needed by the workforce in the future and what programmes are in place to develop these skills.

To help the industry address such issues it is important that agencies and stakeholders responsible for the employment and training needs of the industry work together and use their respective information resources jointly. Strategic organisations such as the Learning and Skills Council (LSC) and the Construction Industry Training Board ConstructionSkills (CITB) can pull their information resource together to help determine issues such as where in the country there is ongoing construction activity, what numbers need to be added to the workforce what skills they need to be trained in to combat skills shortage.

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Geographical information systems (GIS) can aid the industry in achieving this goal. GIS has the capability of processing high proportions of geographic data. It has been claimed that as much as 90% of business data is geographic data (Grimshaw, 1993). GIS provides a way of investigating the geographical dimension of internal and external data. A substantial amount of data collected and used by the industry generally have a geographic dimension. GIS through its integrative nature can contribute to the construction labour market planning process by combining disparate labour market information efficiently, thereby placing analysts in a better position to understand specific spatial patterns.

This paper demonstrates briefly the use of GIS in construction LMP by looking at a GIS application that has been used in the implementation of a labour market planning initiative, and discusses the impact of the system on the organization. The paper starts by discussing the construction industry, showing its unique make up and current state. It then goes on to introducing GIS and examining it as a Decision Support System (DSS) and how it has been used in LMP to contribute to the decision making process of an organization. The paper then explains the evaluation process of the GIS application that has been mentioned and analyse the results. It discusses how the application has integrated not only a process, but also the people responsible for that process at an organizational level. It also shows the wider potential of the system in planning the industry's future labour force. The paper then discusses the limitations of the existing environment within the organization that has impacted the effectiveness of the system.

3. CURRENT LABOUR MARKET PLANNING IN CONSTRUCTION

The UK construction industry provides a tenth of the UK's gross domestic product, & employs 1.4 million people. It is one of the strongest in the world, with output ranked in the global top ten (DTI, 2005). After the US, the UK has the second highest level of construction value added per capita (CITB, 2004). The construction industry is unique when compared to other industries in its make up. In 2001 there were 168,123 construction contractors operation in Great Britain who produced output valued at £74.6 billion and employed 973,600 workers (CITB, 2002). An additional 600,000 workers are estimated to be self employed. Planning for the future of the workforce of such an industry can be very difficult and challenging. Thus it is vital that appropriate strategies are put in place that can help to alleviate problems such as skills shortage which the industry is suffering from now (Delargy 2001, Crates 2001, CITB Skills Survey 2003). The current labour market context presents several challenges for those with responsibility for labour market planning. This includes predicting how many workers will be needed in the next five years, what skills will they require and where in the country will they be needed. These questions can only be answered through labour market forecasting and planning activities. According to Gritzioyis & Stoll, (2002) this enables the industry to:

- Develop better human resource strategies
- Better determine future human resource requirements
- Create more targeted training programs
- Provide more base-line information for labour relations
- Give employers and workers a competitive edge

- Assist builders and developers to plan major projects

At present labour market planning in construction is undertaken by using two types of forecast information namely aggregate industry forecasts and company level forecasts (Briscoe and Wilson, 1993). Aggregate industry forecasts are those produced by organisations such as the CITB the Department of Trade and Industry (DTI) and the Learning and Skills Council etc. This involves the whole industry and are for public consumption. The forecast model being used by CITB at present was originally developed by the Institute for Employment Research (IER); this has now been modified and redeveloped by Business Strategies. The present version of the model takes into account regional output and unemployment data but it uses fixed proportions for determining the share of regional employment across the 22 construction sector occupations. The key input statistic that drives the CITB model is the assumed rate of annual output growth in the construction sector (Business Processes Resource Centre, 2000). This is populated by a range of labour market datasets from the Labour Force Survey, output figures from the Department of Trade and Industry, output growth predictions from forecasting agencies and training supply data measured from surveys of formal training provision. The model is also informed by an employers' skills needs survey and expert opinion from academics and forecasters. The resulting forecast provides a cumulative growth requirement based on a variety of growth scenarios, which are subsequently disaggregated to individual geographical regions. The output of the model can be further informed by other econometric forecasts. Other groups such as the Institute for Employment Research at Warwick University produce construction employment forecasts as part of a national economy-wide forecasting exercise. Company level forecasts are those produced by individual firms to suit their individual objectives and are considered the property of the company. These are generally not made public and so rarely taken into account regional and national forecasts.

Despite the success of the econometric models they do not shed light on the socio economic issues that the problems faced by the industry such as the sectors recruitment and skills shortages are usually grounded in. For example, a certain geographical area might be suffering from recruitment problems linked to a particular upsurge in activity, but the present models are unlikely to shed little light on the complexities realities of local and regional labour market pressures that are affecting these areas. There is a demand for more appropriate decision-support mechanisms that can take account of geographic problems in terms of skills demand and supply influences. The recent accession of Eastern European countries to the EU has further complicated the situation as it is unclear how many qualified workers this will lead to the medium and long term.

4. GIS as Decision-Support Systems

A decision support system (DSS) is a computer based system that helps the decision maker utilise data and models to solve unstructured problems (Sprague and Carlson 1982). DSS aid managers to make decisions that are unique, rapidly changing and not easily specified in advance. They address problems where the procedure for arriving at a solution may not be full predefined in advance. By design they have more analytical power than other information systems. They are built explicitly with a variety of models to analyse data, or they condense large amounts of data into a form where they can be analysed by decision makers (Laudon & Laudon, 2002).

Decision-Support Systems are designed so that users can work with them directly, they include user-friendly software. They are interactive in that the user can change assumptions, ask new questions and include new data. Geographical information systems are a special category of DSS that can analyse and display data for palling and decision making using digitised maps. The software can assemble store, manipulate and display geographically referenced information, tying data to points, lines, and areas on a map. GIS can thus be used to support decisions that require knowledge about the geographic distribution of people or other resources in scientific research, resource management, and development planning. The Query feature allows the user to view different scenarios by asking questions such as: What are there? Why are they there? What will happen if? What might happen if? These different scenarios give valuable understanding of issues to decision makers when planning for the future.

Figure 1 illustrates the basic components of a GIS. This illustrates that both attribute and spatial data are collected. Inputting the data into a computer-based information system requires that the data is reconfigured appropriately before it is inputted and stored in the system. A substantial amount of data collected and used by the industry has a geographic dimension (see Maloney and Kowalchuk.1993) and so it can be applied to a large number of complex data management problems.

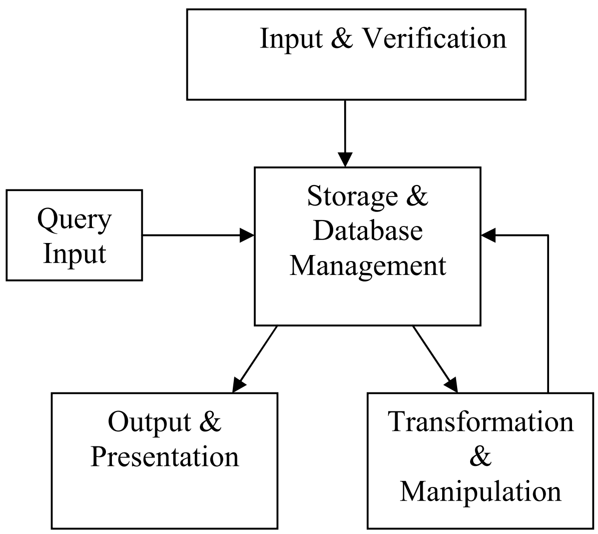

Figure 1: Main Components of a GIS (Burrough 1986)

5. GIS Enabled STEP Process

A labour market planning initiative to which the GIS has been applied as a Decision Support System is called *STEP into Construction*. STEP is being used by the industry's Sector Skills Council in the UK (CITB ConstructionSkills), to address skills shortages in the construction labour market by attracting females and ethnic minorities who are under-represented in the construction labour force. It has been suggested that the reluctance of women and ethnic minorities to enter the industry severely limits the labour pool from which the industry can recruit (Druker & White, 1996; Wall, 1998). With the STEP initiative, if an employer guarantees an interview for a job vacancy, CITB ConstructionSkills provides support for a trial period of six weeks for adult ethnic minority and female candidates. Recruitment at the end of the trial is based on merit alone and is at the discretion of the employer. CITB ConstructionSkills supports associated costs such as short-term childcare, diversity training for staff and site supervisors, or an equal opportunities recruitment campaign aimed at finding suitable candidates.

5.1 The STEP Process before GIS

CITB ConstructionSkills currently uses an Intermediate Labour Market (ILM – employers who get sponsored and are committed to employing and training new recruits to the industry) approach to achieve its STEP outcomes. With this approach, the ILM organization recruits the candidates and offers them the six weeks trial for which they are paid by CITB ConstructionSkills regardless of outcome. At the end of the six weeks the ILM employer and the candidate fill in an 'outcome form' as proof that a STEP trial has taken place. This is then sent to CITB ConstructionSkills, who then pay the employer for the outcome. CITB ConstructionSkills files the form away in paper format and scans it for storage in Livelink (a web-based knowledge management system). This is done for audit purposes and for the Board to use as a guide at the end of the year when setting the organizations targets on STEP.

5.2 Limitations of the Process

An analysis of the scheme and its administration revealed the following limitations in its operation:

- There is no centrally held data for the initiative which means that pieces of information stay with the different organizations for which the other has no access to. This can cause problems when it comes to analysing the forms/data. For example, the form that is completed by the employer and the candidate has no provision for recording the ethnicity of candidates. This makes it difficult to keep track of the different ethnic backgrounds of the candidates and to verify whether the candidates met the required standard of the initiative.
- There is no contact between CITB ConstructionSkills and the candidate in order to gain important feedback on which the initiative can be improved. CITB has no way of knowing if the candidates procure jobs at the end of the trial or not. Similarly, there is no feedback from the ILMs to CITB on the progress of the candidates while they are on the six weeks trial.
- CITB ConstructionSkills has no control over the profile of candidates being secured for the trial process. Thus, there is more emphasis on candidates going through the trial period rather than them securing a job at the end.
- The process involves many manual steps such as form filling and filing.
- The ILMs tend to secure candidates from the areas where they are based, which mean that only certain geographical areas tend to benefit from the STEP initiative.

5.3 Objectives of GIS Application

The rationale for applying GIS to the STEP initiative was based primarily on a review of the initiative, which recommends that the focus of STEP should be on 'job outcomes' (i.e. the candidate securing a proper job at the end of the trial). In order to achieve this CITB ConstructionSkills has to recruit suitable candidates and employers to participate in the initiative, which therefore requires information on the geographical distribution of both eligible candidates and employers. However, the current process does not readily have access to this information, so there is scope for the use of GIS to model this and explore a variety of scenarios. It is this shift that gives the impetus to look at GIS in the context of STEP.

The objectives of the proposed GIS-based process were:

- To automate the STEP process in order to facilitate better data integration, accessibility and enhanced utility;
- To create a central resource that holds all the necessary information required for the STEP initiative, which will help in the tracking and monitoring of successful job outcomes and the recording of retention rates;
- To introduce better integration of operations and collaborations with other entities (i.e. other departments in CITB ConstructionSkills);

- To create a better customer service to candidates and employers, as it will have an available and up-to-date database with all the necessary information;
- To enable CITB ConstructionSkills to match appropriate candidates and employers geographically;
- To facilitate cross-departmental working between the different departments within the CITB ConstructionSkills;
- To generate representations of datasets that show which geographical areas are benefiting from STEP and which are not.

Screen shots of the completed system are shown in Figures 2 and 3. Figure 2 shows a map layer of two databases (eligible employers and eligible candidates), with their data files. The information on the screen facilitates decision making about which candidate is most geographically suited to which employer. The screen shows a close proximity of both eligible employers and candidates, which should help in the matchmaking. It should also be noted that there are other issues outside the GIS application that need to be considered when matching the candidate to the employer such as choice of profession, and the expectations of both parties (i.e. the employer and candidate). For a more detailed description of the GIS system see Anumba et al (2005).

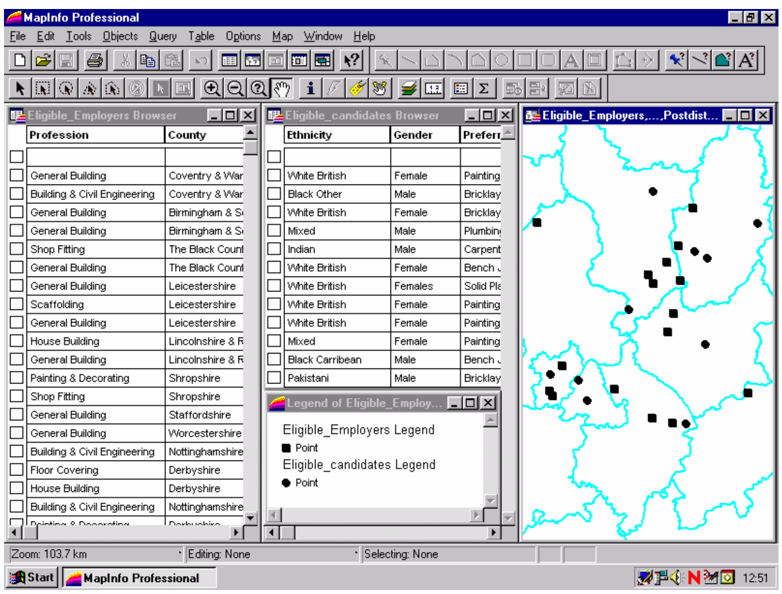

Figure 2: Example of a map layer showing its related data files, it also shows the integration of the eligible employer and eligible candidate databases

A more user friendly interface was designed to make it easier for users to access the database. This was designed with the Mapinfo programming software called Mapbasic. Figure 3 shows the user interface showing a UK map divided into the different counties in the East and West midlands. The black points show the geographical locations of all the female schools in the region.

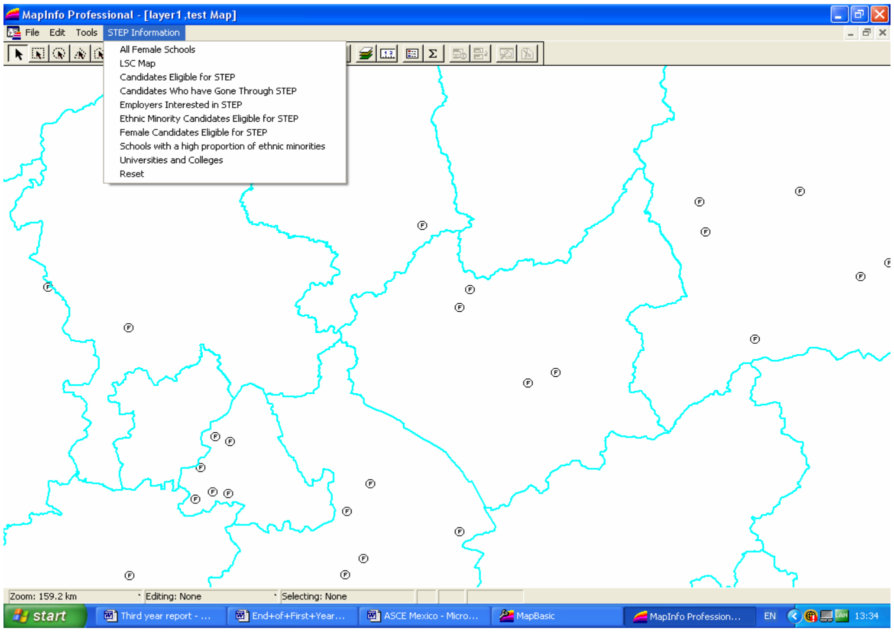

Figure 3: User interface with a list of all the databases

5.4 Evaluation and Findings of GIS-Enabled STEP Process

An evaluation process was undertaken to establish the impact and efficacy of the system in enhancing the operation of the STEP scheme. This process was managed in three phases: Firstly, the system was demonstrated and the users trained in its operation; secondly the departmental managers with overall operation of the system were interviewed along with the area manager and the Equal Opportunities officer who is responsible for overseeing the STEP programme; and finally a workshop was held at which all of the managers were invited to discuss the system and its operation. The cumulative results of this evaluation process are presented below.

5.4.1 Functionality of the System

A simple questionnaire was used to evaluate the relative performance and utility of the system. The respondents included the managers and staff from each of the departments involved in the STEP implementation process described above. With regard to its functionality, the respondents rated the system as being effective at facilitating the STEP process.

5.4.2 User Interface

The second part of the questionnaire related to the usability of the interface that was designed to make access to the information easier. The system was seen as being relatively easy to use, particularly in terms of the user interface which made it easier to perform tasks which met their individual needs.

5.4.3 Interviews

A series of semi-structured interviews were carried out with the departmental managers to gain further insight into their department's perspective of the prototype. These interviews revealed the contextual issues surrounding the implementation of the system and enabled the researchers to explore the socio-technical environment into which the system was to be embedded. These are summarised under headings extracted from the analysis of the transcribed interview data below.

5.4.3.1 Reliance on external agencies

In some cases where the organisation depended on external partners for the data required for the system, some of the information needed was not adequately recorded. There were also problems with the level of granularity of the data provided.

5.4.3.2 Organisational change

During the development and implementation process, the organisation underwent a great deal of change internally and externally. It also had to adapt to external circumstances most notably being commissioned to become part of the Sector Skills Council for the industry. This had marked implications for the process of information management within the organisation.

5.4.3.3 Resource requirements

The system's need for regular updating was a major issue for the users. In order for the system to provide accurate information, this meant there had to be someone responsible for updating it.

5.4.3.4 Timeliness of implementation

Most of the interviewees felt that the GIS system has great potential as a labour market planning decision support tool, but that the implementation period may not have been the most appropriate for it to have been trialled.

6. Discussion

One of the most important outcomes of the application is the way it has enhanced the work practices and integration of the different departments at CITB ConstructionSkills. Before the GIS application was introduced, there had been no mechanisms to share STEP information. The GIS has been used to formalise the information flows, as well as in assisting the organization to achieve its new focus of 'job outcomes'. Thus, the GIS has presented an opportunity for the organization to enhance its cross-departmental working to ensure that their job outcomes and targets are successfully achieved.

At a wider level, the GIS has the potential to facilitate many other labour market planning issues. Most problem solving tasks in labour market planning require reference to both tabular and mapped data, which GIS integrates effectively. The ability to integrate different types of information and highlight patterns in the data means that it can indicate potential problems that might occur in the future. The ability of GIS to integrate with almost any other software provides many opportunities to improve the richness of the industry's labour planning information.

In terms of the current training and skills environment GIS has the potential to make a huge contribution to the provision of a robust planning tool for training providers and funding agencies. As a Sector Skills Council, CITB ConstructionSkills is tasked by the government to understand and articulate the training needs of employers and work with funding agencies such as the Learning and Skills Council and training provides such as colleges to provide a solution to these needs. With its potential to absorb and integrate large volumes of data such as skills types needed, qualifications required and also the geographical location where they are needed, GIS can assist in ensuring that there are the "right people with the right skills, in the right place at the right time".

CITB ConstructionSkills is currently in the development stages of setting up a national construction observatory with regional advisory groups. The GIS has the potential to assist in the regional observatory work particularly as it has the capability to demonstrate outputs visually by geographic location. The ultimate goal of having a national observatory is for it to serve as an accepted central source of labour market information nationally. GIS has a vital role to play in helping to achieve this goal. Construction labour market information tends to be produced with diverging frequency from a variety of sources managed by different institutions. This makes it easy to have several versions of the same data showing different degrees of updates. The use of the GIS as a central resource holding this information should help eliminate these problems thereby improving the quality of the data and helping to avoid discrepancies. It also makes updating the information quicker and easier. Having a central resource for construction labour market information will encourage partnership and data sharing among agencies and communities who have responsibility for LMP.

The ability of GIS to integrate with almost any other software, and its functionality of being embedded directly into other software programs to extend their usefulness, can be an added bonus to LMP. This provides several flexible ways in which the technology can be used to improve the richness of planning information. A measure of the effectiveness of the construction industry is linked to how well it manages its resources, especially the productivity of its labour force, which well-implemented GIS applications can help optimise.

7. Conclusions

In this paper the use of GIS in construction labour market planning has been discussed. This has been illustrated through a specific GIS application that is being used to help in the diversification of the UK construction industry labour market. The ability of GIS to integrate different and varied datasets together to have a bigger picture of what is happening geographically creates a solid platform on which plans for the future of the industry labour market can be built. The GIS can assist the industry in refining its labour market information by eliminating redundancy and creating faster and easier access to data. It also offers opportunities for organisations interested in the construction labour market to integrate their work activities and data resources for construction labour market planning.

This paper has also shown the inherent problems involved in the implementation of a GIS-based system for labour market planning. Although well intentioned and conceived as a technological tool, the implementation process was not well prepared enough to take account of the socio-technical system into which it was to be embedded. It can be seen that ICT system implementation requires careful management as, whilst many positive conditions existed within the case study organisation, rapid internal and external changes can quickly have a deleterious impact on the system’s implementation. To be deployed effectively in the organizational arena and its full potential realised, its implementation must involve a concurrent structural and cultural realignment to take account of the integrated working which it promotes.

Clearly, there is scope for the use of GIS to help tackle a variety of planning problems in the construction industry. Labour market planning is a prime application area as has been demonstrated by the example presented in this paper.

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What are the Best Practices for Skilled Labor Recruitment and Retention? It Depends Upon Whom You Ask.

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Abstract

The construction industry continues to experience a skilled labor shortage, that cuts across both managerial and craft positions. This perception of a skilled labor shortage has been communicated among contractors and within professional organizations and has been documented, measured and identified in literature. Studies have been completed to identify issues and develop best practices to train and educate craft workers, but to date very little research has focused on what these individuals are seeking in a career, from an employer and within their work. This study is part of an initiative to capture information regarding recruitment and retention practices employed by construction firms from both management and craft worker viewpoints. The goal of the research is to determine how well the ideals of management, mesh with the needs and expectations of the craft workers relating to successful recruitment and retention practices.

The first phase of the project examined the current perceptions among construction managers about effective recruitment and retention practices for skilled construction laborers. This led to the creation of a pilot survey that was presented on the internet to gather data concerning effective recruitment and retention practices from the viewpoint of a construction manager. The information collected was used to develop a survey of the labor force to verify if the recruitment and retention practices perceived by management to be successful actually meet their needs, desires and expectations. The paper presents the results of the pilot study phase of the experimental design.

Introduction

This paper addresses the significant reasons for the shortage of skilled labor as identified in the current relevant literature, documents how this information was used to develop a pilot survey of managers and skilled labor, and presents trends identified during the pilot study. The goal is to define the areas that require additional leadership efforts from the industry to more effectively recruit and retain skilled labor.

The findings of the research presented will be used to generate primary surveys for both management and craft workers. The information will also aid in the refinement of the research methodology. There is no expectation that the data obtained from the pilot survey will be statistically significant. The goal is to probe responses to various types of questions and issues required to generate a survey that will effectively capture information useful to industry leaders and the successful completion of the research program outlined below.

1. Conduct a literature review, to identify information relating to labor shortages and the recruitment and retention issues surrounding the construction industry.
2. Based upon the literature review, develop and launch a pilot survey to identify effective survey questions and data collection methods focused at the management level.

3. Gather and analyze collected surveys concerning management's perception of effective recruitment and retention practices for skilled labor. Utilize these results to develop a pilot survey to capture the perceptions of skilled craft workers regarding effective recruitment and retention practices.
4. Utilize the information obtained and lessons learned in the pilot phase to develop and distribute final surveys to management and skilled craft workers.
5. Analyze survey responses from management and skilled labor and identify trends regarding perceived effective recruitment and retention practices.
6. Produce statistically valid data relevant to recruitment and retention practices in the construction industry.

Background

Evidence of a skilled labor shortage: According to a 2001 Construction Industry Institute survey, 75% of the responding contractors surveyed indicated that they were faced with skilled labor shortages (Construction Industry Institute, 2001). A study published by the National Center for Construction Education and Research (NCCER) in 1997, found that 92% of construction firms that have offices in multiple states reported skilled labor shortages, and 85% of the survey participants thought that current skilled laborers were not as skilled as required for the present market (Shelar, 1998).

Economic Factors: The shortage of skilled labor in the construction industry was predicted in the late 1980's (Schriener, 1990). The recession years of the late 1970's through the mid 1980's had a very important and lasting effect on the industry. Many of the older skilled workers retired "early" due to the prolonged recession (Korman & Kohn, 1995). The 1980's recession also indirectly lead to a decline in craft/labor union membership. In the 1970's union membership accounted for 40% of skilled labor in construction. In the year 2000, union membership was 18.3%. It is unclear whether or not unions could have protected and helped maintain increases in workers pay. It is clear that after the recession there was strong pressure on contractors to decrease costs. This led to a leveling off in wage increases, a decrease in wage increases in some areas, and a shift in power from unions to open-shop contractors. This trend was especially prominent among smaller contractors resulting in lower wages and scaled back benefits packages (Roths, 1998). Pressure to lower costs also lead many companies to de-emphasize apprenticeship programs and view them as extra costs. The results have been acknowledged recently by many contractors, complaining that journeymen card members in many areas do not have the skills they require. (Grant Thornton Consulting, 1999). Low pay is certainly an issue. An estimate of a worker making $17 an hour with a spouse and two children would leave the family a weekly disposable income of $29. That equates to a poverty level income (based on $38,000/year for a family of four) (Yancey, 2001).

Image of the Construction Industry: Another important factor indicated in the decline of skilled workers is the negative perception associated with the construction industry. Construction was rated 247 out of 250 possible career options by high school seniors (Katz, 2001). Studies show that general public perception of the construction industry and that of craft workers is that of an "uneducated, dirty, gruff, unprofessional, and not well paid" set of individuals working in dangerous activities (Rosenthal, 1990). Construction competes for a spot in the top three most dangerous professions every year, with the other two being commercial fishing tied with mining, and fire fighting. These facts lend credence to at least part of the contributing factors that lead to negative public perception of the construction industry.

Retention of Skilled Workers: The construction industry has historically relied on immigrants to fill skilled craft and unskilled labor positions. This continues to be the case today, except that the majority of new immigrants are arriving unskilled from Central and South America. Several contractors have indicated that Hispanics have played an important role in filling many positions and that the retention rate is 35% higher for 1st generation and new immigrants than for workers who grew up in the U.S. (Carpenter, 2001 & 1998). Women could also play a large role in the construction work place, but due to numerous factors, women represent 10% of all construction related employees, of which 17% are skilled craft employees (Hopkins & McManus, 1998). It can be inferred that attracting half of the potential work force in the U.S. to construction is a major issue and retaining the small percent that has chosen construction as a career is a challenge.

Several contractors have indicated that one of the major obstacles to employee retention is the resistance to relocate for a job (Carpenter, 2001 & 1998). Construction, by nature, requires workers to move from project to project, as the work dictates. Projects may be next door to each other, as in the case of track housing construction, or all over the world for specialized projects such as power plants and hydro-electric dams. Contractors have experienced a large amount of resistance from skilled craft workers to travel even 20 miles to the next job, let alone 100 miles. This is particularly true if there is a lot of work in the local area for which the worker is qualified (U.S. DOL, Bureau of Statistics, 2000).

Methodology

The first step of this research program was to generate a pilot survey based upon the literature review to assess management perceptions. The pilot survey was first released to managers as the researchers felt the information obtained in the management survey would help generate questions for the craft worker survey.

The survey was launched with the generous help of the Associated General Contractors of America (AGC) and the National Center for Construction Education and Research (NCCER). It was published as a direct link on their websites for three weeks and was easily located by a scrolling banner on their main pages. The survey could be completed by anyone that accessed either website and was not limited to members of either organization. The researchers realized that the survey would reach a limited audience; however, the intent was to determine the relevance of the questions and if the methodology was appropriate. The goals of the pilot test questions were to probe attitudes in the following areas:

(1) Importance of pay in recruitment and retention
(2) Importance of intrinsic qualities (i.e., Company loyalty) on retention
(3) Influence of travel on employee retention
(4) Effect of safety, reputation, and advancement opportunities on retention
(5) Effect of training on recruitment and retention
(6) Identify areas of concern about skilled labor from a manager's point of view

Pilot Study Information Collected

The information collected was not anonymous and was not the intention of the researchers. The researchers were also seeking methodology feedback and industry opinion. This will not be done on the primary surveys, as anonymous data is essential to limiting any bias by either the researchers or the participants.

Respondent information collected included geographical area, company size, and type of construction. The choices given for the type of construction were designated as commercial building construction, large and small heavy civil, residential construction, or specialty construction (such as electrical, mechanical, etc). The researchers were aware that most companies who would view these websites represent commercial and heavy civil contractors, and therefore the pilot test results may not be representative of the entire construction industry.

A majority of the information generated was classified mathematically as cardinal (or nominal) data, based upon the type of questions asked. The nature of cardinal data limits statistical analysis drastically, and results reported are descriptive statistics such as the frequency, the range, and the mode. This was not considered to be an issue, as the purpose of the pilot study was to provide recommendations for the development of the skilled worker survey, determine improved methodologies for conducting the final phase of the research and to identify the appropriate questions to include in the final survey, resulting in statistically significant data.

Results of the Pilot Study

There were 36 responses to the pilot management survey and 52 to the craft worker survey. The information collected from companies indicated they were involved in large and small heavy civil projects, and from the general commercial building sector of the construction industry. Craft workers represented the laborer, framer, carpenter, iron worker, electrician and plumbing professions. Geographical locations of the responding companies and employees were as follows: Arizona, California, Indiana, New York, New Jersey, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, and Wisconsin.

The results of the pilot study have enabled the researchers to refine questions, determine the data necessary to develop "statistically significant" results, and implement an improved distribution process for the survey. While these goals were the intention of the pilot study, the researchers realized that the information collected, while not statistically significant from a scientific standpoint, illustrated three areas that construction leaders could focus upon immediately to improve their abilities to recruit and retain skilled workers. These areas include the location were companies seek potential employees, the method/media used for recruitment and the ideals focused upon during the recruitment and retention process. The locations and the methods of recruitment used by management for skilled workers were assessed and are illustrated in Figures 1 and 2.

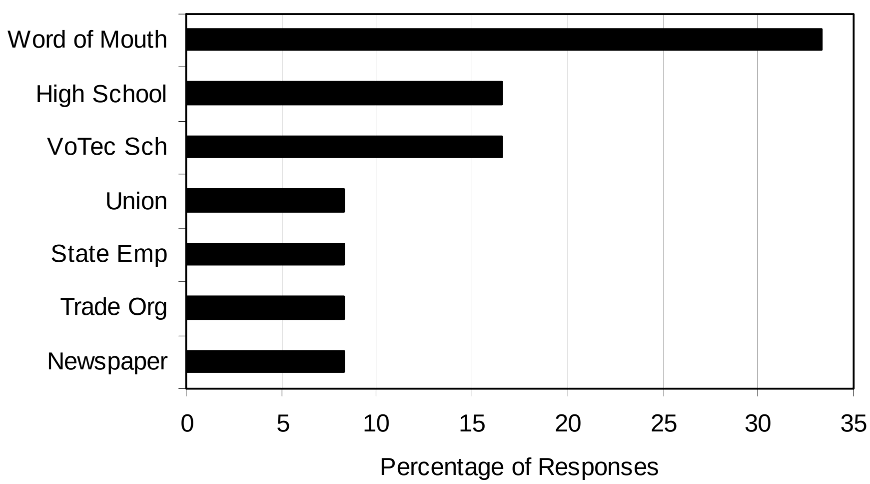

Figure 1: Locations Where Construction Companies Recruit Skilled Laborers

Managers felt that the best way to recruit skilled craft workers was by word of mouth or referrals. This type of recruitment was not addressed in the literature reviewed. It is interesting to note that even though many of the firms who responded to the survey are union contractors, they are less likely to recruit employees from union apprenticeship programs relative to either high schools or vocational schools.

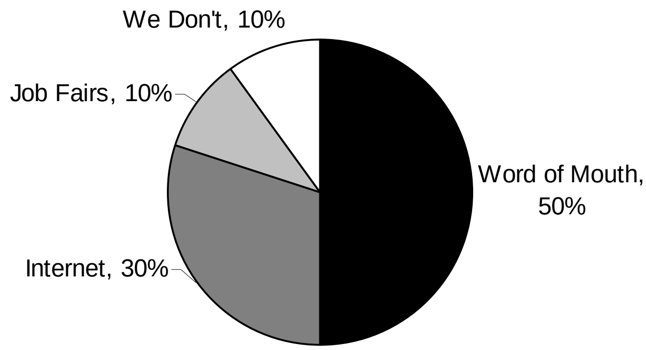

Figure 2: Methods Used to Actively Recruit Skilled Craft Employees

The results shown in Figures 1 & 2 illustrate that the participants in the pilot study do not currently use the major mass media (newspaper, radio, or television) forms of advertisement to actively recruit skilled labor. The results shown in Figure 3 depict the craft worker answers received to the question where do you seek information about potential employment? When comparing these to the results of the management survey it is easy to see that corporate leaders are missing the mark when it comes to advertising for employment. While word of mouth still dominated the percentage of responses, craft workers sought employment through newspapers and radio advertising, forms of recruitment where companies are not investing their effort. According to the literature, the construction industry suffers from a negative image. There may be an opportunity to both improve the image and recruit skilled labor by using the mass media to launch public image improvement campaigns.

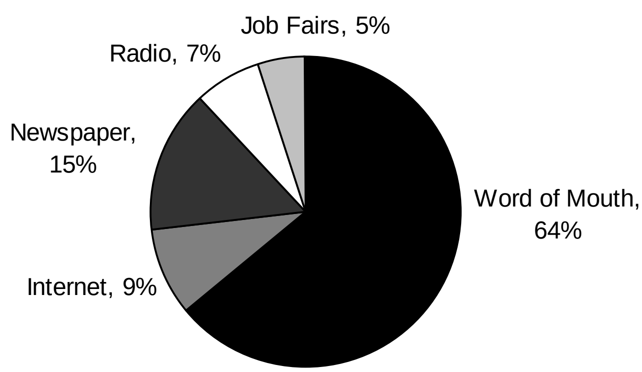

Figure 3 – How Skilled Workers Locate Employment

The most useful piece of information produced by the pilot survey that industry leaders can immediately implement into their recruitment/retention efforts was the ranking of the following variables in relation to emphasis during the recruitment process. The variables were: salary, health care, career advancement opportunities, learning a life-long skill, family, safety, hygiene, retirement benefits, company reputation, company loyalty, and other benefits. Each of these items was ranked from one to five, with five being the most heavily emphasized. The results are displayed in Figure 4.

Company reputation and safety were both considered to be the most heavily emphasized items during recruitment by management. They were both ranked an average of

4.4 out of 5. Managers also considered company loyalty and salary to be important issues to market to potential employees. Are the areas emphasized equivalent to what craft workers are seeking? The results indicate that these areas are also important to craft workers when seeking employment, ranking 4.8 out of 5. However, the other benefits category was ranked at 4.4 by craft workers. The primary areas listed by craft workers to be important included location of the work, hours of the work and type of work performed. These were categories that were not included as options on the pilot survey, but have been incorporated into the final survey.

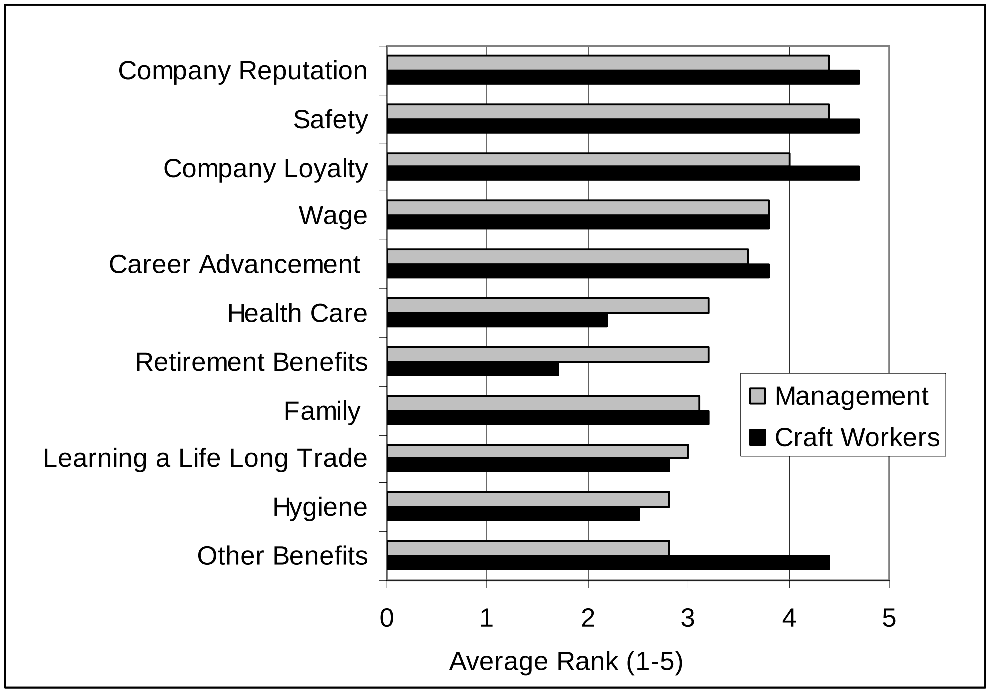

Figure 4: Management Ranked Emphasis of Issues for Recruitment of Skilled Labor

Conclusions

The focus of the pilot study was to determine effective methods of information gathering, the refinement of survey questions, and identifying the gaps between labor and management perceptions relating to recruitment and retention. The researchers identified major weaknesses in the approach of the study. More focus must be placed on national dissemination of the surveys, be certain they reach a larger cross-section of industry areas (i.e., residential and specialty contractors) and labor groups (i.e., union and non-union trade organizations). The goal of developing primary surveys that embody the knowledge gained in this phase was completed and the next phase of the project has begun.

While not statistically conclusive, the preliminary results do indicate general areas where construction industry leaders can begin to focus efforts to improve recruitment and retention of skilled workers. Marketing efforts should take advantage of mass media outlets that are not currently being maximized to include internet, newspapers, television and radio advertising, as these are locations where craft workers seek employment information. Additionally, these efforts should continue to highlight items such as safety, work hours, locations of employment and company reputation as craft workers rated these areas as important issues when deciding upon employment.

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Recruitment and Retention of Women in the Skilled Trades

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Introduction

Despite efforts over almost three decades to integrate women into construction, the overwhelming majority of the industry's skilled trades workforce consists of men and is run by men for men. In 1978, the industry was approximately 2.0% female. Today, it is approximately 2.5%. However, this situation must change because of factors outside the control of the industry.

Robert M. Gasperow, respected director of the Construction Labor Research Council, published an analysis of U.S. Bureau of Labor Statistics and U.S. Department of the Census data and the implications for the construction labor market in a paper "Craft Labor Supply Outlook 2005 - 2015" (Gasperow, 2005). The findings have significant implications for the construction industry:

- Recent labor shortages have increased the awareness of the need for recruiting and retaining new entrants.
- Because of the time required for training, there is a lag between recruiting new entrants and the availability of trained craft workers.
- The construction industry will need to add 185,000 workers annually over the next ten years to replace workers retiring or otherwise leaving the industry and to allow for growth.
- Because of the physical demands of construction work, the working life of construction workers is shorter than those in other industries. Consequently, retirement begins earlier.
- A large influx of Latino workers allowed the industry to meet increasing demand in recent years.
- The number of Baby Boomers leaving the industry will increase faster than the number of Millennial Generation members entering the industry, thus creating significant competition for the new labor force entrants.
- The composition of the new entrants will change because of differences in growth rates: Whites, 6%; Blacks, 21%, and Latinos, 23%.
- There will be increasing competition between construction and all other industries for new entrants.
- The median age of all construction craft workers was 33 years of age in 1988 and 37 in 1997. By 2003, it had increased to 38 and for union members it was 39.
- The growth rate of males in the labor force is expected to be 1.0% and for women 1.3%. The projected growth rate for Latinos is 2.9%.
- While women are participating in greater numbers in the work force in general, they are not doing so in construction. The increasing entry of Latinos represents the biggest change in construction.

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- "An actual shortage of bodies is highly unlikely. A shortage of labor in construction means a shortage of adequately trained, skilled, productive persons. In addition, shortages can occur when there are an adequate number of persons, but there is a mismatch between skills available and skills required. There is also the possibility that there is a geographic imbalance in available craft workers."

- Because construction work is physically demanding, construction workers who remain in the work force longer may do so by changing industries.
- The availability of retirement and health care benefits determines the retirement decision.

In addition, at the same time that the participation rate of women is increasing, several of the traditionally female occupations (such as??) will suffer some of the largest predicted job losses (Fullerton and Toossi, 2001). Consequently, the female share of the labor force will be increasing

The History

As a result of the Civil Rights movement, the 1964 Civil Rights Act was passed with Title VII prohibiting discrimination in employment based on race, color, religion, national origin, and sex. Sex was not initially included in the legislation. Instead, it was added by southern senators in an effort to derail the passage of the legislation in a belief that the Senate would never agree to prohibit discrimination based on sex. Passage of the legislation energized the women's movement. Women felt empowered and exercised their rights by filing charges with the Equal Employment Opportunity Commission (EEOC) and class action suits against employers.

Because of the composition of the membership of feminist organizations such as the National Organization of Women (NOW), which was middle class white women, the focus was on opening up white collar and professional jobs to women. With the goal of breaking through the "glass ceiling," the invisible barrier to the upward mobility of women in organizations, there was little interest in opening up access to blue collar jobs to women.

In the late 1960s, civil rights activists began to press for the integration of the historically white-only building and construction trades and their unions. The model for these locally-based programs was the "Philadelphia Plan," which established goals and timetables for the recruitment of minorities. Because of the skilled nature of the trades and the poor educational background of most of the minority applicants, federal funds were provided to establish Labor Education Advancement Programs (LEAP) that provided remedial education, training in life skills, and a pre-apprenticeship program to give applicants knowledge of construction and work processes and fundamentals of tool usage. These programs were successful in opening the doors of the trades to minorities. However, because of the societal belief that construction was men's work, women were not included

In 1978, President Jimmy Carter amended Executive Order 11246, which requires affirmative action in federal procurement, to include specific goals and timetables for the inclusion of women and minorities in the construction of federally funded facilities. Goals for minorities were to be determined using the percentages of the local workforce represented by minorities. Because of the extremely low numbers of women in the trades, a national goal of 3.1% rising to 6.9% was established. Progress and compliance were to be assessed by the Office of Federal Contract Compliance Programs (OFCCP). The actual rate was 2%.

The Department of Labor's Bureau of Apprenticeship and Training (BAT) established affirmative action requirements for the apprenticeship programs that it certifies as well as for those certified by state apprenticeship councils. The goal was set as 50% of the female labor force participation rate within a local area. Thus, the goal ranged from 20% to 25% depending upon the area.

The Comprehensive Training and Employment Act was authorized, which together with the growth of tradeswomen advocacy organizations, resulted in the establishment of female pre-apprenticeship programs patterned after the LEAP programs of the early 1970s.

The Result

And yet, by 2003, women represented only 2.5% of the construction skilled workforce (Eisenberg and Mastracci, 2003). Given the federal actions identified above, what explains this almost complete lack of progress? To understand the reasons causing the lack of progress, it is necessary to examine the legal environment within which the industry functions as well as the industry itself

The primary reason is the lack of institutional will on the part of government and the industry itself. With the election of Ronald Reagan as president in 1980, the philosophy of government changed. He distrusted government believing it to be too large and intrusive. His approach was not to repeal legislation, but to slash the budget to prevent agencies from pursuing their missions. Discussions with former government officials indicated that succeeding administrations have followed this approach with the result that the EEOC, OFCCP, and the Department of Justice's Civil Rights Division are unable to aggressively pursue the integration of women into the construction industry. At the same time, thinking in the country has shifted from pro affirmative action to government remaining neutral. Federal courts exercise strict scrutiny to ensure that any affirmative action requirement is tailored narrowly to benefit only the individuals harmed by discrimination. States such as California have utilized ballot initiatives to greatly restrict the use of affirmative action.

Historically, the construction industry has been predominantly male only. Construction jobs were considered male jobs. Even when women have demonstrated an interest and capability in performing construction jobs such as during wartime, women were forced to give up the jobs to the men returning from war. As said earlier, construction is an industry of men, by men and for men. There is a belief that to be a construction worker, you must be a macho man to be able to do the outside, heavy, and dangerous work that requires great skill with tools. Any intrusion by women is a threat to that image and, consequently the ego of construction workers. The industry has fought any effort to integrate women.

For a truly enlightening look at the life of women attempting to integrate the trades, the reader is directed to three works in which women were allowed to present their own stories in all the vivid and graphic detail that would be lost in surveys: *We'll Call You If We Need* You by Susan Eisenberg, *Hard-Hatted Women – Life on the Job*, by Molly Martin, and *Alone in a Crowd – Women in the Trades Tell Their Stories* by Jean Ruth Schroedel. A summary of the reasons advanced for the lack of women in the construction trades today include:

- Discrimination in hiring – Many women assert that contractors simply will not hire them either because of a belief that women are unable to do the work or because of a fear of negative reactions from the contractors employees resulting in turmoil on the site.
- Hiring women only in response to outside requirements, e.g., government affirmative action requirements. Women are hired and placed on government jobs and laid off when no longer needed to meet government requirements.
- Discrimination in training – For women, apprenticeship is the primary pathway into the trades. These programs typically require 160 hours of classroom instruction and 2000 hours of on-the-job (OJT) training each year of the program. The OJT is divided into hours by subject area to allow the development of skills taught in the classroom. Many women allege that they are not provided with the full spectrum of training in the apprenticeship program. Instead, they are assigned to work that is menial, boring, and having little potential for skill development. This results in a potential mismatch between the skills required to perform the available work and the skills possessed by the available women.
- Lack of a job – A lack of a job, whether it be a result of a business downturn or discrimination in hiring and/or training is a serious matter for any worker. Many of the women who have tried to enter the trades are single mothers, with serious financial

obligations. They typically lack the financial cushion to ride out an extended period of unemployment. They may be forced to leave the industry to support their family.

- Although there are exceptions, many apprenticeship programs have adopted a passive approach to recruit women and have exhibited little commitment to it. Why go after females when you can get enough males to fill the available slots? A lot of people want jobs; we'll wait for them to knock on the door.
- Sexual harassment - Sexual harassment violates laws prohibiting sex discrimination in employment. As amended, Title VII of the 1964 Civil Rights Act established that unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature constitutes sexual harassment when:
  1. submission to such conduct is made either explicitly or implicitly a term or condition of an individual's employment;
  2. submission to, or rejection of, such conduct by an individual is used as the basis for employment decisions affecting such individual; or
  3. such conduct has the purpose or effect of unreasonably interfering with an individual's work performance or creating an intimidating, hostile, or offensive work environment.

  Construction workers, in general, are perceived to be sexist and racist. There is a great deal of history to support this perception. The sexual harassment of female workers is a major impediment to attracting and retaining highly qualified women as craft workers. Some women have survived by putting up with the harassment until they qualify as journey-level workers and then moving on to jobs such as electrical inspectors that do not require them to work with male construction workers. These are government jobs that have better protection against sexual harassment.

  Many construction sites satisfy criterion 3 above as an intimidating, hostile, or offensive work environment. Upon entering a site, women may be subjected to taunts and requests for sexual favors, find crude sexual objects left in their tools, pornographic pictures posed around the job site, and physical assault including groping, unwanted touching, and assault. Harassment appears to be perceived as a means of driving women off the sites. A recent survey of female journey-level workers and apprentices in California determined that 57% of the women had been sexually harassed during the past year (California Apprentice Council, 2004). Is it any wonder why many women do not want to subject themselves to life on a construction site? Many female apprentices see leaving the industry as their only option if they are to retain their dignity.

In 2005, the skilled trades are only 2.5% female, essentially unchanged in twenty-seven years. As documented at the beginning of this paper, women must become a much more significant source of labor for the construction industry. ***How do we do that?***

The Solution

If the construction industry is to meet its needs of 185,000 new craft workers each year for the next ten years, it must consider women. It is even more crucial for the union sector because this sector must find and employ the "best" workers to justify the significantly higher wage and benefit package received as compared to nonunion workers. Therefore, the remainder of the paper will focus on union oriented approaches to recruiting and retaining women.

There is a lead time between hiring an individual and that individual's availability as a skilled worker. Apprenticeships last between three to five years so unions and their training directors must adopt a longer time perspective on the apprenticeship programs.

A six phase program for the recruitment and retention of women in the skilled trades in the construction industry is proposed with the elements presented below:

Awareness

People must be made aware of the construction industry and the opportunities and occupations available within it. Construction is not an industry that is readily or realistically portrayed in the popular media. Forensic science, military, and law and order shows have captivated the public and are driving college admissions. It is critical that construction be presented to children as early as possible so that they become aware of it and begin to think about opportunities within it. The awareness programs developed must include examples of women and people of color. Some examples of current programs are:

- Bob the Builder – popular children's TV show and games
- Construction Jack & Jill – dolls representing various crafts
- If I Had a Hammer – a program developed by Perry Wilson to teach math to late elementary and early middle school students. Students spend a day building a prefabricated house and receive three weeks of tutoring in math. They learn about building and actually use tools including power tools.
- From Crayons to CAD – a design/build program targeted to middle schoolers that provides a basis for inter-school competition in which students learn what goes into designing a building and how to build while learning the math and science necessary to do it.

Familiarization

In today's world of video games and the Internet, kids rarely build things or work with tools unless someone in their family does so. There is a real need to familiarize children, especially girls, with tools and how to use them. It is particularly important that girls learn in a single sex environment so that they are not intimidated by boys. Some current programs addressing this need are:

- If I Had a Hammer – for girls and boys and discussed above
- Rosie's Girls – a summer camp program for girls to expose them to building and character and skill development, focused on middle school girls
- Girlpower – a program developed by BE&K, a nonunion firm, but adaptable for the union sector that focuses on high school girls
- Girls, Inc. – formerly known as the Girls' Clubs of America is focused on girls 8-20 years of age. Addresses character and skill development and occupational awareness. Operates Project Dollhouse with its partner Home Depot in which girls build dollhouses
- Girl Scouts – focuses on girls 11-14. The Boy Scouts have 16 merit badges directly related to construction. Girl Scout officials are amenable to considering badges in the non-traditional occupations and activities.
- YWCA – licenses programs from Girls Inc.
- Exploring – a program developed by Learning for Life aimed at 15-18 year old boys and girls in which a club or crew is developed around specific interests. Ones focused on the skilled trades have been developed
- Charter high schools for the trades - similar to vo-tech schools, but focused solely on the construction trades
- Preapprenticeship – for adults, similar to the LEAP programs described above.

Recruitment

It is critical to understand that recruitment is an on-going process that begins early with the awareness and familiarization activities. The goal is to identify kids early who may have the aptitude and interest to pursue a career in the building trades. For example, a construction worker can function as a merit badge counselor in an area such as carpentry. While doing this, she identifies girls who have an interest in carpentry and mentors them toward a career in carpentry. When appropriate, this girl is recruited for the apprenticeship program. The organizations listed below are prime sources of recruits for apprentice programs.

- High schools
- Vo-tech schools
- Charter high schools for the trades
- Community colleges
- Community-based organizations – there are many tradeswomen advocacy groups around the country such as Tradeswomen Inc. in the San Francisco Bay Area and Wider Opportunities for Women in Washington, DC that recruit women interested in the trades and conduct pre-apprenticeship programs to prepare them for application to apprentice programs.

<u>Selection</u>

The selection process needs to be more objective and be able to identify issues such as motivation for a career in the trades. Women may have experience in such activities as sewing, which, while not directly related to construction, provides them with an understanding of design, measurement, and fabrication that are relevant.

<u>Training</u>

- Transition to Trainer - A significant aspect of apprenticeship is the training that an apprentice receives on-the-job from journey-level workers. This is a haphazard process at best. The Wisconsin Technical College System Board and the Bureau of Apprenticeship Standards of the Wisconsin Department of Workforce Development produced a program titled "Transition to Trainer" that trains apprentices in how to be effective trainers once they move up to journey-level status.
- Sexual Harassment prevention – every person working in the construction industry should be required to participate in such a program. The hostile work environment present on many sites must be changed and made more receptive to women.
- Cultural Diversity & Awareness – a comment that construction is changing from the "Old World to the Third World" illustrates the pressing need for cultural and diversity training for all construction workers. The trades used to be comprised of large groups of ethnic workers who gravitated toward one another. For example, bricklayers in some areas were of Irish descent while tile and terrazzo workers were Italian. With ethnic conclaves dispersing and more people going to college, the days of the ethnic trade were numbered. Now trades are becoming more and more culturally diverse. People need to be sensitized to cultural differences.
- Record keeping – to prevent apprentices from being under trained, a system of measurement must be employed to track the OJT received by an apprentice and monitor actions taken to ensure that the apprentice is receiving the full range of training required to produce a journey-level worker.

<u>Retention</u>

Once a woman has begun the apprenticeship program and even moved up to journey-level, steps must be taken to create an environment in which she can continue to succeed. Several actions are identified below:

- Mentoring – every woman going through the apprenticeship program needs a mentor to whom they can go to discuss anything dealing with their work and training. It does not necessarily have to be a woman, but that would be desirable.
- Minority & Women's Caucus – these have been successfully organized in the IBEW and provide a mechanism for women and minorities to gather outside of the union to discuss and deal with issues.
- Support systems – although no longer entirely a female issue due to the growing number of men solely responsible for raising their children, child care is an issue of particular concern to women. So, too, is the issue of transportation in urban areas. A support system needs to be developed to provide assistance. It should be area-wide and involve multiple trades.
- Union constitution – because most sexual harassment is between members of a union on a site, precise definitions of what constitutes sexual harassment must be made clear in the constitution. Furthermore, explicit provisions must be made in the union's constitution for members bringing sexual harassment complaints and the penalties associated with such conduct.
- Collective bargaining agreement – provisions must be included in collective bargaining agreements because most sexual discrimination is caused by a contractor's refusal to hire women or other practices and the action of foremen, who are operating as an agent of management.
- Ombudspersons – an informal mechanism should be created to settle issues without formal proceedings.

Conclusion

There are numerous other issues such as workplace culture, sanitary facilities, personal protective equipment and clothing, ergonomics, and reproductive hazards that need to be addressed. However, the primary action that needs to be taken to increase the number of women in the trades is for contractors and unions to take a strong stand that sexual harassment will not be tolerated, and to put into place numerous mechanisms to enforce this stand. This should begin to change the workplace culture. We believe that as the workplace culture changes, more women will become the valued and significant source of labor that the construction industry so desperately needs. An additional outcome will be the development of a workplace where everyone, men and women, can thrive in a civil, fair and safe environment.

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Competencies to Facilitate Public Private Partnerships

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Abstract

The momentum worldwide toward greater participation of the private sector in infrastructure development shows no signs of abating. In the United States, twenty states have enabling legislation that permits some form of public-private initiatives for transportation projects. Internationally, the Private Finance Initiative in the United Kingdom is well known while the use of private capital for infrastructure projects within emerging economies has become a global trend. Indeed, public-private partnerships (PPP's) have become an important infrastructure development strategy. This approach, however, presents unique challenges for the public and private sector agents charged with forging their scope, structure and conditions. Quite often, those interested in pursuing PPP's are treading new ground with little direction or guidance. Accordingly, the intent of this paper is to identify and briefly describe the competencies necessary to establish effective, long-term relationships between the public and private sector. The presentation is based upon the lessons learned from numerous case studies of infrastructure development where substantial private resources were involved. These lessons from the past provide an organizational "primer" for those seeking to partner with either a private enterprise to create or improve infrastructure services.

Introduction

The participation of the private sector in the provision of public services is clearly one of the most significant, recent trends in government. In fact, a survey of a dozen national governments across the globe in the late 1990's indicated that a significant majority of the respondents expected "that the most successful government structure in 2010 will be one in which government focuses on policy and project/supplier management, allowing the private sector to deliver most traditional public services." (Economist Intelligence Unit, 1999). Certainly, the transition toward this type of model is gaining momentum within the infrastructure development and management domain. Consider national initiatives such as The United Kingdom's *Private Finance Initiative* or Australia's *Partnerships Victoria* as well as regional or local programs such as the enabling legislation in place in twenty U.S. states that permits some form of public-private initiatives on state transportation projects (Reinhardt 2004). Indeed, the prediction made by the survey's respondents is on its way towards realization.

One of the interesting aspects of this shift in infrastructure provision is the approach adopted to establish and govern the relationship between the public and private sectors in this new environment. In The United Kingdom and Australia, for example, the central or national government has shaped the policy and fashioned the conditions that define the "partnerships" formed between the public and private sectors. Alternatively, in Canada and the United States, many public-private partnerships have been struck by state, provincial or local governments without a well-defined national policy or framework. Moreover, at least in the United States, it appears unlikely that a strict federal policy will ever emerge to govern public-private partnership arrangements for infrastructure. Thus, state and local governments as well as many federal agencies are likely to continue to shape their own partnership arrangements with the private sector.

In this decentralized model, the flexibility afforded to regional or local agencies comes at a cost. Establishing a stable and reliable national marketplace is rather challenging since each of the local agencies can adopt fairly unique partnership “conditions”. This environment is particularly troublesome for private market players because they are generally forced to adapt to differing provisions depending upon where they are operating within a particular nation’s boundaries. Hence, the material presented hereafter is intended for those agencies that are instituting public-private partnerships without a national policy and regulatory framework. These agencies must develop the competencies necessary to create partnerships that *preserve the public’s interests* but can also *attract private participation*. Finding the right balance between these two objectives is not a simple task. Failure to do so, however, will either prevent or slow the maturation of this market.

Overview of Public-Private Partnerships

Any discussion about the competencies necessary for establishing a public-private partnership (PPP) should start by characterizing PPP’s. Why is characterization important? Characterization will establish the nature of the relationship between the public and private sectors, which will in turn drive the discussion about the competencies required. In other words, are PPP’s truly partnerships or something else? Indeed, partners are not merely bound by mutual interests; rather, each partner has the perspective that their organizational identity and competitive advantage are enhanced through participation in the partnership (Kingsley and O’Neil 2004). A start is to establish a definition for this arrangement. Unfortunately, an agreed upon definition is somewhat elusive. For example, Table 1 illustrates four definitions. Although similar, these definitions do not fully answer the question about whether these arrangements are partnerships or something else. Thus, the characterization effort must look further.

Organization	Definition
National Council for Public-Private Partnerships (USA)	Public-private partnerships are a contractual arrangement whereby the resources, risks and rewards of both the public agency and private company are combined to provide greater efficiency, better access to capital, and improved compliance with a range of government regulations regarding the environment and workplace.
Canadian Council for Public-Private Partnerships	A cooperative venture between the public and private sectors, built on the expertise of each partner that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards.
International Monetary Fund	Public-private partnerships involve private sector supply of infrastructure assets and services that have traditionally been provided by the government.
National Government of the United Kingdom	Public-Private Partnerships fall into three categories: • the introduction of private sector ownership into state-owned businesses, using the full range of possible structures (whether by flotation or the introduction of a strategic partner), with sales of either a majority or a minority stake; • arrangements where the public sector contracts to purchase quality services on a long-term basis so as to take advantage of private sector management skills incentivised by having private finance at risk. This includes concessions and franchises, where a private sector partner takes on the responsibility for providing a public service, including maintaining, enhancing or constructing the necessary infrastructure; and • selling Government services into wider markets and other partnership arrangements where private sector expertise and finance are used to exploit the commercial potential of Government assets.

Table 1 – Definitions of Public-Private Partnerships

A review of several guidance documents issued by various sources indicates that PPP arrangements are contractual or regulatory ones as opposed to true partnerships.[8] Many of these documents first prescribe a form of cost-benefit analysis (most often described as a "value for money" analysis) before deciding to institute a PPP and subsequently emphasize the significance of clear and enforceable partnership "conditions". In fact, one of the preconditions for success identified by the International Monetary Fund is whether or not the quality of services is "contractible". Moreover, one of the key policy documents issued by Australia's *Partnerships Victoria* is its "Contract Management Policy", which claims that "inadequate contract management can compromise value for money and lead to a failure to realise the key benefits expected from the project" (Dept. of Treasury & Finance 2003). This evidence suggests that *PPP's are primarily long-term contractual arrangements between the public and private sector where mutual benefits are derived and generally little more*.

Further support for this conclusion is provided by over twenty-five case studies of innovative infrastructure development strategies that the writers have been involved with over the last decade. These cases were exclusively contractual arrangements between the public and private sectors where private resources were used to design, build and operate an infrastructure asset; in some instances, private finance was at risk, in others it was not. This distinction is important since contractual or regulatory relationships differ substantially from partnerships. The former is focused upon risk assessment, allocation and management whereas the latter is focused upon synergy development and sustenance.

If this conclusion is correct, then governments within the United States should be well-positioned to implement PPP's since contracting has been used since the founding of the nation (Nagle 1992). Actually, the world has a long history of pacts similar to modern day PPP's. In the United States for example, governments at all levels routinely established agreements with the private sector for the provision of infrastructure prior to World War II (Miller 2000). The development of the Illinois Central Railroad which opened for service in 1856 and the development of the New York City Subway which carried its first passengers in 1904 are notable examples.

The current "novelty" of PPP's is tied to the dramatic transition away from this model that occurred primarily after World War II, particularly in the United States and to a lesser extent worldwide. Legislation which began as early as 1893 when Congress permitted the Secretary of Treasury to separately procure the services of an architect during capital projects and culminated in 1972 with the Brooks Act which required architects and engineers to be selected based upon qualifications for federally funded projects moved the method for developing and managing public infrastructure toward what is mistakenly called the "traditional" approach or design-bid-build (Miller 2000). Here, the responsibility of finance and O&M is placed with public owners and the responsibility for design and construction is placed with separate and independent private consultants and contractors.

Essentially, governments were once in the business of "managing the provision" of infrastructure services, and transitioned into the business of "providing" infrastructure services. Now, governments are moving back into a managing the provision mode, primarily to capitalize upon private sector expertise and efficiency through the introduction of market forces. Why is this type of contracting so different? Fundamentally, PPP's have a broader scope and longer time-frame, and they typically require governments to: (a) determine where PPP's can provide real value, (b) establish reasonable conditions for PPP transactions or agreements, (c) select private vendors or contractors based typically upon proposals as

[8] See Australia's *Partnerships Victoria* (2000), the UK's *PFI: Meeting the Investment Challenge* (2003), International Monetary Fund's *Public-Private Partnerships* (2004), and New Zealand's *Achieving Public Sector Outcomes with Private Sector Partners* (2006).

opposed to bids, and (d) monitor the public services provided by private vendors or contractors typically over an extended period of time. These requirements force governments to expand the scope of their expertise in certain arenas and to modify it in others. For example, selecting private vendors or contractors based upon proposals as opposed to bids demands competencies that the current model does not require. Selection by bid is frequently based upon an established criterion – lowest, responsive, responsible bid. Selection by proposal requires a government to adequately define the selection methodology and criteria.

Necessary Competencies

Background. Like PPP's, a universal definition of organizational competencies is difficult to find. Prahalad and Hamel's (1990) seminal paper on the core competence of the corporation brought widespread attention to the topic of organizational competencies. More recently, Chinowsky (2000) focused attention upon this topic within the AEC community. Generally, organizational competencies are the knowledge, skills, and actions that an organization must possess or exhibit to effectively fulfill its mission and to provide value. Moreover, these competencies are derived from the synergy among the organization's human resources, culture and infrastructure. Other definitions are certainly plausible.

The competencies proposed presume that the relationship between the public and private sector is a contractual one, so the conditions are established by agreement not regulation and no deeper relationship between the two parties is sought. Whether movement toward true partnership arrangements is beneficial or not is left for another discussion. The basis of these competencies are the lessons learned from the case studies developed by the writers, which were previously described, and the PPP guidance documents issued by various governments and institutions, in particular the policy documents of the UK and Australia. Figure 1 illustrates the competencies necessary to institute PPP's for infrastructure development and/or management.

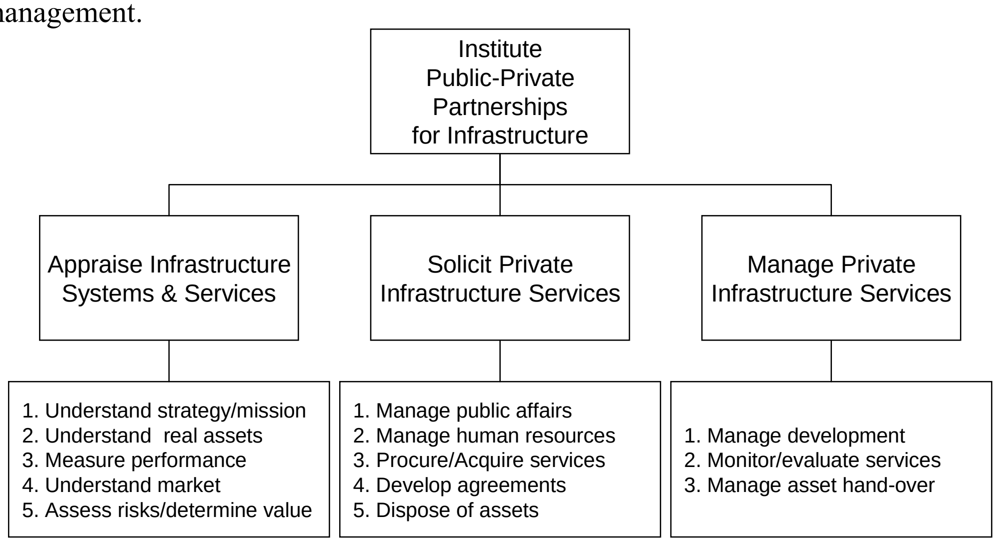

Figure 1 - Competencies to Institute PPP's for Infrastructure

A hypothetical local, public water supply agency supplying 50 million gallons per day of drinking water to its consumers shall provide context for the discussion of the competencies that follows. This agency is interested in turning over responsibility for: (a) operating its two water treatment plants and/or (b) maintaining its plant grounds to a private contractor.

Service Appraisal Competencies. Appraisal competencies are essential for identification of those infrastructure services or systems that are candidates for PPP's.

Understand Strategy/Mission. The organization's divisions and people should fully comprehend the organization's direction and purpose. This facilitates distinguishing services and activities into those that are *critical*, i.e. ones that add value, and those that are *non-critical*, ones that are necessary commodities. Suppose the water supply agency has as its basic mission "to provide the public with water at the right quality, quantity and price", thus it would likely consider "water treatment operations" critical and "plant grounds-keeping" non-critical. This differentiation drives the character of the remaining appraisal activities. Clearly, introducing a private partner into a critical service or activity is riskier than introducing one into a non-critical service or activity.

Understand Real Assets. Real assets, i.e. constructed facilities and equipment, facilitate the provision of infrastructure services. An accurate inventory of these assets that includes such details as size/capacity, age, condition, value and operating costs is essential to the appraisal process. While this seems obvious, establishing and maintaining this understanding over time for a large portfolio of real assets is rather difficult. For the water supply agency, this need is exacerbated by the fact that the majority of its physical plant is underground. Without this information, several subsequent appraisal activities such as "determine value" can become quite challenging.

Measure Performance. Performance measurement is one of the most critical competencies since it facilitates risk assessment and value determination. Consider the water supply agency's "plant grounds-keeping". Since this is a commodity-like activity, the principal driver for introducing a private partner would likely be cost. Thus, the current cost of grounds-keeping is a key performance metric, and it should serve as a central benchmark when electing to initiate a PPP arrangement for grounds-keeping and monitoring a private partner's long-term performance. "Water treatment operations" would clearly be a different story.

Understand Market & Assess Risks/Determine Value. Fundamentally, these competencies demand: (a) evaluating whether qualified private partners are available, (b) identifying and appraising the risks of introducing a private partner, and (c) subsequently determining what value a private partner will add. Lifecycle cost estimation and economic evaluation are common, necessary skills. Consider the water supply agency again. The risks of instituting a PPP for "grounds-keeping" is generally low, so the real questions become is there a market for these services and is the price of these services lower than our current costs? Alternatively, the risks of instituting a PPP for "water treatment operations" are generally high – failure could impact water quality and quantity and subsequently public health and commercial/industrial productivity. Now, the decision to move forward will likely balance such risks against the value that a private partner might add such as cost reduction, water quality improvement and capital investment.

Service Solicitation Competencies. Once the decision to move ahead is made, the focus shifts to fashioning the PPP arrangement and requesting private participation.

Manage Public Affairs/Consensus. Often, the decision to institute a PPP will draw mixed reactions from the citizens that the public agency serves. Typically, the level of reaction is linked to the criticality of the service. Citizens are more likely to oppose introducing a private partner into a critical service, and oftentimes this opposition is funded and organized. For instance in Stockton, CA, a coalition of citizens backed by the Sierra Club and Public Citizen won a lawsuit in 2003 that blocked the city's attempt to institute a PPP for the upgrade and operation of its water supply system over 20 years (Miller 2003). If the water supply agency were to decide to institute a PPP for water treatment operations, then it must have the capacity to effectively communicate its intentions and rationale with its constituency and to adequately handle opposition.

Manage Human Resources. PPP's frequently involve displacing or transitioning the existing workforce. In fact, this reality is commonly viewed as one of the largest impediments to PPP's in the United States (see US Conference of Mayors 1998). Even when private vendors are willing to accept former public employees, working through transitioning the workforce and benefits is not a simple task. How well this responsibility is handled will also clearly influence the amount of opposition that results. More than likely, the water supply agency would need to require the private partner to accept former public employees into their organization. This would require the partner to develop a comprehensive and amenable plan for public employee transition, which would include structuring compensation packages to closely match current public benefits.

Procure/Acquire Services & Develop Concession Agreements. The public procurement/acquisition process determines the response of the private sector and, more broadly, the development of the market. Public owners must treat private participants in a stable and predictable fashion. Otherwise, potential participants will pursue market alternatives that are more attractive elsewhere. The perception of potential participants is of greater importance than commonly recognized since the quality of the services and goods that the government acquires cannot be better than the pool of private sector firms willing to participate in the acquisition process (Miller et al. 2000). Since PPP's generally range from 5 to 50 years, the structuring of the relationship is extremely important. Currently, PPP agreements do not benefit from years of evolution like standard construction agreements, i.e. AIA contract documents. The case study research suggests that transparency in selection methodology and criteria is the most important attributes of successful procurement processes and that agreement development is often effective as an iterative process where a publicly issued initial agreement is subsequently modified following one or more rounds of private sector review and feedback.

If the water supply agency were to solicit water treatment operations services for its two plants, then the procurement process might start by identifying the major selection criteria as qualifications & experience, proposed management plan, and fee for services. The water supply agency could then evaluate the experience of interested respondents to qualify a shortlist and issue a detailed request for proposals along with a draft service agreement. The qualified respondents would return the service agreement with comments, and the agency would issue a revised agreement. When proposals are submitted, the respondents are indicating satisfaction with the service agreement conditions, and the agency would subsequently select the winning team on the basis of *satisfying* published minimum management expectations and providing the *lowest* annual service fee, where satisfaction is determined before the fee is known.

Dispose of Assets. A characteristic outcome of the appraisal of infrastructure services is the identification of assets that are no longer integral to the organization's mission. Essentially, the organization needs the ability to effectively value, market and sell or lease such facilities. Failure will result primarily in lost economic opportunities.

Service Management Competencies. Finally, the organization must possess the aptitude to manage PPP arrangements once they are in place.

Manage Development & Monitor/Evaluate Services. Frequently, PPP's include the development of new or the modification of existing real assets. Thus, managing capital development or reinvestment remains an important public agency competency. The nature of this competency when instituting PPP's, however, shifts somewhat. In most PPP's, the details of design and construction are left to the private partner, so the attention of the public agency is more upon the resulting service that the developed asset will provide than the asset itself. Public agencies still have an interest in design & construction quality, but the principal assessment of this quality occurs once the asset is "in place" as opposed to when the asset is "going into place".

This shift really redefines the quality assurance/control program. Reviews of design plans and construction sites become less important, and more expertise associated with facility operations is necessary. The performance criteria and the review process for the operating period will be set forth in the concession agreement. Since each agreement will be fairly unique, standard performance criteria are not likely, so the public agency must carefully define reliable but reasonable performance appraisal methods. In the case of water supply, these criteria are more easily defined thanks to well-established minimum standards for safe drinking water.

Manage Asset Hand-over. At the conclusion of a PPP arrangement, the real asset that the private partner operated and managed will be handed back over to the public agency. Typically, the public agency will renegotiate a new deal with the existing partner, find a new partner or resume operations. Regardless, the status of the real asset becomes quite important. This hand-over is usually governed by a set of return provisions. Properly structured, these provisions can provide an additional safeguard against under-investment in maintenance by a contractor without introducing unwarranted requirements. Most existing concession agreements stipulate an inspection procedure followed by a corrective period, much like the punch-list process during facility turnover following construction.

Conclusion

The transition to a world where the propensity of infrastructure services is provided by the private sector is underway. Essentially, governments will become the overseers of service rather than the service providers. Some argue that this trend is perilous – it erodes important, existing public sector competencies and it places critical systems in private hands. Peril *can result* if PPP's are entered into haphazardly or for political purposes; however, a public organization that possesses the competencies described can include the erosion of existing competencies and the private management of critical systems as risks during the appraisal process. Moreover, the public agency certainly does not abdicate its responsibility to design and enforce standards. In fact, the presence of well-defined performance criteria and appropriate concession conditions provides the public sector with powerful recourse options during PPP's. Hence, a perilous outcome is not fixed; moreover, the PPP model can encourage both sectors to play to their strengths, the public as policymaker and standard-bearer and the private as innovator and efficiency-expert.

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Uncovering 'Hidden' Project Benefits through Program Management

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Abstract

Hallmarks of successful projects include the delivery of technical objectives within established time, cost and quality targets. Yet, situations exist where benefits beyond these targets may be realized by the use of program management techniques, such as project delay. To substantiate this theory, this paper presents the results of a recent international offshore facilities program, forecast to compress overall schedule by 20% and increase return on capital employed (ROCE) by 57% through the implementation of a program management organization (PMO). Assisted by modeling and simulation software originally developed at the Center for Integrated Facility Engineering (CIFE) at Stanford University, PMO leaders were projected to be able to make decisions that would result in several quantifiable and positive project outcomes. Moreover, because such outcomes were to be obtained in the absence of changes in the internal execution of constituent projects, evidence exists that 'hidden' benefits can be uncovered through applied program management. As a result, the findings advocate additional research regarding the search for optimal sets of project benefits in the program environment; research that is currently underway.

Contemporary Program Management

Program management is typically defined as "The coordinated management of a portfolio of projects to achieve a set of business objectives (CCTA 1993)." While this definition does relay the importance of tying project execution effectiveness to organizational goals and strategy, it does not explain the different variations and expressions of program management that result from different portfolios of projects. However, it is generally accepted that four types of program management exist, each differing in their approach toward the portfolio (Reiss 1996):

1. ***The Multi-Project Organization*****—management of a portfolio of projects that benefit from a consolidated approach within an organization that undertakes project work exclusively. Fluor Corporation is a good example.**
2. ***The Mega Project*****—management of a portfolio of projects towards one specific objective. The International Space Station is a good example of numerous different projects culminating in successful objectives.**
3. ***Numerous Projects for One Client*****—management of a series of projects within an organization for the same client. Projects may differ, yet share similar technical standards. The roll-out of discount retail stores is a good example.**

4. ***The Program Management Organization*—management of a portfolio of projects all of which aim towards corporate objectives. Several institutional investors use this approach.**

While programs differ in their treatment of project portfolios, all four program types share several common factors. Indeed, all programs involve many simultaneous projects, all concentrate on resources, and all need a multi-project view of scheduling. In the architecture, engineering, and construction (A/E/C) industry, not only can programs of each type be found, but many organizations implement hybrid arrangements of these program types. For example, large industrial-sector engineering, procurement, and construction (EPC) contractors organize client-specific alliances within a Multi-Project Organization. Still, most companies in the A/E/C industry are failing to realize latent value inherent in their operations. Largely, this is because incremental value is subsumed within transactional costs and obscured by inappropriate work processes. However, recent advances in modeling and simulation technology are challenging the culture of benefits subtraction.

Program Management and Simulation

In the early 1970's, Galbraith (1974) observed how program managers could become burdened by large numbers of 'exceptions' (i.e., non-routine situations in which project workers lacked the information to proceed, thus requiring assistance from their managers). Since then, Galbraith's view of organizations has advanced theories of organizational design, becoming a prime motivator for the development of modeling and simulation technology for projects and programs. Based on his findings, subsequent research conducted at the Center for Integrated Facility Engineering (CIFE) at Stanford University confirmed the need to model program organizations working on interacting projects so that aggregate performance predictions could be generated (Levitt & Kunz 2002). This research was commercialized by the Vité Corporation and ePM, LLC as software known as SimVision®. This software is capable of taking a unique look at both project and program execution concurrently. It allows a user the opportunity to model the allocation of resources to project and program activities and then simulates the probability of outcomes such as schedule performance and work backlog for all projects in the program. Example inputs (i.e., a model) and outputs (i.e., predictions) from SimVision® are illustrated in Figure 1. Detailed explanation of the processing methods used by SimVision® software are found in numerous articles such as Kunz et al. (2000) and Jin and Levitt (1996). Recently, these methods have been used to conduct virtual computational experiments in alliance settings (Thomsen et al. 2005).

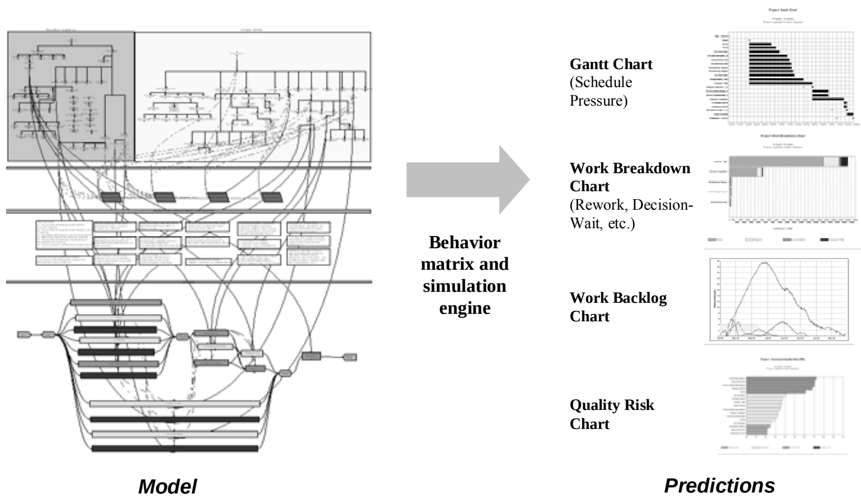

Figure 1. SimVision® Modeling and Simulation (After ePM 2003).

Applied Project Modeling and Simulation

In late 2003, as a consultant employed by ePM, LLC, the author was engaged by a U.S.-based energy company to perform a comprehensive schedule forecast and analysis for the engineering, procurement, and construction (EPC) of a large scale petroleum project off the shore of China. This $3 Billion project was comprised primarily of several subprojects such as a floating production storage and offloading (FPSO) facility, numerous jacketed wellhead platforms (WP), a central processing complex (CPC), sub-sea pipelines, tanker moorings, and various transport activities. Of these subprojects, the FPSO facility was particularly complex given that its hull and topsides were to be designed and fabricated by separate companies on different continents. In addition, the U.S.-based energy company was partnered with an international petroleum firm and had recently hired a global EPC contractor.

ePM's SimVision® software was used to create the model shown in Figure 2. The model ties individual managers to subprojects via lines of responsibility (i.e., shown in grey). Notably, all the organizations involved in the venture are shown (i.e., from left; owner, partner, contractor, and subcontractor organizations). Precedence relationships between the subprojects are shown as dark, solid lines. Paths for rework and coordination are displayed as dark, dashed lines in cases where exceptions might occur. The resulting simulation output is shown as a Gantt chart in Figure 3. The simulation forecasts which subprojects are likely to be critical based on their resource utilization, precedence, and likelihood for exception occurrence. In Figure 3, critical subprojects are shown in dark grey and represent 55% of all subprojects planned for execution. Here, the simulation output also identifies the revised completion date in comparison with the expected date generated using critical path method (CPM) software. In this case, a final project completion date 11 months past the planned completion date was anticipated using a 95% confidence interval.

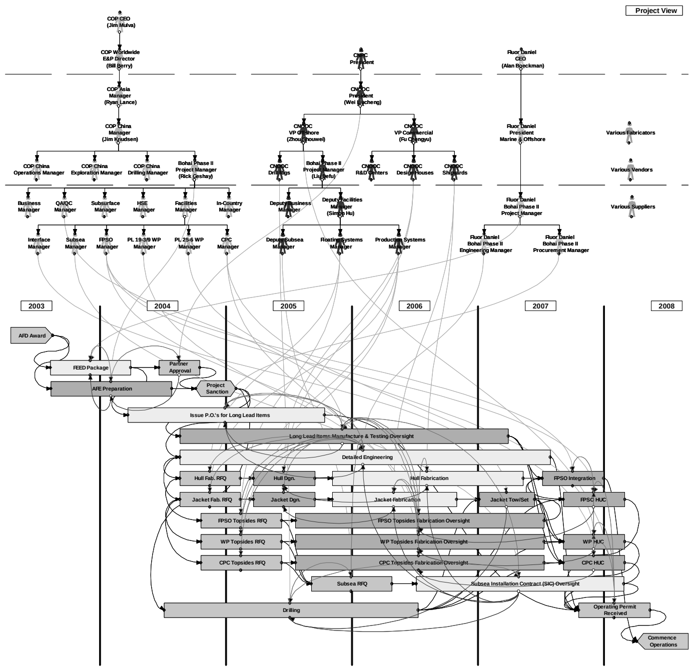

Figure 2. Example Project SimVision® Model.

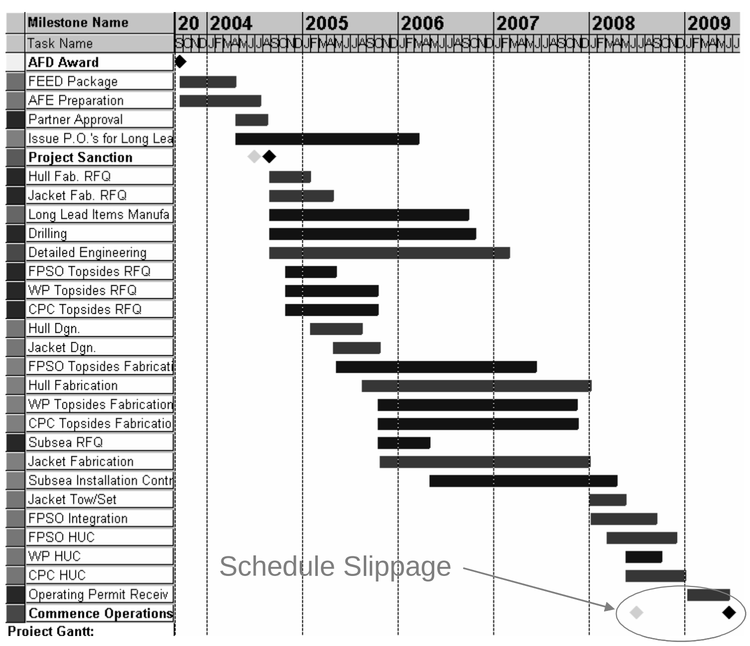

Figure 3. Example Project SimVision® Simulation.

To bring the project back in alignment with planned milestones, the author developed several alternate project and program execution scenarios. Some of these scenarios added resources, some aggregated subprojects, and others changed delivery methods. However, the preferred scenario consisted of a program management organization (PMO) taking responsibility for the entire project which was subsequently recast as a program consisting of a portfolio of projects. The PMO is represented in Figure 4 by the light grey rectangle. The likelihood of exceptions was also reduced by changing the organizational structure within the PMO. Individual managers still retained links to their parent organization, yet their principal reporting lines transferred to new PMO managers. In addition, a monthly coordination meeting (i.e., shown as the grey parallelogram in the organization chart) was installed to keep senior management at the parent firms informed and involved in the program. So, although lines of responsibility changed, the precedence relationships between the projects remained.

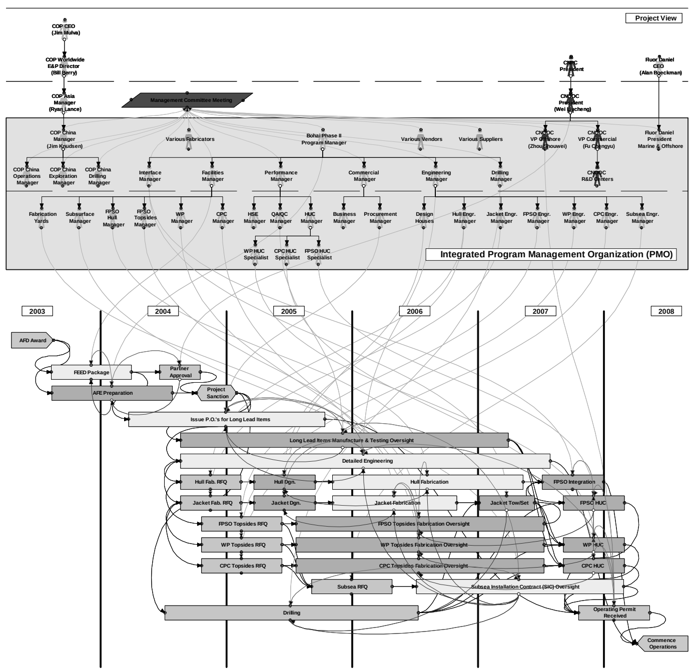

Figure 4. Revised Example Project SimVision® Model.

The installation of the PMO had the intended effect. Principally, by reducing project overhead and facilitating decision-making, the program's performance improved as can be seen in Figure 5. In fact, the PMO was also forecast to mitigate risk by two primary means. First, the percentage of critical projects was simulated to decrease from 55% to 37%. Second, the PMO changed the program's ability to accommodate systemic risk. As a result, executive leaders changed their focus from planning to actual deliverables such as the integration of the FPSO and its 'hook-up' and commissioning (HUC). Notably, the overall program schedule was forecast to be compressed by approximately 20%, again using a 95% confidence interval.

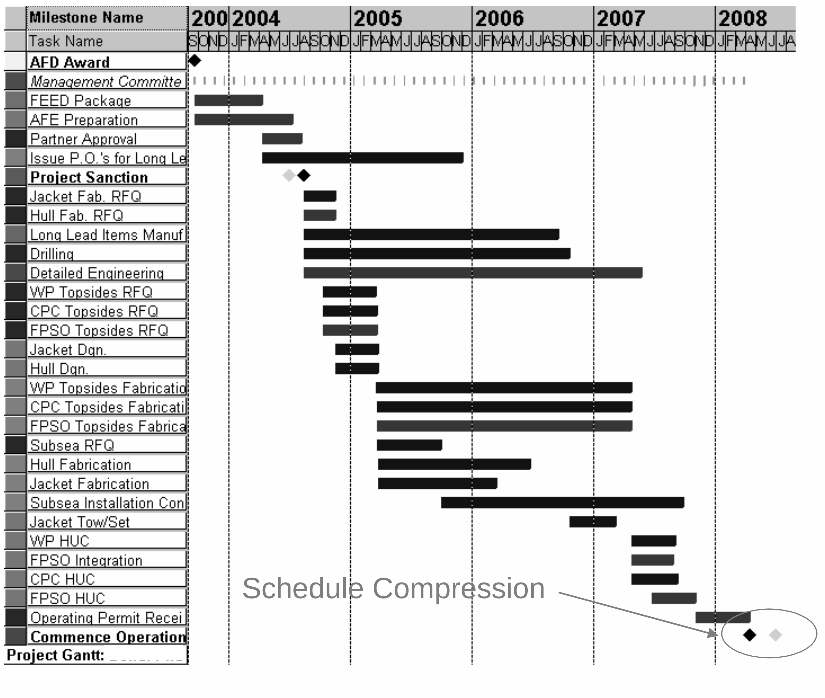

Figure 5. Revised Example Project SimVision® Simulation.

Applied Program Modeling and Simulation

In a project management context, analysis of this program would likely be considered complete. However, as program management is concerned with the attainment of benefits, additional analyses were undertaken. For an offshore development project such as the one considered here, the revenues generated from hydrocarbon production are of primary concern. Consequently, yet another model was created to represent HUC and sanction of each wellhead platform, the CPC, and the FPSO. As can be seen in Figure 6, each of these subprojects was constrained within the same model (i.e., Figure 4) relative to their 'parent' projects and the program as a whole. This type of constraint was especially important since the particular subprojects in question were to be executed using common resources from the PMO. For example, the decomposition of the FPSO's HUC is shown on the right side of Figure 6 as a series of activities necessary for the production of hydrocarbons.

What makes the model in Figure 6 unique is the concept of program delay. In fact, one of the wellhead platform HUC subprojects is shown as delayed by two months and the tie-in from a previously-existing project is shown as delayed by six months relative to the original project CPM schedule. The specific time that each subproject was delayed was developed through iteration of simulation output by the author. Thus, in a rather counter-intuitive way, the delay of certain projects within a portfolio actually improves the schedule and financial performance for the entire program.

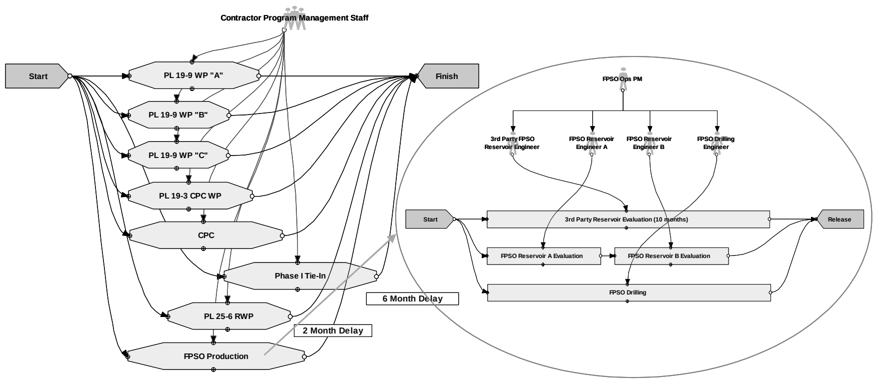

Figure 6. Example PMO SimVision® Program Model.

This improvement is depicted in Figure 7. Here, the delay of these two subprojects is simulated to result in a much faster program schedule and realization of benefits. On the left side of Figure 7, the improvement of revenue from hydrocarbon production is shown as a solid, increasing line. This line can be compared to its baseline target that is shown as a dashed, increasing line. In fact, this improvement was calculated as a 57% increase in the return on capital employed (ROCE) once baseline costs (i.e., the 'horizontal' solid and dashed lines, respectively) were taken into account. Plus, delaying the starts of two projects in the portfolio was forecast to reduce quality, communication, and functional risks as depicted by the SimVision® simulation output shown on the right side of Figure 7. These improvements are mainly attributable to the availability of attendant supervision and competent onsite personnel.

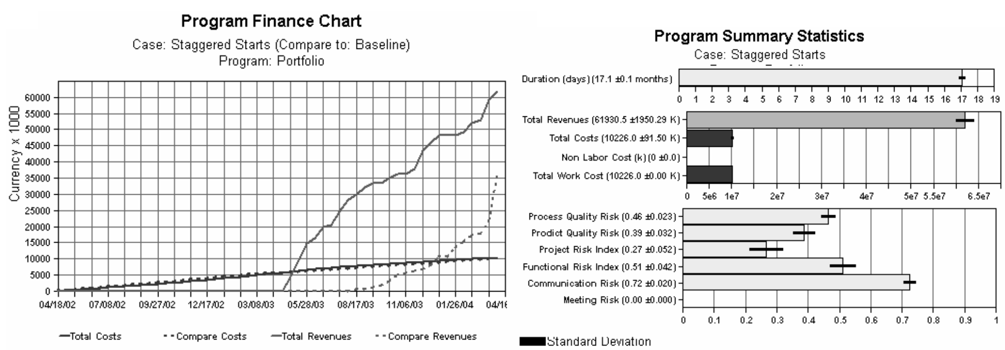

Figure 7. Example PMO SimVision® Program Simulation.

Conclusions

The examples of program management modeling and simulation presented here are analyses of a particular EPC program. As a result, they exist as stand-alone representations of performance and are not integrated within the day-to-day information systems used by program managers. This disconnect points toward a need to develop program management information systems (PgMIS) to quantify the latent value realized through program execution. One way to accomplish this is through the use of a value tree. Indeed, each branch in the tree reflects potential outcomes of decisions as the individual projects in the program progress toward an overall benefit. Consequently, one path through the value tree gives the greatest benefit. The trick to obtaining this benefit is to modify the probability of a desirable outcome for each project in the program. Today, the best means of improving outcome probability are found in forecasts created via modeling and simulation technology. In fact, for the case study presented herein, the amount of latent value captured is calculated to be $1.11 Billion.

This paper demonstrates that 'hidden' benefits can be uncovered through the use of program management. In particular, the implementation of a program management organization (PMO) and use of leading-edge modeling and simulation software led to the creation of compelling performance improvement. However, some performance improvement was gained through the technique of project delay – a technique that likely seems counter-intuitive to many involved in project management. Therefore, it stands to reason that dramatic and quantifiable performance gains are likely only realized through a reliance on program management practice and, partly, through a leap of faith. For these reasons, it is imperative that effective leadership remain a prerequisite for successful program execution.

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AN AGILE STEP FORWARD IN PROJECT MANAGEMENT

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ABSTRACT

Agile project management has recently emerged in the information systems industry; however, its evolution and characteristics are poorly understood. The construction industry has a less than perfect project management record and might benefit from the adoption of agile project management. An extended literature review has established that agile project management does indeed offer significant improvements and that the construction industry might potentially benefit, subject to structural change of the industry. An initial exploration of the underlying rationales for agile has lead to the identification of further promising research areas.

INTRODUCTION

Agile thinking, production and project management has evolved since 1990 as a response to the gains made in Japanese industries since their restructuring after the Second World War. It has made significant headway in the information systems industry; however, impartial academic studies as to its advantages are sparse. In order to investigate the potential for an underlying theory of agile project management, it is first necessary to understand its underlying rationale, and to then assess the possibility of engaging any strengths in other domains.

This paper describes initial research into agile project management and identifies promising areas for further research.

AGILE PROJECT MANAGEMENT

Agile project management has its foundations in the management science of Deming but perhaps harks back to pre-industrial revolution times, before decomposition and management-as-planning took a hold. The real progress today lies in the domain of information systems; however, it may be possible to migrate the core attributes to other domains, including construction.

The evolution of agile project management can be traced from Deming through the Toyota development method (Liker, 2004) to the Agile movement and is well documented elsewhere (Owen and Koskela, 2006). It was not until 2001 that a

'Manifesto for Agile Software Development' (Beck and et al, 2001a) evolved through the efforts of leaders in the field (The Agile Alliance), and the term agile became synonymous with a variety of iterative and incremental information systems development methodologies. The 'Manifesto' stressed the comparative importance of human contribution, product (versus documentation), customer collaboration and responsiveness to change. The Manifesto, together with its underlying 'Principles' (Beck and et al, 2001b) depict a substantial concentration on the early and regular delivery of value, and the use of changes as opportunities to enhance that value. Working practices focus on frequent, sustainable iterative deliveries by facilitated multi-functional, self-organising intercommunicative teams. Scrum and other agile methodologies add to those overall foci by prescribing numbers for the optimum team size (typically 2 to 20) and iteration periods (typically around 30 days, although varying widely).

The Agile Project Leadership Network (APLN) followed on and has a wider focus than just software, focussing on: value, customer, teams, individuals, context and uncertainty. The APLN Declaration of Interdependence (Anderson and et al, 2005) for agile and adaptive management stresses:

- *continuous flow of value*
- *engaging customers in frequent interactions and shared ownership.*
- *uncertainty* (should be expected) *and manage*(d) *through iterations, anticipation, and adaptation.*
- *individuals are the ultimate source of value*
- *group accountability for results & shared responsibility for team effectiveness.*
- *situationally specific strategies, processes and practices.'*

Agility itself is defined by one of its originators (Dove), as follows:

'The Ability of an Organization to Adapt Proficiently (Thrive) in a Continuously Changing, Unpredictable Business Environment. (Dove, 1996)

Agile systems are ones that can respond to both reactive needs and proactive opportunities - when these are unpredictable, uncertain, and likely to change.' (Dove, 2005)

Dove considers that agility consists of practices and processes for knowledge management, value propositioning and response ability and sees these practices and processes as positioning an enterprise to cope with change. Indeed, dictionary definitions of agility generally include words such as quick, quick-witted and nimble. Finally, Goranson (1999) states:

A dominant definition of the agile enterprise is one that responds to (and ideally benefits from) unexpected change.

Whilst some see agility as a state of mind, others focus on methodologies; those who implement 'agile' frequently confuse it with 'lean'. In terms of manufacturing, lean and agile are different, as pointed out below (Sanchez and Nagi, 2001):

'Lean manufacturing' developed as *'a response to competitive pressures with limited resources. Agile manufacturing, on the other hand, is a response to complexity brought about by constant change. Lean is a collection of operational techniques focused on productive use of resources. Agility is an overall strategy focused on thriving in an unpredictable environment. …… Flexible manufacturing systems* (offer) *reactive adaptation, while'* agile manufacturing systems offer *'proactive adaptation'.*

To amalgamate the common themes of the various individuals, teams and initiatives set out above; to be agile an enterprise or project must be structured appropriately to proactively and quickly adapt to change, seizing such opportunities to enhance value outcomes.

In terms of methodologies, these should depend upon the specifics of the project but common themes should include the use of empowered, multi-disciplinary, small teams to iteratively, incrementally and continuously develop value through the transformation of emergent and evolving requirements, products or processes which involve, and provide early enhanced value for stakeholder(s). Excessive discrete planning or documentation should be seen as waste, indeed it is the recombining of 'thinking' (planning) and 'doing' (following the plan) which leads to agility.

AGILE BENEFITS

It is important to verify that agile processes do actually lead to worthwhile improvements, compared with traditional processes. Seven sets of comparative studies consolidated by Boehm and Turner (2004) illustrate the trend for a reduction in the effort required to fulfil a project, averaging around 50%. Further data was obtained from an EC-funded pan-European initiative to identify methods for process improvements; the improvement in organizational skills of 79% resulting from the adoption of DSDM agile practices was particularly noteworthy (Stapleton and Consortium, 2003). Finally, an online survey of 131 companies and their perceptions of the improvements which agile processes offer reported improvements or significant improvements in productivity, quality and business satisfaction. Just under half of respondents reported reductions in costs (cost reduction is a secondary effect of agility as the primary focus is on value or, in this context, quality-improvement) (Shine, 2003).

The evidence of significant improvements in organisational skills (above) provides a starting point to analysing how agile succeeds. DSDM, Scrum and other agile processes and methods all emphasise the advantages of communication flows within small teams. Communication is improved through the use of simultaneous broadband paths instead of discrete cascaded messaging, thus rendering information more immediate and better targeted. Further analysis follows of how management work structures differ from traditional project management.

UNDERLYING RATIONALES FOR AGILE

Coping With Emergent Requirements

Most projects are volatile and subject to unforeseeable chaotic inputs and

emergent requirements. This is particularly so in the case of information systems because they are so difficult to visualise (Wegner, 1995) (Humphrey, 1995) (Ziv and Richardson, 1997).

In the case of construction, research shows that, as late as the start of construction, significant uncertainty remains as to what is to be constructed (Howell et al., 1993). Indeed, other sources point to the nugatory nature of <u>excessive</u> front-end design and/or planning (MacCormack et al., 2003) (Baker et al., 1986) (Baker et al., 1986).

If change if so inevitable and over-specification nugatory, why do we try so hard to plan to the last detail and then to follow that plan at all costs? It is possible that such a strategy emerged in order to permit a better understanding of complexity through decomposition, thus minimising risk, controlling scope, and enabling measurement of progress. However, agile thinking recognises that changes throughout the project force scope control to be an ongoing task: project scope should only be defined as far as we are currently truly able to comprehend and prioritise it from the perspectives of value realisation and risk mitigation. We can then use project team (including the customer) learning for control and feedback. Thus we are compelled to treat the project as a process and not as a serious of pre-scoped milestones/ gateways.

The emphasis therefore changes from delivery to a specification within a timescale and budget, to delivering emergent value within similar constraints. The following diagram illustrates the relative shifts between traditional and agile projects (Cockburn, 2003).

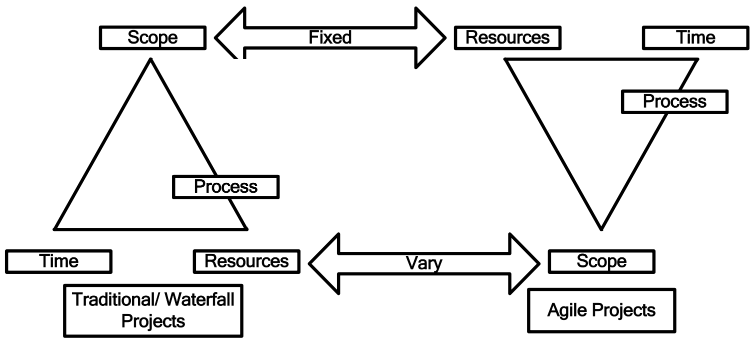


Figure 2: Changing from Traditional to Agile Project Management

Whilst this illustration can easily be mapped to any design or product development process, its application to production scenarios requires caution. For example, construction resources are unlikely to remain fixed if scope is changed.

Motivational Aspects

Another area of ongoing research concerns the motivational impact of agile processes. On initial review, methodologies such as Scrum and eXtreme Programming (XP) have common themes of limiting team effort, whether in terms of scope, time or both. Further positive motivational effects of agile processes appear to include the rapid nature of the feedback mechanism, and the supportive nature of interference-free project management. Thus, at a personal level, it may be possible to more easily envision and achieve tasks, and to gain positive feedback.

Whilst it seems probable that definition and facilitation of closer motivational horizons contributes to agile project success, further research is required on the relative efficiency of the different mechanisms employed. However, the following section on human dynamics seems to have a bearing on the effectiveness of such work organisation.

Complex Systems, Network Theory & Human Dynamics

The approach of management-as-organizing (as opposed to management-as-planning) takes the idea of human activity as inherently situated (Johnston and Brennan, 1996) and thus, planning should focus on structuring the environment to contribute to purposeful acting. In the language/action perspective, described by Winograd and Flores (1986), action is triggered by explicit commitments (promises) resulting from two-way communication. The scientific experimentation model of control, presented by Shewhart and Deming (1939), focuses on finding causes of deviations and acting on those causes. The scientific experimentation model thus adds the aspect of learning to that of control.

However, Ashby's Law of Requisite Variety (Ashby, 1956) shows that complex systems cannot be controlled through a centralised system: only variety can master variety, reducing disturbances and promoting harmonious order. Complex Adaptive Systems (CAS) developments build upon Ashby's ground breaking work, together with observations of the natural world, to provide us with an understanding of pattern emergence and the need for guidance frameworks, rather than rigid adherence to rules or plans.

> *The overall behaviour of a complex system, which we ultimately need to understand and quantify, is as much rooted in its architecture as it is in the nature of the dynamical processes taking place on these networks. We are, however, at the threshold of unravelling the characteristics of these dynamical processes.* (Barabasi, 2005b)

The Barabisi model of human dynamics leads us towards an evolving understanding of the nature of human decision making in terms of task prioritization and may eventually help explain why restricted task choice can lead to enhanced human efficiency (Vazquez, 2005). Barabisi raises *the intriguing possibility that animals also use some evolutionarily encoded priority-based queuing mechanisms to decide between competing tasks.* (Barabasi, 2005a) Human activity does not follow Poisson distribution but is of a burst nature, followed by a heavy tail; this behaviour is *rooted in the fact that humans assign their active tasks different priorities, a process that can be modelled as a priority queuing system* (Vazquez, 2005). In summary, Barabisi's research may explain why short time periods (such as Scrum Sprints) enhance task efficiency; however, the implications for agile understanding require further research in conjunction with motivational science.

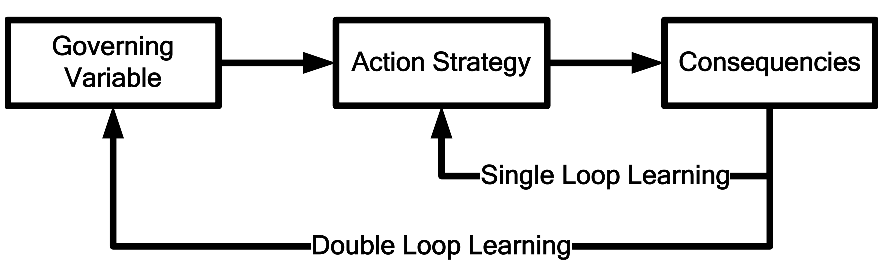
Feedback & Organizational Learning

It could be argued that learning (or the detection and correction of error) in traditional project management is Model 1 single loop learning, i.e. the deliverables, plans and methodologies are operationalized rather than questioned – this is the so-called thermostat model.

> Model 1 Organizational systems *'involve a web of feedback loops that 'make organizational assumptions and behavioural routines self-reinforcing – inhibiting "detection and correction of error" and giving rise to mistrust, defensiveness and self-fulfilling prophecy'* (Edmondson and Moingeon, 1999)

On the other hand, Model 2 learning organizations have governing values which include: valid information, free and informed choice and internal commitment. Model 2 strategies are: sharing control, and participation in design and implementation of action. Model 2 learning organisations are rare, though they foster double loop learning, as shown below. (Argyris and Schon, 1996)

Figure 2: Single and Double Loop Learning



Agile project management has emerged from double loop learning, i.e. by questioning the governing variables such as methodologies. Double loop learning continues throughout the agile project through the formal use of iterative development and through the informal learning inherent in small interactive multi-disciplinary teams. Any Model 2 organisation relies on the sharing of control, design and implementation of action, using minimally defensive relationships and is in direct contrast to the traditional command and control management system and waterfall development methodologies.

However, Model 2 organisations would require the adoption of Japanese or, at least Theory Z practices of collective decision making, employee – employer relationships and long-term employment (Ouchi, 1981). However, the construction industry and its fragmentary and temporary employment patterns and autocratic management styles conform more to Theory X (McGregor, 1960) ; even a move towards Theory Y practices of consensual management (Massie and Douglas, 1992) would require substantial industry change. On the other hand, an agile organisation can be defined in terms of its employment of Model 2 learning and Theory X relationship practices and structures.

Metaphysical Underpinnings

Agile project management can be seen as 'management as organising' (Johnston and Brennan, 1996), indeed, an agile project manager is very much seen as a facilitator who enables small, self-organising multi-disciplinary teams to decide for themselves how they satisfy their value goals.

However, it is necessary to understand the deeper foundations, namely the metaphysical commitments underlying our approaches (Koskela & Kagioglou 2005). Since the pre-Socratic period of philosophy, there have been two basic views on the metaphysical (or ontological) question: What is there in the world? One holds that there are things, that is, atemporal entities in the world. The other insists that there are processes, that is, intrinsically temporal phenomena. These metaphysical assumptions tend to strongly influence how the subject of the inquiry or action is conceptualized. The thing-oriented view seems to lead to analytical decomposition, the requirement or assumption of certainty and an ahistorical approach. The process-oriented view is related to a holistic orientation, acknowledgement of uncertainty and to a historical and contextual approach. The theories discussed may be classified according to their metaphysical choices. Generally, the traditional approach is characterized by a substance (or thing) based ontology, whereas the new approaches subscribe to process ontology. However, the ontological choices affect the practical procedures not only through the mediation of theories, but also directly. A project is, of course a process and fits neatly in the area of process metaphysics, however, agile thinking and processes cover both management and production theories. Only once an underlying theory of agile project management has been resolved can we add this properly place in its true metaphysical context.

INFORMATION SYSTEMS & CONSTRUCTION INDUSTRIES COMPARISON

Both the information systems and construction industries use essentially a design and product development process, with limited, tailored re-use of designs and components. Whilst there is some productionisation within construction (e.g. build to print) and information systems industries, this is atypical. In both domains value is only truly realised during use, although it is generally easier for an 'outsider' to envision the functional constraints and opportunities of a building than those of an information system.

One of the common areas between the two domains is the need for requirements definition. In construction *briefing must be seen as a process not an event* (Barrett and Stanley, 1999) and there are tentative moves towards dynamic briefing throughout the project (Othman et al., 2004), a particular need for which is seen in the internationalisation of construction projects (London et al., 2005).

Whilst the need has therefore been recognised for what is essentially an emergent agile value development process, progress in its use has not reached the levels of use discussed for information systems projects. Although it has been reported that approximately one third of information systems organisations still use waterfall methods (Laplante and Neill, 2004), another survey reported that over 95% of respondents would continue to use or would adopt agile processes in 2003 (Shine, 2003).

AGILE PROJECT MANAGEMENT IN CONSTRUCTION

As Scrum can be considered as a 'management tool' (Boehm and Turner, 2004), it can be easily used beyond information systems (its origins lie in Japanese manufacturing product development). Similarly, DSDM has been used in organisational development and infrastructure projects and even in construction (Stapleton and Consortium, 2003). However, these ad hoc uses are not widespread and barriers to wider adoption within the construction industry remain.

It has been stated that the prevalent theory of construction is a hindrance to innovation (Koskela and Vrijhoef, 2000), thus calling into question whether new management theory could be adopted in this domain. Current construction industry structures, developed partially to ensure contractual risk avoidance appear to be incompatible with Japanese collaborative trust and corporate and individual learning models. There thus seem to be barriers to the employment of agile project management methodologies and thought processes, in view of their inherent requirement for trust and appropriate risk apportionment (i.e., from a value maximisation, rather than a(n apparent) financial risk management perspective). However, the adoption of agile project management could probably offer enhanced construction project values, should adoption prove feasible; although, the scale of any potential improvements has yet to be scoped.

CONCLUSIONS

Agile thinking has a sound basis in both project management and manufacturing in Japan and is currently yielding improved value delivery in information systems project management. Although a common view of agility is not extant, the core attributes can be clearly stated. The structuring of an enterprise or project to enable it to proactively respond to change and to welcome the opportunity that such change affords to increase value delivery may well be challenging. However, there are many apocryphal stories of successful improvements due to the adoption of agile management, though improvement metrics are limited.

Whilst agile project management in information systems has obvious parallels with the design phase of construction, there are considerable differences in the respective production phases which must be further explored as the underlying rationales for why agile works are better understood. These underlying rationales include the manner with which agile deals with emerging requirements, how individuals are better motivationally organised to produce value, how the structure of work affects outcomes and the manner in which it supports organizational (including customer) learning. Bearing in mind agile's emphasis on 'the individual over process', the field of human dynamics bears further research.

The current construction industry employment and sub-contract/ risk avoidance practices militate against successful transference of agile project management into the build phase. However, should evidence of improved value delivery and/or profits be sufficiently convincing, the industry will change through obvious self-interest to adopt Model 2 learning and Theory X relationship practices and structures, thus becoming agile.

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SEMANTIC WEB-BASED KNOWLEDGE MANAGEMENT IN CONSTRUCTION

Chimay J. Anumba[1], Patricia Carrillo[2] & Jiayi Pan[3]

ABSTRACT

There is growing interest in knowledge management (KM) within the architecture, engineering and construction (AEC) sector. KM is seen as vital for ensuring competitive advantage through the capture and reuse of knowledge, avoidance of previous mistakes, reduction of rework, retention of key staff and the timely delivery of knowledge to those who need it. Knowledge management implementation is generally at the organisational level, project level or both. However, there is only limited knowledge management at the personal level. The advent of the Semantic Web provides scope for context-specific knowledge management at all of these levels. This paper explores this, starting with a brief review of developments in knowledge management in construction and then introducing the Semantic Web and its underlying technologies. The opportunities for improved knowledge management based on the Semantic Web are then discussed, followed by a description of the approach being adopted in the development of mechanisms to take advantage of these opportunities. A number of conclusions are drawn on the potential uptake of the concepts introduced.

INTRODUCTION

In the knowledge-based economy, the most important asset of organizations is knowledge (Stewart 1997). An organization's competitive advantage lies in the knowledge residing in the heads of its employees and the capability to harness this knowledge for meeting its business objectives. Given the growing importance of knowledge in the success and even the survival of an organization, the significance of a systematic or organized knowledge management (KM) approach is being increasingly recognized. Scarborough et al (1999) define KM as the process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organisations. It enables "the creation, communication, and application of knowledge of all kinds to achieve business goals" (Tiwana, 2000). KM, therefore, provides strategies that help in retaining organisational knowledge and organisations that are successful in achieving this will increase profits, lead markets, avoid rework, and have better chances for innovation (Davenport, 1997; Tiwana, 2000; Al-Ghassani *et al*, 2001a). The true promise of benefits from implementing KM is evident in many cases and this has encouraged even more organisations to adopt KM with many now allocating considerable resources to retain and manage their knowledge. A survey by KMPG (2003) revealed that the knowledge management practice in the organizations surveyed had improved from one mainly characterized

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by the lack of an established implementation strategy in 1998, to one approaching a higher maturity level with greater board/management support in 2002/2003.

Information Technology (IT) has long been recognised as critical for successful knowledge management. While it is now recognised that good knowledge management does not result from the implementation of information systems alone (Davenport 1997; Stewart 1997), the role of IT as a key enabler remains undiminished (Anumba et al, 2000). The advent of technologies such as the Semantic Web provide an opportunity for KM systems to be better integrated with the socio-cultural and organisational context within which they have to work. This paper explores the potential of the Semantic Web to facilitate knowledge management within the architecture, engineering and construction (AEC) sector. It starts with a brief review of KM in construction, presents the key characteristics of the Semantic Web, and then discusses Semantic Web-based knowledge management. The approach being adopted in an ongoing project is also described and a number of conclusions are drawn.

KNOWLEDGE MANAGEMENT IN CONSTRUCTION

KM practice in construction is mostly informal and people-centred, although there is a growing trend towards the development of 'formal' KM strategies within construction firms (Kamara et al. 2002a). Other strategies include the development of standard operating procedures, best practice guides, communities of practice, and codes of practice. These are mostly used within individual firms, but the greater challenge lies in the management of project knowledge, since the construction industry revolves around projects. Another dimension that is equally important but often forgotten is personal knowledge management. These three dimensions of KM in construction are briefly discussed below:

Personal Knowledge Management: In order to function effectively in their roles, as well as share their knowledge with others, it is important that construction professionals have appropriate systems for managing their personal knowledge. This is an often overlooked aspect of KM in construction, partly because it is assumed that most of this knowledge is tacit and held in people's heads. However, the potential for people to forget, and the need to manage the explicit knowledge required by an individual for his/her work means that that an organised approach to personal knowledge management is required.

Organisational Knowledge Management: This is the most common dimension of knowledge management that is discussed in the literature. The focus is often on how organisations can harness the knowledge that its employees have (making it an organisational rather than individual asset) and deploy it in such a way that it enhances the operational effectiveness and efficiency of the organisation. Many organisations rely on the use of intranets, skills yellow pages and communities of practice as the key elements of their KM strategies.

Project Knowledge Management: The most common approach used in the industry to capture the learning from projects is the post-project evaluation, PPE (Orange et al. 1999). While useful, there is evidence that current practice does not provide an effective framework for the capture and reuse of knowledge. PPE is usually conducted individually by organizations involved in a project and with insufficient time. Furthermore, it does not allow the current project to be improved by incorporating the lessons being learnt as the project progresses. There is also the problem of loss of important information or insights due to the time lapse in capturing the learning. Overall, knowledge is not effectively managed at the project organisation level but some project teams are beginning to address this through provisions in project extranets.

In addition to the limitations of knowledge management at personal, organisational and project levels, there is the lack of effective mechanisms for the appropriate transfer of knowledge between these three levels, or the delivery of knowledge to project personnel based on their particular context. These limitations in industry practice and the acknowledged importance of KM have led to various efforts to improve KM in construction. Within the UK, these include the following projects: Cross-sectoral LEarning in the Virtual enterprise, CLEVER (Kamara et al., 2002b), Knowledge Management for Improved Business Performance, KnowBiz (Carrillo et al, 2003), Knowledge and Learning In CONstruction, KLICON (McCarthy et al., 2000), Creating, Sustaining and Disseminating Knowledge for Sustainable Construction: Tools, Methods and Architecture, CSanD (CSanD, 2001) and e-COGNOS (e-COGNOS, 2002). Other relevant research projects have been undertaken in the US (Reiner and Fruchter, 2000) and in Germany (Scherer and Reul, 2000).

None of the above research projects tackles the knotty problem of knowledge management across distributed, heterogeneous networks and organisations, or the need to support the dynamic environment within which most construction professionals operate. There is scope for the Semantic Web to facilitate integrated, context-specific knowledge management at personal, organisational and project levels within the construction sector. This is explored in detail below, after a brief introduction of the characteristics of the Semantic Web.

THE SEMANTIC WEB

The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation (Berners-Lee et al, 2001). It allows the data to be defined and linked in a way that it can be used by machines not just for display purposes but also for automation, integration and data reuse. The Semantic Web technologies provide intelligent access to heterogeneous distributed information, enabling software applications to mediate between user needs and information sources (Fensel, 2001). Figure 1 illustrates the layers of the Semantic Web Architecture as defined by W3C (URL 1). These layers are described below:

- ***XML + NS + XMLschema layer:*** XML provides the common syntax, while Namespace (NS) and XML Schema define contents and rules;
- ***RDF and RDF Schema Layer:*** RDF (URL 2) is a conceptual data layer on top of XML. It is application and domain neutral, and defines a metadata layer and domain specific vocabulary. RDF model can be used to describe anything that has a Universal Resource Indicator (URI);

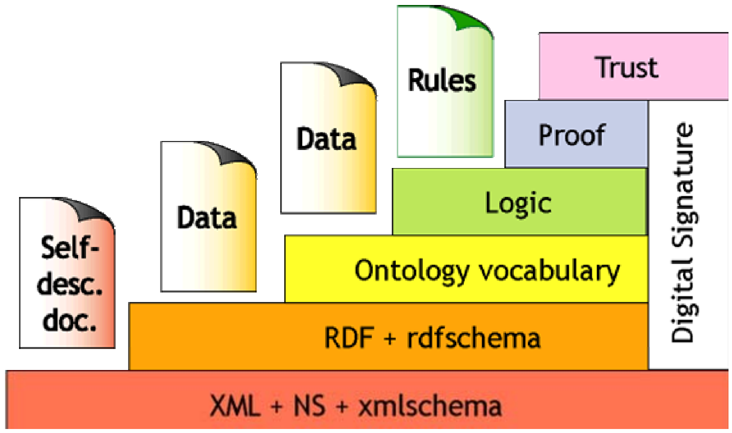

Figure 1: Semantic Web Technologies (URL 1)

- ***Ontology Vocabulary Layer:*** This layer is the backbone technology for the Semantic Web. It provides a common language on the human and machine level to enable knowledge exchange. An ontology provides machine-processable semantics of data and information sources that can be communicated between different agents (Fensel, 2001), thereby facilitating knowledge sharing and reuse. Web Ontology Language (OWL) (URL 3) is used as an ontology definition language;
- ***Logic layer:*** This defines rules for dynamic inference and definition of hierarchies and processing of schemas and instances;
- ***Proof and trust layers:*** These involve the rating of sources and processes, and the monitoring of logical steps.

From the view point of applications in the construction industry, Semantic Web technologies offer considerable benefits in terms of project management, content and document management, knowledge management, supply chain management and integration of distributed applications and services (Anumba et al, 2003). The next section of the paper focuses on the knowledge management dimension.

SEMANTIC WEB-BASED KNOWLEDGE MANAGEMENT

Background and Potential

Systems that are able to encapsulate knowledge and expertise in coded or symbolic form are vital for knowledge management in an organisation. They enable the setting up and maintenance of knowledge bases that preserve knowledge/expertise that might otherwise be lost when a key member of staff is no longer available. Other IT tools for knowledge management have been limited to supporting knowledge editing, storage, retrieval, and distribution/sharing. Intranets and extranets have proved particularly useful for sharing explicit knowledge and/or providing access to people with tacit knowledge or shared interests. While these provide a degree of support, they have significant limitations (Davies et al, 2003; Antoniou & van Harmelen, 2004):

- Information/knowledge retrieval is sub-optimal as keyword searches often return irrelevant information, miss information when different terms with the same meaning are used, and fail to recognise the relationships between different pieces of information;
- System end-users have to browse and read the returned information to determine its relevance - this can be very time-consuming;
- The maintenance of weakly-structured text sources (as in many existing KM systems) is both difficult and time-consuming, especially when these become large;
- Most systems are unable to dynamically reconfigure their outputs in line with the user's changing context;
- There are limited or no facilities for the automatic discovery of new information or knowledge in existing systems.

The Semantic Web has the potential to address the above shortcomings of existing KM systems. One of the key ingredients in its ability to do this lies in the use of ontologies to establish relationships between concepts, knowledge sources, users and organisations (amongst others). Specifically, the Semantic Web will enable:

- The organization of knowledge in conceptual spaces according to its meaning;
- Improved maintenance through automated checking for inconsistencies and the extraction of new knowledge;
- User-friendly query answering that allows knowledge retrieval/extraction from a variety of unstructured or weakly structured documents based on the use of an ontology;
- Controlled access to knowledge based on user profiles (Antoniou & van Harmelen, 2004; Davies et al, 2003).

Framework

The approach being adopted in the development of a Semantic Web-based system for construction project information and knowledge management involves the use of a multi-layered framework (see Figure 2). The framework incorporates intelligent agents, an ontology editor, an XML/RDF Parser, databases and knowledge bases, and user profiling to facilitate the delivery of context-specific information and knowledge to project participants. This framework is intended to enable information and knowledge management across personal, organisational and project levels. The relationships between the information or knowledge managed are established and maintained by a well-defined ontology, which facilitates both human and automated processing.

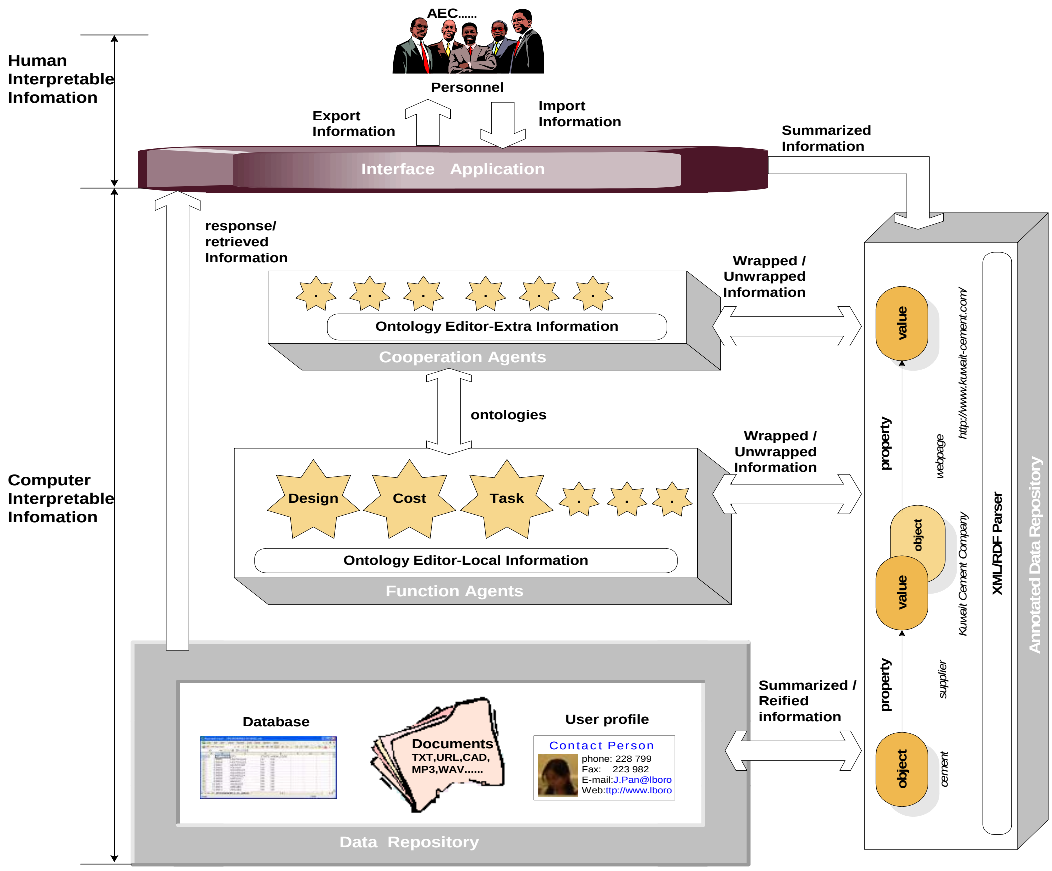

Figure 2: Framework for Semantic Web-based Information and Knowledge Management

Deployment Context and Example

The delivery of information and knowledge to construction professionals based on the above framework is facilitated by the Semantic Web-based prototype environment within which this takes place. The Semantic Web technologies provide for the shared definition of context, resources and their relationships. They also provide an application and platform-independent way to interpret context, thereby enabling both humans and software agents to infer new context knowledge and consequently take intelligent actions. Of particular interest are two components of the prototype environment. The first of these is the facility for semantic annotation of information and knowledge items in the data/project repository based on the developed ontology. The second is the mechanism for context capture and information or knowledge delivery based on the user's context. Based on these, knowledge capture and delivery can be tailored to the individual user's needs. For example, several dimensions of context can be captured for, say, the Project Manager, as shown in Figure 3.

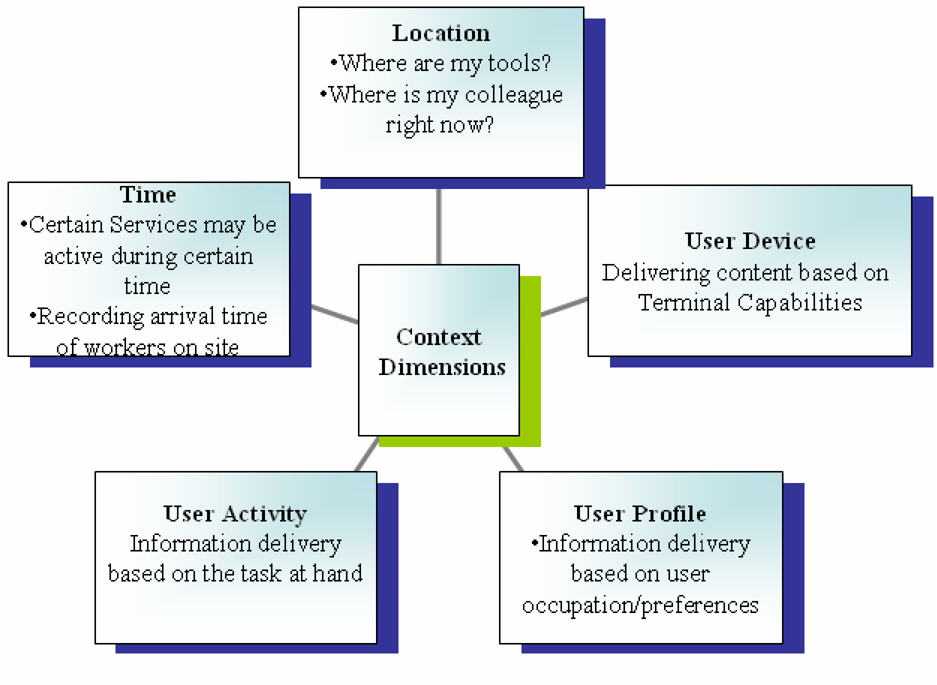

Figure 3: Context Dimensions

Based on this contextual understanding, the information and knowledge relevant to the Project Manager's current requirements can be automatically delivered to him/her using a combination of software agents, wireless communication devices, databases/knowledge bases, Web services and project-specific applications. For example, if the Project Manager is currently working on 'cost control', the lessons learnt on a previous similar project would be automatically delivered to his laptop or PDA.

CONCLUSIONS

This paper has explored the potential for more advanced Semantic Web-based knowledge management systems for the AEC sector. It has described how the technologies associated with the Semantic Web can support the development of more advanced knowledge management systems. The approach being adopted in the development of a Semantic Web-based information and knowledge management system has also been presented. The benefits of the proposed framework include:

- Deeper understanding of the semantics of document content and project task structure, using ontologies, will help construction project team members in intelligent information and knowledge retrieval, extraction and processing;
- Semantic Web techniques, through the introduction of ontological reasoning, can help in on-the-fly resource/knowledge discovery and integration, allowing team members to dynamically locate highly specific knowledge and services on an as-needed basis;
- The use of a shared ontology and semantic standards will ensure increased interoperability and knowledge sharing across devices, platforms and applications;

- Semantic Web technologies can provide a standardised way of interpreting context, enabling both human and software agents to infer new knowledge and take intelligent actions.

It is also important to recognise that technology and culture are inter-twined, as technology affects and is affected by the prevailing cultural environment (Davies et al, 2003). This is critically important in the development of knowledge management systems. As shown in this paper, Semantic Web-based KM systems offer the potential to reinforce this in such a way that construction sector organisations can reap considerable benefits.

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URL 1: W3C Semantic Web Activity, http://xml.coverpages.org/xmlAndSemanticWeb.html
URL 2: Resource Description Framework - http://www.w3.org/RDF
URL 3: OWL Web Ontology Language - http://www.w3.org/2001/sw/WebOnt/

The Application of Communities of Practice (CoP) in UK Large Contracting Companies

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Abstract
The popularized notion of 'communities of practice' is an established element of the discourse of construction industry improvement. The concept is widely promoted as the means of unlocking the potential of organisational resources, mainly knowledge and people, to achieve the strategic goal of sustained competitiveness. The relevance of communities of practice, the supporting theory, benefits and barriers in UK large contracting companies was investigated. Initial results showed variations in the understanding of the concept between contracting companies. While communities of practice were reportedly successfully applied in one company with strategic intent, the concept was not fully understood in another. The application of the concept of CoP appears to be at theoretical level and real examples are lacking.

Introduction

The concept of Communities of practice (CoP) is emerging as one of the most promising structures for building knowledge-based organizations (Wenger et al., 2002). CoP is rapidly becoming the key to the knowledge strategy of a growing number of leading companies, government agencies, and non-profit organisations. Furthermore communities of practice are being hailed as the driving vehicle for knowledge transfer and competence development, and its associated theory has been presented as a bridge between the theories of organisational learning and organisational performance (Wenger, 1998; Wenger et al., 2002).

Unlike a number of other concepts that have arisen to address corporate under-performance, such as business process reengineering and total quality management, which have been labelled as 'fads', CoP theory appears to have had a much longer period of maturation during the last 14 years and has finally come to prominence as a result of its co-evolution with the theory and practices of knowledge management and networking (Wenger et al 2002) and building of dynamic capabilities and competences of firms (Zollo and Winter, 2002; Eisenhardt and Martin, 2000). It has gained considerable currency in the field of corporate development because of the emphasis that is now placed on knowledge and people as a competitive assets (Wenger, 1998, Pfeffer, 1994, Pfeffer, 1998).

Edwards et al. (2003) in a survey of Knowledge Management academics and practitioners, found that CoP represented the second most important concept developed in the literature on knowledge management. CoP is seen is one of the few concepts that take seriously the argument that people are firms' best resources (Wenger, 1998, Pfeffer, 1994, Pfeffer, 1998, Hunt, 2000). Construction companies appear to have also realized the importance of the application of CoP. A recent survey of large construction organisations carried out at Loughborough University (Anumba et al., 2005; Carillo et al., 2002) has shown that CoP's are the most widely used technique for knowledge sharing. Furthermore Anumba et al (2005) have stated that large international construction organisations with a range of specialist skills tend to have the greatest need as well as resources to set up CoPs and to benefit significantly from them. This paper discusses the theory that exists behind the application of CoP; its appeal, benefits and downside as a mean for knowledge transfer and knowledge creation in large contracting firms in the United Kingdom.

The Theory of Communities of Practice (CoP)

History and background

Wenger (1998) defines Communities of practice as groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. Communities of practice were common as far back as ancient times. In classical Greece, for instance, "corporations" of metalworkers, potters, masons, and other craftsmen had both a social purpose in that members worshiped the same deities and celebrated holidays together as well as a business function for training apprentices to spread innovations. In the Middle Ages, guilds played similar roles for artisans throughout Europe. Today's communities of practice are different in one important respect: instead of being composed primarily of people working on their own (not much of a 'community', they often exist within large organisations.

Although the phenomenon of Communities of Practice have been around for many years the term itself was not coined until 1991 when Jean Lave and Etienne Wenger used it in their exploration of situated learning (Lave and Wenger, 1991). The concept of situated learning, in which the learner and the task are placed in the context of the overall social practice, stems from the recognition that a traditional view of learning as the end result of a process of transmitting knowledge is inadequate. Instead, Lave and Wenger (1991) proposed looking at learning from the learner's perspective and viewing learning as a continuous process in which what is learned depends on what has been learned before and the context in which the learner is immersed, a process they termed as "legitimate peripheral participation".

Legitimate Peripheral Participation (LPP)

Wenger (1999) stated that legitimate peripheral participation (LLP) stems from their attempts to articulate that apprenticeship seems a compelling process of learning. Using LLP they wanted to broaden the traditional connotations of the concept of apprenticeship from a master/student relationship to one of changing participation and identity transformation in a community of practice.

LPP is both complex and composite and although Lave and Wenger saw LPP as an inseparable whole, it is helpful to consider the three aspects—legitimation, peripherality and participation—separately. Legitimation refers to the power and the authority relations in the community. Peripherality refers to the individual's social rather than physical peripherality in relation to the community. This in turn is dependent on their history of participation in the group and the expectation of their future participation in and interaction with the community. Thus, a new member of the community moves from peripheral to full participation in the community. Initially, activities of the new comers to the community may be restricted to simply gathering knowledge. Later the newcomer may become involved with gaining knowledge associated with the specific work practices of the community. Gradually, as the newcomer learns, the tasks will become more complicated and the newcomer becomes an old-timer and is recognised as a source of authority in the community (Wenger, 1999). Lave and Wenger (1991) thus found triadic group relations (society or a group colluding together) between 'masters' (or 'old-timers') and 'apprentices' (or 'newcomers') and they argued that the power dynamics of such triadic relations are different from the dyadic relations between teacher and student in the context of schooling. Newcomers must learn from old-timers but, unlike students, must also make a contribution to the work of the group, typically by doing the simple, routine aspects of the practice. The novices are legitimate members of the community of practice; they start off as peripheral but end up being more central.

Participation refers not just too local events of engagement in certain activities with certain people, but to a more encompassing process of being active participants in the practices of social communities. Participation shapes not only what we do, but also who we are and how we interpret what we do. A social theory of learning must, therefore, integrate the components necessary to characterize social participation as a process of learning; meaning, practice and community.

Communities of Practice in Organisations

Brown and Duguid (2001) describe communities as peers in the execution of real work who are held together by a common sense of purpose and a real need to know what each other knows. Communities of Practice (CoP) are a concept that refers to the ways in which people naturally work together. It acknowledges and celebrates the power of informal communities of peers, their creativity and resourcefulness in solving problems, and inventing better, easier ways to meet their commitments. Further to the above, three important dimensions that define communities of practice are suggested by Wenger (1998) including:

The domain: This is what the members care about or their area of interest. It may be a skill, a professional discipline or a topic. It must be focused and defined well enough so that people can identify with it. They must also have a passion for the area of interest because this is the catalyst that draws people together. Wenger (1998) observes that people organize around a domain of knowledge that gives members a sense of joint enterprise and brings them together.

The community: the community is an intricate web of personal relations of people who know and trust each other. Members do things together which may be social or a work activity. Wenger (1998) further characterises the community as people who function through relationships of mutual engagement that bind members together into a social entity. Members interact regularly and engage in joint activities that build relationship and trust.

The practice: This is how the community works. As a community work together on their domain, they create tools, documents, processes, a common vocabulary, and shared ways of doing their work. Many communities also solve problems that arise in the day-to-day work and many develop and document best practices. This shared repertoire created by the community serves as a foundation for future learning. Forming a community of practice takes time and sustained interaction. A sense of trust must be developed across these connections (the relational dimension) and the members of the network must have a common interest or share a common understanding.

Peltonem and Lamsa (2004) observe that the idea of knowledge as the source of competitive advantage has been celebrated in the management literature for some time. But the understanding of how knowledge emerges and develops in the actual work practices still remains relatively limited. They further argue that the approach of ‘communities of practice’ offers a relatively coherent view of the *social processes* of knowledge creation. They thus introduce the ‘communities of practice’ approach as a general perspective for making sense of and planning organizational knowledge management programs in a more effective and contextually sensitive way.

The difference between CoP, teams and workgroups

A common difficulty met by organisations attempting to apply CoP are difficulties in distinguishing CoP from teams or workgroups. Brown and Druguid (1998) fundamentally set

CoP apart from teams or other group structures in that communities are defined by *knowledge* rather than task. In a CoP it is the knowledge derived from a common practice that binds members together. Wenger(1998) explains that communities of practice are not a new kind of organizational unit; rather, they are a different perspective on the organization's structure–one that emphasizes the learning that people have done together rather than the unit they report to, the project they are working on, or the people they know. Communities of practice differ from other kinds of groups found in organizations in the way they define their enterprise, exist over time, and set their boundaries.

A community of practice is different from a *team* in that the shared learning and interest of its members are what keep it together. It is defined by knowledge and exists because participation has value to its members. A community of practice's life cycle is determined by the value it provides to its members, not by its parent organisation's objectives. (Fontaine, 2001). It does not appear the minute a project is started and does not disappear with the end of a task. It takes a while to come into being and may live long after a project is completed or an official team has disbanded. A community of practice is different from a *network* in the sense that it is "about" something; it is not just a set of relationships. It has an identity as a community, and thus shapes the identities of its members (Wenger 1998). A community of practice exists because it produces a shared practice as members engage in a collective process of learning (Fontaine, 2001).

The business case for CoP

Wenger (1998) observes that CoP fulfils a number of functions with respect to the creation, accumulation, and diffusion of knowledge in an organization: communities of practice are beneficial for the business, for the community itself and for employees. They are powerful vehicles both for sharing knowledge and achieving business results. For the Business CoP helps drive strategy, support faster problem solving both locally and organization wide, aid in developing, recruiting and retaining talent, build core capabilities and knowledge competencies and more rapidly diffuse practices for operational excellence. For the organization CoP helps cross fertilize ideas and increase opportunities for innovation and help build common language, methods and models around specific competencies. It further aid embed knowledge and expertise in a larger population, aid retention of knowledge when employees leave the company, increase access to expertise across the company and provide a means to share power and influence with the formal parts of the organization. For the individual CoP helps people do their jobs, provide a stable sense of community with other internal colleagues and with the company. CoP further foster a learning-focused sense of identity, help develop individual skills and competencies and help a knowledge worker stay current.

The paradox in managing Communities of Practice

By definition CoP are meant to be organic and emergent structures (Wenger 1998; Wenger et al, 2002). These characteristics mean that communities of practice are not easily amenable to top-down control. Communities of practice are autonomous, self-managing systems, which can exist and flourish without the need for any senior management support. Managerial attempts to control and influence communities of practice may therefore conflict with a community's system of self-management (Wenger et al, 2002). However, despite these difficulties and potential problems, more and more organizations are attempting to start and support communities of practice as part of their knowledge management initiatives. Thus, the risk, in attempting to explicitly manage communities of practice is that such attempts may in fact have adverse effects on the community, and the very knowledge processes that such efforts are intended to support and develop (Brown and Duguid, 2001). Research undertaken by Thompson (2005) indicated that there are risks in management attempting to intervene too much and formalize CoP. One specific risk of attempts to formalize a community may introduce rigidities which inhibit its innovativeness or adaptability. McDermott (2003) admits that it was originally thought that CoP does not lend itself to topdown approaches. Wenger (2002) states that the topdown approach does not conflict with the CoP principles as long as knowledge remains as key binding force of the community rather than the task or objective as set by management for the community.

Critique of communities of practice

Much of the communities of practice literature presents CoP in a very positive light, suggesting that in relation to knowledge processes they are largely or exclusively beneficial for organizations. However while communities of practice may facilitate processes of knowledge-sharing, they also have the potential to inhibit them. Wenger et al (2002) highlight that potential problems may arise from dysfunctional behaviours in any of the three structural elements. With respect to the domain, community members may either be overly zealous in guarding the domain which leads to imperialistic perspective, or lose ownership over the domain resulting in the community becoming marginalised by the organisation. With respect to the community, members may bond too tightly resulting in egalitarianism. Rigid conformity to the group leads to mediocrity in performance. With respect to practice, members may develop an overly strong sense of competence that leads to dogmatism. The above downsides are not confined within a single community but also in a constellation of communities as well as the organisation as a whole.

Hislop (2005) argues that one of the major criticisms of the majority of the mainstream knowledge management literature is the neglect of issues of power and conflict. In *Situated Learning* (1991) Lave and Wenger do discuss these issues of power and conflict and their appeal for future analyses to take greater account of, 'unequal relations of power' within communities has been neglected by subsequent authors. Fundamentally, communities of practice have inherent tensions built into them which unavoidably results in them possessing an, 'unequal distribution of power'. The uneven distribution of power results from the greater amount of community knowledge masters have compared to newcomers. Thus while communities of practice do not have a formal hierarchical structure all members of the community are not necessarily equal. This uneven distribution of knowledge creates potential conflicts in processes of legitimate peripheral participation (Wenger 1991). Furthermore, Wenger (1991) argued that 'there is a fundamental contradiction in the meaning to new comers and old- timers of increasing participation by the former. Legitimate peripheral participation thus requires the 'old-timers' helping to develop the knowledge of the 'newcomers' who will over time, take their place. Hislop (2005) stated that there are difficulties involved in attempting to share knowledge across CoPs which requires an understanding of inter-community dynamics. The lack of consensual knowledge and diverging senses of identity that exist between communities represent two of the most important reasons why such processes are complex and difficult.

Communities of Practice in the Construction Industry

A growing number of people and organizations in various sectors are now focusing on communities of practice as a key to improving their performance. Examples of communities of practice are found in many organizations and have been called by different names at various times, names such as “learning communities” at Hewlett-Packard Company, “family groups” at Xerox Corporation, “thematic groups” at the World Bank, “peer groups” at British Petroleum, p.l.c., and “knowledge networks” at IBM Global Services, but they remain similar in general intent. The question whether the construction industry is a knowledge-based industry or not has been a common topic of debate of recent times. Anumba et al (2005) state that a recent Competitiveness White paper has defined a knowledge economy as one in which the generation and exploitation of knowledge play a predominant role in the creation of wealth. Similarly, the OECD report *The Knowledge Based Economy* suggests that what is created in knowledge-based economies is a network society, where the opportunity and capability to access and join knowledge and learning intensive relations determine the socio-economic position of individuals and firms (Anumba et al, 2005). Anumba et al (2005) go on to state that today's UK construction industry progressively moving towards sharing many of the characteristics of the knowledge economy They substantiate this by stating the following: 'the industry is diverse and professionally provides a range of services for clients, customers and the wider community. Construction activities can be highly knowledge intensive. Construction products have a high proportion of their development costs attributable to knowledge-based elements such as design, assessment of cost alternatives of different components, advice on contractual aspects.

Large construction firms in the UK are typically seen as hollowed-out organizations in that very few of them actually carry out the work themselves. Practically all their work is carried out by subcontractors or by subcontract labour. The large firms are thus more involved in managing the processes on projects rather than doing the work themselves. This has implications in that if CoP is to be formed to promote knowledge transfer at levels closer to the workface then this will probably have to take place with people from different organisations. Secondly it means that large contracting firms have limited influence on promoting learning at the levels that work actually gets done. However they have a great deal of influence in promoting learning among 'white collar' workers.

CoPs in large contracting firms

The application of the CoP in contracting companies is investigated with a case study approach complement by questionnaires and interviews. Two large contracting companies were selected. Company A made access to people for interviews and information for analysis easier thus ensuring maximum co-operation and willingness to participate. The selected company A had been deemed to be progressive in its application of communities of practice. It was felt undertaking an investigation within a company quite advanced in their application of CoP could present a better case for analysis. Company B was chosen for a more detailed study as a result of its response to the survey questionnaire that was sent out. In its response the company had indicated that the application of communities of practice was an important part of its business strategy and that it was in a mature state in its application of CoP so it was thus thought to be an appropriate unit of analysis to facilitate comparison.

The companies that were chosen for the questionnaire surveys were selected from the top 100 contractors list for 2005 as published by *Building* magazine. A large sample size was chosen as research indicated that response rates to survey questionnaires are normally only expected to be around 30%. Survey questionnaires were also sent out to selected email groups. Interviews for the purpose of the case study were mostly undertaken in a semi-structured framework. Whenever it was realised that the person being interviewed had very limited understanding of the concept of CoP a number of the questions could not be explored. The only situation in which the entire set of questions was used, was in the interview with the Knowledge Manager from Company B, which were using CoP as a key part of their knowledge management strategy. The interview questions were then modified into an online survey questionnaire. This online survey questionnaire was then sent out electronically to the top 100 contracting companies as defined previously. The questionnaire was also sent out to selected email groups. Two contrasting approaches to the application of CoP were observed between the companies studied. Company A has adopted an *ad hoc*, non-strategic view towards the application of CoP and the company appears to view support mainly in terms of providing the IT tools to facilitate collaboration. In contrast Company B has identified the application of CoP as strategic and is making deliberate attempts to nurture, support and promote community development. In examining this contrast we will attempt to identify what the underlying reasons are for the differences and also what the possible consequences or implications are for the companies. Further results and discussion on CoP in contracting firms will be shared in future publications.

Conclusions

The construction industry has often been criticized for being slow at learning and poor at innovating. Many construction projects are lost when a project ends and a team is disbanded. The result is that much ‘reinventing of the wheel’ and repetition of past mistakes. Such practices cannot be sustained and have thus ‘latched’ unto the practice of knowledge management to bring about change. Knowledge by nature is multidimensional and cannot be easily separated from the context in which it is created. Furthermore people hold knowledge and thus the social element also has to be contented with. Communities of practice have come to prominence as a result of its co-evolution with the theory and practices of knowledge management and networking. It also gained considerable currency in the field of corporate development because of the emphasis that is now placed on knowledge and people as competitive assets. The appeal of Communities of Practice stems from its roots in the concept of situated learning. Situated learning is a theory of learning derived from studying apprenticeships. The strength in Communities of Practice lies in the ability of communities to negotiate meaning through social relationships.

Although the theory of Communities of Practice presents a very compelling case for knowledge sharing and knowledge creation, it fails in addressing power struggles within communities of practice. Indeed the application of CoP warrants further consideration by the construction industry on how its principles can be applied. There seems to be an underlying paradox in the application of Communities of practice. Strictly speaking one cannot speak of applying or managing CoP as by nature and definition they are meant to be emergent, organic structures. However theory and practice has indicated that with the correct amount of nurturing and guidance construction organizations may benefit from ‘managing’ CoP.

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Partnering as a Way to Stimulate Knowledge Sharing among Partnered Firms

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Abstract

Hong Kong's construction industry is increasingly being recognized as inefficient and facing lots of problems. These problems include mistrust, poor communication, and adversarial relationships which adversely affect the performance of construction projects and the possibility of knowledge sharing among construction firms (CIRC, 2001). With clients' ever-increasing demands and the construction industry becoming more and more competitive, partnering has recently been recognized as one of the ways of improving the performance of construction projects and meeting clients' requirements. In addition to partnering, knowledge management has also been seen as a way to remain competitive in the market. This paper aims to examine whether or not partnering could promote and stimulate knowledge sharing. This is done through a questionnaire survey to partnering as well as non-partnering participants. From the collected data, comparisons are made between the situation of knowledge sharing in non-partnering projects and that in partnering projects, by analyzing the effects on knowledge sharing due to the characteristics and process of partnering, the identification of benefits gained from the knowledge that was shared in partnering projects, and the results generated afterwards. The results of the study reveal that the essential characteristics of partnering, such as mutual trust, enhanced communication, closer relationships, equity, etc. are able to remove major barriers to knowledge sharing, proving that partnering can be regarded as a way to stimulate knowledge sharing among partnered construction firms. However, the results indicate that some of the barriers, such as efficiency of communication, and understanding of benefits of knowledge sharing as perceived by construction parties, still need further improvement in order to achieve the best knowledge sharing practices within the construction industry.

Introduction

Hong Kong's construction industry has for many years engaged in contractual arrangements that are often been described as more adversarial than cooperative. With this kind of poor relationship among construction firms, the performance of construction projects is adversely affected and jeopardizes the success of the construction industry as a whole (Larson, 1997).

The effects of bad relationships between construction parties are being recognized, and partnering has become an increasingly popular form of business relationship within construction over the last decade in order to improve the relationship among construction parties (Crane et al., 1997). By analyzing some completed partnering projects, many researchers have already proved that partnering is able to change the relationships among construction firms from adversarial to cooperative, enhance communications, develop trust within the construction team, improve quality of work, etc. (AGC, 1991; CII, 1991).

The competition in the construction industry today drives companies toward continuous improved performance, and companies are showing a growing interest in introducing knowledge management. The exchange of knowledge and experience among firms is regarded as the sustainable competitive advantage enabling firms to stay ahead in the market (Senge, 1990). However, this kind of sustainable competitive advantage is not easy to achieve as barriers such as lack of trust, inefficient communication means, lack of sharing channels, etc. are present in the current construction industry and prohibit the effective sharing of knowledge among construction firms.

This research attempts to examine whether partnering would promote and stimulate knowledge sharing among construction firms. The research objectives include: comparing the current knowledge sharing situation in both traditional and partnering projects, and examining how partnering would promote and stimulate knowledge sharing among construction firms.

Partnering and Knowledge Sharing

Partnering is a contracting strategy. Its main objective is to encourage contracting parties, the client, the contractor, sub-contractors, etc. to change from their traditional adversarial attitude to more co-operative, team-based relationships. It is advocated as a means of achieving reduced costs and improved performance by the adoption of information sharing and non-adversarial contract administration, possibly coupled with incentivization arrangements and shared management controls (Roe and Jenkins, 2003).

There are no fixed definitions used when defining partnering, although common themes/elements prevail (Matthews, 1996). Essentially the relationship is based on trust, dedication to common goals, and an understanding of each other's individual expectations and values. Crowley and Karim (1995) stated that partnering can be defined in one of two ways: 1) by its attributes such as trust, shared vision, and long-term commitment, and 2) by its process, whereby partnering is seen as a verb and includes developing mission statements, agreeing goals and conducting partnering workshops. It is clear that the following elements are commonly found in a successful partnering project: mutual goals and objectives (Bennett and Jayes, 1995), equity (Hellard, 1995), trust and sharing (Schultzel and Unruh, 1996), problem resolution (Bennett and Jayes, 1995) and continuous improvement (Bennett and Jayes, 1995).

Awad and Ghaziri (2004) state that knowledge sharing is the mechanism installed to encourage the sharing of expertise throughout the organization. Ramchandani (2002) defined knowledge sharing as the social way and the technical means by which an individual, team, organization and/or community connects and communicates to continually create, innovate, learn and take action.

The kind of knowledge concerned for sharing in a partnering project usually consists of hands-on skills, special know-how that individual parties develop as they perform their specialist field of work. This is personal knowledge that is available for sharing with others. During partnering meetings, knowledge is shared among professionals of different disciplines: this is referred to as 'inter-disciplinary knowledge sharing'. The professionals or experts share the expert knowledge of their own disciplines, general knowledge and past project experience. "Flow of knowledge is what creates value", as stated by Buckman (2004), implies that benefits will be gained through proper knowledge sharing among people. Encouraging people to share knowledge about problems as they arise yields better solutions to those problems (Buckman, 2004). Giannetto and Wheeler (2000) also wrote that employees who share their best practice will bring continuous improvement in terms of products, services, their performance, and to the company as a whole. This means that proper knowledge sharing within the project team is able to achieve continuous improvement to the project and to each participating company.

Ramchandani (2002) states that knowledge sharing will not happen if there is a lack of trust among the employees. As knowledge is an intangible asset, it will not be recognized as an asset until the value of knowledge is estimated, tracked and managed. With this kind of lack of visibility of value of the knowledge and lack of understanding of the benefits of knowledge sharing, people in a project team will not treat knowledge sharing as an important success factor (Ramchandani, 2002). Other barriers such as fear of loss of superior power, lack of time and meeting opportunities, inefficient communication means, lack of sharing channels, etc. are also regarded as barriers to knowledge sharing (McIlhenny, 1998).

According to Coleman (1999), Buckman (2004) and McIlhenny (1998), critical factors for the success of knowledge sharing can be summarized as follows: trust, ability to find knowledge, recognizing people's unique skills and needs, open and honest communication, ability to interact with others in a non-purposeful way, diversity, i.e. bringing together people with different knowledge and experience, a common context or language and common goals. They further added a knowledge friendly culture, a flexible organizational structure that supports knowledge sharing, support from senior management, the infrastructure to support knowledge and information sharing, awareness that knowledge is local and sticky and cannot be transferred easily, and recognition and rewards. It seems that outcomes such as mutual goals, trust, better relationship, improved communication means, etc. from "partnering" match with these critical factors for the success of knowledge sharing.

Research Methodology

The questionnaire survey was selected as the instrument used to collect data. It was used because it is comparatively convenient and enables a large number of respondents to be obtained: this in turn allows accurate and convincing conclusions to be drawn. Questionnaires were addressed to the target parties by letters, facsimiles and e-mails. The questions were mainly based on the literature review. The purpose of this type of question design was to determine the extent of agreement or disagreement from the respondents. In the questionnaire, the respondents were asked to rank each question according to a five-point system. In this score system, '1' represented strongly disagreed and was weighted '1' while '5' represented strongly agreed and was weighted '5'. Based on the weighting that was already assigned for respondents' choices, the mean scores for each question were calculated.

The target parties included those companies that had participated in partnering projects. The received questionnaires came from clients, designers and consultant teams, main contractors and sub-contractors that had participated in partnering projects. In all, 54 responses were obtained out of the 124 questionnaires administered. This accounted for an overall response rate of 43.5%. Black et al. (2000) stated that a response rate of around 30% is often received from construction industry surveys, suggesting that the response rate of this research is quite high. Of the 54 questionnaires received, 10 of them were from clients, 19 from consultants, 18 from main contractors and 7 from sub-contractors.

Results

This section aims to compare the knowledge sharing situation between non-partnering projects and partnering projects in order to find out whether there are any improvements in knowledge sharing through the application of 'partnering' arrangements.

Willingness to share knowledge

According to Table 1, the overall mean score for non-partnering projects is 2.74, indicating that the respondents slightly disagree that they are willing to share their knowledge with other project team members, while the overall mean score for partnering projects is 3.97, which indicates that the respondents agree that they are willing to share their knowledge with other partnered firms. This gives an overall view that project team members have changed their attitude towards "knowledge sharing" from unwilling to share their knowledge with other project team members in traditional projects to willing to share their knowledge in partnering projects.

Table 1. Respondents' willingness to share knowledge

Project Type	Respondents	Score					Mean Score	Overall Score
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
Non-partnering project	Client / Consultant Team (29)	0%	17%	55%	28%	0%	3.11	2.74
	Contractor Team (25)	12%	53%	27%	8%	0%	2.31	
Partnering project	Client / Consultant Team (29)	0%	0%	17%	55%	28%	4.11	3.97
	Contractor Team (25)	0%	0%	28%	64%	8%	3.80	

It is further observed that no respondent chose "strongly disagree" and "disagree" in partnering projects, which implies the successful outcome from partnering arrangement in changing their attitudes towards knowledge sharing. The possible reason for their change of attitude is that with the mutual objectives of all participants, the pre-agreed problem resolution system and committed continuous improvement to the quality of work in a partnering project, trust and openness has been created among all participants. With the developed trust and openness between each party, all the team members in a partnering project are more willing to share their ideas and information with each other as they no longer treat knowledge and information as commercially sensitive and not to be shared or disclosed to other parties.

From Table 1, it is observed that the contractor team has comparatively changed a lot in its attitude towards knowledge sharing (from the mean score of 2.31 to 3.8). It is not difficult to understand the reasons behind this. As the traditional hierarchical structure of construction projects does not exist in partnered projects, the working relationship is changed from adversarial in the traditional project arrangement to cooperation, leading to a situation in which the contractors believe that other project team members are more willing to help them than mistreat them. Besides, "partnering" concerns equity: each stakeholder, including those of contractor's interests, needs, expectations, and risks, must receive fair and proper consideration during the creation of mutual goals and in each partnering meeting. Because of these kinds of essential characteristics of "partnering", contractors' teams feel that they are fairly treated, and the superior positions of client or consultants that existed in past projects no longer exist, thus encouraging them to share their knowledge with other project team members.

Ease of sharing knowledge among project team members

From Table 2, the overall score for "non-partnering project" is 2.33, implying that all the participants in non-partnering projects feel that it is not easy to receive or to accept other project team members' ideas and knowledge. The mean score for "contractor team" in non-partnering projects is only 2.08: no respondents chose the answers "strongly agree" and "agree", which shows that it is very difficult for them to receive or to accept other project team members' ideas and knowledge. The results demonstrate there is a major problem in the construction industry. The insufficient and inefficient communication means increase the chances of abortive works and claims, as the contractors do not receive adequate information and directions during the construction process.

Table 2. Respondents' views on ease of receiving or accepting other project team members' ideas and knowledge

Project Type	Respondents	Score					Mean Score	Overall Score
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
Non-partnering project	Client / Consultant Team (29)	7%	38%	48%	7%	0%	2.55	2.33
	Contractor Team (25)	12%	68%	20%	0%	0%	2.08	
Partnering project	Client / Consultant Team (29)	0%	0%	21%	65%	14%	3.93	3.81
	Contractor Team (25)	0%	8%	20%	68%	4%	3.68	

On the other hand, the overall score for "partnering project" is 3.81, implying that all the participants in partnering projects feel that it is easy to receive or to accept other project team members' ideas and knowledge. The difference in overall mean score between non-partnering projects and partnering projects implies that "partnering" arrangements provide a better communication environment or means to facilitate the exchange of ideas, information, etc. The reason for the difference is that "partnering" encourages face to face communication and verbal communications through regular contact in periodic evaluation meetings throughout the whole partnering process, while the traditional project arrangement relies heavily on written communication in order for the parties to protect themselves from any mishaps in the future. With face to face communication and verbal communications, the ideas and information from others are clearer, faster and easier to receive as compared to those in written communication.

Effectiveness in knowledge sharing

According to Table 3, the overall mean score for "non-partnering project" is 2.35, indicating that the respondents disagreed that relevant information is provided to relevant parties for the execution of the work, while the overall mean score for "partnering project" was 3.39, indicating that the respondents slightly agreed on this issue. This gives the overall view that "partnering" arrangements improve the rate of effectiveness in providing relevant information to other project participants.

As the contractor team is responsible for carrying out the work on site, their mean scores for "non-partnering project" and "partnering project" are 1.96 and 3.36 respectively, which indicates a significant improvement in effectiveness of transferring information to them. However, half of them still chose "disagree" and "neutral", which indicates that they did not receive enough relevant information for the execution of their work and thus improvements should be made.

Table 3. Respondents' views on the effective sharing of project information to relevant parties

Project Type	Respondents	Score					Mean Score	Overall Score
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
Non-partnering project	Client / Consultant Team (29)	0%	45%	41%	14%	0%	2.69	2.35
	Contractor Team (25)	28%	48%	24%	0%	0%	1.96	
Partnering project	Client / Consultant Team (29)	0%	7%	45%	48%	0%	3.41	3.39
	Contractor Team (25)	0%	12%	40%	48%	0%	3.36	

Barriers to knowledge sharing

The mean scores for each type of barrier in "non-partnering project" ranges from 3.93 to 4.79, while the mean scores for each type of barrier in "partnering project" ranges from 1.26 to 2.59, indicating that "partnering" arrangement is successful in assisting the removal of the barriers to knowledge sharing. By comparing the mean scores for each type of barrier in "non-partnering project" and "partnering project", the differences between the mean scores in each type of barrier are presented and ranked in Table 4. Among the stated barriers, the degrees of improvement in descending order are as follows: 1) trust and honesty does not exist, 2) the traditional hierarchical structure of the industry, 3) poor working relationships, 4) lack of respect, 5) ineffective communication means, 6) lack of respect, 7) lack of sharing channels, and 8) lack of understanding of the benefits of knowledge sharing.

It is noted that some of the respondents still chose the answer "agree" in "partnering project" for the barriers: "ineffective communication means" and "lack of sharing channels". This reflects that improvements are still required for these two barriers. In addition, the barrier "lack of understanding of the benefits of knowledge sharing", which was ranked as the least improvement, should take more effort to improve it in order to achieve a satisfactory improvement.

Table 4. Comparison of the barriers to knowledge sharing between non-partnering and partnering projects

Barriers to knowledge sharing	Type of projects	Overall Score	Difference	Rank
Traditional hierarchical structure of the industry	Non-partnering projects	4.69	3.08	2
	Partnering projects	1.61		
Lack of top management commitment	Non-partnering projects	3.93	2.19	5
	Partnering projects	1.74		
Poor working relationships	Non-partnering projects	4.39	2.97	3
	Partnering projects	1.42		
Trust and honesty does not exist	Non-partnering projects	4.79	3.53	1
	Partnering projects	1.26		
Lack of respect	Non-partnering projects	4.06	2.45	4
	Partnering projects	1.61		
Ineffective communication means	Non-partnering projects	4.63	2.04	6
	Partnering projects	2.59		
Lack of sharing channels	Non-partnering projects	4.17	1.97	7
	Partnering projects	2.20		
Lack of understanding of the benefits of knowledge sharing	Non-partnering projects	4.14	1.92	8
	Partnering projects	2.22		

Conclusions

The current situation is that all non-partnering projects are operating in an environment with limited trust and little cooperation, which leads to a bad working relationship, making all project participants unwilling to share their knowledge with other project team members. The results have also reflected that there are great problems in the current construction industry, such as the insufficient and inefficient communication means, lack of sharing channels, etc. leading to a situation in which it is not easy to share knowledge among the whole project team. In addition, it is difficult to provide information to the relevant parties for the execution of their work. This further supports the fact that knowledge sharing among project team members in non-partnering projects is extremely inefficient and insufficient, and needs immediate improvement.

The essential characteristics of partnering, such as mutual trust, mutual goals, enhanced communication, long-term commitment, closer relationship, equity, etc. are able to remove the major barriers of knowledge sharing, which increases the project participants' willingness to share their knowledge with other project team members and ease the transfer of knowledge or ideas among the whole project team. The results also suggest that the frequency of knowledge sharing among project team members, the effectiveness in providing relevant information to project participants and the rate of contribution of different parties to solving a problem are all increased as compared to the situation of non-partnering projects. Although the results suggest that partnering is able to stimulate knowledge sharing among construction firms or construction team members, there are some areas that need improvement. Some respondents feel that the rate of knowledge sharing is still not enough and that they did not receive enough relevant information for the execution of their work. More parties should also be involved in solving a problem in order to obtain the best solution. In addition, factors such as inefficient communication means, lack of understanding of the benefits of knowledge sharing, etc. are still regarded as a kind of knowledge sharing barrier as indicated by the partnering participants.

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EMOTIONAL INTELLIGENCE AND LEADERSHIP BEHAVIOR IN CONSTRUCTION EXECUTIVES

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ABSTRACT

This paper provides research results in the area of leadership and emotional intelligence among construction industry industry executives. Specifically, the paper documents the study of 130 construction executives for their emotional intelligence and leadership behaviors as measured by their emotional quotient (EQ). The paper establishes a baseline for critical leadership traits and challenges facing the construction industry. Through the use of established testing procedures, the researchers identify five specific components of EI that are related to the leadership of multi-participant construction teams and that reflect the leadership needs identified in leadership trait study. Of particular importance is the identification of interpersonal skills and empathy as key emotional intelligence behaviors that need additional attention during the development of construction industry executives. The authors put forth that these traits are as important as classical traits of intelligence and experience in developing the leaders of tomorrow's construction organizations.

INTRODUCTION

The construction industry of today is both similar and very different from that of twenty years ago. In terms of the former, many processes, operations, and practices have changed very little over the last several decades. While technology is slowly modernizing activities such as project management, field activities still have a great resemblance to traditional processes. In contrast, the forces on industry organizations continue to change at a rapid pace. Influences such as globalization, evolving delivery mechanisms, and changing organizational structures require business decisions that challenge the traditional transactional focus of the industry. Given these changing business influences, the issue that is emerging for the construction industry is one of leader preparedness. One primary concern for the construction industry over the next decade is the development of leaders at all levels of the organization who have the knowledge and skills to address rapidly changing business environments. Leadership ability to transform organizations in response to dynamic market forces is essential for sustained success within the construction industry. Additionally, the ability for leaders to both motivate the internal workforce as well as communicate to a diverse project team is a challenge to individuals to develop their interpersonal communication skills.

This paper presents research to establish a baseline framework for leadership development requirements in the construction industry. The focus of this paper is twofold, first to document what current leaders consider the primary leadership challenges facing the industry with respect to the changing business environment. Secondly, the paper discusses measuring leadership and emotional intelligence behavior of current industry leaders. Finally, the paper will draw a connection between the leadership traits identified as critical from the first study with the EQ profile developed in the behavioral study.

EQ BACKGROUND

Beginning in 1970 psychologists began to depart from what was considered traditional psychology research and desired to study the combination of intelligence and emotion resulting in exploration into the realm of "cognition and affect". In the decades that followed more and more research focused on proving that humans possessed multiple intelligences. From the period of 1990-1993 interest from psychologists to research emotional intelligence was gaining momentum and from this time period the early publications on emotions as an intelligence were introduced.

EI is defined as: an array of noncognitive capabilities, competencies and skills that influence one's ability to succeed in coping with environmental demands and pressures (Bar-On, 1997). Psychologists have been studying these noncognitive intelligences and have been able to group them into three intelligence categories as follows (Johnson and Indvik, 1999):

- Abstract Intelligence: The ability to understand and manipulate with verbal and mathematical symbols.
- Concrete Intelligence: The ability to understand and manipulate with objects.
- Social Intelligence: The ability to understand and relate to people.

These intelligence categories reflect the idea of multiple intelligences as introduced by Howard Gardner. In 1983, Gardner introduced his theory of multiple intelligences contending intelligence is comprised of an array of component intelligences. These intelligences included: Linguistic intelligence, musical intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence and personal intelligence (Gardner, 1983). Widespread attention were gained for the newly named 'emotional intelligence' as psychologist and journalist Daniel Goleman contended that emotionally intelligent people will experience greater success and satisfaction in life therefore essentially equating EI with positive social behavior (Goleman, 1995)

Similar to the efforts of Gardner and Goleman, Reuven Bar-On produced a model of 'noncognitive intelligence' that included a multifactorial array of emotional, personal and social abilities that allow individuals to cope with demands and pressures of their environments (Bar-On 1997). These fifteen multifactors fall within five areas of EI: Interpersonal skills, intrapersonal skills, adaptability, stress management and general moods. The factors and the areas under which they fall are illustrated in Table 1.

Bar-On's model is multifactorial and relates to potential for performance, rather than performance itself. Success is defined in this model as "the end product of that which one strives to achieve and accomplish". (Bar-On 1997) Bar-On believes that EQ scores, when combined with cognitive IQ scores, provide a better comprehensive indication of an individual's overall intelligence, hence, offering a better indication of potential to succeed than relying on one score. During his 19 years of research on EI, he has developed the Bar-on Emotional Quotient

Inventory (EQ-i) test measuring interpersonal skills, intrapersonal skills, adaptability, stress management and general moods. Based on the extensive validation of this test as documented by Bar-on (1997), and the extended time in which it has been applied, the decision was made to adopt the Bar-on EQ-I for this research effort.

Component Measured by EQ-i Subscales	**Definition**	**Area**
Self-Regard	The ability to respect and accept oneself as basically good.	**Interpersonal Skills**
Emotional Self-Awareness	The ability to recognize one's feelings.	
Assertiveness	The ability to express feelings, beliefs and thoughts and defend one's rights in a nondestructive manner.	
Independence	The ability to be self-directed and self-controlled in one's thinking and actions and to be free of emotional dependency.	
Self-Actualization	The ability to realize one's potential capacities.	
Empathy	The ability to be aware of, to understand and to appreciate the feelings of others.	**Intrapersonal Skills**
Social Responsibility	The ability to demonstrate oneself as a cooperative, contributing and constructive member of one's social group.	
Interpersonal Relationship	The ability to establish and maintain mutually satisfying relationships that are characterized by intimacy and by giving and receiving affection.	
Reality Testing	The ability to assess the correspondence between what is experienced and what objectively exists.	**Adaptability**
Flexibility	The ability to adjust one's emotions, thoughts and behavior to changing situations and conditions.	
Problem Solving	The ability to identify and define problems as well as to generate and implement potentially effective solutions.	
Stress Tolerance	The ability to withstand adverse events and stressful situations without "falling apart" by actively and positively coping with stress.	**Stress Management**
Impulse Control	The ability to resist or delay an impulse, drive or temptation to act.	
Optimism	The ability to look at the brighter side of life and to maintain a positive attitude, even in the face of adversity.	**General Moods**
Happiness	The ability to feel satisfied with one's life, to enjoy oneself and others and to have fun.	

Table 1: EQ-I definitions of scales and subscales.

RESEARCH METHODOLOGY

As a first response to the questions of leadership development in the construction industry, the authors have undertaken a multi-part study to determine the state of leadership development in the industry as well as the profile of industry leaders in terms of their leadership behaviors. This paper summarizes two of these efforts, the current perspective of industry leaders on leadership and the leadership behaviors of senior construction executives.

In the first of the studies, industry perspectives, industry executives were surveyed as they attended conferences and workshops hosted by the Construction Industry Institute during 2005. During these meetings, attendees were asked to fill out the survey to provide insights into their own career, their concerns for the next generation of industry leaders, and their thoughts on the challenges for the industry in the near future. From these requests, 140 surveys have been completed at this point. In the response group, there were 14 females and 126 males with the average age being 50.9 years. The respondents represent opinions from large engineering and construction firms and as such they should not be interpreted as reflecting the industry as a whole at this time.

In the second of the studies, the leadership behavior study, 155 individuals responded to the request to participate in the study out of 400 letters sent to ENR's Top 400 contractors list (Butler 2005). The participants were requested to complete the study using a research website developed specifically for this study. Of these respondents, 130 completed all three parts of the survey and could be used in the analysis. Of the 130 individuals, 96 were employed by ENR's Top 400 Contractor list. In the response group, there were 18 females and 112 males with the average age being 43.19 years. The female average age was 38.5 years while the male average age was 43.95.

For the leadership behavior study, participants completed the most current version of the BarOn EQ-I test. This is a self-report questionnaire that consisted of 133 items, all phrased in the first-person singular. The response format for these items was a five-point scale ranging from "very seldom or not true of me" to "very often or true of me." These items were used to provide scores for 21 EQ scales (Bar-On 2000). Responses to the BarOn EQ-i produced a score for the Total EQ scale; scores for 5 composite scales (Intrapersonal, Interpersonal, Stress Management, Adaptability, and General Mood); and scores for 15 subscales (Table 1). Raw scores were normalized using norms for the general population of North America. As such, a score of 100 points represents exactly average.

In addition to the 21 EQ scales, there were also 4 scales that assessed the response validity of each participant. These four scales included the Omission Rate, Inconsistency Index, Positive Impression, and Negative Impression scales. The four validity scales were used to filter out invalid responses from the data analysis procedure.

RESULTS: THE INDUSTRY PERSPECTIVE STUDY

The industry perspective study illustrates current industry leaders' primary concerns about leadership and future leaders entering the construction industry as well as the primary challenges facing the industry. Of primary interest in the survey were the sections related to the challenges facing the next generation of industry leaders. The following sections highlight the results from the survey.

The first question of the survey focused on what executives believed were the most important attributes of a leader. The respondents were given the opportunity to enter three traits in rank order. The results of this question were very clear in their focus as illustrated in Table 2. The respondents believe strongly that the two most important traits of a leader are integrity and the ability to interact with others either through communication or interpersonal relationships. The respondents also believe that having a leader who is visionary and can set long-term strategic goals is essential for the organization. This last trait is one that will be revisited later as the question arises as to how an organization develops visionary leaders when the industry has a strong bias towards project or transactional decisions.

Table 2. Leadership Traits

Biggest Challenges	
Challenge	Frequency
Lack of Quality People	35
Attracting Talent	23
Globalization	16
Aging Workforce	15
Workforce Issues	13
Change/Transition	7
Teamwork/Communication	6
Training	6
Education	5
Costs	3
Politics	1

Table 3. Challenges

Trait	1st Trait	2nd Trait	3rd Trait	Total Points
Integrity	48	27	14	335
Vision/Goals/Change	34	22	25	261
Interpersonal Skills	23	55	65	345
Communication	17	21	21	169
Other	8	2	5	51
Experience/Competence	6	9	6	63

Table 3 illustrates responses for the question, “What do you consider the biggest ‘overall’ challenge facing the EPC/AEC industry in the next 10 years? Interestingly, all of the participant inputs demonstrate leadership challenges or suggest needs for leadership development. The principle challenges of lack of quality personnel, attracting talent, aging workforce, workforce issues, and training indicate both a need for leadership development and a call for leaders to act. The predominance of workforce issues is not isolated to labor, it includes the shortage and need of mid and senior level leadership training (Preistland 2005). This double edged requirement for leadership development and leadership for the next generation establishes the need for further investigation into aligning existing leadership traits with future leadership demands.

RESULTS: LEADERSHIP ASSESSMENT of EQ

When examining the descriptive statistics for the entire sample, it shows that the average total EQ is 101.14 (Table 4). Similar to an IQ score, the average EQ score is 100 with a standard deviation of 15 (Table 3). The respondent group also scored higher than the average 100 on four out of five major components of the EQ (intrapersonal skills, stress management, adaptability and general mood) as well as eight of the 15 subscales (self-regard, assertiveness, independence, self-actualization, stress tolerance, reality testing, problem solving and optimism). The group scored right around average in four of the 15 subscales (self-actualization, flexibility, impulse control and happiness). The only major component of EQ the group scored lower than average was interpersonal skills. They also were lower than average on four of the 15 subscales (emotional self-awareness, empathy, social responsibility and interpersonal relationship).

Table 4: Group Descriptive Statistics for EI

EI Variable	N	Range	Min	Max	Mean	Std. Deviation
Total EQ	**130**	**50**	**76.00**	**126.00**	**101.14**	**10.72**
Intrapersonal Skills	**130**	**58**	**70.00**	**128.00**	**102.55**	**11.78**
Self Regard	130	56	70.00	126.00	102.65	10.64
Emotional Self-awareness	130	71	60.00	131.00	99.25	15.72
Assertiveness	130	78	52.00	130.00	102.87	13.72
Independence	130	47	79.00	126.00	105.72	10.75
Self Actualization	130	60	63.00	123.00	100.22	11.44
Interpersonal Skills	**130**	**69**	**51.00**	**120.00**	**94.92**	**13.98**
Empathy	130	89	34.00	123.00	94.58	15.37
Social Responsibility	130	76	45.00	121.00	96.95	13.10
Interpersonal Relationship	130	77	48.00	125.00	94.85	15.68
Stress Management	**130**	**49**	**79.00**	**128.00**	**103.50**	**10.65**
Stress Tolerance	130	47	81.00	128.00	106.05	11.11
Impulse Control	130	63	62.00	125.00	100.22	12.49
Adaptability	**130**	**50**	**78.00**	**128.00**	**101.65**	**10.03**
Reality Testing	130	51	71.00	122.00	102.42	10.47
Flexibility	130	69	60.00	129.00	100.12	12.60
Problem Solving	130	51	71.00	122.00	101.25	10.41
General Mood	**130**	**55**	**67.00**	**122.00**	**101.82**	**11.06**
Optimism	130	60	68.00	128.00	104.16	9.54
Happiness	130	69	51.00	120.00	100.35	13.47

ANALYSIS

The data analysis illustrates that construction leaders have a slightly higher than average total EQ. The group's EI is less variable with respect to total EQ than the general population as shown by the standard deviation being less than the standard deviation for the general population.

EI Strengths

The top three EI strengths in the group assessed for this study were stress tolerance, independence and optimism. Stress tolerance falls under the stress management area of EI, independence is categorized under intrapersonal skills and optimism is a component of general mood.

- **Stress Tolerance:** Many people involved in construction would concede there is stress associated with the majority of jobs in the industry. There is pressure to complete a project within a specified time and financial budget. In addition there is risk involved in undertaking a construction project because of the uncontrolled nature of the sites. Each project is different and has unforeseen conditions associated with it. Also there is financial pressure because profit margins are historically low reducing flexibilty to make mistakes and still gain financially. The leaders assessed in this study have proven to be resourceful and effective as a way to handle stressful situations. The data shows they are capable of coming up with suitable methods to deal with adversity and how to implement a plan to alleviate stress. Additionally, these people overall have a belief in their own ability to face and handle stressful situations.

- **Independence**:The next strongest EI subscale for the group studied was independence. Scoring high in the area of independence means the group has a high degree of self-confidence as well as the ability to make decisions. As a whole the leaders surveyed have the ability to think independently as well as involve others in their decision-making process. These are undoubtedly characteristics strong construction leaders need to be successful. The higher score in independence shows that the leaders surveyed posses these characteristics and are in high positions within their companies.

- **Optimism**: Finally, optimism was found to be a strong EI component of the group assessed. This characteristic measures the way the group regards the future. This subscale may have been different if assessed a few years ago when the post 9/11 economy was uncertain and beginning a recession. In recent months, construction and the rest of the economy received a boost and this may contribute to why leaders are more optimistic about the future than the general population.

EI Weaknesses

The EI weaknesses identified in this study are each components of the Interpersonal skills area within the EI profile. The three weakest subscales for the group were: empathy, interpersonal relationship and social responsibility.

- **Empathy:** Empathy was discussed above and was also an area where women strongly outscored the men in the study. The ability to be aware of, to understand and to appreciate the feelings of others is not necessarily something practiced often in the construction industry. Historically, construction leaders did not need to be aware of others feelings because it was an industry of "low bidder wins". There were no hurt feelings if one subcontractor was chosen over another because of a lower price. Historically construction leaders did not address issues of feelings in the workplace.

- **Interpersonal Relationship:** The second weakest EI area for the group was interpersonal relationship. This subscale aligns with empathy in that it is the ability to form intimate relationships with others. Again, this was an area where the women studied outscored the men by a large margin. Construction is not considered a "touchy-feely" industry by any means. As mentioned above, relationships with subcontractors were historically based on pricing, not how well one "liked" the subcontractor. Construction leaders did not need this aspect when they were expected to act as tyrant-type rulers. Intimate comfortable relationships were not typically formed between construction leader and subordinate.

Leadership Challenge-EI Relationship

The EI weaknesses identified in this study have a direct relationship to the required leadership desired traits identified by current industry executives. Specifically, as illustrated in Table 2, the need for Interpersonal Skills and Communication are of primary importance to the next generation of leaders. Closely aligned with those traits are the needs to be visionary and advocate change. Each of these traits is dominated by the ability to communicate and develop personal relationships with organization members. This emphasis on communication and relationships raises a red flag due to the fact that the primary EI weaknesses found in industry executives are in interpersonal skills.

The weakness in interpersonal skills brings the focus of the analysis to the question of how is this situation going to be modified in the next generation of leaders? It is clear that current executives recognize the need for individuals to possess skills in this area. However, it is also clear that a weakness exists in these skills. Thus, there is an identified need to change the path through which the next generation of industry leaders are prepared for their positions. Specifically, the research identifies that a greater emphasis on interpersonal training is required to meet the identified traits. The challenge to organizations will be if this additional emphasis is not addressed. If this situation occurs, then the future generation of leaders may not have the abilities to address issues such as workforce, globalization, and attracting qualified professionals that have been identified as industry challenges.

CONCLUSION

The paper summarizes a two-phased investigation into executive leadership in the construction industry. The first phase summarized results from an assessment of construction executives which queried their views on important leadership traits and construction industry challenges over the next 10 years. The challenges expressed by industry leaders suggest a critical need for leadership development. Phase two of the research studied the emotional intelligence and leadership behavior of construction executives.

The relationships identified in these studies have a significant impact for the preparation of the next generation of construction organizations. Specifically, as organizations prepare the next generation of executives, the criteria for selection as well as the development of the selected individuals should be expanded to recognize the value of EI and leadership traits. Additionally, current executives should analyze their own leadership behaviors to determine if an acceptable level of attention is being given to interpersonal skills and training. Addressing the need for these skills will ultimately enhance the ability of the organization to meet future challenges based in interpersonal skills and to remain competitive in the changing business environment.

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The Role of Strategic Leadership in Creating Change for Construction Innovation: A North Cyprus Perspective

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Driving forces in construction industry indicate that the ability to innovate is quickly becoming a competitive necessity. However construction industry has been generally slow to embrace innovation and radical changes as fundamental changes in construction processes require shifts in the conservative management perspectives of construction contractors. Thus the strategic leadership has a crucial role in change initiatives for innovation in construction contractors. Our research focus is to investigate the role of strategic leadership in creating change for innovation in North Cyprus construction industry. Main objectives are to 1) analyze the current strategic role of leadership in change initiatives for innovation, 2) identify the innovation driving leadership models, roles, and styles 3) assess the effectiveness of innovation leadership models, roles, and styles in construction contractors. The research includes review of background literature, interviews with project/construction managers in the industry on change initiatives for innovation in construction processes, analysis of this information to develop findings and extending these to present the key strategic issues that could be targeted for creating wider awareness of existence and persistence of incumbent and prevailing innovation initiatives in the management perspectives of construction contractors. The paper commences on understanding the current management perspectives of construction industry leaders in change for innovation in North Cyprus. The paper concludes how the changes in owners' demands and more complex new facilities require innovative change initiatives to leave the old paradigms in construction organizations. Besides technology and project-oriented perspectives, social issues like organizational change and strategic focus on clients (market oriented) can be regarded as the most important change initiatives for the construction industry leaders in North Cyprus.

Keywords: Leadership, change initiatives, innovation, construction contractors, construction industry, North Cyprus.

Introduction

Against a backdrop of increasing globalisation, deregulation, the rapid pace of technological innovation, a growing knowledge workforce, and shifting social and demographic trends, few would dispute that the primary task of management today is the leadership of organisational change (Jackson, 1997). Managers with a strong influence on innovation processes in organizations have substantial leadership competence (Tatum, 1989; Nam and Tatum, 1989; 1997; Winch 1998; Kim et al., 1999; Norrgen and Schaller, 1999; Gann, 2000; Hauscildt and Kirchmann, 2001; Stoker et al., 2001; Jung et al., 2003; Bossink, 2004a). Leadership in innovative construction projects is often seen as an important management function, based on human capabilities such as entrepreneurship, championship and strategic vision (Tatum, 1989, Nam and Tatum, 1989; 1997; Winch, 1998; Gann, 2000; Bossink 2002; 2004a). Managers driving innovation perform distinctive leadership styles. Bossink (2004b) emphasized the effects of these styles on the processes in, and the outcomes of innovative construction projects. An explorative quantitative study shows that the mainstream paradigm of construction industry leaders today is much as it was in the past: technology- and project-oriented. Acting out of this paradigm, issues as social-organizational change and strategic focus on the client - regarded as important for the industry - will probably not be addressed properly. Change initiatives could gain in success, when they create wider awareness of existence and persistence of incumbent and prevailing paradigms (Pries et al., 2004).

The innovation management literature presents leadership as a role to be performed by managers but also by employees (Kim et al., 1999; Hauschildt and Kirchmann, 2001). It typifies and defines leadership roles such as *Inventor*, *Champion*, *Entrepreneur, Gatekeeper*, *Sponsor.*The leadership styles of these innovation leadership roles (Harmsen et al., 2000; Waters, 2000; Stoker et al., 2001) are *Charismatic, Instrumental, Strategic, Interactive.*Researchers who explore and describe how leading individuals contribute to the creation of innovative products, technologies, and organization structures and processes, often use this innovation leadership role model (Nam and Tatum, 1997; Rice et al., 1998; Hauschildt and Kirchmann, 2001).

Construction industry in North Cyprus is aware and recognizes the need to modernize in order to tackle the severe problems it is encountering, namely, Profitability, Research and Development, Training, Price and Cost, Dissatisfaction of Clients and Fragmentation. The necessary conditions for competitiveness for the North Cyprus construction industry include strong and sustained levels of productivity growth, openness to innovation and new technology and a commitment to delivering value for clients' money. There is growing interest in the role of innovation within the North Cyprus construction industry (Yitmen and Al Qadi, 2005; Yitmen, 2005). Driving forces in construction industry indicate that the ability to innovate is quickly becoming a competitive necessity. However construction industry has been generally slow to embrace innovation and radical changes as fundamental changes in construction processes require shifts in the conservative management perspectives of construction contractors. Thus the strategic leadership has a crucial role in change initiatives for innovation in construction contractors. Our research focus is to investigate the role of strategic leadership in creating change for innovation in North Cyprus construction industry. Main objectives are to 1) analyze the current strategic role of leadership in change initiatives for innovation, 2) identify the innovation driving leadership models, roles, and styles and 3) assess the effectiveness of innovation leadership models, roles, and styles in construction contractors.

RESEARCH METHOD

To meet the objectives of the study, a meeting was organized by the EUL Civil Engineering Department Research Group and representatives from all sub-sectors of the North Cyprus construction industry, related institutions, chambers, miscellaneous firms etc. were invited to discuss the role of strategic leadership in creating change for construction innovation. Then the empirical data was collected through structured interviews within the main large private sector construction contractors. Forty key people from senior managers of construction contractors were conducted during the interviews. The outcomes from the meeting and interviews constitute the basis of the main structure of the questionnaire. The paper deals with the results of a survey conducted by research members on strategic leadership in change initiatives for innovation in construction organizations in North Cyprus. Main topics in the questionnaire were as follows:

i. Organizational structure of construction contractors

ii. Change initiatives for innovation in construction
iii. Innovation driving leadership models, roles, and styles

Literature Review

This stage involves a thorough review of literature about the role of strategic leadership in creating change for construction innovation in North Cyprus construction industry. The intensive literature review resulted in the identification of two leadership models as *Transformational,* and *Transactional*, five leadership roles as *Inventor*, *Champion*, *Entrepreneur*, *Gatekeeper*, and *Sponsor,* four leadership styles as *Charismatic, Instrumental, Strategic*, and *Interactive,* and four distinctive innovation drivers as *Environmental pressure*, *Technological capability*, *Knowledge exchange*, and *boundary spanning* which are active at the *Transfirm*, *Intrafirm*, and *Interfirm* level in the network of contractors in the construction industry.

Data Collection

The second stage involved the collection of data. A questionnaire, which was administered to almost all the firms registered to the Association of Building Contractors, has been used in conducting the survey. The survey includes three main types of information involving *Organizational Structure*, *Change Initiatives for Innovation in Construction,* and *Innovation driving leadership models, roles, and styles*.

1. Organizational structure: General company characteristics were sought which include the general functions of service areas of the organizations, size of the organizations involving the production, firms' turnover, number of permanent employees, human resources and development and target group of customers.
2. Change initiatives for innovation in construction: This portion of the questionnaire focused on drivers for change to improve the project success and sustain continuous improvement including committed leadership, focus on the customer, product team integration, quality-driven agenda, and commitment to people.
3. Innovation driving leadership models, roles, and styles: This portion of the questionnaire was aimed to assess the effectiveness of innovation leadership models, roles, and styles in construction contractors.

The questionnaire was designed using a nominal scale for the real values of the independent variables. In evaluating the dependent variables, a scale of 4 intervals (with a '0' value given to no effect, '2' to a middle value, and '4' given to maximum effect). The respondents were asked to check a number on the scale, which reflects their assessment regarding the different factors. A list of all contractor organizations within the construction sector was obtained from the Association of Building Contractors. The list consisted of a total of 35 organizations. An attempt was made to contact every single organization. During the survey 30 organizations were contacted and 20 (66%) of these questionnaires were evaluated. Contact personnel in the companies for the questionnaire survey were either the top management or senior management in their respective departments, therefore their level of knowledge expected to provide responses was acceptable for the purpose of validity of the survey results.

FINDINGS

This section of the study discusses the key strategic issues that could be targeted for creating wider awareness of existence and persistence of incumbent and prevailing innovation initiatives in the management perspectives of construction contractors.

Determination of Importance Indices

The participating contractors provided numerical scoring expressing their opinions on the significance of each factor in determining the current management perspectives of construction industry leaders in change for innovation in North Cyprus. The weighted average for each factor was calculated and then it was divided by the upper scale of the measurements in what is referred to as "important index" therefore the level of important of the factors classified into three categories as Models, Roles and Styles of the Leadership were calculated using the formula (Kish, 1965):

Level of Importance (Index) = $[\Sigma(aX). 100] / 4$
a= the score given to the factor by each organization (varying from 0-4)
X= n/N
n= Frequency of organizations
N= Total number of participant organizations

Table 1. shows a matrix of variations in level of important indices of the factors for determining the current management perspectives of construction industry leaders in change for innovation in terms of *Leadership Models-Roles-Styles versus Innovation Drivers*. The X-axis of the matrix indicates the innovation drivers classified into four categories as *Environmental Pressure*, *Technological Capability*, *Knowledge Exchange*, and *Boundary Spanning*. The *Leadership Models-Roles-Styles* were listed in the Y-axis of the matrix with their index values. The matrix also includes the calculated mean of importance indices and the rank orders of all the categories of innovation drivers listed at the bottom of X-axis with their index values. Studying the matrix the Leadership Models-Roles-Styles carrying the highest level of importance are mostly from the driver *Technological Capability*. These factors are "Inventor" and "Intellectual Stimulation" (Technological Capability), "Interactive" (Environmental Pressure), "Entrepreneur" (Knowledge Exchange), and "Instrumental" (Boundary Spanning). In observing the highest ranked innovation driver, it can be noted "Technological Capability" carries the highest level of importance.

Table 1. Matrix showing the Variations in the level of Importance Indices –
Leadership Models-Roles-Styles versus Innovation Drivers

				IMPORTANT INDEX VALUES			
MEAN IMP INDEX	RANK		Innovation Drivers / Leadership Models-Roles-Styles	Environmental pressure	Technological capability	Knowledge exchange	Boundary spanning
		Models	***Transformational***				
32,06	**5**		Charismatic leadership	28,50	28,50	28,50	42,75
35,63	**4**		Individualized consideration	28,50	42,75	28,50	42,75
35,63	**4**		Intellectual stimulation	14,25	**57**	42,75	28,50
			Transactional				
32,06	**5**		Contingent reward	28,50	42,75	28,50	28,50
35,63	**4**		Management by exception	28,50	28,50	42,75	42,75
42,75	**2**	Roles	Inventor	28,50	**57**	42,75	42,75
39,19	**3**		Champion	28,50	42,75	42,75	42,75
42,75	**2**		Entrepreneur	28,50	42,75	**57**	42,75
24,94	**7**		Gatekeeper	14,25	28,50	28,50	28,50
21,38	**8**		Sponsor	28,50	28,50	14,25	14,25
28,50	**6**	Styles	Charismatic	42,75	28,50	14,25	28,50
46,31	**1**		Instrumental	42,75	42,75	42,75	**57**
35,63	**4**		Strategic	28,50	42,75	28,50	42,75
42,75	**2**		Interactive	**57**	28,50	42,75	42,75
			RANK	**4**	**1**	**3**	**2**
			MEAN IMP. INDEX	**30,54**	**38,679**	**34,61**	**37,66**

Discussion of the Survey

Both the structured interviews conducted to senior management in their respective departments and as well as the construction site observations conducted by research members during the survey study were relied on for the validity of the survey results.

The Leadership Style, “Instrumental” is ranked #1 and is perceived by respondents to have an influence on the Innovation Driver, *Boundary Spanning* with a value of importance index 57. The interviews and observations highlighted that an instrumental leader sets goals, establishes standards and defines roles and responsibilities. He or she creates systems and processes to measure, monitor and assess behaviour and results, and to administer corrective action. The project leader delineates task boundaries within which the members of the project team were expected to work. The Leadership Style, “Interactive” is ranked #2 and is perceived by respondents to have an influence on the Innovation Driver, *Environmental Pressure* with a value of importance index 57. The interviews and observations highlighted that an innovative leader interacts with the environment and shows individualized consideration when providing support, coaching and guidance to employees. Innovators use cooperative tactics to influence other people and that they have a strong influence on people’s target behaviors when they enjoy positive personal relationships with them. The Leadership Model “Inventor” is ranked #2 and is perceived by respondents to have an influence on the Innovation Driver *Technological Capability* with a value of importance index 57. The Leadership Model “Entrepreneur” is ranked #2 and is perceived by respondents to have an influence on the Innovation Driver *Knowledge*

Exchange with a value of importance index 57. The Leadership Model "Champion" is ranked #3 and is perceived by respondents to have an influence on the Innovation Drivers *Technological Capability*, *Knowledge Exchange, and Boundary Spanning* with a value of importance index 57. The interviews and observations highlighted that the inventor leader promotes the technological know-how that is translated into innovative products and services. The entrepreneur leader initiates, drives and controls the innovation strategies and processes in the organization. The champion leader promotes the organizational adoption of innovations.

As perceived by the respondents regarding the drivers for change within the management perspectives, changes in owners' demands and more complex new facilities require innovative change initiatives to leave the old paradigms in construction organizations. Besides technology and project-oriented perspectives, social issues like organizational change and strategic focus on clients (market oriented) can be regarded as the most important change initiatives for the construction industry leaders in North Cyprus. Figure 1. shows the model framework of the strategic role of leadership in creating change for construction innovation, a North Cyprus Perspective. The driving forces (i.e owners demand) in construction industry indicate that the ability to innovate is quickly becoming a competitive necessity. However construction industry has been generally slow to embrace innovation and radical changes as fundamental changes in construction processes require shifts in the conservative management perspectives of construction organizations. Construction managers are able to determine the knowledge required for a particular degree of newness. On the other hand they get support in identifying the knowledge gaps when aiming at a certain innovation degree and in choosing an appropriate alternative to close the gaps. However, until now there has been a lack of validation as many barriers like old paradigms exist, thus turning the management of innovation into a very challenging task to do. Thus the strategic leadership has a crucial role in change initiatives for innovation in construction organizations.

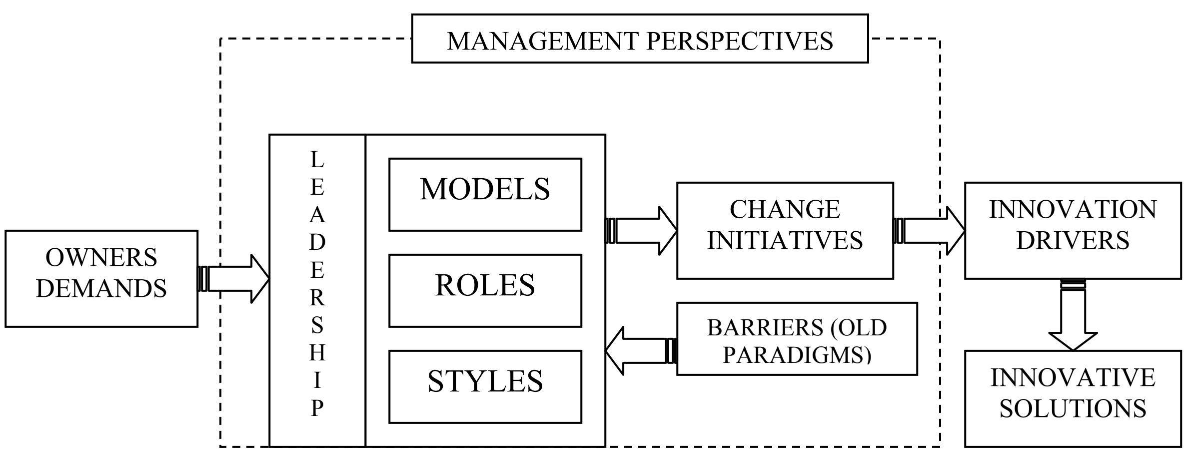

Figure 1. Model framework of the strategic role of leadership in creating change for construction innovation: North Cyprus Perspective

Conclusion

The paper commences on understanding the current management perspectives of construction industry leaders in change for innovation in North Cyprus. The key strategic issues that could be targeted for creating wider awareness of existence and persistence of incumbent and prevailing innovation initiatives in the management perspectives of construction organizations were identified based on the analysis of the variables. Despite the existence of the old paradigms, the performance of an instrumental leadership style can have a positive effect on the innovativeness of a construction project when the leading manager also assures that the project is injected with information, knowledge and competence.

The leadership styles, roles and models were related to change initiatives for innovation in construction processes. It was found that the instrumental leading individuals having an entrepreneur role not only contribute to the creation of innovative products, technologies, and organization structures but also they drive and control innovation strategies, and processes.

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Developing Skills to Manage Complex Projects

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Abstract

This paper is based on the experiences of two industry consortia to address the requirements of developing next-generation technology leaders by synthesizing tools and training materials to manage the development of complex projects. Such programs and/or projects are characterized by evolving specifications, rapid technology change and the need to create platforms that can be updated through many generations. Extendibility, adaptability and flexibility can be achieved but only by inflating the cost of the initial project to an uneconomic level. Hence the dilemma: how to design for a point solution in order to get the contract but then face continuing difficulties to sustain the product through all the enhancements of its working life. A new range of personal skills and working relationships are defined and an approach suggested.

Introduction

Projects are continuing to become more complex, even to the point where few managers feel satisfied that the outcomes met customer expectations. This complexity of projects is noted by the International Project Manager's Association (IPMA) the carries a certification for project managers that are able to handle complex projects. This paper is based on the experiences of two industry-academic consortia to develop next-generation technology leaders by synthesizing tools and training materials to manage the development and completion of complex projects. Such complex programs and/or projects for the industry consortia are characterized by evolving specifications, rapid technology change and the need to create platforms that can be updated through many generations. The interests of the consortia cover construction, aerospace and electronics for both government and private customers. The products are sourced and delivered on a global scale. In these respects, the focus for the programs may be considered to be representative of the most technically advanced and complex systems projects.

Common characteristics exist for both consortia across all company activities. In spite of increasing costs and complexity, customer expectations are for ever-faster execution at lower cost per function and with greater performance or application effectiveness (faster, cheaper, better). Being able to move continuously along such a multi-dimensional efficiency curve is a mark of corporate leadership.

The real difficulty, however, lies in being able to sustain that ever-advancing metric of improved quality, reduced cost and time throughout many upgrades in the product/project life cycle with technologies that were unimagined at the time of the original design. In this respect, an airframe or gas turbine is no different from a semiconductor facility or a software-defined communication system. Each will be totally refurbished several times during its operational life. Extendibility, adaptability and flexibility can certainly be designed-in at the beginning - but only by inflating the cost of the initial project to an uneconomic level. Hence the dilemma: how to design/construct for a point solution in order to be awarded the contract but then not be overwhelmed by the requirement to sustain the product through all the enhancements in its working life.

Today's Scenario

Outsourcing of manufacturing and engineering jobs has received a great deal of press attention but it is really a symptom of the way companies continue to restructure themselves to address more specialized functions. The monolithic vertically integrated corporation is long gone (at least in the manufacturing sector). In its place, we have an extended supply chain that has many levels:

Table 1: Extended Supply Chain

Level	Description	Example
1	Global deployment	All Navy communications or International Construction Companies
2	Large system entity	Building complex
3	Product family	Interlinked tools or facility campuses
4	Stand-alone product	Single tool or single structure
5	Major sub-system	Control system or power distribution
6	Functional building block	Computer or motor
7	Design library component	CAD file that can be re-used
8	Components	Capacitors, frames, boxes
9	Refined materials	Silicon, steel
10	Commodity materials	Copper, concrete, lumber

Today's trend finds companies actively seeking to optimize their position in one level and have a few selected suppliers and major customers downstream and upstream. Although this trend may appear to be heading towards a simpler set of business arrangements, there are sub-layers within each layer in the above table. Even if each major enterprise had only 20 accounts (up- and down-stream), the dependencies in delivery of a high-level system are clearly very complex.

Four additional factors raise the stakes in being a leader at the chosen level in this supply hierarchy:

1. In the last 15 years, approximately half the world's population has entered the open-market trading system [Barrett 2005]. That means many new customers but they also wish to be producers as well as consumers.

2. In the same period, available tools, such as quality control machines, have allowed communities with no culture of manufacturing to enter the high-tech business and produce quality products.

3. Communications and the tools to manage data have become cheap. A world-wide supply network can now operate as if it were all in one company in one location.

4. These same influences show up in both the construction and manufacturing arenas when international firms set up offices and production operations in the many countries.

These are powerful drivers for change. One of the first results has been the continued migration of labor-intensive jobs to developing countries. This is not new as far as basic-technologies are concerned. However, the trends above now also allow high-tech jobs to be more readily done offshore which also moves the facility construction to developing countries. The underlying indication then is that construction is labor intensive and less expensive to do overseas. There seems to be every likelihood that other cherished monopolistic reserved practices will tumble as global resources are harnessed for greater business success.

Tools designed for another job

Project management is one of the oldest professional skills. From building pyramids to semiconductor factories, a specific job needs to be done within constraints of time, cost and available skills. We also know, all too well, that goals are not achieved, usually due to poor specifications or slow responses to visible problems.

Unfortunately, with more complex systems and the many interactive components within them, generating project or product requirements becomes a difficult task. The last job may have been similar, but cloning is no solution since the customer's needs have changed and the technology has improved. As a result, requirements may only become clear after enough design work has been done to define how the new system will function, yet severe time constraints may force projects to start before all the necessary information has been assembled. Global communications and terabytes of data do not of themselves constitute sufficient information that can be used for decision-making. With a multi-layered global supply chain, problems are often only visible if they are being actively sought. Thus all combinations that are new are usually excluded and unfortunately, today's large systems are defined by their new combinations of sub-systems, components and software. The conclusion is that the key attributes of today's complex systems are also the well-known causes of failure in project management.

The tools that are available to support project management are great for traditional monolithic projects where the activities and their interaction can all be fully represented. However, that is of little advantage if some activities are missing because they are layers deeper in the supply chain. Similarly, the assembly of modules from many sources is dependent on a common interpretation of standards and specifications for their combination. We should therefore consider incorporation of other tools that more accurately represent the decision-making steps within a complex project. This means changing the focus from known activities to the factors that link them together.

An example of such a development has evolved from research studies done on common tool interfaces within a semiconductor facility [Ma and Chasey 2000]. The specification covers the physical and functional features. As might be expected, it is a crucial component of the contract specification. However, it is also a virtual interface for software upgrades as well as test and diagnostic information transfer between the manufacturer and owner. The owner can test and examine the tool pre-delivery and the vendor can provide pre-emptive diagnostic advice and software patches when the tool is commissioned.

Needs for the next generation of project leaders

To deliver a whole new range of personal skills and working relationships, new means and methods must be defined and developed to include such areas as:

- How to decompose systems in such a way that it is subsequently proven to be effective when the parts are reassembled
- How to decentralized decision making coupled with resultant accurate communication of the reasons and outcomes
- How to exploit enterprise software to organize production from many sources in many countries (many subcontractors in many places)
- How to acquire and sustain knowledge to remain competitive
- How to work in different leadership roles on multiple projects.

The successful individuals and organizations will be those who can manage continuous change and make sound decisions under conditions of profound uncertainty. They are also likely to be nearer the top of the supply chain pyramid and to determine how the other contributors to the project interact with the many contributors.
The companies within the two Consortia echo comments that are widely held throughout the technology-based industries – a large percentage of their most experienced general practitioners in program management will retire in the next 5 – 10 years and few replacements are in view. One of the most valuable attributes these individuals have is an ability to identify leading indicators of trouble based on very inadequate information. Call it inspired guesswork, but it works. Are any processes available that can be substituted for experience short of working diligently on the subject for 30 years?

A closer examination of the skills that will be needed for the next generation of complex projects indicates three essential components (See Figure 1). There is a strong core of common communication, data management and business process skills but the response to increasing complexity of the job is to foster workforce development in three complementary roles: Specialists, Integrators, and Sustainers.

- Specialists are the practitioners that know how a system works or are the functional contributors of a component to an overall system. (Designers or Superintendents)
- Integrators are the master planners that can fit the systems together to determine the functionality of an overall complex system of systems. (Project/Program Managers or Chief Engineers)

- Sustainers are the system operators that keep the complex systems operating to support the overall mission (Operators or Users)

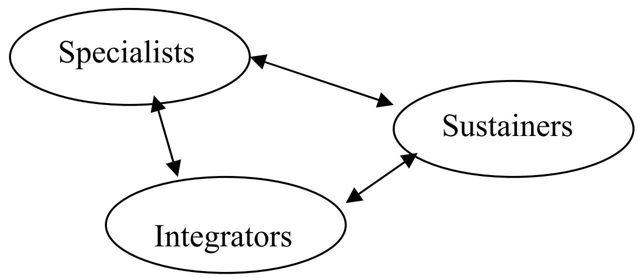

Figure 1: Next Generation Skills Integration

The specialists may be designers or manufacturers anywhere in the supply chain. They initially feed the integrators who create the master-plan to tie the components together for the first system. It is then handed over to the support groups.

The cycle continues as the system matures in service with many upgrades and technology additions. Then, however, it is the sustaining group who takes on the role of customer advocate and initiator of change specifications. This is a much larger role than such groups have traditionally enjoyed - but where better to start to define the evolution path? In the first cycle, the integrator's role was concerned with strategic design. In the mature system evolutionary stages, the integrator has to abstract the lessons passed on by the sustainers and make sure they are effectively transferred to the next job. The individuals in all three roles have the difficult personal task of taking different leader and support roles throughout the system life cycle.

Although these roles may be spread across several companies, the customer does not separate accountability according to contributions. If successfully done, the system provider can lock in business for years or even decades. However, any system integrator that does not attend to designing out today's problems will likely find that bidding for the next generation contract is much more challenging.

The development path for such professional skills does not yet exist in the mainstream educational system. However, it is currently being explored through short courses and industry-led cooperatives to provide specific solutions. The common educational characteristics involved in this development are:

- Systematic professional development will be spread over many years
- The path will be largely steered by the individual
- Point solutions with no guarantee of continuity
- Numerate communication
- Use of standard software tools available on the open market

These features make it clear that the educational process to learn how to manage large system development is very much like the system development process itself.

Next Steps

ASU is fortunate to be able to work with two industry consortia for training in advanced technologies, both manufacturing and construction – JACMET and CREATE. JACMET (led by Boeing, Honeywell, Raytheon, Motorola and General Dynamics) deals with electronics and aerospace manufacturing while CREATE's member companies (led by Intel) are devoted to the construction of advanced technology facilities with highly controlled environments and many complex systems. Both consortia provide short courses to their industry members and are tightly focused on the skill priorities of their member companies. One of the long-term goals in being associated with a State University is to transfer industry experience into both the content and strategic direction of academic programs.

Both consortia have similar concerns about retirement of many senior technical staff in the member companies and the need to prepare the next generation of leaders quickly for more demanding tasks ahead. The first-tier solutions are similar – to establish a series of short courses that can lead to a certificate. In the case of CREATE, the developed graduate courses have been utilized to develop an on-line training program for project managers in the Asia region that have no understanding of the complexities of an advanced technology manufacturing facility. The program, with a practical application of concepts taught, has provided a methodology to learn the unique skills needed for constructing a high tech factory while minimizing the impact on their current workload, remaining within travel limitations and still providing an excellent learning environment

The JACMET solution is a certificate program for potential Chief Engineers that covers the changing role, systems design, requirements specification, decision-oriented risk management, root cause analysis, reliability and how to make a business case. It is all very practical and focused on the direct job skills enhancement needs of the participants.

A number of enhancements to both programs are currently being considered:

International business, eg: distance courses for employees in Asia.
Techniques to enhance communication effectiveness. Language is often more prone to misunderstanding than data. However, data needs to be formatted carefully to deliver a clear message.
International standards, especially as embodied in the International Technology Roadmap for Semiconductors, [ITRS 2005].
Effective distance delivery
Metrics for competency that are relevant to company goals and performance
Extend the industry short courses to become the basis for academic course modules that reflect workplace skills priorities.
Extended partnerships beyond the Arizona consortia.

Conclusion

The challenges to prepare the next generation of leaders to manage complex technology-based programs are being met in a number of innovative ways. This paper has demonstrated how companies can work together with academic partners to provide the new types of training that are needed. The successful individuals and organizations will be those who can manage continuous change and make sound decisions under conditions of profound uncertainty. Innovation and rapid progress to deliver these outcomes are likely to enhance international competitiveness and go some way to help retain jobs in the US.

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Additional information about JACMET activities can be found at: http://webapp.poly.asu.edu/jacmet/

Additional information about CREATE can be found at: http://create.asu.edu/

FACILITATING A VALUE-BASED APPROACH TO DESIGN AND CONSTRUCTION THROUGH INFORMAL LEADERSHIP: REFLECTIONS ON A DANISH APPROACH

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ABSTRACT
The work reported here is based on a longitudinal case study, which has followed the development of a 'new' way of working by a large contractor working closely with a large firm of consulting engineers in Denmark over the past three years. A value-based process model incorporates aspects of lean thinking and partnering with emphasis on the individuals contributing to the project and the management of their interaction practices. Value is seen as *the* end-goal of construction projects and therefore the discussion and agreement of value parameters is fundamental to the achievement of improved productivity and client/user satisfaction. This is achieved primarily through the use of creative workshops in which the main actors come together to discuss and agree a set of value parameters. Workshops are coordinated and managed by a process facilitator; a person who plays a key role in the development of projects but who has no contractual responsibility for the outcome of the process. This 'informal' leadership role is crucial to the successful development and delivery of projects using a model in which great emphasis is placed on people and their collective ability to work together. Thus the facilitator has a socialising function running parallel to project management functions; a role fundamental to successful leadership and collaboration between organisations and individuals.

Keywords: Communication; Culture; Informal leadership, Lean philosophy; Value-based management.

INTRODUCTION
Like many construction sectors around the world the Danish construction sector was heavily criticised during the 1990s for its poor performance and failure to deliver value to the customer, although parallel research found that some innovative practices were being implemented across the sector (Kristiansen et al, 2005). More recently a number of initiatives have been taken to try and improve the value delivered to clients and building users. Concepts such as lean construction, partnering and more recently value management have been promoted as 'the' way to better performance. These management fashions have been adopted and adapted by organisations to fit their organisational culture, with varying degrees of success. The current situation in Denmark is a very fluid construction market, with actors claiming to use different approaches to distinguish themselves from the competition and improve performance.

At the level of the individual construction project it may be very difficult improve working methods even when all participants and organisations 'sign up' to some common values. Maister (1993) has argued that many firms do not share values within the organisation and also fail to adequately discuss values with clients early in the appointment process. The implication is that the sharing of values is a challenge for organisations and temporary project groupings. The challenge is not exclusively with the implementation of tools to streamline the process, more it is about the interaction of organisations, or more specifically the efficacy of relationships between the actors during the project lifecycle. This social interaction needs to be managed and someone has to take responsibility for leading the process.

Communication, cooperation, competences and values of actors are vital components in helping to achieve integration and synergy. To do this effectively all actors must engage in dialogue to explore and then confirm a set of values that form the basis of the project, and the most effective way of doing this is through face-to-face meetings that recognise the value of group process (Luft, 1984). The value-based model described in this paper relies on the ability of project stakeholders to reach consensus. Value is seen as ‘the’ end-goal of all construction projects and therefore the discussion and agreement of value parameters is fundamental to the achievement of improved productivity and client/user satisfaction. In this model the role of the process facilitator is key to project success. He or she has no contractual responsibility for the content of the project, but has a significant role to play as an informal leader. The work is based on a longitudinal case study (started in March 2003) that has followed the development of a ‘new’ way of working by a large contractor working closely with a large firm of consulting engineers in Denmark. Data collection has mainly been via non-participant observation of meetings and interviews with project participants. This has been supplemented with written documentation and analysis of a small number of independent research reports on the method.

CASE-STUDY - A VALUE-BASED APPROACH

The value-based building process model has developed through a series of trials, starting in the early 1990s. The aim was, according to the actors interviewed, to develop a better approach to the design and construction of buildings through attention to the process. This has been done through small pilot projects, interaction with the academic community in Denmark and advice from consultants from within Denmark and abroad, notably from the UK and the USA. Early models were based on logistics and lean production thinking, which has been further evolved through a focus on value, partnering, integrated teamworking and greater attention to interpersonal communication. Influential literature is cited as Miles (1972), Porter (1985), Womack *et* al (1991), Kelly & Male (1993), Koskela (2000) and Ballard (2000). From a Danish perspective value-based management attempts to control values; primarily through value management to ‘create’ value in the early stages of the project and via value engineering to ‘deliver’ value in production (Christoffersen 2003).

Getting to know each other and thus establishing common values and/or knowing why values differ between the stakeholders is crucial to the value-based method and gives some sense to the partnering philosophy. It is about how to work together and how to keep agreements between the client and the delivery team. Establishment of common objectives and common values are important objectives in the drive for greater cooperation and reduced conflict in construction projects (e.g. Kelly & Male 1993). Often the result of the value work will be the best compromise between stakeholders.

CREATIVE WORKSHOPS

All actors are influenced and equally interdependent on others for the realisation of tasks and projects. Interconnectivity places pressure on the ability to communicate and share information and knowledge. Interpersonal communication, intra-organisational and inter-organisational communication is particularly pertinent to the establishment of an effective project communication network (Emmitt & Gorse 2003) and also for enabling learning to take place within the project, helping to improve end value. Architects Konrad Wachsmann and Walter Gropius introduced a teamwork method for the development of complex building concepts in the 1940s; with the teamwork approach once again fashionable (see Emmitt *et al*, 2004). Interactions within groups, power relationships, leadership and decision-making are extremely complex matters and contradictory views exist as to the ability of a group to reach its defined goals (e.g. Stroop 1932, Yoshida *et al* 1978, Emmitt & Gorse 2003). In the case study model workshops are used to encourage face-to-face interaction, with the aim of helping actors to understand the cultural values of others. The goal is better integration and realisation of project values. This places considerable pressure on the process facilitator to manage the workshops effectively and tease out the different value sets.

The workshop sequence

Workshop 0: (Partnering) Building effective relationships

The function of the preliminary workshop is to bring various actors together to engage in socialising and teambuilding activities. The intention is to build the communication structures, the system architecture for the project, thus allowing actors to engage in open and effective communication during the life of the project, the architectural dialogue. In addition to setting the stage for the events that follow the ‘outcome’ of the first workshop is the signing of a partnering agreement, which confirms the process values for cooperation. Early workshops are also concerned with the selection of the most appropriate consultants; evaluated on their ability to contribute to the project (their ‘fit’) rather than the lowest fee bid. Collective dialogue helps to explore and develop relationships that can (or conversely cannot) develop into effective and efficient working alliances.

Workshop 1: Vision

It is not possible to know values in depth at the start of a project, so workshops are primarily concerned with exploring values and establishing a common vision. Knowledge and experience from other projects is brought into the workshop, for example from facilities management. The main focus of the effort is the establishment of client values (value-based parameters); on the basis that the better these are known the better the team can deliver. Collective dialogue helps to explore and develop interpersonal relationships that can (or conversely cannot) develop into effective and efficient working alliances. Critical connections between decision-making are explored so that everyone is certain of roles and responsibilities. The result of Workshop 1 is the establishment of basic values for the project; a very pragmatic document of prioritised values, which does not contain any drawings.

Workshop 2: Realism

Workshop 2 addresses how the basic project values may be fulfilled by presenting various design alternatives that reflect how they meet the basic value parameters, while at the same time addressing the contractual framework of the project. Project economy is introduced here along with restraints imposed by, for example, authorities and relevant codes. Design proposals are worked through and ranked according to value. Architects are encouraged to produce at least three schemes that can be presented and discussed. Two to three workshops are required because there is a lot of material to discuss. Basic project values and project economy are respected in this process and any changes justified within the value parameters. The outcome of the realism phase is the selection of the 'best suited' proposal.

Workshop 3: Criticism
The proposed design solution is criticised; is it really the 'best' solution? Could it be 'better'? Discussion is centred on the chosen solution and its improvement within the value parameters. Uncertainty and urgency is high on the agenda prior to the scheme entering the production phases. Client (stakeholder) satisfaction with the process value and the product value is measured on the base of the partnering agreement and the basic product value parameters. Then the project is approved for production and the contractual delivery specifications fixed.

Workshop 4: Design planning
It is here that there is a shift in thinking, as the more abstract work turns into production information. Values are concerned with delivery. The designers, contractor and sub-contractors interface most here as value management techniques turn more toward value engineering and a process management tool is introduced to help guide the planning of the process and results in a process layout of the design process similar to the process plan in construction. A lot of decision-making still remains related to production activities, which are dealt with by the main contractor, working closely with the sub-contractors.

Workshop 5: Buildability
Here the focus is on improving the constructability of the project, while trying to reduce waste in the detailed design and construction phases by having the designers and the foremen/craftsmen meeting with this specific value in mind giving their input to improving the design or focus it on the competences of the actual production capability and capacity.

Workshop 6: Planning for execution
Workshops involve interaction between the main contractor and the sub-contractors. A process plan is produced that helps to map the various production activities and help identify missing information. Information flow is an important consideration at this stage. On completion of the construction schedule, in an ideal world, the information should be complete and there should be 'no scope' for uncertainty of the delivered value at the production phases.

Practical issues

The term workshop is used, although in practice this will comprise a series of facilitated workshops that deal with a particular issue, or value stage, which continue until agreement has been reached. In extreme cases, if participants are unwilling to discuss and hence share values they are asked to leave the process and are replaced by new consultants (incompatibility usually manifests in the first couple of meetings). Flexibility in programming is required to accommodate the inherent uncertainty in knowing exactly how many workshops will be required to reach agreement and hence move forward. When problems with understanding and attitudes exist, additional workshops are convened to help explore the underlying values and tease out creative input. The whole process is consensus based. Bringing people together and facilitating workshops is time consuming and expensive, but proven to be cost effective over the project life cycle.

Workshops are ‘value generators’ or ‘value drivers’ and are concerned with problem framing. Delivery of client value is achieved between the main workshops, where the problem solving takes place. Project team meetings are held between the formal workshops to discuss and agree progress. The number of participants present in the meetings varies between projects and stages, however numbers typically range from between 15 and 30 people. Workshops never last longer than one working day. The schedule of meetings may be extensive on a large project and there is a concern that the cost of the meetings may outweigh the value realised through them. All parties to the project need to constantly monitor the effectiveness of the meetings and critically assess their added value through the use of various benchmarking tools. There is the constant danger of holding too many workshops and the participants becoming jaded though over-familiarisation. There is considerable pressure on the process facilitator to keep the actors together and thus prevent entropy. It is also critical that the process manager and design manager are able to communicate effectively on an inter-personal level. There are two types of communication in the workshop model; namely, workshop communication (to establish values) and process communication (to implement values). It is critical that the actors are aware of these communication levels.

A ‘demand’ of the project philosophy is that all key stakeholders are represented from the start to the finish. A standard value agenda is used as a framework for decision-making in the workshops, based on six key areas of value; Beauty; Functionality; Durability; Suitability (for the site and the community); Sustainability (respect for the environment); and Buildability. This value hierarchy addresses the primary project objectives and breaks them down into further sub-objectives as part of an iterative process carried out within the workshops. Each area is explored until the value parameters have been mutually agreed through the use of the Value Tree. Tools like quality function deployment (QFD) can also be used to weight options (values) in a decision matrix to help find the solution that provides the best value. A process facilitator guides participants through the discussion of values in a systematic and objective way.

THE FACILITATOR’S ROLE

A characteristic of the model is the role and contractual responsibility of the process facilitator. The process facilitator plays a key role in scheduling and facilitating the meetings. He or she has no contractual responsibilities and is not at liberty to contribute to the discussions, merely to try and ensure that all participants have equal participation rights. Thus the facilitator acts as an informal leader, charged with creating an effective social system that can drive the project forward based on consensus. The responsibility of the facilitator extends only to the process, not the output of the process, which remains the responsibility of the team. The facilitator has no influence on the programme running alongside the workshops, other than to discuss and coordinate workshops with the project manager and the master project programme.

Non-participant observation of meetings has helped to illustrate the way in which the process facilitator encourages participants to work together. During the early meetings the facilitator is primarily concerned with creating a harmonious atmosphere within the workshops so that actors are able to communicate and share their values, with the hope of reaching agreement. Conflict is managed to ensure that any disagreements are dealt with in a positive manner. Indeed, criticism is encouraged. The facilitator's role changes as the workshops proceed, with priority given to keeping the team together during difficult discussions in the later stages when cost and time become the focus of the discussions. With no formal 'power' the facilitator has to build trust and respect within the project team to enable the workshops to function effectively. Moral support from formal managers, e.g. the project manager and the design manager, as well as the client is essential in this regard, helping the process facilitator to function as an effective informal leader. The process facilitator must possess excellent interpersonal skills and have sufficient knowledge of construction to be able to guide the process, allowing sufficient time for discussion, but by the same token knowing when to prevent unnecessary talk around the subject.

Success of the process-facilitated workshops will be coloured by to a large extent by the experience and skill of the facilitator. However, the actions of the participants are also a determining factor. Observations have revealed instances when participants have come to the meeting unprepared (for example cost information was not circulated before the meeting). This has the effect of causing a certain amount of turbulence within the team and in the meetings observed resulted in the need for another workshop to be scheduled. In such situations the facilitator speaks to the 'problem' participant(s) outside of the workshop environment to try and encourage better performance in future meetings. Observation has also revealed that a great deal of informal communication takes place before and after the formal workshop sessions. Driven by the process facilitator, the aim is to encourage the formation and retention of interpersonal relationships.

It is common for the client to employ the process facilitator directly to represent their interests, although in the examples observed by the author the contractor has paid for the facilitation role because it is seen as a more cost effective approach in terms of the complete life cycle of the project. The perception of the project participants is that the facilitated process saves them time and money in the longer perspective, although it has not been possible to separate this out from other project factors and hence quantify it in financial terms. There is a widely held view in the Danish construction sector that females make better facilitators than their male counterparts. This perception appears to come from strongly held stereotypes about specific roles in a very conservative construction sector. There has not been any research undertaken that may help to confirm or dispel such views. Women are perceived to be better at communicating and to have better social skills then males. Scientific research, based on some form of comparison between male and female facilitators would be helpful to see if differences between facilitators are related to gender and/or other factors.

CONCLUDING OBSERVATIONS

There are some obvious challenges associated with this model. First, it has to be implemented very early in the project and all key actors must sign up to the approach. There have been some examples where the facilitated workshop method has been applied later in the process, and these 'insertions' have proven to be ineffective despite the efforts of the facilitators. Second, is the problem of scheduling the process accurately to coincide with project management programmes and specific milestones. The number of workshops required to ensure all participants reach agreement on the project value parameters can easily exceed that planned since the method is driven by consensus. For projects with very tight frameworks such uncertainty can present problems for the project management team. Third, the model is very sensitive to the social skills of the process facilitator and also to all participants signing up to such an approach. This must be agreed and to a certain extent driven by the client for the approach to work effectively. Fourth, the model only works when all participants engage in open communication, and his takes a shift in thinking for many of the participants who are more familiar with adversarial practices and closed (defensive) communication practices.

The creative workshops appear to encourage open communication and knowledge sharing, with learning as a group contributing to the clarification and confirmation of project values. According to the participants the clear perception is that the workshops encourage integration and teamwork. Although the workshops act an informal control gate, there is no formal set of control gates (unlike other process models) and the participants do not use a quality management system. Some consideration of more formal procedures in line with total quality management may be a useful tool for future implementation of the model. This may help the process facilitator and project managers to coordinate programmes a little better.

Improvements brought about by the model have been confirmed in a small independent study carried out by the Danish Building Research Institute, which found improved performance across a whole range of performance parameters (By og Byg, 2004; SBi, 2005). In addition to this the members of the project have consistently evaluated the process highly, finding it an enjoyable and productive way of working (although as stakeholders in the project one would expect this sort of response because it is difficult to criticise one's own contribution). Further work is required to investigate the effectiveness of, for example, the workshop method in terms of the realisation of group goals. In particular, the role of the workshop method in promoting and delivering creative solutions would be a logical extension of this case study. A related area of research relates to the skills and competences of the process facilitator, not just in facilitating the meetings but also as a socialising function of project management. Some investigation of interpersonal communication skills (task-based and social-emotional) may also be useful avenues to explore in terms of educating/training process facilitators.

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Engineering Leadership for High Performance Green Buildings

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Abstract

The demand for high performance "green" or "sustainable" buildings is rapidly becoming the most significant trend in the building industry. As the architecture, engineering, and construction (AEC) industry develops the strategies and technologies for these projects, an increased emphasis must be placed on the engineering competencies required to deliver high performance buildings. This places a challenge squarely at the feet of the engineering community to adopt a more prominent leadership position in high performance projects. Presently, engineers are not the drivers of high performance buildings, despite the technical content in these buildings. The consequence is sometimes substandard or high-cost solutions to green challenges. This paper starts to provide a systematic analysis of the challenges to and opportunities for engineering leadership on high performance building projects. Through a number of high profile high performance building projects, these challenges and opportunities are explored, and solutions explained. The results point to the vital role of engineering ingenuity and leadership to the success of high performance projects.

Introduction

Environmentally sustainable building is a vital emerging market in the architecture, engineering and construction (AEC) industry. High performance "green" buildings are reducing the environmental and economic footprint of buildings by minimizing energy use, reducing resource consumption and waste, and providing healthy and productive environments for occupants (US DOE 2003, Smith 2003). This is vital given that buildings consume 36% of total energy use, 30% raw material use, and 12% of potable water in the U.S. (Roodman and Lensen 1995). Public and private owners alike see these buildings as solutions to their facility and infrastructure needs. By giving tangible and measurable recognition to environmental building features, the Leadership in Energy and Environmental Design (LEED) system has been critical to the growth of the green building market.

High performance buildings often adopt an integrated design process to meet the design requirements of these buildings (Horman et al. 2006). The integrated design process places great demand on the design team because intense interdisciplinary collaboration is needed to ensure that building systems are synergistic and “right sized.” The analysis of envelope, lighting, and mechanical systems for example, can no longer take place in a sequential manner, but must be completed in an integrated fashion using advanced analysis and simulation tools that permit the interplay between these systems to be understood and optimized.

The types of collaboration required in integrated design environments necessarily involve the engineering and construction community. Spearheaded largely by the architectural design community, integrated design practices have not always taken optimum advantage of engineering and construction expertise. For example, mechanical contractors can help to specify equipment that is best suited to a given sized facility and often provide independent advice on which equipment is superior to operate and maintain. Yet, early models of integrated design do not even involve contractors in the process. Consequently, substandard or high-cost solutions to green buildings have occasionally occurred.

The prevailing strategies for high performance building projects present an opportunity for the engineering community to enhance their leadership in the design and construction of these projects. Strong engineering leadership on these projects often brings rigorous and well thought through solutions that ultimately lead to a superior facility for the owner.

This paper begins to identify opportunities for engineering leadership in high performance building projects based on our research experiences in sustainable project delivery. The paper is a synthesis of some of the results garnered from our research conducted through the Lean and Green Research Initiative at Penn State.

Role of Engineering

Engineers play a vital role in the potential success of high performance green buildings, especially those where energy efficiency and indoor air quality are priorities. Apart from advising on building layouts that maximize energy efficiency, engineers advise on systems availability and optimum configurations, complete energy and lighting analyses, and conduct detailed analyses to ensure that building systems are synergistic and “right sized.” Engineers develop building façade details and specify sustainable building materials, both critical dimensions of high performance buildings. Engineers are often the source of innovative solutions to complex challenges. For example, an induction AC system designed by the design-build mechanical contractor was used in renovating the Pentagon in order to resolve space congestion problems competing with daylight penetration requirements, and first cost and life cycle cost needs. Engineers provide important cost and estimating services during design, and technical details needed to make sound design decisions. Engineering provides verification and commissioning capabilities critical for building sustainability needs.

Leadership in Energy and Environmental Design (LEED)

The Leadership in Energy and Environmental Design (LEED) rating system was developed by the United States Green Building Council (USGBC) and is currently the most widely used method for quantifying how well a building achieves green building guidelines. The LEED system offers a total of 69 points available in the 6 categories of:

- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere (EA)
- Materials and Resources (MR)
- Indoor Environmental Quality (IEQ)
- Innovation and Design Process (ID) activities

Table 1 shows the point distribution in these areas for different LEED programs (excluding the pilot programs). To be considered LEED certified, a building must achieve a minimum of 26 points and satisfy prerequisites in each of the 6 categories. Buildings may also achieve Silver (33 points), Gold (39 points) and Platinum (52 points) LEED certifications for earning additional points. LEED's development in 1998 is recognized as a primary reason for the growth of green building in the U.S., and has become the (defacto) national standard of what constitutes a green building. To date, more than 300 projects have been certified.

Table 1. Point Distribution Under Various LEED Programs

Checklist	Possible Points		
	LEED-NC (New Constn)	**LEED-EB (Exist. Bldg)**	**LEED-CI (Commercial Interiors)**
Sustainable Sites	14	14	7
Water Efficiency	5	5	2
Energy & Atmosphere	17	23	12
Materials & Resources	13	16	14
Indoor Environmental Quality	15	22	17
Innovation & Design Process	5	5	5
Project Totals	**69**	**85**	**57**
Certified	26-32	32-39	21-26
Silver	33-38	40-47	27-31
Gold	39-51	48-63	32-41
Platinum	52-69	64-85	42-57

Weaknesses of Current Metrics

LEED has brought public awareness of sustainable construction to new levels. However, there are weaknesses to the system that must be considered when it is used on a project. The LEED rating system makes many inherent assumptions about the needs of the project, including the use of alternative fuel vehicles, additional commissioning requirements, and life cycle costing in material comparison. Adhering to these strategies might assist the project in achieving LEED certification, but the long-term sustainability benefits remain in question.

The additional commissioning credit (EA Credit 3) introduces the independent commissioning agent to the project team. An independent commissioning agent can add value by ensuring the building systems are meeting the owner's needs, however, experience shows this level of commissioning rarely occurs. In satisfying the LEED requirements for this credit, the agent must review the submittals to ensure the design requirements are met, not the owner's requirements. In other words, the added level of commissioning makes an implicit assumption that whatever has been designed is what the owner needs. This is not always the case, and so this added commissioning does not add value to the project, and seems to do little to enhance the system's ability to provide the occupants with a healthy indoor environment.

Current techniques for life cycle analysis of green materials are not sufficiently rigorous when they assess building system function. While a green material may compare to conventional materials under design conditions, their capabilities outside design conditions are often unknown. These conditions often pose a threat to green materials, i.e., water on bamboo flooring, whereas a ceramic or vinyl tile can overcome such conditions.

Questions are also present about the true sustainable impact of a LEED certified facility. Simply, this has not been studied and consequently is not really known. Furthermore, questions are also being posed about the merits of a system that allows a building to be certified as sustainable without seriously addressing any energy efficiency or indoor air quality credits in the design or construction.

Opportunities for Leadership

LEED has been a catalyst for raising the awareness of environmentally sustainable building. It has been a ready system for building owners and users suddenly aware of consumption with sharply rising energy prices. The weaknesses present are not fatal, but in fact highlight the opportunities for leadership by engineers on high performance projects. Engineers are able to address many important technical issues and help owners weigh benefits and costs in their decision-making. Engineers are strong systems thinkers, who understand that a decision on one issue has repercussions on others. This section outlines the opportunities for employing engineering competencies to help steer a project to superior sustainable outcomes.

Delivery Selection and Strategies. The ways project teams are procured, contractual arrangements are enacted, and team members incentivized to work collaboratively in an integrated fashion are known to impact project cost, schedule and quality outcomes. However, there is growing evidence that these issues also affect levels of building sustainability. For instance, project teams experienced in delivering sustainable projects are able to deliver green buildings at costs approaching conventional buildings (GSA 2004). More specifically, the use of a LEED consultant over a project team experienced in LEED projects will cost the owner more

(GSA 2004). In the current environment, engineers and contractors are being involved increasingly early in projects, and can advise owners about alternative project delivery methods and innovative teaming strategies to maximize opportunities for green project success.

Integrated Design. Projects where engineers either partner with the architect or drive the integrated design process themselves, seem to demonstrate better design success through fewer design flaws and more timely design progress. This seems to be because the engineering community has a better handle on the challenges and processes of integrated design than the architecture community. This may well be the result of the differences in training and education received. In particular, engineers often recognize the need for key competencies at key points in the design process, e.g., energy and lighting analyses, which is vital to a successful integrated design experience (Riley et al. 2004).

Process Management. Levels of delivery process waste affect project costs and levels of sustainability achieved (Horman et al. 2006). Consequently, there is a need to have a competent champion of the process, and for that champion to be dedicated to delivery process innovations (Lapinski et al. 2006).

Case study projects in which design-build mechanical services were acquired to address unique and challenging project conditions provide examples of how the combination of design and construction competencies enabled cost savings and energy efficient mechanical systems design solutions. Examples of up to 20% initial costs savings combined with improved overall energy efficiency in design were found on several case study projects (Riley et al. 2005).

In an integrated delivery process, engineers can apply lean principles to identify waste reducing and value-added activities in the conception, design, fabrication, and construction of projects. In the case of progressive design-build mechanical contractors (DBMC) three trends are beginning to emerge:

1. DBMC are often willing to adopt technologies and innovative solutions,
2. Integrated design and detailing expertise possessed by DBMC leads to both first cost and long term energy cost savings, and
3. Early involvement of DBMC in the design process to address challenging project conditions adds significant value to the project.

In the domain of project delivery processes, the weaving of lean principles and green design solutions is revealing a strong case for the closer management of the delivery process on green building projects (Huovila and Koskela 1998, Lapinski et al. 2006). Timely integration of engineering competencies with fabrication and constructability knowledge creates a tremendous opportunity for unique and innovative solutions that are able to reduce schedule, initial cost, and life-cycle cost while providing higher quality sustainable buildings.

Prefabrication. With growing interest in sustainable construction, practical solutions are being sought to enhance the performance of green buildings while lowering first costs. Prefabrication has been widely used in building construction and is often viewed as an approach to reduce labor costs. However, if employed properly, many green benefits can also be achieved through prefabrication, such as safer working conditions, reduced environmental impact, more efficient use of labor and materials, and better quality control. Furthermore, the rapid technological improvements in the manufacturing industry and the increasing supply chain integration in the construction market make it possible and easier to extract these potential values.

A need exists for project teams to fully understand the synergies and tensions between prefabrication, building processes, and building performance at an early design phase. If this is to mature, engineering needs to continue to innovate the use of prefabrication and to adopt decision-making models early in design to evaluate the potential for prefabrication when flexibility remains open for decision-makers. Complete designs leave very little flexibility for contractors to wisely employ prefabrication due to the difficulty in influencing methods that are embodied by early design decisions, and as a result, the value of prefabrication is often limited.

Continuous Value Enhancement Process (CVEP). The task of delivering high performance green facilities is more difficult than for traditional projects and existing project management techniques struggle to handle the high levels of complexity present. In particular, current engineering and project management strategies fail to provide an opportunity to discover and test potential solutions in a systematic way. Tools like CVEP have been developed to enable project teams to systematically discover new and innovative solutions on sustainable projects (Pulaski and Horman 2005). When engineers and project managers use tools like CVEP, numerous opportunities are identified to simultaneously improve both project performance (i.e., constructability) and increase sustainability (Pulaski and Horman 2005).

Operations and Maintenance Input. While increased attention is now placed on the operation and maintenance (O&M) of a facility in sustainably designed buildings, we are far from being able to optimally inject O&M information in project design. “Operating expenses represent over 95 percent of building life cycle costs, yet operations and maintenance personnel are usually the last to be consulted during programming and design” (NIBS 2003). Facilities engineers, with their wealth of knowledge in the operation and maintenance of building systems, are at the forefront of being able to provide independent advice on the life-cycle performance of equipment. Working closely with engineers of project delivery processes (e.g., project managers) as well as architects and design engineers, the engineering community can add significant value to the life-cycle. Critical to ongoing success here is to learn when the right O&M information is needed in the design and construction processes.

Further Research and Conclusions

In many high performance green building projects, engineers hold the keys to economically delivering high-value sustainable buildings. However to do this consistently, engineering needs to take an increasing leadership role in the design and construction of these buildings. This paper articulated six areas where engineering can adopt a greater leadership role to advance the high performance nature of the facility. These included: Delivery selection and strategies; integrated design; process management; prefabrication, CVEP, and O&M input. Garnered from ongoing research by the Lean and Green Research Initiative at Penn State, the areas identified are the start of a systematic assessment of the leadership opportunities for engineers in sustainable buildings.

In addition to continuing research to identify and assess further areas for engineering leadership opportunity, these results also present a challenge to engineering education. Engineers produced by the current education system are qualified for leading sustainable building projects. However, continuing with the traditional approach to engineering, where givens are accepted and standards are designed to, is not optimal for sustainable building performance. Engineers, similar to architects, should be encouraged during their education to be innovators, or building performance will continue to meet standards and never achieve the advances that are possible. Innovative engineers will provide more proficient leadership on sustainable projects, becoming the linchpin of building design, rather than being a group that helps the architect's design to function. It is important to learn about how to encourage this innovation in the education of engineers.

Also critical is the development of an understanding of how to educate engineers to be contributors and leaders in integrated design environments. The traditional paradigm for engineering education divides students into specialties (electrical, mechanical, structural, etc.) where they are isolated and focused beginning at an early stage in their academic careers. Clearly, the in-depth technical knowledge of a specific engineering discipline is essential to developing quality engineers. Still, it is becoming apparent that the future model for engineering education should include more interdisciplinary design integration to best develop engineers that can contribute to and lead sustainable design projects. Progressive engineering programs are already attempting strategies to encourage this interdisciplinary design integration, so it logical to examine which are most effective in preparing engineers to be capable leaders of the integrated design process.

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PREPARING CONTRACTOR ORGANIZATIONS FOR IMPLEMENTING LEAN CONSTRUCTION

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Abstract

Chilean construction companies are currently developing several initiatives to improve their competitiveness in the local an international market. More than twelve construction companies, under the guidance of a research team of the Universidad Católica de Chile, have carried out collaborative research to implement Lean Construction practices. The approach followed for implementation include some key elements such as: training for action, collaborative sharing among companies, coaching and action research. All these aspects are part of an overall strategy to introduce principles of lean construction and better practices in the organizations. More recently, companies have focused on redesigning their organizations, the role of project managers and reviewing their performance evaluation systems to align all the aspects of their organization with the requirements of Lean Construction implementation. The incremental nature of the implementation, has made possible to observe, analyze and identify the impacts of individual changes in the project/production management practice of the companies and their organizations. The paper reports the results obtained, analyzes critical factors, barriers found in the organization, and approaches adopted to manage them in order to get from them opportunities to strengthen the implementation process. The paper focuses mainly on human and organizational aspects that seem to be key for a successful implementation.

Introduction

Researchers from Production Management Center (GEPUC) at the Universidad Católica de Chile are leading a collaborative research project that included participation of twelve construction companies and the Chilean Chamber of Construction. The general objective of the project is to allow companies to reach higher levels of efficiency in the competitive Chilean construction market through systematic actions of research and implementation of changes in management practices based on the Lean Construction Philosophy.

These companies have committed to work together on several activities like the implementation of methods to identify and reduce waste in construction projects (Alarcon, 1997), the development and implementation of a performance measuring system for internal and external benchmarking (KPI, 2000) (Alarcón, et al. 2001), the implementation of production management concepts in their project planning systems (Ballard and Howell, 1998), applications of 4D modeling (Rischmoller et al, 2006) and subcontractors evaluation methods (Vrsalovic et al, 2004), among others .

This paper describes the strategies applied by the research team to introduce principles of lean construction and better practices in the organizations, discussing the critical factors and barriers founded to achieve it, and the approaches that companies has adopted to manage them to get opportunities to strengthen the implementation process. The focus is on human and organizational aspects of implementation, because they appear as key aspects for successful implementation.

A strategy that promotes collaboration among companies was selected to reduce implementation barriers and to facilitate action research. To introduce permanent changes in management practice, training was one of the main aspects of the strategy. Training was mainly developed in field, where practical materialization is essential. Also, current efforts to develop organizations that are appropriate for successful long term implementation are described.

Interaction between GEPUC and companies

GEPUC promotes long term research and implementation alliances among companies to pursue common goals. The Chilean Chamber of Construction is a Contractors, Designers and Suppliers organization that represents the interests of these actors within the industry and it has been a key facilitator of these alliances. The companies undertake their improvement programs working as a group, around common topics and with a common work agenda, in this way problems and solutions to the individual processes of improvement is shared.

The collaborative work scheme includes different forms of interaction among the representatives of the companies and GEPUC, all of them seek to achieve competence in the participants for the autonomous development of the implementation under way, once the specific research and implementation goals have been achieved.

Description of the Implementation Strategy

The implementation strategy is based on a *change process* to make easier the incorporation of innovative improvement process – into the companies – like “Lean construction practices” (LCP). This process of change has four main elements that are key for the dynamic of change:

1. Alliances among companies to improve the efficiency as a group working together.
2. Collaborative research (it has proven its effectiveness to companies).
3. Pilot projects within individual companies (with training included).
4. Long term research and implementation projects to promote strategic thinking.

The general strategy described above is supported by a series of activities that enable the *change process* in the field. These activities promote what is called “training for action”, because one of the major requirements of the companies’ upper management was the ability to obtain good results quickly and with the effective involvement of employees. These activities are showed in Table 1 with a brief description of each of them.

Table 1. Activities carried out in the Implementation Strategy

Name	Description
Periodic Meetings	These meeting allows for coordination among companies, training of internal leaders and development of a collaborative spirit for the research.
Workshops	Training sessions that use a methodology based on “training for action” that enables step by step implementation of the concepts and tools.
Plenary Sessions	In this activity each one of the participating companies shares with the group its experience of implementation, including successes and failures and the results reached. This is another way to formalize the exchange of experiences among the participating companies and to develop the collaborative work spirit
Site Visits by the researchers	These visits enable the researchers to monitor implementations and assure the correct direction of the improvement process

As mentioned above the activities are designed to “learn by doing” where practical materialization of all the concepts and tools learned is essential, along with monitoring and feedback obtained from the individuals and their processes. The GEPUC researchers only play a coaching role for the companies, without a direct intervention in their developments and decisions involved with the improvement process.

Identification and Analysis of the Critical Factors of the Implementation

Diverse factors influenced the implementation of the “Lean Construction Practices” (LCP). These factors did not depend exclusively on the field conditions. Factors coming from the upper administration and external agents to the project also influenced the effectiveness of the implementation. The factors were identified through direct observation and with the aid of two surveys applied to all the participants at different stages of the implementation. The factors identified are discussed in the following paragraphs.

Time

The main difficulty in the implementation according to the participants was the lack of time for implementing new practices in the projects that were already under way. Meetings, training activities, preparation of forms, etc., were not usual activities and surpassed the capacity of the project personnel. This condition became more critical when these activities were relayed exclusively upon the field administrator. These professionals usually assumed administrative tasks, such as quotation of materials, personnel problems, etc., tasks that distract them from managing production. The lack of time for implementation affected the rigorousness and extend of implementation. As a result, partial implementation, intermittent implementation and insufficient preparation of the planning meetings was often a problem. This situation had an impact on the effectiveness of the system and increased the need for more time for implementation. More recently, the use of time by project manager has been studied more thoroughly in order to deal with this issue (Alarcón and Pavez, 2006)

Training

According to the studies carried out, the second difficulty, in order of importance in the implementation, was the lack of training. The training activities seek to deliver the necessary knowledge to allow project personnel to carry out implementation. These activities had an additional importance, because according to the persons involved (Alarcón and Seguel, 2002), they were key to convey motivation and commitment to the process. In order to respond to the individual needs of each sector of the organization, distinct training activities were carried out, directed to different actors, and with different modalities and objectives. One key activity was the training of "coaches" to prepare people within the companies to support the implementation in order to achieve some autonomy and to diminish the need of external aid. The role of this people has reinforced the implementation and consolidation of the Lean planning tools in the companies.

Organization

To respond adequately to the challenge of implementing the LCP, it was necessary to create or strengthen some organizational elements. The internal organization for a company implementation requires the active presence and involvement of upper management in some of the key activities. The implementation of an internal committee, including some top executives and people with leadership skills, became a requirement. This committee responds to the need of developing an implementation strategy at the company level with monitoring and control mechanisms to introduce and consolidate the new practices. At the project level, the total support and leadership of the project managers turned out to be a fundamental aspect that made the difference between success and failure in the efforts of implementation. The main organizational aspects related with the effectiveness of the implementation were (Alarcón and Diethelm, 2001): (1) discipline of the implementation (with an orderly methodology), (2) early implementation of the internal committee, (3) quality of the communications present in the implementation site and (4) commitment from upper management clearly visible to all the employees.

Parallel Implementation With Other Improvement Programs

Parallel improvement efforts in lean planning and other improvement programs such as quality management, risk prevention and reduction of environmental impact usually run in competing tracks. The LCP implementation was mainly affected in companies that were doing parallel efforts of implementing LCP and quality, getting to the point to oblige one of the companies to abandon the LCP program. However, companies where other improvement systems functioned, or those that had participated in similar programs before, were better able to deal with the implementation by doing an integration effort of both programs.

Problematic Projects

In some specific fast track projects, the last moment changes in the specifications, during the execution of the work, complicated the implementation. The constant changes introduced a great deal of variability and uncertainty to almost all the planned activities.

Human Elements have a Great Impact

During the application of LCP, diverse human factors became important barriers that obstructed the efforts of implementation and affected the team synergy. However, some of these weaknesses were used to strengthen the implementation in early phases. The barriers identified in this environment are discussed in the following paragraphs

The role of site/office manager

Due to the hierarchical organization that characterizes the Chilean construction companies, the project/site managers and/or department managers, in case of central offices, were very important in the implementation process. They exercise leadership, they are important in the establishment and removal of barriers and they are the link with middle management. In most cases when the commitment of the manager was obtained, a successful implementation was achieved. A central issue in the role of the site/officer manager was their leadership and the way followed to incorporate the different hierarchical levels existing into the company in the implementation effort (Alarcón and Diethelm, 2001).

The importance of commitment

One of the major aspects that trigger all LCP implementation process was commitment, first from upper management then from site/officer manager and then from all the employees that had a relation with the program. It worked like a waterfall where decisions, motivations and commitment were flowing down from the higher hierarchical positions to the rest of the organization including in most cases site operative workers that had to carried out implementation tasks.

Resistance to Change

One of the main obstacles to defeat in order to achieve a successful implementation, is the fear of change. This problem was made evident by symptoms such as the early refusal to assuming commitments, or refusal to include subcontractors in planning meetings or negative reactions to the theoretical concepts of LCP and to its application in the project. A research to identify the elements that motivate change was carried out, in order to facilitate the implementation of lean techniques (Alarcón and Seguel, 2002).

Self-Criticism

The lack of self criticism prevented a clear view of project problems and limited the capacity of learning from errors since only part of the problems were perceived. For example in the implementation of Last Planner System (Ballard and Howell, 1998), initially the problems of non completion were associated exclusively with subcontractors and owners or designers. This situation did not allow the companies to take advantage of the opportunities to take improvement actions within the own contractor organization. In this case, self questioning can be transformed into the first occasion of improvement.

Short Term Vision

Short term vision does not allow people to visualize problems with enough time to make the right decisions. This was an obstacle, for example, to implement the look-ahead plans in several projects. However, in projects located at a long distance of the provision centers, the real benefit of Look-ahead plans was really appreciated. In projects in these conditions, due to the distance and accessibility of means of transportation, the actions to free restrictions had to be at least with six weeks of anticipation. This experience served like example to the other companies that had been slow in implementing look-ahead planning.

Organization Development Needs

As showed above, there were some factors that hindered the implementation and they were classified as “barriers to the implementation”. Taking into count these barriers, and with the experience acquired in five years of implementation of LCP, companies realized that the major problem in these implementations had been related with cultural and organizational aspects.

After several years of LCP implementation, the mechanic vision of the improvement centered in specific improvement tools has changed towards an organic view of the improvement, where the central elements are the human and organizational issues. This change of view, motivated the companies to guide their collaborative strategic efforts about LCP for the next two years to an *organization development* program (French and Bell, 1996) that included aspects like: review of the role of project managers, review of their performance evaluation systems, redesign of their organization to achieve LCP goals, review or redesign of their incentive programs and the development of a professional training program for all levels, to become a “lean organization”.

The organizational development work began with an organization diagnosis that showed the precarious existing systems to manage the human resources in these companies (Alarcón, Pavez, Bascuñan and Diethelm, 2005). Some results of this diagnosis were: lack of procedures to structure the site-organization, poorly defined functions, poorly defined incentives policies, lack of formal procedures to develop performance evaluation and poor information flow to lower levels of the organization. A better detail of the diagnosis results can be seen in Table 2.

Table 2. Organizational Diagnosis Results

Diagnosis element	Results
Structuring site-organization	– Lack of procedures to structure the site-organization – Difficult to establish stable work teams – Lack of qualified employees to assume the different roles that site-organization requires
Roles and responsibilities	– Lack of definition of roles and responsibilities – Lack of skills and competencies – High rate of professional's rotations
Performance evaluating systems	– Lack of transparency – Did not motivate good performance – Was not bound to the organizational objectives
Communication	– Poor information flow to lower levels of the organization – Lack of formal and effective communication mechanism – Lack of communication's skills to achieve a good communications process
Incentive systems	– Lack of transparency – Centered in economics rewards – Were informal and people did not know how their economic reward were calculated – In most cases it was seen as a payment for overtime
Motivation	– The main motivator for professional staff was related to personal issues, such as: intellectual challenge and sense of achievement – After personal issues, other categories were: professional development and economic retribution
Trust	– Three parameters were the most important to obtain trust: reliable promises, personal knowledge of people and skill and competency level – These parameters were consistent with theory that consider two kinds of trust: *trust based on reason* and *trust based on feelings*

The main reasons that causes these failures seems to be: lack of knowledge about human behavior in productive organizations, lack of application of existent techniques related with the human resource management (HRM), lack of functional areas related with HRM into the companies and lack of qualified personnel to manage human aspects of the organization in the staff of the companies. In the Chilean construction industry most professionals in construction companies have an engineering or building background with very little emphasis people issues, so that there is a need to provide skills and soft competences that allow construction professionals to manage and develop HRM practices in a more effective way.

A study carried out by some of the authors as a more specific part of the organization diagnosis tried to answer the question: How Construction Project Managers use Their Time? (Alarcón and Pavez, 2006). The study showed that one of the main challenges of the Chilean construction project managers consists of realizing the eminently social character of their work, characterized by a great number of human interrelations (approximately a 75% of the work) and intensive communication activities, in which their social skills play a fundamental role and impact their performance in a significant manner.

To overcome the situation exposed above, these companies have focused their collaborative work in four topics of development to adequate their organizations to sustain LCP in the long term. These topics, that are currently carried out by researchers of GEPUC are: (1) design and implementation of incentive systems (considering intrinsic and extrinsic rewards), (2) design and implementation of performance evaluation systems, (3) design and implementation of training programs, and (4) development of a framework and/or methodology to structure site-organizations that make easier the implementation of LCP. The methodology followed to achieve the organization development has three classical stages (Rodriguez, 2004; French and Bell, 1996): diagnosis, intervention (planning the action and implementation) and evaluation. The current state of implementation is showed in Figure 1. Most topics are in the early "intervention" state, only the "performance evaluation system" is in the implementation state.

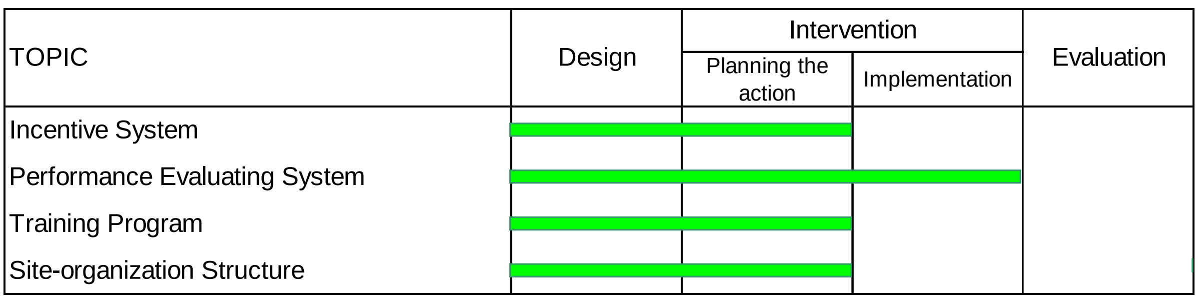

Figure 1. State of Organization Development Implementation

One of the most positives aspects of these work has been the involvement and motivation from companies' employees that participated in the research-action based methodology (French and Bell, 1996; Shepard, 1960). Most employees have involved themselves in a participative process that create a good dynamic to develop results that fit closely with organizational requirements.

Conclusions

The empirical observations of this collaborative implementation effort confirms most recommendations found in the technical literature regarding planning and organization for managing implementation of new practices (Juran, 1990) (Scholtes, 1991). Most of this experience comes from the TQM literature. In fact, in a very early stage of the project, these recommendations were made available to company managers and to the original implementation committees of the firms. However, learning from the actual experience of these firms seems to be a much more powerful message to each of the participants.

The lessons learned so far have been very useful to help some of the companies to improve their implementation approaches, learning from each other. Some of them can be summarized as follows:

- Signals from upper management are very important for motivation and commitment of other levels of the organization.

- Commitment from site/office managers is a must for a successful implementation.
- Early constitution of an improvement committee, in charge of implementation, is very important.
- Leadership is relevant to ensure success of the process.
- Collaboration and sharing among companies are key to support implementation.

A general conclusion is that successful implementation of new practices in construction companies requires the rigor and discipline of a well established organization. To sustain a continuous improvement organization in the long term, it is necessary to align all aspects of the organization with its strategic goals. The culture, the organizational structure, career development, performance evaluation and incentive systems need to be consistent with the company management practices. One of the obstacles seems to be the lack of soft skills and competencies of construction professionals. The personnel of the companies participating in this collaborative research are taking an active role in designing the solution to this need and this seems to be an important part of the solution itself.

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A Primer on Social Science Research Methods in Construction

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Abstract

The fact that people play key roles in nearly all aspects of construction suggests that effective construction research requires proper application of social science research methods. This is particularly true for researchers studying leadership in construction. After reviewing the existing literature on construction research methods, six principles of social science research methods are presented and illustrated using theoretical and actual examples from past research.

1. A mixture of research approaches is appropriate.
2. Terms and concepts must be explicitly defined.
3. Theoretical concepts must be measured carefully.
4. Hypothesized causal relationships must be stated explicitly but are difficult to "prove."
5. Proper statistical analysis is critical;
6. Proper research design must be performed before data are collected.

Key Words: Research methods, leadership, social science, data analysis.

Introduction

Construction can be defined as the application of technology to achieve goals involving the erection or retrofitting of infrastructure and buildings. This definition implies that the focus of construction research should be on technologies and constructed facilities. Yet the actions of people underlie every aspect of construction. A more accurate definition of construction would therefore be "the application *by people* of technology developed *by people* to achieve goals established *by people* involving the erection or retrofitting of infrastructure and buildings." The fact that people play key roles in nearly all aspects of construction suggests that effective construction research requires the proper application of social science research methods.

The number of papers presented at this and the 2004 leadership conference suggest that leadership is an important and growing topic in construction research. Indeed, leadership may represent a strategic area of research for our community because our civil and environmental engineering (CEE) colleagues are increasingly realizing that CEEs need to focus on leadership to restore the stature of our profession in society, and the construction community is in the best position to lead the way. To serve as effective leaders in explicitly incorporating leadership into the CEE profession, we must not only incorporate leadership into our curriculum, we must also perform effective and important research on leadership within the construction industry.

It is the author's opinion that some construction graduate students and faculty pursue research with methodologies that inappropriately ignore the human element implicit in leadership and in many areas of construction practice. Other construction research areas in which the human element plays a particularly critical role and require social science research methods include technological and organizational innovation, strategic management, knowledge management, emotional intelligence, and contract partnering. Even when the research concepts do not ostensibly involve individual human traits or behavior, such as alternative delivery methods, people issues can complicate the research process and jeopardize the results.

The consequences of such improper research methods can be severe. Graduate research projects take longer than expected and produce results that disappoint their faculty advisors. Such research typically adds little to the stream of research because the research concepts remain vague and reported statistical relationships are suspect. Perhaps most importantly, ineffective research methods diminishes the respect that other disciplines and funding agencies hold for the construction research community, resulting in research on leadership and other important topics not being funded.

While the use of inappropriate construction research methods is unacceptable, it is also somewhat understandable. The majority of construction researchers are engineers, not social scientists. Our coursework and work experience has prepared us to be good engineers and perhaps good construction managers, but not to conduct research involving human behavior. When it comes to research methods, many of us do not know what we do not know. That is, we are not aware that we are lacking perspectives and skills necessary for our research goals. On the other hand, some of us have realized what we are missing in our research tool box, yet have clung stubbornly to our normative worldview and failed to invest the time and effort to "fix" ourselves. More damning, we have failed to insist that our graduate students who are performing construction research involving social science adequately prepare themselves to conduct effective research.

The goal of this paper is to serve as a primer on research methods for construction research topics involving social science. It is intended not only for new construction doctoral students but also for construction faculty performing research in social science areas of construction for the first time. This paper represents a contribution to the literature not because it represents cutting edge research, but because it applies principles found in existing literature to the focus of this conference and provides a summary of critical research issues that does not currently exist.

The paper's structure is rather straight forward. The paper first provides a very brief overview of the existing literature on construction research methods then proposes six principles of effective construction research, illustrating them with examples from the author's experiences.

Review of the existing literature on construction research methods

The literature on construction research methods is rather sparse, having appeared mostly in the UK journal *Construction Management and Economics*. Three 1997 papers discuss research methods only at the broadest levels, debating the relative values of theoretical versus empirical papers and qualitative versus statistics-oriented quantitative research (Seymour et al 1997, Raftery et al 1997, and Runeson 1997). Loosemore (1999) identifies cultural differences, especially those involving communication, that make one category of research methods more appropriate than another. Walker (1997) discusses his doctoral research process as a case study of the challenges of obtaining data from thirty-three projects and analyzing them using linear regression. El-Diraby and O'Connor (2004) similarly use collecting and analyzing bridge construction data as a case study to summarize key research methodological issues taken from one of the preeminent manuscripts on social science research methods by Cook and Campbell (1979).

The title of the Cook and Campbell book—*Quasi-experimentation: design and analysis issues for field settings*—points at the insight that true experiments are rarely possible in social science so we must strive to perform quasi-experiments that best achieve the scientific goals of our research. Cook and Campbell suggest there are four type of validity that should be considered during research design to maximize the chances the researchers will be able to draw sound and compelling conclusions from the data. The four types of validity and questions that typify the types of validity are shown in the table below.

Type of Validity	Key Issue
Construct validity	Do the indicators adequately capture the theoretical concepts being researched?
Statistical conclusiveness validity	Are the relationships between hypothesized independent and dependent variables statistically significant?
Internal validity	Has the research truly proven a causal link between the hypothesized variables, or are there plausible alternative explanations for the statistical association between the variables?
External validity	Are the apparent relationships found within the sample able to be generalized to the larger population assumed in the hypothesis?

Six principles of social science methodology

The remainder of this paper discusses six principles of appropriate research methodology for construction research that involves social science. These principles were identified from Cook and Campbell (1979), Judd et al (1991), doctoral seminars on social science research methods taken by the author at the Sloan School of business, and the author's experiences as a researcher, paper reviewer and *JCEM* specialty editor. To illustrate the principles, a hypothetical leadership research question will be used as an example. The specific hypothesis will be that "good" (i.e., successful or high performing) construction leaders ensure their firms are technologically innovative. Stated differently, the example hypothesis is that leaders who direct their firms to be technologically innovative will allow their firms to be more successful than firms that are not technologically innovative.

Principle 1. A mixture of research approaches is appropriate

The debate over the relative values of fundamentally different research approaches has persisted in social science literature for many decades and has generally focused on several sets of related polar opposites: quantitative versus qualitative, nomothetic versus ideographic, positivist versus phenomenological, statistical analysis versus case study or ethnography, etc. If we wish to investigate our hypothesis involving leadership in technological innovation, should we use a survey to obtain a lot of objective data that could be subjected to rigorous statistical analysis, or should we do a 3-6 month ethnographic study involving shadowing top managers in several firms? The survey approach would allow us to report statistical relationships with high degrees of confidence, yet we might not even include the key variables in our survey or be able to explain some of the relationships that appear in the data. The ethnographic approach, on the other hand, would provide us with the rich data that would allow us to describe our observations and posit explanations in tremendous detail, yet would still be subject to criticism that our writing merely reflects our opinions and filtered observations, not actual facts.

Social science research methods books such as Judd et al (1991) suggest that an effective stream of literature on a topic should include all research approaches. It is this author's perception that a typical practice in construction is to distribute surveys to large samples via the postal service, email or a website, perform statistical analysis on the data collected and to supplement the survey with interviews before or after the survey. Another common method is to do a detailed case study of one issue within a firm, or mini-case studies of four to twelve firms. The research methods books suggest our discipline would benefit from more ethnographic studies, especially in research areas still in the exploratory stage. There have been a few "insider's story" books on specific construction trades and major projects but these have not met the standards of true ethnographic research. It is recognized, however, that most construction researchers have neither the time, desire nor capability of doing ethnographic studies.

2. Terms and concepts must be explicitly defined

The meanings of most engineering terms are unambiguous. Stress, flowrate and viscosity, for example, are well understood across the engineering community. Many construction management terms, on the other hand, are somewhat imprecise, with meanings that vary with individuals and with contexts. For example, leadership may be considered to be the ability to articulate an organizational vision, to mobilize resources towards a set of goals, to motivate coworkers to perform at their best, to enact change, or to establish systems that enable operational efficiently. Similarly, technological innovation may be thought of as creating new technologies, adopting new technologies, transforming processes through a new type of system, or establishing a culture of embracing anything based on new technology. Effectively researching many construction management research topics requires the research to explicitly define their theoretical concepts (referred to as "constructs" in social science) as early in the research as possible and to maintain a uniform definition from literature search through reporting the results of the research.

A key aspect of defining a construct is determining whether it is an individual, group or organizational concept. Emotional intelligence, for example, is clearly an individual trait. Effective teamwork is a group construct. Corporate financial performance is an organizational construct. Some constructs, such as leadership, can be associated with more than one level. For example, we say an individual can exhibit good leadership skills over his or her subordinates, a team can exercise leadership by suggesting improved procedures within a firm, a firm can demonstrate leadership by introducing a series of new products in a market. Similarly, the construct of knowledge management involves behaviors at the individual level as well as a set of collective behaviors that represent knowledge management at the group and firm levels.

It should be noted that the two principles discussed thus far apply to both qualitative and quantitative research methods. The remaining principles are applicable mostly to quantitative research involving statistical analysis.

3. Theoretical concepts must be measured carefully

Most engineering terms have a standard method for measuring a value associated with them. Using the examples listed earlier, stress, strain and viscosity all can be measured using specific types of equipment and a range of procedures such that any engineer would agree the resulting values are accurate. Many construction management concepts are neither uniformly defined nor easily measured. Consider our hypothetical hypothesis, that successful leaders ensure their firms are technologically innovative. How do we identify a leader in an organization? Are all individuals holding certain titles (President, Chief Financial Officer, Water Resources Group Manager) leaders? Do all leaders in an organization have one of these titles? If we focus our study on individuals who are Vice Presidents or higher, how should we measure the success of each leader? Should we ask the individuals themselves if they are successful leaders? Should we ask their bosses or subordinates? Should we seek objective archival metrics that demonstrate their organizations were recently successful, such as unit profits, growth in sales, productivity, or reported customer satisfaction?

Identifying appropriate ways to measure constructs, i.e., appropriate indicators, is critical to the success of an empirical social science study because the portion of variance in a dependent variable explained by an independent variable is usually so low. (In other words, correlation is typically low.) Poor indicators in essence contain random noise that may mask a statistically valid relationship. The author is aware of a doctoral student who spent many hundreds of hours collecting data from a large sample of construction firms for the student's dissertation. The hypotheses were important and interesting, pilot interviews seemed to indicate the hypotheses were accurate, and a reasonably large number of firms provided survey data. The research plan seemed sound other than concern voiced by the doctoral committee about the quality of the indicators. Ultimately, the results were statistically inconclusive, apparently because the indicators did indeed not capture well the underlying constructs.

The reliability of many social science indicators is particularly low for indicators that are reported, not archival data. Social scientists generally agree that archival indicators are preferred over reported indicators because the latter are inherently subjective and may reflect biases and inaccuracies. For example, self-report indicators often reflect that most people have an inflated opinion of their own abilities. Answers about other people or issues are often biased because the respondents fear answering the question truthfully may lead to trouble with their boss or coworkers or will disappoint the researchers.

Our example hypothesis requires an indicator for successful leaders and an indicator for technological innovation. It seems reasonable to define a successful leader as one who manages his or her company to financial success. One set of potential indicators would be asking the individual and those who know this individual (bosses, subordinates, stakeholders, competitors) whether this individual is a successful leader or has lead his or her company to financial success. The reader can probably appreciate these reported measures may very well be biased in some way. Potential archival measures include the firm's growth in sales, net income or earnings per share, but these are typically only readily available for publicly traded companies. Reported financial data for private companies (i.e., "What was your firm's net income last year?") are often considerably less accurate than true archival indicators.

It should be noted that identifying accessible and reliable archival indicators is very difficult for many constructs. In fact, some social scientists unapologetically identify some constructs as latent constructs, meaning they cannot be measured directly by one or more indicators (Loehlin 1998). Structural Equation Modeling is a relatively recent statistical tool that uses factor analysis of multiple indicators to measure latent variables. Molenaar et al (2000) provide a good explanation of the use of Structural Equation Modeling in construction research.

4. Hypothesized causal relationships must be stated explicitly but are difficult to "prove"
Essentially all research should start with at least one meaningful research question, which typically leads to at least one hypothesis that is investigated through an empirical study. Most hypotheses are causal in nature, that is, they posit that one or more independent variables influence one or more dependent variables. Many scientists—social or otherwise—adhere to four requirements for proving causality. First, there is a plausible theoretical explanation causually linking the two variables. Second, there is evidence that the hypothesized independent variable precedes the dependent variable in time. Third, there is objective statistical relationship between the two variables. Fourth, plausible alternative explanations for the statistical relationships can be dismissed through discussion (Cook and Campbell 1979)

It is this author's opinion that many construction researchers typically do a decent job of achieving the first and third criteria but not the second and fourth. Most construction researchers have heard the saying that correlation does not equal causality, yet fail to acknowledge that regression only presumes causality; it doesn't prove it. The challenge to achieving the second criterion is that it usually requires us to conduct experiments involving individuals and companies, which is problematic. (Imagine the responses you would receive if you asked ten firms to participate in a research project in which five firms were directed not to adopt technological innovations while five firms were told to adopt innovations in order to later measure differences in profits between the two firms.) Leadership researchers typically measure both the independent and dependent variables simultaneously and presume the former has influenced the latter. For example, we might measure a firm's innovation level and a firm's financial performance at one point in time and presume that innovation has contributed to the firm's financial performance. An astute colleague, however, might argue the causal relationship is reversed, that is, that a firm's financial success provides them with slack resources that allow the firm to be innovative.

The example above points at the importance and difficulty of achieving the fourth criteria, rejecting alternative explanations for any statistical relationship found between two variables. Because we are rarely allowed to manipulate independent variables and control other variables involving humans, spurious relationships are a constant issue in social science research. A spurious relationship exists when two variables are correlated because both are causally related to a common independent variable. For example, if we were to measure the technological innovation levels and financial performances of 100 construction firms and found the two variables to be highly correlated, it may be that the correlation actually reflects the fact that both variables reflect the size of the firm, i.e., large firms are both innovative and achieve higher profit margins.

Because identifying appropriate ways to empirically investigate hypotheses, including measuring theoretical concepts, is so challenging, social scientists use special terms and a special graphical tool. A broad hypothesis involving constructs is *operationalized* into a testable hypothesis and constructs are operationalized into measurable indicators. The graphic that indicates this process is a *nomological net*, which is somewhat like a table with the columns being the independent and dependent variables in the hypothesis and the rows being the successive layers of operationalizations.

One value of a nomological net is that it may reveals when we are inappropriately mixing levels of analysis in our constructs or our indicators. Our example hypothesis inherently contains mixed levels of analysis because it involves individual leaders and their firms. This is not necessarily a problem until we identify whether an individual is a successful leader based on the leader's company's financial performance. If our data sample includes the President and three Vice President's in a firm, all four individuals will have the same indication of being successful, which suggests our operationalization of successful leaders has really captured whether a group of leaders or an entire company are successful, not one individual leader. This observation leads two conclusions. First, if our data for one variable is obtained from four individuals each in ten companies and company level data is used for another variable, the sample number (n) is ten, not forty. (This sounds obvious but the author has found a similar mistake in a paper accepted in the *JCEM*.) Second, we should probably reconsider using reported indicators rather than archival indicators or even to reconsider the levels of analysis in our hypothesis.

It should be noted that some researchers acknowledge the difficulty of proving causality and merely hypothesize that two variables are associated in some way. It is this author's opinion that such hypotheses are more technically appropriate but make a rather limited contribution to the literature. Real contributions to our understanding come from overcoming both the statistical and theoretical challenges that inevitably arise from compelling causal hypotheses.

5. Proper statistical analysis is critical

The example just discussed points at a fifth principle for conducting social science research: the need to conduct proper statistical analysis. The author's experience suggests that linear regression is the construction research statistical tool of choice and that two mistakes involving linear regression are common. One mistake is that linear regression is often used when it is not appropriate to do so. The most common mistake is to use regression even when the data violate fundamental assumptions underlying regression: 1) dependent variables are continuous and approximate a normal distribution, 2) independent variables approximate a normal distribution or are categorical, and 3) the relationships between dependent and independent variables are linear in nature. Multiple regression textbooks suggest the need to perform various procedures before and after performing multiple regression analysis to confirm that the underlying assumptions are not violated by the data or the model. In addition, the independent variables should be analyzed to confirm that collinearity is not excessive (Belsley, Kuh, and Welsch, 1980).

Construction research data, especially those using Likert scales, are often neither continuous nor normally distributed. When this is the case or if residual diagnostics performed by advanced statistical software such as SPSS or Systat indicate violations of regression assumptions, researchers should consider supplementing their standard regression analysis with probabilistic regression, logistical regression or another more appropriate statistical technique, as reported in Toole (1998).

The second common error that some construction researchers make is to perform only univariate analysis. It was discussed under principle 4 that many relationships between variables may be statistically significant but spurious. If two variables are found to have statistically significant (i.e., the chance of a Type I error being 5% or less) correlation, we cannot be sure the relationship between them is spurious unless we control for all possible antecedent variables, that is, perform partial correlation analysis. For our sample hypothesis, we would need to analyze the partial correlation between firms' innovative score and financial performance while controlling for firm size and other possible antecedent variables.

The relatively easy way to eliminate plausible alternative hypotheses is to perform multivariate linear regression using a model that contains other potentially relevant variables. This way, one gets a sense for how much each independent variable in the model contributes to each dependent variable. The results of the multiple regression analysis will also include how much of the overall variance in the dependent variables is explained by the independent variables. Some researchers focus on the ρ values to identify relationships that are statistically significant, but ignore the fact that the adjusted R squared (the square of the Pearson product moment correlation coefficient adjusted for the degrees of freedom) of the model are so low that the models are essentially meaningless. An adjusted R squared above 0.25 is considered typically meaningful in social science research.

6. Proper research design must be performed before data are collected

Proper research design includes several distinct issues, some of which are related to the previous five principles. One key aspect is the sampling plan, which consists of two decisions: the type of sample and the size of the sample. Regarding the type of sample, the scientists in us know that good science typically involves random samples to minimize the chance of bias within our sample. One problem with random samples is that we will often be unable to obtain a reasonable response rate, which is why convenience samples are so common in construction research (that is, we ask firms that we feel are likely to agree to participate). Another problem with random samples is that we may not end up with enough firms in a particular group that we would like to make conclusions about. Stratified samples, in which we include specific numbers of firms from each subgroup that we are interested in researching, are therefore common. Ideally, the firms within each subgroup are randomly selected, but this is not always possible.

Regarding the size of the sample, we know that the statistical power of our analysis will be higher if our sample is as large as possible, yet we also know that large samples take considerable time, effort and money. An easy mistake for researchers intending to perform multivariate analysis to make is focus only on the overall n required based on their number of variables in their multivariate model. They fail to realize it may be necessary to choose a sample size that will yield acceptable number of firms in each variable grouping, that is, ensuring sufficient cell counts to ensure the model is stable. This author spent hundreds of hours surveying over 100 firms about safety programs and performance, only to later find the desired multivariate analysis could not be performed due to insufficient cell counts!

Another set of research plan issues are associated with conducting research on humans. All universities should have Internal Review Boards (IRB) that are supposed to review the research plans for all proposed human subjects research projects to ensure no participants will suffer any mental or physical harm, that confidentiality or anonymity is maintained, etc. Depending on how often a university's IRB board meets, securing IRB approval can take months.

A second human subjects issue is what to tell the participants before or while data is being gathered. Social scientists have long known that subjects who know they are being observed and/or know the research hypothesis often change their behavior (referred to as experimental effects) or give inaccurate answers (demand characteristics). For these reasons, it is suggested in some research methods textbooks that researchers give misleading statements to subjects who ask about the research. It has been the author's experience in construction research, however, that firms will either not agree to participate in the study or will not provide the needed documents unless they are truthfully told the research's focus.

Conclusions

This paper has suggested six principles that researchers of leadership in construction should follow to increase their ability to draw credible and compelling conclusions from their empirical research. These principles are applicable to all areas of construction research that are aligned with social science rather than with, for example, operations research or information technology. Following these principles will help researchers reduce the threats to each of the four types of validity identified in Cook and Campbell (1979) and increase the likelihood that their research will make a meaningful contribution to the literature.

It should be clear to the reader that the issues raised in this paper regarding proper research methods are only the proverbial tip of the iceberg. This paper is only intended to serve as an introduction to effective research methods in construction and to encourage researchers to more fully study the topic. The author feels strongly that graduate construction students performing research on social science topics should take at least one course on social science research methods and one course on multivariate statistical analysis before initiating their research. (The author also believes such students should also take at least one graduate course on organizational behavior.) Including social science research methods courses in a graduate curriculum in construction management is unusual and likely controversial. But such courses will be an important step if the construction research community is to establish a reputation for effective research in leadership and similar topics.

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A Construction Sociological Systems Model to Relational Contracting

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Abstract

Recent construction research efforts and industry reports worldwide identify self-destructive trends creating disjointed relationships among construction contracting parties. Several reports suggest remedial measures to arrest and reverse the trend. The common primary thread called for in each report is the necessity for dramatic "cultural" change to reduce adversarial conflicts and promote collaboration through different team-working approaches. Impeding such change is the Industry's reliance on contracts to instill trust and define collaboration. However, "an organization which depends solely upon its blueprints for prescribed behavior is a fragile social system" (Katz, 1964). Contrary to the call by many experts for more contractual requirements outlining collaborative behavior, the key to successful collaborative construction projects is the willingness of the participants to behave in a positive manner beyond contractual requirements. These extra-role behaviors, otherwise known as Organizational Citizenship Behavior (OCB) (Bateman, Organ, 1983) or lack thereof, may be the key attribute to a collaborative culture in construction project organizations. Many viewpoints of OCB, including commitment to supervisors, careers, unions, and the organization itself continue to be researched. However, little empirical research on multi-party project organizational commitment exists. Therefore, the prevailing conceptualization of commitment in organizations may be considerably less salient in short-lived construction project environments and therefore generating OCBs on construction projects may be more a function of commitment to the social relationships of the participants than the contractual organization.

Key Words: Relational Contracting, Corporate Culture, Organizational Commitment, Project Delivery, Collaboration, Organizational Citizenship Behavior

Introduction

Numerous reports in the United States (CII, 1990, 1996), Australia (ISR, 1999), and Hong Kong (CIRC, 2001) call for radical and dramatic "cultural" change in the construction industry and recommend fostering collaboration through various team working approaches such as partnering, project alliancing, and relational contracting. A daunting task as change rarely comes easy on an individual basis let alone on a societal level comprising of ten, twenty, or even three thousand people on any given construction project.

Culture is defined as the shared meanings, technology, language, norms, attitudes, beliefs, behaviors, and material objects of a society or group (Kanagy, Kraybill, 1999). Culture then by definition is not a definitive, tangible, or measurable thing. Rather it is a system of inter-related characteristics that give rise to culture. Culture's individual components however, are tangible. For example, numerous scientific and philosophical discoveries such as the Earth being spherical and Martin Luther's 95 Theses significantly altered medieval culture. With these discoveries, the first to fall were commonly shared beliefs. The world was no longer flat and every man had the right to petition God personally. Subsequently, this led to measurable changing attitudes, behaviors, and norms. New technologies such as the printing press were developed and science was no longer considered the work of the Devil. Today, these distinct cultures are defined as "The Dark Ages" and "The Enlightenment". Neither can be easily defined or measured, but since their attributes are definable, the resultant culture is describable through these attributes.

Although the time periods of the Dark Ages and the Enlightenment appear to happen at two different distinct periods of time, the transition took hundreds of years. History is littered with failed social programs that attempt to effect cultural change in too short a time, often with catastrophic results. The Chinese Cultural Revolution (1966 – 1976), which resulted in chaos, numerous deaths and millions of injuries and imprisonments, attests to this condition. Cultural change takes time and requires battle after battle; defeat after defeat until a decisive moment of proof (i.e. Columbus's return from the "Indies" proved that the world was indeed round) causes a sea change of belief.

Hong Kong based studies on joint risk management through relational contracting (RC) and actual project alliancing efforts in Australia are two examples that reflect a growing desire for change within the construction industry itself. The reason for this trend is attributable to many factors, but it is primarily due to the continued destructive effects that the industry's historically adversarial and selfish nature has on quality, customer satisfaction, profitability, and professional relationships (Rahman, Kumaraswamy, 2004). Perhaps the changing attitudes and desire for change may be a necessity for survival. Although the recent efforts in Australia and Hong Kong may not have the historical significance that Christopher Columbus or Martin Luther has, the Construction Industry may be on the cusp of a similar renaissance namely, the birth of collaboration.

The Construction Social System

In addition to culture as defined by Kanagy and Kraybill, any society's social system is also comprised of architecture and ritual. Social architecture describes how a society is organized and how it fits together. Ritual is orderly, repetitive, and meaningful social interaction amongst the society providing harmonious interplay between culture and architecture ensuring each reciprocates the expected returns (Kanagy, Kraybill, 1999). Recent efforts to change the architecture from the traditional construction project delivery systems (i.e. Design-Bid-Build, Design-Build, and CM at Risk) are currently being employed (Hauck, 2004). These changes include structurally aligning the participants toward a more project oriented focus verses an individual focus. This new focus has participants share risks and rewards. These changes are a step in the collaborative direction by changing one of the social system components - architecture. These changes implicitly structure the relationship in a covenant-based format holding the project as the central focus. Meanwhile, the project participants' success and/or failure are inextricably linked to the success of the project. However, despite the structural changes, it is evident that firmly held beliefs and perhaps habits continue to generate the same distrustful and adversarial environment prevalent in the industry. This reality spawned additional studies declaring that a cultural change in construction is required (Rahman, Kumaraswamy, 2004). Undoubtedly, the industry could benefit from a cultural change. Equally important though, is to consider ritual as it provides harmony between architecture and culture without which the social system breaks down.

Trust and Culture

Routinely, studies have shown that the primary ingredient that fosters collaborative cultures is trust but trust is difficult to achieve. Rational behavior for human beings is behaving in such a way that maximizes one's self-interest while reducing potential costs or pains (see, for example, Collins, 1982). The second part of the definition for rational behavior does not bode well for the establishment of trust. The best way to reduce potential costs or pains is not to trust the other person. A common exercise performed in many trust building lessons is for a person to hold his arms in front of him and begin to fall backward trusting that another person will catch him before hitting the ground, which obviously would entail great pain. The best way to ensure that costs or pains are reduced in this situation is to not fall to begin with. Therefore, it can be surmised that trust and collaboration is inherently irrational.

Too often researchers and practitioners act as if trust is rational and attempt to instill trust through the vehicle of a contract. For example, Flora states "behavior of the project participants must be clearly specified when approaching construction with a more collaborative project delivery system" (Flora 1998). Kanter further asserts that "the contract must identify how project participants will behave in the pursuit of a common goal" (Kanter 1994). These are commonly held beliefs that many experts adhere to as a requirement to foster collaborative construction projects. In each of the former theses, the focus is on defining appropriate behavior and its enforcement through contracts or some other legal document as a vehicle to establish trust. However, this approach reverses the causal order of the variables. Contracts do not have the ability to establish trust. Contracts are based on established trust. Underlying all contracts is an unstated established level of trust that the other party will meet their responsibilities and "catch the person falling backwards." Worse yet, attempting to instill trust through a contract heightens the expectation that one party will not fulfill their responsibilities let alone act collaboratively outside contractual requirements. Therefore, many prescribe that more "contract" is required to spell out what is and what is not collaborative, again making the condition more and more distrustful ultimately spiraling down to an inability to collaborate.

While laying the groundwork for research on organizational behavior, Katz states that "an organization which depends solely upon its blueprints for prescribed behavior is a fragile social system" (Katz, 1964). In an effort to protect individual's rights by defining roles, responsibilities, and behavior, contracts inherently divide the project participants from each other and encourage individuals to look out for individual self-interest (Clegg, 1992). Contracts provide rather prescriptive formulas that disrupt collaborative relationships. In lieu of being inspired to work collaboratively, fear of the consequences of breaking the contract then becomes the only motivating factor for collaboration. Fear may generate obedience, but it rarely generates collaboration. Therein lays the problem with using contracts to instill trust. Focusing on the contract to generate collaborative behavior inherently retards a culture of trust. The social system then becomes dysfunctional as the architecture is designed around collaborative intent, but the rituals of contracts do not give rise to a collaborative culture. Although the new collaborative architectures may yield some operational benefits, the culture of fear and distrust remains and collaboration is therefore not fully realized.

Trust or lack thereof is minimally dependent upon the completeness of the contract or the quality of the construction drawings. Rather, trust is a dependant variable that stems from some sort of relational construct. Once trust or distrust is established, the characteristics of culture are developed and the culture of a given society begins to take shape. The established level of trust plays a significant role in the attitudes, beliefs, and behaviors of the players involved leading to the type of culture expected. It is at this point beyond contractual obligations that tests the metal of collaborative culture and establishes the point where this study begins.

Organizational Commitment

Commitment in organizations has generated a great deal of interest in organizational behavior circles over the past several decades. Researchers have identified organizational commitment as an antecedent of any number of work-related variables including absenteeism, performance, turnover, and altruistic behavior. However, most of the research is unclear as to whether commitment is behavioral or attitudinal. O'Reily and Chatman (1986:492) suggest that "the lack of consensus in previous research can be attributed in part, to a failure to differentiate carefully among the antecedents and consequences of commitment on the one hand, and the basis of attachment on the other." They maintain that commitment is best defined as the basis of an individual's psychological attachment to the organization." This basis of attachment is distinct from either the antecedents of commitment or from its consequences. In keeping with this concept, Meyer and Allen (1991) distinguished between three separate types of commitment. Specifically, these types are affective commitment, continuance commitment, and normative commitment. Following are the descriptions of each:

> *Affective commitment refers to the employee's emotional attachment to, identification with, and involvement in the organization. Employees with a strong affective commitment continue employment with the organization because they <u>want</u> to do so. Continuance commitment refers to an awareness of the costs associated with leaving the organization. Employees whose primary link to the organization is based on continuance commitment remain because they <u>need</u> to do so. Finally, normative commitment reflects a feeling of obligation to continue employment. Employees with a high level of normative commitment feel that they <u>ought</u> to remain with the organization.*

Of greatest interest to establishing collaborative culture in the construction industry and on specific construction projects, is affective commitment. Dealing within the contractual boundaries falls into the “needs” or “ought to” category whereas, collaborating outside the contract falls into the “want to” category. Understanding a project participant’s emotional attachment to, identification with, and involvement in the project organization will conceivably help to predict one’s willingness to collaborate. Unfortunately, research in this area generally focuses on commitment in organizations from the viewpoint of commitment to supervisors, careers, unions, and the organization itself. Little to no empirical research exists that examines commitment in multi-party project organizations. Presumably, the prevailing conceptualization of commitment in organizations may be considerably less salient in short-lived construction project environments and therefore project organizational commitment is more likely to be a function of the extra-role behaviors described by Katz.

Organizational Citizenship Behavior

Two decades following Katz’s recognition of the significance of extra-role behaviors to organizational success, Bateman and Organ produced the seminal piece on Organizational Citizenship Behavior (OCB). OCB is defined as “individual behavior that is discretionary, not directly or explicitly recognized by the formal reward system, and that in the aggregate promotes the effective functioning of the organization” (Bateman & Organ, 1983). Citizenship behaviors are classified into six categories: sportsmanship, organizational loyalty, organizational compliance, individual initiative, civic virtue, and helping behavior (Podsakoff, 2000). Each category correlates with each of the three types of commitment. Helping behavior, otherwise termed as organizational citizenship behavior directed toward other individuals (OCBI), has a moderate correlation to affective commitment and provides a springboard from which to analyze project organizational commitment (Bolon, 1993).

OCBI is important in several ways, including enhancing individual and group productivity, freeing up resources, increasing coordination, and aiding in the maintenance of a favorable work climate (Podsakoff, Mackenzie, Pain, Bachrach, 2000). The value of OCBI in contributing to individual, group, and organizational performance has prompted much research concerning the antecedents and consequences of OCBI. These antecedents are generally classified into one of four categories: employee characteristics, task characteristics, leadership behaviors, and organizational characteristics (Podsakoff et al., 2000). Justification for these relationships between these variables and citizenship behavior are generally based upon the existence of a social exchange relationship between the employee and the organization. According to social exchange theory, employees are likely to provide effort and perform beyond their prescribed role definition if they feel that the organization is providing them with positive work experiences (Blau, 1986). This positive relationship between employer and employee promotes a relationship of trust and reciprocity. Based on the established trust and a desire for reciprocity, the employee is then willing and motivated to provide extra effort and performance through citizenship behaviors.

Of the various element of OCB, only OCBI is directed at fellow employees (Podsakoff et.al., 2000). The other elements of OCB do not require a second party and are therefore less likely to be affected by interpersonal relationships. For example, an employee choosing to be more conscientious in his or her work habits (an element of citizenship) likely does so because of an exchange relationship with the organization, not because of interpersonal relationships among employees. The construction project environment does not lend itself to an exchange relationship with the organization and is not fitting for this application. It does, however, lend itself to social exchange analysis between the players. Although OCBI has a moderate relationship to organizational commitment and job satisfaction, other variables may be at work. An employee might be involved in a social exchange relationship that results in OCBI for his or her colleagues even if the employee does not have a positive social exchange relationship with the organization. Regardless of one's level of satisfaction with or commitment to the organization, strong interpersonal relationships among employees will likely result in high levels of OCBI. OCBI is the act of providing help to another employee, not necessarily the organization. Therefore, the interpersonal exchange involved in helping a fellow employee would have different antecedents unrelated to the exchange relationship between the employee and the organization. This scenario has profound implications for construction project participants if it could be shown that strong interpersonal relationships between project participants would result in OCBIs.

The Research Question

Social Exchange Theory provides a theoretical framework for the intended research. Social Exchange theory purports that the most fundamental form of social interaction is a mutual exchange of benefits or favors, which can include not only material benefits but also psychological benefits such as expressions of approval, respect, esteem, and affection (Yukl, 1998).

Purportedly, OCB theories present processes and guidelines that fulfill the "ritual" requirement of a social system. Existing OCB research considers citizenship behaviors within monolithic organizations, however, in construction the multi-party project organization is the primary arbiter of organizational success and existing research offers limited emphasis on such multi-organization project organizations. Therefore, the research question is "Do the attitudes, behaviors, and sentiments found within OCBI provide the necessary ritual impetus to establish a collaborative culture in multi-party construction project organizations?"

Appropriate dependant variables to be considered include OCBI performance and receipt specifically, who receives OCBIs and why. Additionally, what impact do OCBIs have on collaborative culture? Independent variables may include, but not necessarily be limited to, previous experience between players, assymetrical relationships, third-party influence, affective commitment, organic solidarity among players, interpersonal similarities among participants, and the structural networks that link individual participants and their participating organizations (see van de Bunt et al, 2005).

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Program Renewal: A New Approach to Project Development

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Abstract

Capital budgeting processes have historically been used to select proposed projects for funding. However, because these processes are largely based on financial prioritization metrics such as net present value (NPV) or internal rate of return (IRR), they often do not capture various project risks which could erode potential benefits. While numerous asset development processes exist to track project progress during different phases, none examine the financial and operational impact of an entire portfolio of projects at any one point in time. Consequently, this paper presents the concept of program renewal as one remedy to these limitations. Through program renewal, a portfolio may be expanded or contracted depending upon the performance of the individual projects contained therein. Besides providing an integrating mechanism for planning, budgeting, and strategy, program renewal improves communication between business leaders and project managers – creating confidence that A) projects are being built right and, B) that the right projects are being built.

Background

The ultimate result of the management practices of an owner's organization is performance – market performance, operational performance and financial performance. However, after implementing numerous operational and management practices that were reputed to lead to improved project performance, many architecture, engineering, and construction (A/E/C) industry clients have experienced mixed results at an aggregate level when all projects are considered. This situation may arise from both cultural and structural disconnects in project execution. Indeed, today's project management explicitly understands and uses techniques that, in some cases, may help one project succeed at the expense of another (Fricke & Shenhar 2000). This problem is often compounded by functional corporate structures and processes at odds with flexible project-based forms of organization. Thus, many A/E/C owner firms' financial project performance results follow a 'whale curve' of cumulative profitability (Cooper & Kaplan 1999) as can be seen in Figure 1. Data for this plot were obtained from the 2002 project performance results of a Fortune 500 commercial building program owner, illustrating that 235% of the company's earnings before income tax (EBIT) were generated by 41% of their projects (Mulva 2004). In other words, 59% of this firm's projects generated either no profit or a loss on a recurring, annual basis (i.e., taken 18 months after 'grand opening').

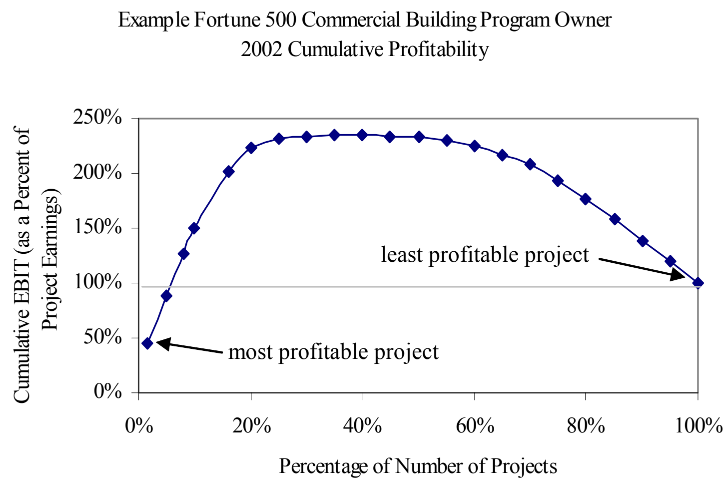

Figure 1. The 'Whale Curve' of Cumulative Profitability.

As a result, the need for effective techniques for what is commonly called multi-project, portfolio, or program management has become clearer. Program management is needed to avoid the type of 'value subtraction' depicted in Figure 1 (i.e., when one project depletes the benefits of another). Plus, because up to 90%, by value, of all A/E/C industry projects occur in a multi-project context (Turner 1993), owners' strategic procedures such as the capital budgeting process must be modified to reflect the project environment(s) faced by each individual firm. This paper does this by demonstrating that quantitative benefits have been achieved by A/E/C owners practicing program management within a corporate process of program renewal.

The Traditional Capital Budgeting Process

For the most part, companies consider their operations and planning processes to be decentralized because the actual plans of the organization – the initiatives, milestones, schedules, resource allocations, etc. – do not exist at the executive level where financial goals have traditionally enjoyed top billing (Federal 1997). As a result, vast differences often exist within A/E/C organizations regarding the organization's business strategy, long-term planning objectives, and day-to-day operational needs. Moreover, the goals of project management, the executive suite and the customer are different and are generally not taken into account by the traditional capital budgeting process (ibid.). Taken together, this situation leaves A/E/C owners particularly vulnerable to a 'cycle of decay' resulting from the use of financial measures (e.g., net present value (NPV) and internal rate of return (IRR) analysis) instead of control data for decision making regarding their selection of projects. This 'cycle' manifests itself in these ways:

1. Approval is given for projects in year n which meet financial criteria and whose cumulative value is below a predetermined budgetary constraint.
2. As long as these projects progress satisfactorily as determined by asset development processes (ADP's), funding continues into year $n+1$.
3. In year $n+1$, another portfolio of projects is approved using a different budget that is inadvertently constrained by the set of year n projects.

The main problem with this 'cycle' is that funds allocated to projects in year *n* are rarely reallocated to year *n+1* projects. This reallocation might occur if the slate of year *n+1* projects fit into corporate strategy better or if they possessed better financial metrics. Effectively, this means that if select year *n* projects were eliminated or modified in year *n+1*, a different portfolio of year *n+1* projects would result. Consequently, traditional capital budgeting practices have the potential to obtain suboptimal results when projects extend across multiple years. Thus, an improved portfolio selection and management process is needed.

The Role of Program Management

Program Management is not about executing projects, but rather about creating benefits. At a fundamental level, a program is a group of projects that are managed and controlled in a coordinated way to achieve a set of business objectives that would not be possible were the projects to be managed independently (CCTA 1993). Consequently, program management is concerned with the coordinated support, planning, prioritization and monitoring of projects to meet changing business needs. It is an owner's 'bridge' between project execution and fiscal reward. The added value it creates depends on the appropriate allocation of resources to individual projects via tailored processes. This requires effective and dedicated leadership.

Programs create value by improving upon the management of projects in isolation, especially where the working environment is made up of numerous interrelated projects and where project integration – in terms of both development and deliverables – is crucial to competitive success (Pellegrinelli 1997). Thus, the benefits of implementing programs include (ibid.):

- Greater visibility of projects amongst executive management
- Better prioritization of projects
- More efficient and appropriate use of resources
- Projects driven by business strategy and needs
- Better planning and coordination
- Explicit recognition and understanding of project dependencies

While these advantages are not guaranteed, the application of program management can make the most of resources (i.e., personnel, money, and time) and effort expended on projects, and can sustain the drive to maximize the benefits to the business. However, it is important to remember that successful benefit delivery need not depend on successful projects. A poorly managed project might still deliver benefits due to changes in the client's business environment. In fact, benefits are typically obtained when combined with the outcome of other projects. Therefore, within a program, it is helpful to classify projects in terms of their ability to deliver benefits. Reiss (1996) has identified four project classifications:

- Direct projects: projects with direct benefits
- Enabling projects: projects that deliver no direct benefit but are vital to the delivery of a whole range of benefits from other projects
- Passenger projects: projects that can only add to benefits expected from other projects
- Synergistic projects: a group of projects, each of which makes no (or only a small) contribution, unless combined into a program

Programs also require continual adjustments to their composition in order to preserve benefits. These adjustments are required to avoid the erosion of benefits resulting from internal or environmental changes. This phenomenon is commonly known as 'benefits creep' (ibid.). To steer clear of benefits creep, program management requires that individual projects be dropped or modified and new projects be introduced in order to maximize benefits. Unfortunately, few A/E/C owner firms formally define their work within a program management context due to the overriding and incorrect belief amongst project managers that a program is merely a complex project (Mulva & Vanegas 2002). As a result, a new method for implementing program management within an owner's organization is required.

Implementing Program Management

Beyond project management, program management places more emphasis on being a business tool and strategic aid, thereby allowing the horizon for business planning to go beyond one year to create longer-term plans. It may also allow executive management the opportunity to balance current and future business prospects with corporate strategy, technology, and methods. Consequently, Figure 2 provides a sample diagram that could potentially be used as a template by an owner to integrate the benefits of program management into their organizational workload and information flows. This diagram, partially based on the work of Strange (1998), illuminates how the activity of program management links to a company's corporate planning and business strategy activities.

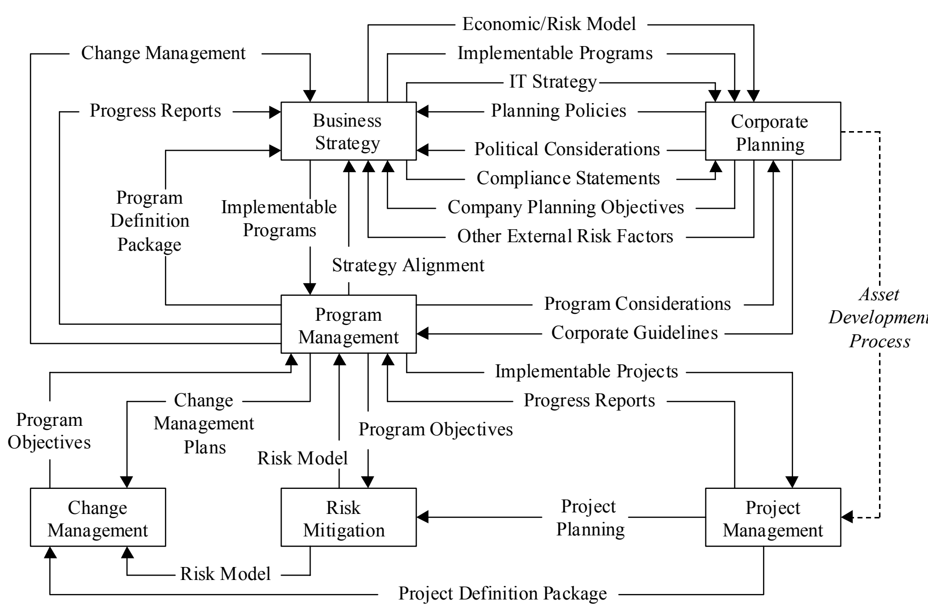

Figure 2. Program Management Installation

Program management can become an integral part of an owner company's capital budgeting process where decisions are made about what projects can and cannot be pursued. In such an environment, the 'buy-in' of corporate objectives and goals may occur, often empowering program management staffs to deliver benefits that are expected to be achieved. In fact, under such an arrangement, project management may actually become simpler due to the fact that it would focus primarily on traditional tasks of planning, monitoring, and control. Similarly, risk mitigation and change management may be managed at the program level, possibly enhancing a firm's competitive position through execution economies of scale and/or economies of repetition. Notably, program management can essentially become the 'heart' of an owner firm, bypassing even 'leading edge' asset development processes (ADP's) and benchmarking database assessments used to link planning with project outcomes. Indeed, it is not enough for executive management to ask project staffs "Are we doing the project right?" They must also ask "Are we doing the right project?"

A New Business Process: Program Renewal

Since projects result in deliverables and deliverables result in benefits, the introduction of an improved project selection process is needed. Such a process would provide a 'top-down' approach to the management of benefits in a program management environment. In the context of deciding whether an owner firm can cope with another project, a formal project selection process that parallels capital budgeting processes would help executives consider the impact of additional project(s) on the existing portfolio. As a result, it is imperative that owner companies have the flexibility in their processes to stop projects so that others can be carried out. This is not a trivial matter because, at present, few owners have the processes necessary to alleviate the impact of legacy projects (i.e., projects funded in prior years) upon projects under consideration in capital budgeting. Fortunately, one process possessing the flexibility to halt specific projects is program renewal.

There are many possible developmental paths to consider for a program. In fact, one of the fundamental differences between programs and projects is the pattern of activities over time. Unlike projects, programs do not necessarily have a single, clearly-defined deliverable, or even a finite time horizon. Instead, they are part of a continuum (Pellegrinelli 1997) as depicted in Figure 3.

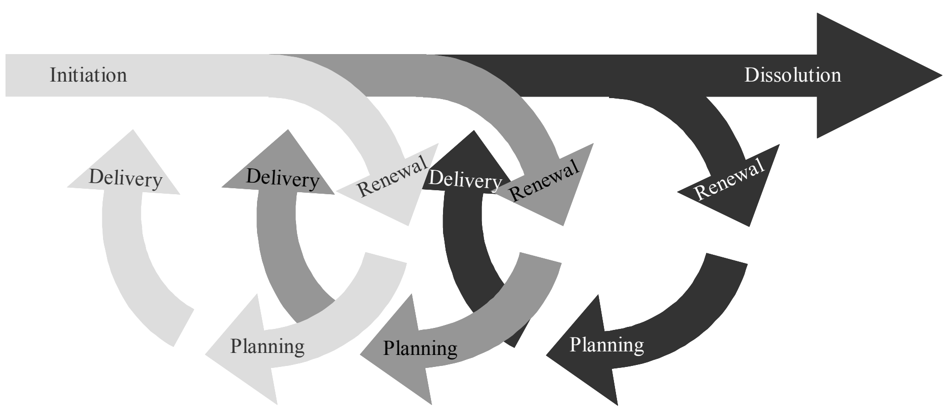

Figure 3. The Program Continuum.

In the continuum, a new program is only initiated as a result of a new operating environment, a business requirement, a new strategic direction, or a review of existing programs. In the initiation step, the need for the new program must be justified and supported by an estimate of benefits to be delivered through its execution. Next, the program must be defined and planned in detail. This includes the development of program objectives and the allocation of responsibilities throughout an owner's organization. Notably, programmatic planning follows either initiation or renewal, thereby forming the continuum itself. When modified, this planning step becomes the basis for a new class of asset development process, one based on a dynamic form of benchmarking.

Once a program is planned, it enters the delivery phase of the continuum illustrated in Figure 3. In this phase, project performance is controlled closely and program benefits are continually evaluated. Where the potential for benefits subtraction exists, projects in the delivery phase are modified and new program requirements are identified. Once benefits are confirmed as originally conceived, the program is renewed if its continuing business requirements can be justified; otherwise it is dissolved. However, the program may also be renewed with a new sense of strategic direction or focus. Such program renewal may accompany changes to an owner's business model. Finally, in the case where greater benefits can result from a different program, an existing program will be dissolved and its projects and personnel reassigned. Undeniably, these forms of renewal underscore the need for periodic adjustment to a firm's portfolio of projects. One way to accomplish this is to make program renewal a process which parallels an owner firm's annual budgeting cycle.

Study and Findings

To quantify the benefit of program management paired with program renewal, accounting data were collected by the author in 2001 and 2002 from 167 commercial building projects developed between 1996 and 2000 by three different large building program owners (Mulva 2004). Specifically, these projects were developed within seven programs and were analyzed regarding the percentage of projects cancelled. This data can be seen in Table 1. While no causal link is claimed, the findings of this

Table 1. Program Performance Quantification.

Program	No. Projects Completed	% Projects Cancelled	% Cost Improvement
1996 Restaurant	24	10.5%	12.1%
1997 Restaurant	44	29.0%	4.9%
1998 Restaurant	17	38.5%	10.4%
1999 Restaurant	23	30.0%	5.9%
2000 Restaurant	32	33.3%	15.5%
1998 Hotel	13	9.1%	10.5%
1998 Discount Retailer	14	0.0%	9.5%

study empirically indicates that the practice of program management, when paired with a formal program renewal process at an owner firm, may produce significant performance improvement. Consistent with Figure 2, the projects cancelled by program managers mitigated risk and managed change. This had the advantage of delivering significant benefits to the individual program owners. These benefits are expressed in Table 1 as the percent cost improvement for the program when compared with cumulative cost projections had each project been managed in isolation. The processes by which this was accomplished are detailed in Mulva (2004). However, the findings presented here are comparable with results from other organizations that manage programs within a process of program renewal (ibid.). In fact, Boeing Commercial Aircraft (BCA) executives have credited these procedures with reducing their project development costs by over 11% (Kolesar 2001).

Conclusions

Some owner companies are losing their ability to balance project development with harsh business environments. Fortunately, it may be possible to benefit from properly implementing program management. Doing so calls for a more active role of owner executives in developing a portfolio of projects through an implementation strategy and the process of program renewal. Yet, this demands leadership. Given this context, programs may act as the 'bridge' between strategy and project development, thereby increasing the prospects for improved performance as presented here. This is important because these findings justify the combined practices of program management and program renewal as both new and not normally performed. In fact, the author is only aware of a dozen owner firms in the U.S. construction industry which employ both practices simultaneously.

The path of program renewal has already met overwhelming success in the automotive industry. In particular, that industry's practice of developing programs as common platforms for a variety of new vehicles as diverse as a sedan, a convertible, and a sport-utility vehicle is routine. Moreover, each platform is sanctioned, managed, and renewed on a periodic basis (Nobeoka & Cusumano 1995). Consequently, the experience of the automotive industry presents a model for leaders of companies that participate in the construction industry to potentially change their own management structures. Given a change of this type, owners could even begin to award contracts on the basis of benefits delivered through specific programs using measures such as return on capital employed (ROCE) or net present value (NPV). After all, the creation of benefits underlies the development of projects anyway.

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Integrating Sustainable Construction Research and Education: The American Indian Housing Initiative

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Abstract

Construction processes constitute a major consumer of both energy and natural resources. High performance "green" or "sustainable" buildings have emerged as an answer to growing concern for the environment, offering the advantages of minimized ecological impact and improved occupant health, as well as reduced operating costs for owners. In an effort to incorporate an environmental consciousness in engineering education, the American Indian Housing Initiative, a three part course series and research program at The Pennsylvania State University, integrates sustainable techniques in both building design and construction processes. Experiential learning through an annual design-build project affords students the opportunity to develop the knowledge, skills, and attitudes necessary to achieve environmental consciousness in both their professional and personal lives. The practical aspect of the course, during which students erect a building in Montana, also serves to provide a valuable service to the collaborating Northern Cheyenne Tribe. This paper presents the lessons learned in the areas of integrated design and construction education, as well as the proposed potential of public scholarship as a strategy for integrating sustainability in engineering education.

Key Words: Green Building, Sustainable, Construction, Education

Introduction

Producing 30% of green house gases, consuming 36% of energy produced and 12% of potable water, and contributing to 30% of the waste stream added to land fills each year, buildings represent major consumers of energy and natural resources in the United States (USGBC, 2002). Unfortunately, the pursuit of sustainability in construction remains the exception rather than the norm. Antiquated methods of delivering buildings must be replaced by techniques that facilitate environmentally conscious decision-making and the disciplines of building design, construction, and operations must adopt integrated perspectives and engage in a comprehensive evaluation of building design and delivery.

This paper describes an effort at The Pennsylvania State University to explore the design and construction of green buildings through an integrated applied research and education program. Currently in its 6th year, the American Indian Housing Initiative (AIHI) provides opportunities for practitioners and students to explore sustainable building techniques and apply their research in actual building projects. As part of the series, students research sustainability during spring semester classes, journey to Montana during the summer to participate in building construction, and then return in the Fall to evaluate and document their experiences. AIHI works in collaboration with the Northern Cheyenne to explore solutions to the grave housing dilemma faced by American Indian tribes through sustainable building design. Partnering classroom learning and laboratory research, student participants construct structures during summer “blitz builds”. The utilization of state-of-the-art analysis tools for virtual prototyping and building performance modeling facilitate a fluid transition from classroom design to on-site construction. The summer blitz build also emphasizes distributed teamwork and student leadership while applying lean production principles to streamline production on site.

A Learning Model For Sustainable Construction

Models of environmental education have existed for decades and include a broad set of learning goals that constitute the parameters of sustainable design-build pedagogy. These attributes are characterized in the Tbilisi Declaration, created as a result of a UNESCO and the United Nations Environmental Program (UNEP) conference in 1977 (The Stockholm Declaration, 1972, Belgrade Charter,1975, and Tbilisi Declaration, 1977). According to the declaration, the objectives of environmental education are to develop students who possess: awareness and sensitivity; knowledge, experience and understanding; attitudes, values and feelings of concern for the environment and motivation to take action; skills for identifying and solving environmental issues; participation opportunity in resolving environmental problems. In 1992, the United Nations produced Agenda 21 that intended to direct society towards increased sustainability (Agenda 21, 1992, Cortese 1997). Agenda 21 called for integrated decision-making by individuals, organizations, institutions, businesses and governments in order to incorporate environmental considerations and goals into social, economic, and environmental decisions (Calder and Clugston 2003). In 1997, the US President’s Council on Sustainable Development defined the role of education for sustainability as: “strong core academics, understanding the relationships between disciplines, systems thinking, lifelong learning, hands-on experiential learning, community-based learning, technology, partnerships, family involvement, and personal responsibility” (PLDE, 1997). Common theme among these initiatives is the importance of developing a broad collection of educational measures that serve to mold learning objectives, which include: (1) ***knowledge*** and ***awareness*** of sustainable practices and technologies, (2) ***skill sets*** that permit action to be taken to support environmental causes, and (3) ***attitudes*** that will continue to influence students’ decisions in both their personal and professional lives.

Service learning models, such as those employed by *Engineering Projects in Community Service* (EPICS) founded at Purdue University, offer students an opportunity to learn in an applied and hands-on setting and facilitate the acquirement of the knowledge and skills required in professional fields. An increased awareness of the role of engineers and the well-being of communities is also demonstrated by the emerging program entitled *Engineers without Borders* founded by Bernard Amadei at the University of Colorado. Public Scholarship is a pedagogical model that unites these concepts. A subculture of service learning, Public Scholarship examines the reciprocal engagement between university and community partners rather than the unidirectional flow of knowledge and skills from service provider to service receiver. Through the application of the knowledge and skills of both academic and community-based partners, Public Scholarship integrates teaching, research, and service in a way that validates and enhances the knowledge base of those both inside and outside of the university.

Program Design

There is a severe need for housing in the Native American Communities (NAIHC, 2001). The American Indian Housing Initiative (AIHI) is a collaborative effort between several research institutions and Chief Dull Knife College on the Northern Cheyenne Reservation that aims to help meet the need for housing in Native American Communities. The Pennsylvania State University serves as the lead institution of AIHI, housing an integrated research and education program on sustainable building methods. Courses and graduate research focused on sustainable technologies and practices utilize AIHI as a mechanism for hands-on and applied experiences in the planning, design, construction, and operation of green building projects. The Chief Dull Knife College and the Northern Cheyenne Community being the future users of the green buildings, directly contribute to the design and construction phases of the building processes by attending the design charettes, providing input and feedback during design, and helping construct the facilities. Partners at the University of Wisconsin and the University of Texas at Austin also contribute in conducting the design and on-site leadership of AIHI projects. The program serves as a mechanism to realize public scholarship at The Pennsylvania State University. The following objectives are pursued through graduate research and through a three-part course series offered to undergraduates from diverse academic backgrounds: (1) Introduce students to the fundamental concepts of sustainable building design and construction, including those methods of inquiry required when working with new and unproven material technologies, (2) Build collaboration and leadership skills through participation in interdisciplinary teams that are responsible for defines outcomes on a real building project, and (3) Immerse students in a distinct culture in which sustainable technologies can be applied to make a visible improvement to the living conditions in an American Indian community.

Core Sustainable Technology: Strawbale Construction

AIHI projects strive to incorporate regionally appropriate, sustainable technologies, with locally available materials, environmentally friendly paints and finishes, waste-reducing prefabrication and panelization, and the reuse or recycling of materials. The technology that serves as the fulcrum of all AIHI projects, however, is strawbale construction. An alternative to the standard wood, concrete, and steel construction methods taught to architecture and engineering students, strawbale construction offers an excellent medium for students to explore an alternative building material. To this end, the AIHI course series provide students with the chance to experiment with strawbale construction in the laboratory, participate in design and construction of strawbale structures, and assess the performance of completed strawbale projects. The process of strawbale construction and plaster finish is also engaging, and facilitates volunteer participation in the construction process. Although the mechanical properties of strawbale construction are not fully understood, the limited strategic testing completed thus far has demonstrated the viable properties of strawbale construction as a mainstream building material (King, 2002, Kocak, 2003 and Premchandran, 2004).

Teaching Sustainable Design and Construction

The AIHI course series has evolved from an initial attempt to provide hands-on and meaningful experiences for students to an integrated educational program on sustainable building methods. While the course includes a broad array of experiences and objectives, each contribute to the unifying theme of education in sustainability, and help to develop the knowledge, skills, and attitudes that foster environmental decision-making. Specifically the goals of the course series are to help students to; (1) Develop knowledge of sustainable practices and technologies, including an awareness of building impacts on the environment, an awareness of alternative materials, integrated understanding of a single material from the lab through construction and operation, (2) Develop skills required on green building projects including interdisciplinary appreciation, inquiry and research skills, and team building and leadership skills, and (3) Develop attitudes that shape environmentally conscious behavior, including an understanding of the environmental impact of personal behavior, experience sustainable technologies that make a difference in a community, and a personal connection with a community possessing sustainable values and practices.

The year-long AIHI course series developed at The Pennsylvania State University attempts to address these three learning goals through a series of active and experiential learning activities. These activities combine to create an applied and integrated experience with strawbale construction. The specific goals, learning objectives, and related course activities are described on Table 1.

Course Series Description

The AIHI course series, one of the main vehicles through which AIHI objectives are served, follows a plan-act-reflect model of active learning. Each spring, 20-30 students from disciplines including Architecture and Architectural Engineering take part in a workshop and seminar series. The course is vertically integrated, and open to both undergraduates and graduate students. The content of the spring semester familiarizes students with the culture and community in which the sustainable building project will be performed and engages them in design and construction planning. Practicum sessions serve a dual purpose by allowing students to experiment with strawbale construction techniques through the construction of test specimens and mock-ups used in actual structural and thermal experiments. This hands-on experience is used to inform a

Learning Goals	Specific Objectives	Related Course Activities
Knowledge of sustainable practices and technologies	*Awareness of building impacts on the environment*	*Readings and discussion on the role of buildings in the consumption of resources in the US, case studies of green buildings in which sustainable practices and principles have been implemented*
	Awareness of alternative materials	*Hands-on workshop with strawbale construction and presentations on alternative building materials*
	Integrated understanding of a single material from the lab through operation	*Laboratory experimentation, design analysis, construction planning, on-site building experience, and post occupancy evaluation of AIHI projects*
Skills required on green building projects	*Interdisciplinary appreciation*	*Teamwork to solve real problems related to AIHI projects*
	Inquiry and research	*Student researches to support value-enhancement ideas into AIHI projects*
	Team building and leadership	*Leading and planning of individual construction activities on site*
Attitudes that shape environmentally conscious behavior	*Understand the environmental impact of personal behavior*	*Discussions of personal decisions and environmental footprint*
	Experience sustainable technologies that make a difference in a community	*Energy efficient building construction projects in combination with discussions and visits with occupants of previously completed projects*
	Make a personal connection with a community possessing sustainable values and practices	*Cultural discussions, workshops, and community events with tribal members*

Table 1: Goals, Objectives and Related Course Activities in the AIHI Course Series

detailed planning process in which student teams are assigned to plan and lead specific construction activities on site.

After the spring course, students converge in Montana for two weeks in the summer to take part in the construction of the building. On site, they meet volunteers and students from other universities participating in the project. After a day of orientation and team building, the construction process begins through the leadership of student teams. Typically, the entire shell and core of the home or community building is completed in the two week timeframe. During the evenings and occasional breaks in the construction process, members of the Cheyenne tribe provide cultural presentations and discussions. Evening campfires and cultural events help round out the experience and allow students to build friendships and bonds with tribal members.

Returning to Penn State in the Fall semester, students reconvene for a series of discussions that center upon the main themes of the course, including cultural interaction, sustainability, teamwork and leadership, and interdisciplinary collaboration. Progress and performance to date on completed AIHI projects are also presented in the Fall semester, to emphasize the operation and performance aspects of the sustainable practices applied in the course. Students also develop artifacts to record their experience including a public presentation about their experience and a yearbook which is professionally printed and distributed to all supporters of AIHI.

Accomplishments to Date

To date the AIHI program has supported and/or managed the construction of four homes, an adult education center, a technology center, a teaching laboratory, and a spiritual building to house a Cheyenne sweat lodge. Each of these structures is currently in use and occupied by tribal members on the Crow, Lakota, and Northern Cheyenne reservations. In the summer of 2006, AIHI team members will complete a 4800 SF, LEED certified daycare and early childhood development center. Initially supported by private donations, all current AIHI projects are funded through federal housing and rural assistance programs at the Department of Housing and Urban Development and the U.S. Department of Agriculture. Through collaborative partnerships with tribes, AIHI has helped to raise over $1,150,000 in direct support for construction projects on the Northern Cheyenne Reservation. All educational expenses related to AIHI are currently covered by student fees, sponsors, and grants from the National Science Foundation.

In addition to the physical spaces made possible by AIHI, new knowledge has been generated through the graduate work associated with the program. This knowledge both informs and supplements the basic research conducted by undergraduates in the AIHI course series. Five Masters Thesis projects have been devoted to the development of a long-term sustainable housing and economic development program on the Northern Cheyenne Reservation including a self-determined housing program for the Northern Cheyenne Tribal Housing Authority, a sustainable design process model for the Northern Cheyenne, lateral load testing of straw walls, energy modeling strategies for strawbale walls, and most recently, an assessment of the AIHI course series as a model for incorporating sustainability in engineering education through public scholarship.

COURSE Assessment

During the 2004 AIHI course series a comprehensive set of research instruments were developed and implemented to assess the AIHI course series. These mechanisms included entry-exit surveys for students, content analysis of student discussions, reflective essay assignments for individual students, on-site interviews, and focus group discussions. The results of these assessment tools were then used to refine the course series and to develop more concise assessment techniques for future offerings of the course. The core class activity found to influence student's *knowledge of sustainable practices* was the integrated and hands-on experience with an alternative building material. In addition, students cite the chance to actually improve the environmental aspects of an AIHI project through research as an important and motivating feature of the course series. Students completing the course series have elevated interests in sustainable practices; however, few can fully articulate a well-rounded position on sustainability. This is understandable due to the conflicting and debatable issues that embroil environmental issues. It is more reasonable to expect students to gain an awareness of sustainable practices and an interest to pursue further lessons in the future that will shape their individual perspectives about building and the environment. The development of *attitudes* that will lead to more environmentally conscious behavior has been by far the most challenging outcomes of the course series to assess. Initial indicators surfaced as students cited the course experience as the motivation to pursue a job with an environmentally conscious design or construction firm. Some students indicated that they had begun to alter their personal energy and water use as a result of the course. Early assessment results are currently being used to develop entry and exit surveys for students that do a thorough job of assessing the incoming and exiting attitudes of students, and the key elements of the course that result in attitude shifts.

The skill sets of interdisciplinary collaboration and *leadership that* the course series strives to develop are challenging for students to master in just one course. The course does successfully expose students to leadership positions in which they have the chance to plan, succeed, and sometimes fail as teams in the deployment of sustainable practices in the field. The vital component of this experience is the feedback that they receive regardless of the outcome, and has resulted in the development of new peer assessment and alternative feedback mechanisms in the course. Another key lesson learned has been the *contribution of the Northern Cheyenne* in the learning experience of the students and the ability to demonstrate the impact of a sustainable technology in a community in need. Possessing inherent principles that place great value the on environment, the Northern Cheyenne, like most American Indian tribes, set a powerful example of environmentally responsible behavior. The chance for students to interact and engage with tribal members during the AIHI course series, and at times develop friendships and bonds with the Cheyenne community develops an inferred value for the technologies and practices that can help a community.

Conclusions and Recommendations

The contribution of the building environments to the depletion of natural resources and energy and water use in the US demand that increased emphasis is placed on embedding concepts of sustainability in construction engineering and management education. The potential of the AIHI course series to develop the knowledge, skills, and attitudes essential to environmental decision making have yet to be developed to their fullest potential; however, substantial progress has been made. The most challenging element of environmental education is shaping attitudes about sustainability, as each student brings varying levels of preconceptions and positions on the environment. The assessment of how the AIHI course series affects the attitudes of students has demonstrated the benefit of the public scholarship model in which sustainable practices are applied by students in a community in need, thus creating a lasting “real” value to sustainable technologies in the minds of students. This value is greatly amplified when students are able to make a connection with the community. Also, by exposing students to a culture, such as the Northern Cheyenne, that is highly respectful of the environment, students are able to experience an entirely different value system with respect to man and environment.

The public scholarship model applied by AIHI does provide a portable strategy for embedding sustainability into existing courses by the adoption of increased environmental considerations in existing engineering course projects and the application of these projects to communities in need. While the AIHI model may be difficult to duplicate at other institutions, public scholarship can be integrated into existing design and construction courses to enable students to gain an appreciation for the complexity, importance and promise of sustainable technologies to the welfare of communities.

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Empowering PowerPoints — Using Mind Maps in Construction Education

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Abstract

Developed by Tony Buzan in the late 1960's, mind mapping is a technique of organizing information into visual maps which display relationships among pieces of information. In the adaptation presented in this paper, the material is summarized in a PowerPoint presentation and the slides are printed on business card size paper. Rather than presenting the material, the instructor provides teams of three to four students with a complete set of shuffled slides. The teams are given the task of organizing the unsorted material in mind maps. The class ends with a competition in which teams must answer various material related questions. The article shows how to organize the material and the class, points out the changes in the role of the lecturer, and also recommends ways to better motivate students.

Introduction

A simple search on the Web will reveal over fifty learning and teaching theories (Kearsley 2005). However, these models fall in one of three categories described below (Ryder 2005):

1. **Behaviorism** is based on the idea that behavior can be observed, replicated and conditioned without studying the functions of the brain. Pavlov's experiments with salivating dogs are probably the most famous applications of behaviorism in psychology, but this principle was used much earlier by Romans. The Romans simply referred to behaviorism as "repetitio mater studiorum est" (repetition is the mother of studying). Simply put, behavioral teaching theories provide for a sufficient number of problems or exercises so the learner can efficiently solve the next similar problem.
2. **Cognitivism** is almost the opposite of behaviorism. The cognitivist approach is based on the study of mental processes, attempting to build a "pyramid of knowledge". An illustrative way to present the cognitivist approach is credited to Edgar Dale (1959) and reproduced in figure 1. Both behaviorism and cognitivism assume that knowledge is absolute and given
3. **Constructivism** assumes that knowledge cannot be "transmitted" from one person to the other and, thus, it has to be (re)constructed by the "recipient". The constructivist methods are concerned with creating an environment for monitored peer interaction and continuous building on known concepts. Collaborative learning is probably the most popular application of the constructivist approach.

The mere existence of more than fifty learning and teaching theories proves that no one theory can cover all the facets of teaching. This paper does not attempt to provide yet another teaching theory.

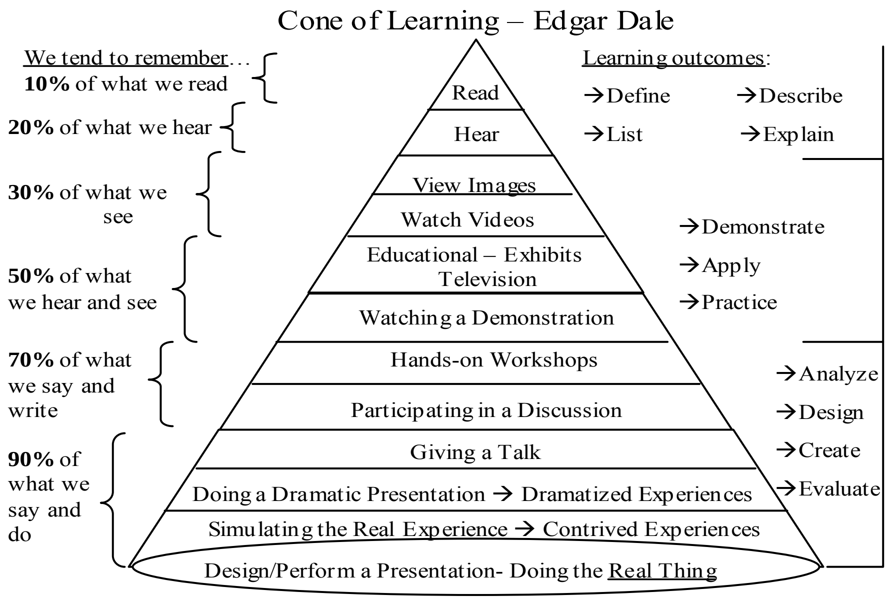

Figure 1. Dale's Cone of Learning (adapted from Dale 1959)

Instead, this paper focuses solely on one teaching method: concept mapping, and its application to a specific type of problem. (References made to the broader theories of learning have the purpose of putting the concept mapping in perspective.)

Concept Mapping

As a teaching method, concept mapping is part of cognitivism. This means that the knowledge to be imparted is considered to be given and absolute (i.e. no ambiguities). According to Jan Lanzing (1997) "Concept mapping is a technique for representing knowledge in graphs. Knowledge graphs are networks of concepts. Networks consist of nodes (points/vertices) and links (arcs/edges). Nodes represent concepts and links represent the relations between concepts."

A simpler form of concept mapping is "Mind Mapping", a term copyrighted by Tony Buzan in the UK and US. Mind maps are a subset of knowledge graphs in the sense that they have a tree structure rather than a complex network (no loops), and there is no detailing of the type of relationship between the nodes. While representationally, mind maps may not be as accurate as knowledge maps, mind maps are easier to teach and are more attractive to educators and to people who do not specialize in knowledge representation. According to Mindjet, one of several information mapping software developers, Mind Mapping is used by over half of the Global 500 Corporations (Mindjet 2005). Mind maps owe their success to the capacity of the human mind to interpret and supplement information presented graphically on paper or other medium. They also help focus on a single subject and its ramifications. To better serve the various types of learners, mind maps are augmented with colors, pictures and variations in the thickness of the branches.

Mind Maps in Education

Theoretically, the reason mind maps work better than other techniques is because they address the needs of several types of learners. According to Budd (2004) "The construction of a Mind Map provides a learning experience for visual and tactile learners who are traditionally not as well served by lectures". Budd further describes an exercise in which he implemented the principles of collaborative learning by having groups of three students build mind maps. He attempted to categorize the 39 students participating in the study into four different categories of learning styles (Kolb 1984): 1. active experimentation (doing), 2. abstract conceptualization (thinking), 3. reflective observation (watching), and 4. concrete experience (feeling). The survey revealed information only about two types of learners: "doers" and "thinkers". Budd's conclusion is that "thinkers" feel that they learn more from lectures than from building mind maps, while "doers" rank the two methods as being essentially the same. This conclusion seems to be contradictory to the expectations set up by the theory and one may start questioning the wisdom of using mind maps in the classroom.

The literature survey did not reveal any super-study on the efficiency of using mind maps as a teaching tool. Reports of individual experiments, such as Budd (2004) and Sivathasan and Ho (2005) do not give an undisputable educational advantage to mind maps and they advocate using them as a way to break the monotony of the class delivery systems. This conclusion is consistent with anecdotal information I received from colleagues who have attempted using mind maps in their classes. However, in all those experiments the mind maps were used to represent idea structures **given** to the students. This paper reports on an approach in which the students are asked to structure amorphous data.

Where Mind Maps Shine

In essence, mind maps are similar to an outline. An outline is a list with levels of indentations, each level having its own types of detailing and eventually different styles (letter size, color or font). In a mind map, the list is practically wrapped around a central concept, and each level of detailing is a new branch in the tree. Due to this similarity, mind maps are more suited for learning topics in which an outline already exists or can be easily derived. Colors and images are used to enhance the meaning of the mind maps.

In the exercises described in the literature, the students are given structured material (such as a textbook chapter), and are asked to represent the material in a mind map. Essentially, the students are asked to map the outline of the material. It should be no surprise that the students are ambivalent to this methodology. While it exposes them to a new way of taking notes, the use of mind maps does not provide any improvement of the depth of understanding or the speed at which knowledge is acquired when a given text is mapped. There may be a benefit in the amount of material retained at the end of the class, but that benefit is probably offset by the fact that some class time has been spent on repeating the material and taking notes, which is normally done after class.

The conjecture proposed in this paper is that, in education, mind maps should be used to arrange information that is originally presented in an unstructured fashion. In other words, the material presented to the students should be complete but lacking structure, similar to the notes taken at the end of a brain-storming session. As a matter of fact, a closer look at the uses suggested by Mindjet (2005), reveals brain-storming as the top application of mind mapping in businesses, government, education and home office.

The two questions we try to answer in the remainder of this paper are:

1. How do we separate content from structure?
2. Are there any advantages in learning by rebuilding the structure of a given content?

Separating content from structure

To discuss the topic of teaching and learning, we need to introduce a definition of the various levels of knowledge. Until 2001, the most widely accepted hierarchy of knowledge was one proposed by Bloom (1956) under the name of Bloom's taxonomy. Bloom's taxonomy defines six levels of learning, ranking from lowest to highest: 1. Knowledge, 2. Comprehension, 3. Application, 4. Analysis, 5. Synthesis, and 6. Evaluation. In 2001 those levels were revised by Anderson and Krathwohl (Atherton 2005) to become: 1. Remembering, 2. Understanding, 3. Applying, 4. Analyzing, 5. Evaluating, and 6. Creating. These levels of knowledge build upon one another. Lower level knowledge must be acquired before one can advance to the next level of learning. The main differences between Bloom's taxonomy and Anderson and Krathwohl's taxonomy are at the higher levels of learning. The first four levels are practically identical.

The two highest levels of learning, namely evaluating and creating, are a culmination of the learning processes and require many hours of "lower level" learning. It is this "lower level" of learning that is addressed by the mind mapping technique described below.

Consider, for instance, the task of teaching about a certain type of building material, such as wood. Having the students read the material in the book should suffice to learn the first two levels of knowledge (remembering and understanding), yet most of the students will probably be discontent with such an approach and will lack the discipline required to retain (remember) the material. So, according to Edgar's cone of learning (see Figure 1), the retention rate is only 10%. The current trend is for the instructor to present the material in a lecture, usually using PowerPoint sprinkled with some humor. With this method, the expected retention rate is between 30% and 50%. In one of the continuing education classes I teach, I need about two hours to present the fifty slides referring to wood. At the end of the two hours, there is little time and energy left to go to the next two levels of knowledge, namely application and analysis of the knowledge.

According to Dalton and Smith (1986) the next two levels of learning are induced by asking the following types of questions:

1. Application - Do you know another instance where...?; Could this have happened in...?; Can you group by characteristics such as...?
2. Analysis - How was this similar to...?; What do you see as other possible outcomes?; Can you explain what must have happened when...?; What are some of the problems of...?; Can you distinguish between...?

Getting students to answer those questions at the end of one lecture is difficult not only because they have little energy left, but also because they need more than the 30% to 50% of the material presented in the lecture to be able to answer the questions.

The exercise described below overcomes this problem by addressing the first four levels of learning in a very efficient way. In essence the students are given all the material at once and in an unstructured fashion and are asked to construct a structure of ideas that helps apply and analyze the newly acquired knowledge.

Mind Map Building Exercise

After having the process of building a mind map explained to them, the class is divided in teams of three to four students. Each team is given a **shuffled** stack of business-card size printouts of the PowerPoint slides, one large sheet of paper (27" x 34" easel sheets work well for this purpose), glue, adhesive tape and colored felt-tip pens. The teams are then asked to organize all the slides in a mind map. This exercise takes place in two rounds.

First round is a competition between the teams on the time it takes to produce a quality mind map. The first team to finish the mind map hangs it on the white board, followed by the second team, third and so on, thus forming a queue. As they come up to the white board, each team is then asked to “question” the map of the previous team. If they can find logical mistakes in the mind map, and those mistakes are endorsed by the instructor, the team with the faulty map goes to the end of the queue. At the end of this round, each member of the top three teams receives a reward. The reward can be either an object such as an apple, a tootsie roll, a trinket or some bonus points that can be used later in the semester. I have found that, contrary to what one may first think, only about one in thirty students will benefit from a grade increase (say from a B to an A) when bonus points are awarded (Wiezel 1998).

Second Round - Questions. There are two levels at which the second round of the data mapping exercise can be played. At the lower level, the instructor can ask questions of the type described by Dalton (see point 1 and 2 in the previous section). The student who answers first **and** points to the right place on his or her team’s mind map receives a reward. This level is a “learning how to learn” level and is used in the first few data mapping exercises with the class, when the students are not yet used to asking questions. The main purpose of this level is to teach the students about the type of questions that can be asked. In the higher level of the second round, the students are asked to pose questions to the class. The instructor then judges the quality (value) of the question. If the question is “a good question”, the author of the question and the respondent are both rewarded. Alternatively, the quality of the question can be judged by the length of time it takes to identify the answer on the mind map.

Tricks and Tips to the Teacher

This section presents the lessons I have learned during the past two years while using mind mapping exercises in some of my classes.

1. Mind mapping works well for topics that need roughly 50 slides to be covered. This amount of material is hard to follow in a regular PowerPoint presentation and is challenging enough to make the mind map exercise useful.

2. If you have topics that spread over more than one slide, provide hints in the title. Students need to be able to work with “chunks” of information. Some of the questions in the “second round” (see previous section) can be directed towards information hidden in those “chunks” to ensure that students read the information on each slide.

3. It is best to introduce the idea of mind mapping with an example of material presented in class. Start by delivering a regular PowerPoint lecture then distribute handouts and 11”x17” printouts of the mind map (see point 4 below) representing the same material. Have the students identify the information and its links on the mind map. I use some jokes in the delivery of the PowerPoint presentation, and then show on the mind map where I made a joke in the PowerPoint. This helps make an easy reference to particular slides that students are now more likely to remember.

4. To build a mind map in PowerPoint first save the sequential (50 slides) presentation as GIF or JPEG, then open a new PowerPoint presentation, set the page size to 11”x17”, and import each slide as an image. Select all the images and re-size simultaneously. Use the freeform line tool to draw the branches.

5. To save time on cutting and shuffling the business-card size slides, create a special PowerPoint file specifically for this purpose. I call these files “Mixed Slates”. The handouts of these files contain six instances of the same slide on each printed page. To generate a file of “Mixed Slates” follow the steps below:
    a. Generate a randomized list of the numbers of the slides.
    b. Open the PowerPoint file and save it under a different name. (This will ensure that you do have the original sequence of slides.) You will need the original file to print handouts that the students will take home.
    c. In the new file, move the slides in the positions indicated by the randomized list. This can be done programmatically, using VBA, but it is not always worth the effort of writing and debugging a program.
    d. Add five copies to each slide, so that you have sets of six identical slides, one after another. If you started with 50 slides this will increase your file to 300 slides.
    e. Save the file and print handouts of 6 slides per page. You now have as many pages as original slides and on each page you have 6 business-card size images of the same slide.
    f. Cut out the slides following the cutting schema presented the appendix. You will have 6 sets of shuffled presentations. (You may need several sets of 6 for one class.)

Conclusion

During mind map building, students have to read each slide several times and consider how the information on a particular slide links to “the bigger picture”. The two rounds of a mind mapping exercise will take together about 60% of the time it takes to deliver the same material in a lecture format. This was a surprising finding considering that students have to rebuild the data structure that has been discarded. Usually, the teams will quickly distribute the work between them and each team member becomes an expert in a few branches of the mind map. There is a lot of slide trading between “experts” and they start questioning the position of each slide on the map. The exercise is very dynamic and the instructor should be comfortable in having the class in disorder.

If the instructor is successful in implementing level two of the second round, the mind map exercise will cover al six levels of learning as presented in Bloom’s taxonomy. According to

Edgar's cone of learning, because the students are actively involved in (re)generating part of the knowledge they ultimately learn, the expected retention rate is above 70%.

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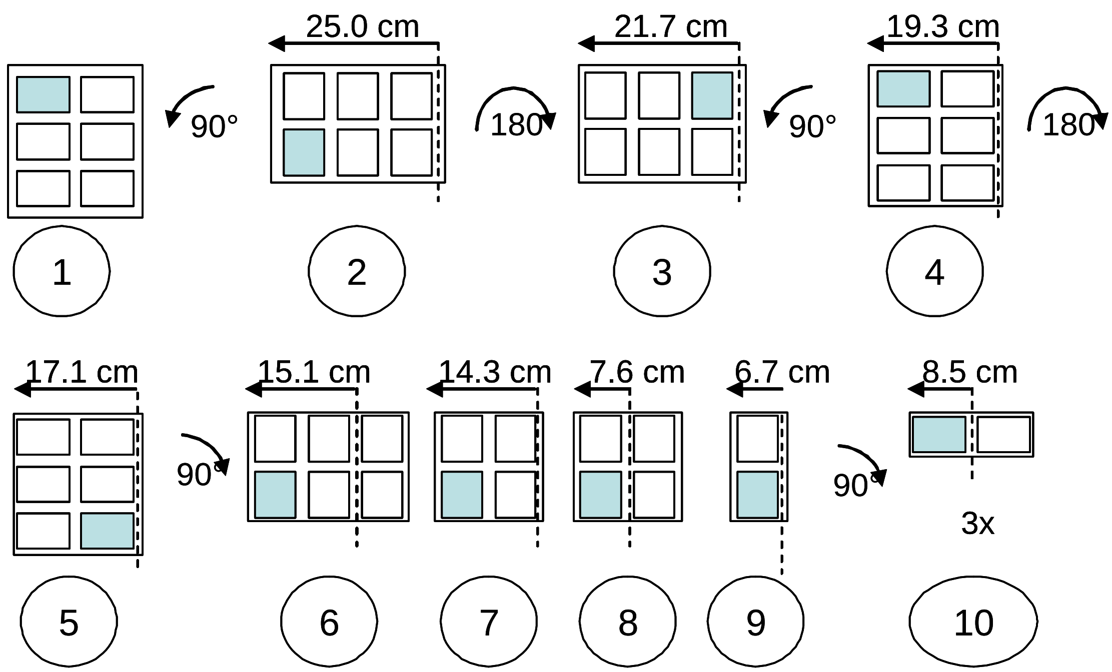
APPENDIX

Cutting Schema



Student-Centered Learning Environment During Undergraduate Education in Construction Engineering and Management – Developing a Construction Consulting Project

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Abstract

Construction engineering and management education is facing special challenges that lie within the nature of the subject area itself. Construction is a highly interdisciplinary profession whose body of knowledge has grown since its formal conception several decades ago to reflect the manifold dimensions of the projects that construction engineers and construction managers are controlling. New learning models need to be explored in teaching to avert the risk of conveying this knowledge to students at the undergraduate level in a fragmented and irrelevant manner. This paper presents an innovative teamwork approach used in a sequence of two undergraduate construction courses at The Catholic University of America (CUA). Following an introduction of student-centered learning, the *Construction Management Consulting Project* is outlined in its major phases and features, including its realistic scenarios, its modular integration with classroom knowledge, and its review and final documentation. They are linked with the six levels of competence in Bloom's taxonomy of learning and consider different learning styles. Research studies have confirmed the success of such project-based and student-centered learning environments. The paper concludes with feedback from students and with recommendations for implementing learning experiences that actively engage students to grow into the leaders of tomorrow's construction industry.

Introduction

Construction engineering and management education needs to give students the technical and personal skills for being successful in a practical work environment where they will solve real problems in the complex interplay of the various dimensions of the project. Construction itself is the youngest and most interdisciplinary specialization within civil engineering. Its research areas and teaching agendas have been developing dynamically since its inception as a separate discipline. Characteristic are the breadth of topics that it encompasses, e.g. scheduling, estimating, operations planning, and contract administration, and the many additional fields from which it draws specialized knowledge applicable to the successful planning and execution of construction projects. For construction courses in an undergraduate curriculum this wide array of topics poses a challenge to not present a fragmented accumulation of the construction body of knowledge within the limited amount of time, but to achieve a meaningful and deep integration.

Needs in Construction Education

Several authors have contemplated the current situation and future demands on education in construction engineering and management. Bordogna (1998, p48) argues that in light of the "increasingly complex and interconnected" nature of the systems that sustain our lifestyle in its "social, economic, environmental, legal, and political" setting, there is an ever-growing need to provide an educational training ground where future engineers can obtain “a broad, holistic background” and develop integrated skills. He criticizes that “[p]resent curricula require student to learn in unconnected pieces, separate courses whose relationships to one another and to the engineering process are not explained until late in a baccalaureate education, if ever” and calls for ways to allow students to become “master integrators” (Bordogna 1998, p49-50). Earlier, Jester (1990) had encouraged bringing a stronger systems perspective into the civil engineering curriculum. Fondahl (1991) had also emphasized developing teamwork skills in students to prepare them for their roles in the professional relationship between owner, engineer, and contractor. The consensus nowadays is that communication, teamwork, systemic thinking, creativity and an understanding of societal issues are important pieces of engineering education, adding value to the traditional analytical emphasis on mathematics and the natural sciences. More than ever before the old saying applies that engineers are hired for their technical skills, fired for their lack of people skills, and promoted for their management and leadership skills. Sawhney and Mund (1998, p1319) stressed previous research findings that “students learn more effectively and permanently when they can actively participate in the learning process” and underlined the need for integrated learning, as “curricula do not give students a holistic view of their field of study” but fragment the information into many specialized but unconnected courses. Senior (1997, p45), in his discussion of simulations and case-based instruction in construction, is of the opinion that “[p]ractical activities are probably more important than theory in this field.” Chinowsky and Vanegas (1996) support returning to an educational approach that is generalist and sought by industry employers, noting that the focus on modeling and simulation of construction operations has furthered the fragmentation. The consulting project described in this paper turns their vision of an integrated learning system specifically for construction management into reality. In particular, different from the case studies criticized by Rojas and Mukherjee (2005) as being limited due to missing context, the consulting project provides a rich situational learning environment in which the students themselves create most of the materials under the guidance of the instructor.

Student-Centered Learning Philosophy

Student-centered learning is an approach that reconciles the confusion that oftentimes exists in the exact use of the terms teaching and learning. Using the analogy of manufacturing for the educational process, teaching is to learning what the process is to the product. One could also compare the teacher-centered style to a ‘push’ model in the manufacturing chain and the student-centered style to a ‘pull’ model. Cannon (2000) defines student-centered learning as a new way of thinking about education:

> *Student-centred learning describes ways of thinking about learning and teaching that emphasise student responsibility for such activities as planning learning, interacting with teachers, and other students, researching, and assessing learning.*

The student-centered learning philosophy thus puts much weight on the students as the clients and beneficiaries of, and indeed the reason for the entire educational process. Since students are given more freedom and responsibility for their own learning progress under this approach and are expected to be active participants rather than merely passive recipients, it may initially be met with uncertainty and irritation by them. However, numerous studies, e.g. Barr and Tagg (1995) have shown that student-centered learning yields more lasting educational experiences, as the students themselves will eventually perceive the value of being actively involved in their own learning, e.g. through creating study materials themselves, and will consider it more rewarding. Clearly, it also places higher expectations on the teacher, who can no longer recite a much-repeated monologue anymore but rather has to carefully and flexibly guide students in "learning how to learn" by using the particular topic at hand as sample contents to practice this new skill. Instructors will have to be more creative in their evaluation of the broad spectrum of work products that their students generate, which will no longer be so straightforward, e.g. answers to true/false questions As demonstrated in this paper, it is possible to evaluate students just as clearly under the student-centered approach as under the teacher-centered approach with its traditional assessment methods.

The spirit of student-centered learning is fully reflected in the eleven Engineering Criteria 2000 of the Accreditation Board for Engineering and Technology (ABET), whose new approach focuses on learning outcome (Abudayyeh et al. 2000), not on teaching input, and includes problem solving in teamwork among its requirements. As Cannon (2000) explains, project-based instruction is an excellent way to incorporate student-centered learning into an engineering curriculum. The following sections describe the innovative student-centered approach of the construction management consulting project (CMCP), an extensive teamwork activity spanning two consecutive undergraduate courses of the Construction Engineering and Management Program at The Catholic University of America (CUA).

Consulting Project Features

The semester project is a semi-realistic construction project. Working in teams of four, students act as construction management consultants (CMC) to the owner, who in this role-play is embodied by the instructor. The CMC teams are tasked with developing full guidelines for a successful execution and completion of their project. The results of these efforts are documented in a comprehensive project execution manual. The design only is taken to the level of detail of line drawings with a plan view of the space layout and landscaping and elevations of the structure. The following table of contents lists items addressed by the CMC teams in order of their typical occurrence in the project delivery process: Feasibility, marketing, and environmental impact studies, preliminary design and specifications, engineering, estimating and bid preparation, permits and approvals, financing arrangements, planning, organizational structure and interface coordination, staffing, suppliers and procurement, schedule preparation with milestones and incentives, contract development and administration, construction means and methods, safety program, quality control, development of project controls, turnover and start-up preparations, facility operations and maintenance, cash flow forecasting, and other requirements as deemed necessary. Specifics of the project and its site are a combination of actual data, e.g. materials and labor costs, and justifiable engineering assumptions, e.g. forecasted rental or sales revenues. The estimate and schedule are based on a preliminary take-off with about 75 activities. Scenarios include a new engineering building at CUA, a 15,000 m^2 two-story anchor store for a mall, an upper-scale fitness and health spa club, a country club with support facilities, a 10,000 m^2 multi-story senior citizens' residence, and a 250-slip marina to dock and service pleasure craft.

Levels of Learning and Project Elements

Bloom's (1984) classic taxonomy of learning has been implemented in designing countless educational programs. Its hierarchical levels of competence have also been used in the elements of the consulting project as shown in Table 1.

Table 1: Bloom's Taxonomy of Learning and CMCP Elements
(Adapted from Bloom 1984)

Level	Competence	Instructional Activities	CMCP Elements
6	Evaluation	Critique, evaluate, justify, optimize	Progress review, incorporation of feedback
5	Synthesis	Create, design, formulate, propose	Project specifics development, data research for scenario
4	Analysis	Classify, derive, predict	Feasibility, marketing, and environmental impact studies
3	Application	Apply, calculate, solve	Cost estimate and construction schedule development
2	Comprehension	Describe, distinguish, explain, paraphrase	Project presentation, project execution manual
1	Knowledge	Identify, list, outline, recite	Project phases breakdown, specifications

It has been noted that a discrepancy may exist between the traditional teaching styles of professors and the predominant learning styles of students. Recognizing that learning is "a two-step process involving the reception and processing of information," Felder and Silverman (1988, p674) revised early models of learning styles that were based purely on the human senses, leading to the well-published distinction into visual, auditory, and tactile or kinesthetic learners, and developed a model that in its updated form comprises four dimensions. These are perception, input, processing, and understanding with their respective individual preferences of sensing or intuitive learning, visual or verbal learning, active or reflective learning, and sequential or global learning. The elements of the consulting project have been specifically designed to address such different learning styles as listed in Table 2.

Table 2: Learning Styles and CMCP Phases
(Adapted from Felder and Silverman 1988)

Dimension	Preferences	CMCP Elements
Perception	Sensing	Design drawings and descriptions
	Intuitive	Creative development of specifics
Input	Visual	Visiting location, design development
	Verbal	Project presentation, review session
Processing	Active	Teamwork, discussions
	Reflective	Incorporation of feedback
Understanding	Sequential	Lecture series, project life-cycle steps
	Global	Project execution manual

Project Phases

Both civil engineering and architecture students enrolled in this cross-listed course sequence. Their different backgrounds were taken into consideration when CMC team assignments were made, enabling them to gain from each other's diverse skills. The following sections outline the individual project phases and features. Regular lectures, including guest lectures by industry experts and visits at various types of construction sites, continued during the project work in topical modules that built on the previous semester in a sequence that was coordinated with the developing project materials. Project activities were woven into the schedule to complement the classroom sessions.

Initial Work and Consulting

At the onset of the project, the owner and the CMC teams extensively discussed the desired nature of the completed facilities with respect to scope, location, design, and functional details. Afterwards, the owner was flexibly available as requested by the CMC teams. While not required in the original assignment, several CMC teams visited their respective project location, investigated its surroundings, and selected a specific site, which they documented in digital photos and later included in the project execution manual, in some cases with CAD renderings inserted into the photos.

Progress Review and Report

About halfway through the consulting project the CMC teams participated in a progress review to keep the owner informed of the progress achieved in planning the project. Part of the review was the written progress report with a depth approximately equivalent to a 50% design review. It contained at least a formal description of the progress, areas identified to still be addressed, major concerns and suggested solutions, and aspects of the project that are typically completed at an early date, e.g. location and environmental setting, a preliminary design contract type, organizational structure, and feasibility, marketing, and environmental impact studies.
The CMC teams met with the owner in a review session for which they were asked to select and formally present specific issues. Should competing options exist for a particular issue they were asked to develop such alternatives in sufficient detail, present their advantages and disadvantages to the owner, and receive guidance in choosing. Each team was given extensive feedback, both during the meeting as well as in written comments, on the work that they had performed, and directions for continuation of the work and potential areas of improvement.

Project Execution Manual and Presentation

At the conclusion of the two-semester course sequence, the CMC teams prepared a project execution manual with its detailed explanations of each topic. A sample table of contents as listed above under Consulting Project Features had been provided. The teams were briefed about elements of good presentations, effective use of visual aids, and rhetorics skills to prepare them for their oral 25-minute presentations. Presentations required participation of all team members and were open to the university public. The School of Engineering at CUA was equipped with several “smart classrooms” whose information technology the teams could use for their presentations. Audience members commented favorably on the quality of the work products and the professionalism with which they were presented. Evaluation and grading of the manual and the presentation strongly considered that in reality these materials should ultimately convince the owner to hire the CMC team as experts for consulting on the actual construction project.

Assessment Techniques

All aspects of the consulting project are considered to determine the overall grade. A detailed catalog of evaluation criteria, each with their relative weights, for all individual work products is distributed at the onset of the project work. Criteria cover the completeness and structure of the contents and the accessibility and clarity of its communication. Additional materials with specific information on how to produce different types of professional quality engineering submittals are made available to the CMC teams. Work that goes beyond the announced requirements and adds relevant new dimensions to the individual project scenarios can receive partial extra credit to stimulate and reward creativity.

Student Feedback

Anonymous feedback was solicited from the students to obtain the widest range of possible comments. An intermediate survey questionnaire with open-ended questions was distributed at mid-semester and a survey was again distributed at the conclusion of each semester in addition to the official university course evaluation. These snapshots of the students' perception allowed gaining insights into developments during the project. The following representative transcriptions are a sampling of the students' reflections on the course sequence, the consulting project, communication, and teamwork from both the original course evaluations and from the surveys.

Please give your opinion about the course:

> *The project helped in pulling everything together*[.] *Helped in my greater understanding of the basic fundamentals of const.*[ruction] *management* [.]

What is the idea or concept that will stay with you the longest?

> *The concept of working as a group. The group project helped me understand the complete concept of const. management.*
>
> *The semester project helped me understand the construction process very well.*

What have you learned about construction management through this semester project?

> *I learned a lot about the overall construction process and all that is involved in getting a project off the ground* [.]
>
> *Am*[oun]*t of planning + coordination that goes into construction B4* [before] *construction + the importance to do so.*
>
> *There is a lot that goes into a project. Communication is probably the most important part of construction management.*

What have you learned about teamwork through this semester project?

> *it is difficult to coordinate Architect + Engineers, especially when randomly chosen* [.]
>
> *that commitment, flexibility, and fairness is essential for a team project's success.*
>
> *It's not easy, but with good communication you can have a successful project.*

A former student who now works as an Office Engineer with a major construction contracting company wrote in retrospective:

> *The project definitely helped in the bringing together of the various aspects and smaller disciplines that make up construction management as a whole. Being able to see and help guide a project from a concept to a reality proved very exciting, but for me however, the most important aspect was the opportunity to function as part of a team. Evaluating the team members, focusing everyone on their individual strengths and coming together for brainstorming sessions is what I believe led to successful project. It was seen then and I've seen it since on other projects, both in school and in the field.*
>
> *As a personal note, I believe it helped quite a few of us realize that we are all capable of emerging as valuable contributors to a project team. This role is key on construction sites*

and also for one's own personal advancement. The ability to draw and learn from those whom we work with has proven invaluable in both my past and current position, and I am of the belief that it began during my academic career by participating in assignments such as the CM Consulting Project.

Quintin K. Hackshaw, Class of 2005

Recommendations And Conclusion

Based on several years' worth of experience since first implementing the consulting project at CUA, the author believes that it offers the opportunity for a rich educational experience in a fully student-centered learning environment. If implemented at a university program in construction engineering and management, its semi-realistic project scenarios should be located in the vicinity of the campus so that the students on the CMC teams can relate to the location, and through visiting it and researching actual data pertaining to the particular site achieve a degree of realism that is just one step below performing real field work for a construction contractor during a summer internship. One improvement planned for upcoming iterations of the consulting project is stronger industry involvement. Representatives of the regional construction industry, e.g. from the departmental advisory board as recommended by Abudayyeh et al. (2000) or from the many CUA alumni in the metropolitan region, could become engaged beyond serving as guest speakers; rather, the CMC teams could be assigned industry mentors who could share their experiences during project development, facilitate visits to the offices of construction management companies, and would also form an expert panel to whom the final presentation is given. Moreover, student comments support the addition of a peer evaluation component to the overall assessment, including self-evaluation of their own performance as described by Riley et al. (2004). Such team evaluation can use a range of questions that measure various aspects of the teamwork. Each question would carry 100 points that the students distribute among all team members. Equal points would represent equal contributions by each team member. The instructor then calculates the average percent for each person and multiplies it with the project grade to obtain the individual grades. Open-ended questions should be included in the questionnaire to capture any issues that the students consider essential in reflecting upon their learning experience with the consulting project.

Acknowledgement

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Construction Industry Craft Training: Experience to Date and the Path Forward

by
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Abstract: The issue of craft shortages is not new to the North American construction industry. Research in the early 1980s by the Business Roundtable forecasted severe work force shortages in the open-shop sectors if more effort was not employed to recruit and develop future craft workers. As predicted, craft shortages appear to have worsened. Recently, a study by the Construction Users Roundtable in 2001 indicated widespread and worsening work force shortages. Several factors have contributed to the craft shortages including declining real wages, unattractive industry image, poor work environment, lack of stable worker career paths, and insufficient training opportunities for craft workers. Addressing the training needs of the construction work force is a first step towards assuring that an adequate work force will be available in the future. While there is resistance to training from both some companies' reluctance to provide training and crafts' resistance to receive it, training does exist in many forms from formal apprentice programs to informal on-the-job training experiences. This paper reviews known issues that craft workers experience with the different forms of craft training, including experiences in both the union and open-shop sectors. Next, the paper examines programs utilized by the construction industry to promote craft training, which include craft certification programs, funding mechanisms to promote training, and income support systems for craft workers to enable their pursuit of training. Known deficiencies of these and other programs are reviewed as well. Finally, the paper outlines an approach to quantify the effectiveness of craft training.
Although some of the observations apply to all construction, our focus is primarily on industrial construction work.

Introduction

The union sector of the construction industry traditionally has conducted the bulk of training of skilled craft workers. In 1982, the Business Roundtable Construction Industry Cost Effectiveness Project Report reported that the union sector provided 90 percent and the open-shop sector provided 10 percent of the expenditures on formal training, even though 60 percent of the construction market was open shop and 40 percent union (The Business Roundtable, 1982).

The 1982 Roundtable report forecasted severe work force shortages in the open-shop sectors if more effort was not employed to recruit and develop future craft workers. As predicted, craft shortages appear to have worsened. Several recent reports have indicated widespread and worsening work force shortages (Business Roundtable, 1997; CURT, 2001; Construction Industry Institute, 2003). Many factors have contributed to the craft shortages including declining real wages, unattractive industry image, poor work environment, instable employment on constantly changing jobs sites, lack of recognized worker career paths, and insufficient training opportunities for craft workers (Tucker et al, 2001).

Yet today the construction industry remains the only major goods-producing industrial sector in the US where employment is still growing. The U.S. Bureau of Labor Statistics (BLS) projects a need for additional 125,000 craft workers annually both to fill new jobs and to replace workers leaving their jobs.

The problem is not just lack of training opportunities but also overcoming an unattractive image to successfully recruit and attract workers to the industry and to find ways to keep them employed. Addressing the training needs of the construction work force is a first step towards assuring that an adequate work force will be available in the future. While there is resistance to training from both some companies' reluctance to provide training and crafts' resistance to receive it, training does exist in many forms, ranging from formal apprentice programs, to short-course task training, to informal on-the-job training experiences.

Programs to Promote Craft Training

In the union sector . The union sector has developed training institutions to cope with the problems raised by construction labor markets where attachment between workers and individual employers is casual, jobs and job sites are ever changing, and employment is subject to cyclical and seasonal fluctuations. In this environment, individual employers tend to under-invest in training because they fear losing their investment as workers who move to other employers. Multi-employer sponsorship and training trust funds negotiated through collective bargaining help alleviate this problem by offering a means to share the benefits and costs of training among all stakeholders in the industry—workers, contractors, and unions. Whether or not contractors train apprentices themselves, all firms pay the same negotiated rate per hour worked into a dedicated training fund. The rate varies widely by trade and area. In some trades, a portion of this rate goes to national training funds, administered by national joint apprenticeship and training committees. The general mission of these national training funds is to improve the quality and uniformity of training. The national funds commission studies of future technology and developments affecting the craft, develop curriculum materials and conduct instructor training, make arrangements for college credit, monitor the quality of local programs, and provide special training assistance or equipment where it is needed.

While the union sector represented an estimated 20 percent of the construction market, they sponsored nearly three-quarters of the registered apprenticeships during the period 1996-2003 (Glover and Bilginsoy, 2005). Overall, jointly sponsored programs have higher enrollments, greater participation by minorities and women, and enjoy significantly higher rates of apprenticeship completion than registered apprenticeships sponsored by employers alone. Yet even among jointly sponsored programs, more than half of apprenticeships are cancelled and a large portion of these were cancelled early in the apprenticeship before significant skill acquisition could occur. Participation of women remains low, which effectively limits the available pool of applicants to the industry. Overall, the average age of a starting apprentice was

27 years, which raises the question "How might the industry reach young adults earlier to bring them to full levels of productivity?"

Apprenticeships in the union sector face significant challenges, however. For example, it is often difficult for local union officials–who must stand for elections regularly– to agree to start sufficient numbers of apprentices in a declining market with journeymen union members unemployed. Also, many union members reach journeymen status without completing an apprenticeship. Some unionized employers question whether the apprenticeship system is efficient and what return they are getting for their mandated investment.

Training developments in the open shop. Most non-union construction contractors do not sponsor registered apprenticeships. In fact, until the last decade or so, only a few of the largest firms sponsored much formal training at all. While open-shop contractors respect the skills produced by apprenticeship, especially in the mechanical trades (electrical work, plumbing and pipefitting, sheet metal and air conditioning work), they favor more flexible, less formal and shorter-term methods. Many open-shop employers tend to offer task training on an "as needed" or "just in time" basis. The non-union sector also tends to place greater responsibility for skill development on schools and individual workers.

A long-standing problem in open-shop construction has been the lack of institutions to organize and fund training as well as establishment of a consensus on skill standards and certifications. In 1995, eleven large national construction companies and several national contractor associations established the National Center for Construction Education and Research (NCCER) as a non-profit education foundation at the University of Florida "to address the severe workforce shortage facing our industry and to develop industry driven standardized craft training programs with portable credentials" (NCCER, 2006). The NCCER has developed curricula, assessments, and certifications for 22 construction specialty skill areas, and, in collaboration with the American Petroleum Institute, another 15 specialty skill area in pipeline installation and maintenance. Curriculum development has been an emphasis since the inception of NCCER in 1995. Current curriculum materials as published as the Contren® Learning Series. NCCER has also negotiated arrangements for college credit for learning in NCCER training.

NCCER offers craft certification for individuals through written tests and performance testing. Craft workers who pass both the written and the performance certification tests are designated by NCCER as "Certified Plus" craft workers. Certified craft workers are listed on an electronic National Registry that is accessible by participating employers. In addition to certifying the skills of individuals, the NCCER has begun an initiative to review and accredit construction training programs in high schools, community colleges and proprietary schools.

To facilitate funding of training programs, the NCCER has established a National Training Service Agreement. Through this voluntary agreement, participating contractors contribute 15 cents per craft labor hour worked into an individual account that NCCER establishes and maintains for the contractor. Of the hourly contributions, 13 cents are available to be reimbursed to the contractor on submission of appropriate invoices for training expenses. The remaining 2 cents are used for national activities such as curriculum revision and updating, maintenance of the National Registry, and program development. Through this process, the NCCER service aims to provide third-party verification to construction owners that the contractor is conducting training and that funds paid for training by owners are actually used for training and certification.

Important considerations in construction craft training

Types of projects. Maintenance offers more steady work and is typically characterized by relatively low turnover of craft personnel, which fosters training. In contrast, construction capital projects involve a temporary buildup of work force. Staffing “green field” sites located in isolated rural areas away from population centers can be especially difficult. Perhaps the most challenging types of projects to staff are “outages” or “turnarounds” because they generate huge short-term demands for workers. Due to cyclical certification requirements on machinery and the needs to get ready for peak seasonal demands, major construction owners find themselves with little flexibility in coordinating the timing of outages with owners of nearby facilities. The results are often extraordinary peaks in employment that are not sustained.

Differing time horizons from various perspectives. Time horizons differ significantly by perspective. A traveling contractor coming into an area for a limited duration capital project, a contractor who stays in area (closer to an industry perspective), a worker seeking a short-term job, worker seeking a lifetime career, the industry as a whole, the government—all these have different perspectives and different time horizons. The time horizon is important because it determines the period over which benefits accrue in a return-on-investment framework.

Nature of the tasks and skills involved. Some projects involve “one of a kind” or unique functions; others feature a significant proportion of repetitive tasks. Projects with high proportions of repetitive tasks are more suitable to task training. Also, the shortage situation varies by craft; some construction skills are in especially short supply (e.g., currently certain welding specialties and boilermakers). A challenge with construction work and training generally is that many of the craft jobs require significant skill levels that cannot be acquired overnight or learned quickly. Further, most construction skills cannot be taught effectively in a classroom alone. They are best learned in a combination of classroom and worksite venues. The skills must be learned and practiced on the job through experiential learning; but without being properly structured and organized, learning on the job can interfere with productivity and safety.

Breadth of training/skills developed. The possible breadth of craft training ranges from individual task training to full craft training to training in several crafts. Confusion over the definitions of the terms “multi-skilling” and “multi-crafting” obscure these topics. Some union spokesperson have resisted or objected to the terms “multi-skilling” and “multi-crafting,” yet at the same time, most union sector apprenticeships cover multiple skills or crafts (depending on definitions). Union officials recognize that the broad training offered in apprenticeships allows a worker to be employed more continuously and facilitates job referral.

Multi-skilling offers potential benefits to workers and employers alike. Multi-skilled employees can be kept on a project longer, thereby extending their employment and increasing earnings. Multi-skilled employees have greater flexibility and thus facilitate management of a project, reducing the need for turnover (which, in turn, improves project safety and reduces expenses). Analysis by Haas et al (1998 and 1999) has revealed that while there are significant benefits to employing multiskilled workers on a project, there are limits to the returns of proportions of multiskilled workers on a construction project. But some critics wonder even how multi-skilling can be considered when funding for even single-craft training is so insufficient.

As important as technical craft skills are, whether these skills are actually used on project is equally vital. Borcherding et al (2001) outlined a fuller vision of the trained worker in construction in the "Tier II strategy" and developed metrics to measure implementation of this concept. The Tier II journeyman is well prepared in management skills, including such skills as cost management, computer use, and short-interval planning. In addition, the Tier II project is organized to facilitate craft workers using their technical and management skills. This includes designing projects with high performance work teams who have full authority and information to make full use of their skills.

Promising Approaches to Promote Craft Training

Efforts are currently underway to overcome the barriers and challenges that have hampered craft training in the past. These include the following:

Skill certification. The problem with certification in the past is that there have been no generally accepted industry-wide standards in the nonunion sector. With the development of NCCER certification, industry standards are coming into place. They are not perfect and do not yet have the confidence of all in the industry; but the standards and certification procedures are improving over time. Certification of craft workers is increasingly required by major construction owners as part of the bidding qualifications for all their construction contractors and subcontractors. In part, these requirement are motivated by a perceived decline in the quality of craft workers over time. For example, in November 2005, ExxonMobil began requiring Craft Skill Certification for all craftworkers among its contractors and specified the certifications to be used. The allowable certifications include completion of an apprenticeship in the union sector and NCCER "certified plus" certifications in the open-shop sector.

Mechanisms for funding craft training. The challenge of filling the needs for craft training requires funding, which can come from only three sources: the firm, the individual being trained, and/or the government. Ideally a collaborative approach involving all three sources is needed. Individuals pay by investing their time in training, by cash payments for tuition, or by accepting lower-than-market wages during the term of their training. The union-sector apprenticeship model and the NCCER training service offer two examples of approaches to overcome the special challenges posed by construction labor markets.

Training evaluation and the business case for craft training

In contrast to other industries, little research has been devoted to evaluating the returns to training in construction (Glover et al, 1999). Cox (1999) has produced one of the more carefully researched studies of returns to training in construction; however, his research focused on task training, rather than full craft training.

Current CII research aims to quantify the effectiveness of craft training, which includes outlining the business case to examine the benefits and costs of craft training programs and evaluation of the tradeoffs that companies should consider for training, e.g. technical versus craft management skills and hiring costs versus training costs. Considering that a myriad of factors simultaneously impact construction performance on a jobsite, it was determined that directly measuring the impact of craft training on say a crew's productivity was not feasible or would likely produce unreliable results. Instead, this CII research effort has outlined the framework for a decision making system that proposes a meta-analysis to utilize a series of case studies and existing datasets that document organizations' experiences with their training effort through both quantitative and qualitative evidence. It is anticipated that this expert-type system would be used to provide answers that industry commonly encounter when engaged in craft training decisions such as how companies can maximize their training return-on-investment, the effects of training on an individual worker, and the reasons why more craft workers do not seek training..

Conclusion

Continuing demand for craft workers in the face of increasing reports of shortages of qualified workers and declines in the quality of applicants for construction jobs prompt a need to examine sources of construction training. Without significant increases in craft training and resulting improvements in the availability and quality of skilled craft workers, the future of the construction industry is at risk. The current training infrastructure in construction consists of apprenticeship training, company craft progression programs, community colleges, trade schools, school-to-career programs, national cooperative training efforts, military construction force training, and various forms of structured or unstructured on-the job-training (OJT). The question remains, however, of how effective training efforts are in construction. Although training has many logical positive impacts on construction performance, such as productivity, quantifying the impact is not always possible, at least in a direct manner. Not knowing the effectiveness of craft training efforts impedes the development and implementation of the craft training programs throughout the North American construction industry.

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(Fr)agile Innovation in Small Professional Service Firms

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Abstract

The success of small professional service firms in the construction industry is heavily dependent on the creation and exploitation of innovation within and through localised professional-client interaction which appropriately responds to client and project specific characteristics and needs. The enduring challenge for professional service firms is how to capture and amplify the benefits from innovation activity across fragile individual knowledge worker to individual knowledge worker, and project to project boundaries.

This paper presents empirical findings from a longitudinal case study on the role of leadership and innovation championing in a small architectural practice in the United Kingdom. The case study consisted of exploratory and action research phases. The findings indicate that senior managers have a critical role in nurturing and harnessing the creative tension between fragile, intrinsic motivations of individual professionals and agile extrinsic motivation to develop corporate-wide dynamic capabilities and sustainable competitive advantage.

Instruction

The central question we address in this paper is the role of senior managers in successful innovation in small construction professional service firms. Existing research describes the important role of owner-managers in successful innovation within small firms has been demonstrated in manufacturing and service contexts (for example, Carter, 1996; Vyakaram, et al., 1996) and, to a lesser extent, in a construction context (for example, see Sexton and Barrett, 2003). The aim of this paper is use this literature as a point of departure, and to consider the role of leaders in the innovation process within small construction knowledge intensive professional service firms.

The role and unique characteristics of small knowledge-intensive professional service firms within construction

The 'knowledge economy' has grown from its origins to a degree where it is now significantly changing the structure of industry and the key determinants of competition. There is consensus that the knowledge economy is fundamentally based on the 'knowledge' capabilities of people (for example, Dougherty, 1999). It is argued that the knowledge possessed by 'staff' represent a key source of sustainable competitive advantage for individual organisations (Raich, 2002), countries (Porter, 1990) and trading blocs (EC, 2004).

The services offered by these professional service firms (PSFs) are characterised by being highly knowledge intensive in nature. There is significant agreement that the principal means by which this growing body of PSFs create value is through the successful creation and management of knowledge. It is argued that highly qualified knowledge workers are the catalyst for managing knowledge within PSFs (Alvesson, 2001). This is consistent with the recognition that appropriate human capability within construction firms is vital for successful innovation and performance improvement in the construction industry (Slaughter, 1998).

An important starting point in this literature is the 'service' dimension of PSFs. 'A service' has been usefully described as "a process consisting of a series of more or less intangible activities that normally, but not necessarily always, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problem" (Grönroos, 2000:46). The core of the definition is that the generation of successful services demands a high degree of interaction and co-production of the service provision between the client and the service provider (Hansson, 2002). Extending the service concept to professional services, Hill and Neely (1988) characterise a 'professional service' as one where the client is significantly dependent on the provider to define the problem and give appropriate advice.

The literature then moves on to argue that the principal 'provider' of these services is the knowledge worker (Despres and Hiltrop, 1995). A 'professional' is considered as "someone who can act independently while bringing a body of special knowledge to bear in a work situation" (Shapero, 1985:21). Returning back to the services concept, services undertaken by professionals have been referred to as knowledge based services (Wood, 2001). The grouping together of professionals to provide services to clients is known as a knowledge-intensive organisation (Alvesson, 2001).

In summary, PSFs in a construction context have four principal characteristics: professional services are knowledge-intensive in nature; professional services are delivered by knowledge workers; but, professional services are nonetheless co-produced between the knowledge worker and the client; and, the majority of construction professional services are provided by small firms. PSFs thus have unique characteristics (when compared to other types of firms), and these characteristics have a significant impact on the focus and nature of innovation activity. The next section will thus focus on innovation within this context.

Innovation within small knowledge-intensive professional service firms

Innovation is often defined as developing and implementing a new idea in an applied setting, both in the general literature (e.g. van de Ven et al., 1999) and in the construction literature (e.g. Sexton and Barrett, 2003a). The 'new idea' component embraces a range of domains. Rogers (1983:11 emphasis added), for example, defines innovation as "a product or service that is perceived as new by the members of the social system" and that "it matters little whether the idea is 'objectively' new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it. If the idea seems new to the individual, it is an innovation." The key common theme across the definitional debate in the literature is that 'new ideas' are taken to be the starting point for innovation. The central question which arising from this is what is the stimulus for these 'new ideas?'

There are two main schools of thought on the principal stimulus for innovation: the market-based view and the resource-based view. The market-based view of innovation emphasises the role of market factors in stimulating innovation within companies. From this perspective, industry structure and the competitive environment are seen as the principal drivers of innovation. For example, the influences have been articulated as customer-supplier relations (von Hippel, 1988), network configurations (Håkanson, 1989), market conditions (Ames and Hlavacek, 1988), and external knowledge infrastructures (Nelson, 1993).

In contrast, the resource-based view of innovation emphasis is that resources available to the firm, rather than on the market conditions (market-based view), are the principal stimulus for innovation (Barney, 1991; Grant, 1995; Itami, 1987). The resource-based view of innovation emphasis is that firms attempt to identify and nurture resources that enable firms to generate innovation to 'shape' market conditions; rather than the market-based view within advocates that market conditions 'shape' the resources which firms develop and exploit to response to opportunities and threats. The key proposition of this paper is that the market- and resource-based view of innovation can be gainfully linked, by extending the argument that there is mutual adjustment between companies 'reacting to' market opportunities and threats and 'proactively' identifying, developing and exploiting resources and capabilities to secure a foundation for innovation in dynamic environments. The principal stimulus for innovation from the market-based view comes from knowledge workers' relationships with their clients, and the principal resource from the resource-based view of innovation is the knowledge worker. It is the proposition of this paper that the development of the optimal dynamic capabilities which bring these two resources together to co-produce innovation which creates sustainable competitive advantage.

To reiterate, it has been recognised that the knowledge-intensive nature of services is the primary way to distinguish PSFs from non-PSFs, and that knowledge-based services are principally the outcome of the co-production of new innovation between the knowledge worker (resource-based source of innovation) and the client (market-based source of innovation). Further, it has been emphasised that 'new ideas' are the starting point for successful innovation in PSFs. As a consequence, innovation for PSFs should be considered synonymous with a 'knowledge-based' view of innovation consisted of knowledge-based resources and capabilities.

The concept of knowledge-based innovation

De Long and Fahey (2000) offer a synthesis of knowledge as an 'asset' and knowledge as a 'process,' and identify three distinct, but interactive, types of knowledge:

(1)Human knowledge constitutes what individuals know or know how to do, and is manifested in experience, knowledge and skills. Human knowledge is tacit knowledge.

(2) Relationship/Social knowledge exists in relationships among individuals and groups which add value to activities. Relationship knowledge is largely tacit, composed of cultural norms that exist as a result of working together. Relationship knowledge is reflected by an ability to collaborate effectively.

(3) Structure/Structural knowledge is embedded in organisational systems, processes, tools, rules and routines. Structure knowledge is largely explicit and rule based and can exist independently of staff.

These three types of knowledge are proposed as being critical to understanding innovation in PSFs. The argument here is that the appropriate generation of, and conversion between, human knowledge, relationship knowledge, and structure knowledge is essential to successful knowledge creation and thus (particularly in PSFs) successful innovation. For PSFs human knowledge or capital is the principal stimulus for innovation, and its management presents key challenges for successful innovation.

Key managerial challenges for innovation

The human capital of a company is defined as "the sum of competence, compliance and commitment" (Rabey, 2000:23); and, as "the composition of human knowledge, skills and attitude that may serve productive purposes in organizations" (Nordhaug, 1993:50). These two definitions are similar in stressing that human capital represents staff motivation and ability to undertake directed and productive work. The development and use of human capital is particularly important for PSFs. First, knowledge workers are central to the performance of PSFs. Maister (1993), for example, indicates that knowledge workers' expertise and skills, and their ability to influence the client and perform their knowledge-intensive tasks, depends on their personal qualities. The generation of 'new ideas' requires the motivation and in-depth knowledge and experience of knowledge workers (Baumard, 2002), thus the capability to successfully innovate within PSFs is significantly located within human capital. Second, human capital is an important prerequisite condition for the 'absorption' or 'capture' of the value of knowledge into organisational structure. This view is particularly important for small firms, as often a significant proportion of their knowledge about clients and work activities are embodied in a small number of knowledge workers. The concentration of knowledge in a few staff renders small firms especially vulnerable to key staff leaving the firm (Barrett, 1993).

The co-production of professional services demand a high degree of interaction between knowledge workers and clients. Knowledge sharing and creation is thus significantly based on human capital held by knowledge workers and others at work. Adopting De Long and Fahey's (2000) categorisation, this knowledge can be viewed as 'relationship knowledge.' Sverlinger (2000:236 emphasis added), for example, argues that in PSFs that "knowledge about *market* and knowledge about *customers* [are] stored mostly in the *heads of people*." Knowledge located within the knowledge worker can be viewed as 'human knowledge.' The implication of this is that relationship and human knowledge are often not effectively 'structurally' embedded within the firm; rather, they are located within the knowledge worker. This is compounded by knowledge workers tending to exhibit unique behavioural characteristics when compared to non-professionals (Maister, 1993); in particular, they are intrinsically motivated to seek challenging projects and develop new, valuable skills for themselves, i.e. their individual ‘relationship knowledge’ and ‘human knowledge.’ This individual motivation might not always be appropriately aligned to the needs of the organisation (Maister, 1993) – making the coupling between the individual knowledge worker and the organisation *fragile*.

Knowledge workers’ knowledge about customers tends to be personal and anecdotal, situationally prescribed (Clippinger, 1995:28). This ‘person specific’ knowledge held by knowledge workers can be labelled as ‘individual knowledge’ (Simon, 1957). The accrued or cumulative learning and knowledge of individuals has been referred as ‘individual knowledge capital’ (Neilson, 1997:1). The challenge within PSFs is to combine various individual knowledge domains to form dynamic, *agile* ‘organisational knowledge’ in new configurations with feed back to, and enrich, individual knowledge (Bhatt, 2002). Organisations therefore need to develop mechanisms for tapping into the collective intelligence and skills of knowledge workers in order to create a greater ‘knowledge base’ (Bollinger and Smith, 2001). The argument to this point identifies two key managerial challenges for successful innovation in PSFs. First, PSFs need to develop a context in which knowledge conversion takes place not only at the individual level (the knowledge worker and the client), but also at the organisational level (the knowledge worker and its organisation). Second, for this to happen, PSFs need to motivate their knowledge workers to create and engage in this context. These challenges were investigated through a single case study described below.

Case study methodology

An interpretative philosophy was adopted for this research. The rationale for this is that the authors adopt the view that innovation in PSFs cannot be reduced to rational cause and effect relationships; rather, it is a product of idiosyncratic social constructions. Further, the motivation of the knowledge worker requires individual interpretations of the consequence of specific behaviour and therefore cannot be brought together in unconditional causal generalisations that enable the researcher to predict and control individual human actions (Rosenberg, 1994). Within this context, a 22 month single case study research approach was used with an exploratory phase and an action research phase. The research techniques for secondary data collection consisted of a review of the relevant literature; and, for primary data, semi-structured interviews, company documentation, action research ‘real world’ activities and workshops. The primary data analysis research techniques comprised content analysis and cognitive mapping.

Results

Background of the case study company

The case study company, labelled hereafter as ArchSME for confidentiality reasons, is an architectural design studio (‘practice’) located in Manchester in the northwest region of England. Its principal markets are the residential sector: varying from one off commission from domestic clients to repeat business from national house builders. Over the past five years the practice has grown significantly with an increase in turnover from £0.3m in 1999 to £1.6m in 2003. Employee numbers have grown: 12 in 1999; 34 in 2002; and, 40 in 2003. Turnover per employee increased from £25,000 per employee in 1999 to £40,000 per employee in 2003.

Key findings from the exploratory phase and action research phase

It was found that the firm's short-term success was driven to a significant degree by 'explorative' innovation and long-term success by 'exploitative' innovation:

(1) Explorative innovation was viewed as innovation which focused on client facing, project-specific problem-solving. Explorative innovation activity heavily relied on the capacity, ability and motivation of ArchSME staff at an 'operational level' to solve client problems and, in doing so, generated short-term competitive advantage (i.e. project specific). The outcome of this innovation focused on effective and efficient delivery of services to satisfy prevailing external project needs, but were often not embedded in the organisational structure capital due to management attention and company resources being constantly focused on current or near future project-specific considerations.

(2) Exploitative innovation was viewed as innovation which focused predominantly on internal organisation and general client development activity which was not project-specific, fee earning activity. Exploitative innovation activity heavily relied on the capacity, ability and motivation of ArchSME senior management at a 'social' level to improve organisational effectiveness and efficiency to generate sustainable competitive advantage. The distinctive feature of exploitative innovation (compared to explorative innovation) was that new phenomena, systems or structures were securely embedded in the structure capital of the firm.

It was found that the key distinction between successful and unsuccessful innovations was the 'social' or 'operational' knowledge being applied to a specific innovation. Operational knowledge was generated and created in operational interactions where the focus was on solving project-specific issues/problems. These projects were either 'external', fee earning projects, or 'internal' but specific client-driven projects. Social knowledge was generated through social interactions where the focus was on generating non-project-specific innovation which built up general organisational capability, and forged and replenished deeper client relationship over the medium to long term. Moreover, social knowledge was found to have a significant effect on feeding operational knowledge at a specific project level at a future date.

Human capital

The research results confirm the importance of human capital for successful innovation. This is broadly consistent with the prevailing literature which notes that small businesses rely heavily on human capital (Barber and Manger, 1997). The research findings draw attention to the importance of the company's internal capacity, ability and motivation. This is in accord with the literature that stresses that the internal capability to know how to discover, find, filter, gather, store, get access, and act on information to optimise performance is particularly important in knowledge-intensive firms (Correia and Sarmento, 2003).

For explorative innovation, the critical role of staff capacity, ability and motivation is emphasised. This is consistent with the literature on the role and capabilities of knowledge workers (Quinn *et al*., 1996). Indeed, it was found that the nature of knowledge-intensive work encouraged staff to be 'self-motivated' in that they are directly responsible for the creation and use of an idea within a project-specific situation. This is consistent with Maister (1993) who emphasises that professionals are highly self-motivated to perform their own work. This view is extended by Scarborough (1996) and Tampoe (1993) who identify personal growth, operational autonomy and task achievement as key motivators to the knowledge worker.

For exploitative innovation, the research findings stress the dominant role of senior management, employee participation in decision-making and time. First, the role of senior management in exploitative innovation involves the envisioning, creation and application of knowledge. The need for dedicated top management support to motivate senior management to drive through the innovation was emphasised in exploitative innovation. This is in agreement with the literature on SMEs which notes the significance of the role of the owner-manager in small business (Carter, 1996; Vyakarnam *et al.*, 1996). Second, the critical role of senior management in providing inspiration for providing the correct conditions for employee participation in decision-making was particularly pertinent in exploitative innovation. Without appropriate engagement in the decision making process, employees became alienated from the innovation implementation process. Finally, the tension between the short term work pressure and 'surplus' time for move blue sky experimentation was evident. As a consequence, time was generally insufficient to dedicate to exploitative innovation. This is congruous with Chase (1997) who asserts that lack of time is the one of main barriers to knowledge transfer and innovation.

Conclusions

The paper has investigated the role of senior managers in the innovation process within small professional service firms. The case study results indicated that the interaction and co-production between the knowledge worker and the client within a 'project setting' is the principal vehicle for managing and motivating knowledge workers. Knowledge workers are intrinsically motivated to undertake interesting knowledge intensive work in their chosen field – in the case study company's case, to engage with clients to produce high calibre architectural solutions on a project-to-project basis. The research findings indicate that 'senior management commitment' was the key for small professional service firms to manage and motivate their knowledge workers to create and engage in knowledge development and application cycles across individual and organisation, and project to project boundaries. Senior management commitment to appropriate 'leadership' is necessary to generate an inclusive, galvanising strategic vision which balances and progresses both individual and organisational needs within a project-based setting; and, which empowers knowledge workers to meaningful 'participate' in the innovation process and to delegate appropriate 'ownership' and 'accountability' of the innovation to encourage its enduring relevance and success.

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A Move from Project-Based Organisation to Integrated Supply Chain

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Abstract

Recent moves, with respect to procurement, within the UK construction industry have resulted in innovative and new arrangements of supply chain partners. Recent policies, by the Central Government, have now being adopted by local governments, some private clients, and other governmental organisations to ensure that the best value is achieved through these new procurement initiatives. In traditional procurement, projects are awarded individually and contractors have to submit tenders for each project separately, which then result into formation of a project based organisation or one-off supply chain where project participants are taken on board for that specific project. Research shows that, in this type of procurement arrangement, when projects are completed, the supply chain partners usually disperse and move to other projects immediately, without giving enough time and attentions to post project reviews. Therefore, knowledge gained in the whole process is taken away by the individuals involved in the project, and in very rare cases become part of organisational knowledge for any of the companies involved. If those individuals are moved to a different type of project then their knowledge even does not get utilise on other similar projects either! Since, knowledge was neither captured, nor retained, nor shared, therefore, becomes 'rusted' in the minds of individuals. The new innovative procurement initiatives take the above issues in account and bring solutions with it. Therefore, now the way in which work is awarded is changed from one-off project to a stream of similar projects, sometimes called framework agreements. Relationship of client and contractor has now moved from short term period to long term period with continuous flow of similar type of projects. This has now resulted into change in the structure of project team, which in traditional model, work on one project and usually called project-based organisation, to a set of partnering organisations which would now work together with each other on a long term bases on several projects, usually called integrated supply chain. This paper will present these moves, with the help of an example of three contractors from the construction industry in the North West of England, working for a local authority, experiencing the transition from project-based organisation to integrated supply chain. The paper will also sum up some of the key benefits of the new arrangements, one of them is the development of an integrated supply chain as a knowledge-based organisation, where knowledge is not only captured, retained, and shared but new knowledge is also created in form of innovative solutions, processes, and products.

Keywords. Project-based organisation, Integrated supply chain, Knowledge-based organisation.

Introduction

As the abstract suggests, this paper presents the outcomes of and changes experienced due to the adoption of an innovative relationship model (a framework agreement) by a local authority (the client) in the UK with three national contractors, in order to facilitate the move from a project development team to an integrated supply chain, which is working with, and providing services to the client in a specific sector, resulting in building better long-term relationship and development of a knowledge-based supply chain. This case study is being carried out as part of a research project focusing on supply chain integration; details of the research project could be found in other publications by the authors (Khalfan *et al.* 2004; Khalfan *et al.* 2005a).

The Framework was developed by the client to construct educational buildings in the value ranging £500,000 to £5M. The three Constructor Partners were appointed in December 2003, with an aim to retain knowledge and pass it on from one project to another over three year period. The developers are referred as Contractor A, B and C in this paper. Since their appointment, a few Educational Projects have either been completed; some started or are in the early stages of their design. The authority's vision is that the Framework partnership would deliver good quality school buildings that will lead to: Better educational results; Greater inclusion within the community; Better safety and environmental performance; and Reduced demand on future school budgets by addressing whole life cycle costing at the inception of the projects.

The Framework Management Group (FMG) is the overarching management group to steer the project towards its' high level and corporate objectives. It is a representative group that addresses high level issues for the Framework. The core FMG values are: Trust; Honesty; Openness; Commitment; Co-operation; and Respect. There are also different Special Interest Groups (SIG's) within the framework. They are designed to address issues that are impacting framework and project delivery across a global basis, i.e. impacting all or many projects within the framework. The special interest groups cover the following areas: IT; Contracts and admin; Design; Procurement and materials; and Operations.

The following sections present the changes experienced and approaches adopted by all three main contractors while working with the local authority as part of the framework agreement resulting in the move from traditional contracting, one-off project teams to an innovative procurement (Khalfan *et al.* 2005c), and knowledge-based (Asad *et al.* 2005, Khalfan *et al.* 2005b) long-term integrated supply chain partners.

Contractor A

Contractor A believes in the best value procurement with their suppliers and subcontractors and has around 12 – 13 key strategic goals for supply chain management. For the below mentioned activity streams, Contractor A has developed a long term partnering relationship with one company in the North West (NW) of England in order to provide services to the local authority as part of the framework agreement: brick layers; carpentry; plastering; painting and decoration; and scaffolding. Contractor A makes sure that all the above trades are involved at the initial stage of project development so that the best price could be achieved, and also the issues related to the build-ability are resolved by contributing towards value engineering exercise. For other trades and products, contractor A goes for a list of 3 selected suppliers/subcontractor for each trade/product. But in NW region, this list of three is now reduced to one for suspended ceiling and ceramic tiles as well.

Selection process. In order to select the companies, the contractor looks for right size company, which can provide best value with quality labour work. Size, shape, quality of workmanship, quality of the manpower/labour, capacity and capability of the organisation are also considered but price comes last. In some cases, subcontractors are selected based on their speciality, e.g. ground works, etc. Usually three subcontractors and suppliers are selected for each trade and product through PQQ process resulting into the list of preferred organisations and then they are asked to tender for a job. Quality-price mechanism is used to select one company out of three for each trade and target price is agreed. In some cases, this relationship becomes stronger as some suppliers and subcontractors get work continuity because of their performance and the list reduces from three to only one supplier/subcontractor. If the selected organisation does not perform repeatedly, then the list goes from one to three again in order to bring in more competition and best value for client.

Performance measurement. Contractor A believes in measuring performances, verifying the performances of subcontractors and suppliers before partnering with them through site visits and references, and also measuring the performances while they are on site working with the contractor. They have their own key performance indicators (KPIs), which are used to benchmark the performances of suppliers/subcontractors, including: management, supervision, quality, safety, commercial attitude, etc.

Feedback process. All subcontractors and suppliers are given feedback if they were unsuccessful for getting a job. This gives subcontractors, the idea about their competency, capacity, capability, and also the knowledge about their competitors. Also in some cases if a subcontractor has worked with main contractor at the initial stages of project and was involved in giving out prices for the job and took part in value engineering exercises etc, and later on, if dose not get selected for that job then they are given their fees for their contribution. There is always a likelihood that the company involved at initial stages for a particular work would get selected for that job.

Building relationship. Contractor A believes in transparency of information, and shares all the upcoming work and start dates of the jobs with their preferred subcontractors and suppliers. They also use the information from suppliers in the tenders and bidding document, and also pass on their quoted figures to their subcontractors/suppliers as well with trust and confidence. Partnering ethos are further reinforced through the introduction of partnering contracts such as PPC 2000 or JCT partnering contract, between the main contractor and subcontractors/suppliers.

Work allocation. Work allocation is based on the concept that subcontractor/suppliers should take work load as much as they can deliver. The work is usually awarded in the region of 30 – 70 % of subcontractors'/suppliers' turnover. Contractor A does not go for 100% allocation.

Contractor B

Contractor B usually goes for few sub-contractors for each trade, based on their resources and the contract size. For the framework agreement with the local authority, the architectural team, the M & E team, and pre-cast concrete team, are all part of integrated supply chain of contractor B in providing services. There are three preferred subcontractors for the ground works, used for this framework agreement. The list of preferred suppliers and subcontractors for each trade is an evolving list and new subcontractors get on the list as well. For the school projects as part of this framework, drawings and BOQ were sent out to the subcontractors for pricing. Selection was done based on resource capacity; value of work; location of subcontractor; flexible start and finish dates; price; quality; etc. Selected sub-contractors then had a pre-order interview, which is basically the invitation to discuss the project. Feedback is also given, most of the time verbal, to the unsuccessful subcontractors if they approach the contractor.

Selection Process. As discussed earlier, new subcontractors do get on to the select list. Contractor B looks at letter and broachers sent by new subcontractors, and also contact the people for the references, and in case of live projects, contact the site managers. If contractor B is satisfied then they are asked to send the quote for an upcoming job.

Performance measurement. At the end of each project, a list is produced which contains names of all subcontractors. The site manger is consulted for his feedback on the work done by those subcontractors while they were on site. The feedback includes: quality of work; environmental issues considered; progress according to the programme; safety; value for contractor/client; Punctuality and Turing-up; etc. All subcontractors and traders are scored for above mentioned criteria from 1 till 10 as 1 being very good and 10 stands for poor. If the performance of a company is well then they are given opportunity to price the upcoming job, or sometimes nominated for the next project. If a company did not perform then they are taken off from the preferred suppliers' / subcontractors' list.

Work allocation. Contractor B has a specific policy for work allocation. Maximum value of a job awarded to a subcontractor usually does not exceed more than 25% of their turnover.

Select list. Select list of contractor is good for both, contractor and suppliers / subcontractors. Good for the contractor B because they do not have to go out into the market and choose from thousands. Good for subcontractors also because they do not have to market themselves to contractor B, and since they are on select list already, they are given opportunity to provide a quotation. Once they are on the list, they are told about the upcoming work, and if they are interested then they can contact the contractor for the relevant documents.

Getting towards fully integrated design team. On one hand, Contractor B has their own internal architectural and structural design teams, their in house M & E (building services) team for services design, and on the other hand, has very good relationship with their concept architect. Therefore, the design team is actually fully integrated.

Contractor C

The total turnover of contractor C is around £ 350 m and has an aspiration of around £ 100 m from their activities in the NW. Around 3 – 4 years ago, the contractor decided to go for 100 % Partnering throughout their business activities. Before that, most jobs were based on traditional contracting rather than partnering. Now around 90% of the work is done either by partnering arrangements or by negotiations from the companies, which have worked with the contractor C for a long time. The current experience of the contractor on this framework agreement is regarded as a very good learning opportunity by the senior management. The contractor has also worked with the local authority before using JCT 98, where everybody on the project was struggling for the information from each other; problems related to extension of time; and increased cost for client; etc. Now the contractor C has moved on from all the above mentioned problems to a long term partnering relationship with the authority.

Learning from projects. In the past, contractor C never finished projects on time for the authority, but working on framework has brought improvements and now achieving completion dates for the school projects. Overall relationship and understanding with the client has also improved since the framework agreement was started. Being some sort of supply chain in place with architects on board with the contractor, most of the design brief and information from the client have managed properly. The learning form a school project with the client is taken and reported back to the staff of the company, which results into organisational learning. This is then used on new school projects within the framework. In some cases the learning has already been taken back to some non-framework projects done for other authorities. Contractor C also had their regular subcontractors for example, for brick lying, window manufacturer, etc. and had brought them along to this framework agreement.

Selection process. For electrical and mechanical contractors, contractor C has a list of selected or preferred sub-contractors. So when work comes, a competitive bidding is encouraged among those subcontractors for the best price. M & E contractors are the first one to become part of the supply chain. For other trades, the contractor C has started to develop list of preferred subcontractors and suppliers. For selecting M & E for the framework agreement, the contractor organised an open day and invited interested subcontractors. It was followed by PQQ stage, and companies were selected and list of preferred subcontractors was prepared, based on their responses to PQQ, references, site visits, etc. Even books and accounts were also checked in some cases! Now there is also a need to measure these successes and benefits of working with preferred M & E subcontractors before taking the same model for selecting the other trade subcontractors.

Performance measurement. Recently, contractor C has carried out client's KPI with suppliers and subcontractors for one of its school projects, as part of the framework agreement. The contractor also has their own KPIs to measure progress weekly, and also measures achievements against specific factors for each project. A database is maintained and feedback is reported on each subcontractor's work in areas such as Health and Safety, Quality, Programme, etc. The subcontract or Buyers Procurement department looks into when new work comes up and sends invitation to only those who have performed well in the past or on the current projects.

Work allocation. As part of pre qualification questionnaire (PQQ), all the subcontractors and suppliers are asked for the percentage of work they want to carry out with contractor C. Smaller companies wish to work with the contractor and put down that they want to generate 100 % of their turnover by working with the contractor. But there are other subcontractors as well which are already involved in different other projects with different clients/main contractors and are also part of some partnering agreements; therefore, for them, only a small percentage of their turnover comes from working with the contractor C.

Conclusion and discussion

To date the results from the projects are showing savings in time and cost. To maintain the momentum of these gains there must be a continuation of the positive attitude amongst the partners in sharing their knowledge and experiences on future projects, resulting in development of a knowledge-based supply chains. By this approach further benefits will be passed onto the client and end users. Additionally, there needs to be better continuity of workload. The Constructor Partners have unanimously stated that there initial submissions were based on a certain level of turn-over with dedicated staff, particularly in the area of management, having been allocated to this Framework. One area which has caused problems to the flow of workload is the protracted timescales now required for the CAPEX approvals, however now these are better understood by all parties, this can be programmed for. At this point however it is fair to say that there is a positive approach by all partners to take this Framework forward to achieve its targets.

The major benefits that are being achieved in the following broad area by adopting the strategic partnering framework and development of integrated supply chains: Improved design; Less waste and duplication; Improved delivery; Greater certainty of cost; and Better whole life cycle costing. The following gives a representation of the gains in developing integrated supply chain for long-term period, which are not present in traditional “one off” projects: Savings on Tendering / Procurement Costs; Time Savings on Programme; Lesson learned and rolled forward within the delivery team; Benefits of Performance Management Systems; Fewer Delays; Added Value to the client; Knowledge retention, capture, use, and creation; Building of Trusting relationship; etc.

The best thing about this new way of working is that all three main contractors do sit together with each other and are willing to share their knowledge, experiences, best practices and other project related information. In order to create and maintain this sort of culture, the role of the client is the most critical (Khalfan and McDermott, 2005). In the above mentioned case study, the client’s role is appreciable. One could see that the things which were even unthough in construction are now being practiced. One of the example of these new emerging practices is the move from project based organisation to a fully integrated supply chain to provide long-term services to clients in a specific sector such as building schools, etc. Clients, on the other hand, are also making efforts for fairer procurement process. The local authority mentioned in the case study has changed the mechanism of selection for contractors and sub-contractors. It used be the case that the small companies were rejected based on their turnover. Now the turnover figure is not used as part of the selection criteria and is considered afterwards when the percentage of the work is being allocated. Therefore, those companies, which were loosing out (specially the SMEs) because of their small turnover, are now able to pass through the initial 2 stage selection process based on Quality-Price Mechanism, and then are awarded work which is equivalent of 25 % of their turnover (irrespective of how much their turnover is!).

This process of putting into place a Framework Partnership has also provided the authority an opportunity to take note of where there are lessons to be learnt for future agreements. It was very evident that the process required to achieve the appointments was a very steep learning curve adopting new documentation and methodologies which had to be developed to assist in the selection of the partners. It has also been a feature that new procedures and mechanisms have had to be put into place to deal with the ongoing developments of schemes and the Framework itself. This need has been necessary on both the early stages and the on-site stages. Working in partnership is proving to be much more productive than the more traditional approach of working in separate camps. It is building trusting relationships, bringing all "project knowledge" together at the inception of a project, and achieving a "better value" output in terms of cost, time, and quality.

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Critical success factors (CSFs) in a multidisciplinary engineering practice

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There is increasing interest in how organisations in construction manage, organise and deliver successful projects. In the project management literature these challenges are often defined in terms of better control of timescales, budgets and resource planning. Yet these are impoverished terms for conceptualising success, which is both multi-dimensional and contextual. The aim of the paper is to explore the perceptions of critical success factors (CSFs) in a multi-disciplinary engineering practice. The findings indicate that project success is related to five dimensions of work: individuals, teams, process, project and product. Understanding these elements and their interdependence may enable managers to identify strengths and weaknesses in current work practices. An important insight provided by this research is that CSFs is a form of knowing, which needs to be articulated and communicated more effectively within the project community.

1. Introduction

Construction organisations are facing a dramatic shift in having to develop new approaches in the way projects are conceptualised and implemented to deliver success. The recent interest in the intricacies of complex project environments and attempts to apply social science methods to analyse construction management problems confirm this (Cicmil & Marshall, 2005; Bresnen, Goussevskaia & Swan, 2005). Another important driver is the emergence of a more people-centred discourse around 'team integration', 'trust' and 'respect for people', as a means of improving work relationships and boosting performance. However, the extent to which these methodologies deal with today's project complexities, the new language of positive affirmations and universal urge to move 'from good to great' remains an area of conjecture. Research over the last four decades using the concept of critical success factors (CSFs) has made an important contribution in terms of establishing what 'must go right' for a business to reach its goals (e.g. De wit, 1988; Pinto & Slevin, 1988; Cooke-Davies, 2004). But what really constitutes project success? For the past 20 year or so textbooks have maintained that there are three critical factors are what define projects: a definite due date, a limited budget (including personnel resources), and a specified set of performance goals. However, researchers and practitioners alike now recognize that there are projects where these three items are not always clearly specified (Meredith & Mantel, 2006). In addition, there are often many implicit goals for projects, such as making a profit, not harming the reputation of the firm, extending the organization's sophistication in project management, and so on. Although the lists of success factors that may contribute to successful projects now also include a variety of human, organisation and technical variables, there are many critics to the CSF approach (Cooke-Davis, 2004). First there are many definitions of success, which makes it fundamentally difficult to assess and measure any set of factors that research has come up with. Further, empirical research have concluded that perceptions play a strong role of a project and therefore project success should be termed 'perceived project success' (Baker, Murphy & Fisher, 1988). A particularly important finding is that the factors associated with project success are different for different industries (Baker et al, 1983) and cultures (Diallo & Thuillier, 2004). At the very least, success factors and their relative importance are idiosyncratic to the project type and the firm. Generalising a ‘checklist’ of factors derived from one project environment to another is therefore hardly worthwhile. The present study attempts to address this issue by focusing on CSFs in a construction design context, where current frameworks of success factors do not seem to apply. Second, recent findings overhaul the assumption that CSFs are independent of one another. Due to the complexity of the project implementation process, success factors are most likely to be dynamic, interdependent and change across time (Pinto & Prescott, 1988). Nevertheless, relationships between them are rarely explored in practice which renders them too simplistic to take account of complex construction project environments. Given the apparent drawbacks, the need for CSFs seems to remain and this has spurred new research efforts and a reconsideration of methodological issues (Cooke-Davies, 2004; Belout & Gauvreau, 2004). In this paper, the authors take the view that perceived CSFs can only be fully explored and understood in relation to one another. By understanding the interaction between the factors could provide insights into how organisations/practitioners can best meet all their CSFs (Ang, Sum & Yeo, 2002). This highlights the need to apply a more grounded CSF approach to explore CSFs in particularly complex project settings. The focus of the present study is a large multidisciplinary construction design practice. The daily life in an engineering practice is characterised by the uniqueness and temporality of project arrangements. The challenges that the various project participants (engineers, architects, clients, contractors) in design projects face are many and varied. For example, there is a high degree of complexity and interconnectedness of tasks, a high dependence on diverse skills and collective knowledge and little time to find out where relevant knowledge resides (Cicmil, 2004). It is suggested that teams such as these often have difficulty developing a shared project vision since they tend to create their own understandings of the project reality based on their background and world view (Dogherty, 1992). This paper aims to explore the cornerstones of successful multidisciplinary engineering projects. By capturing the perceptions of project success as experienced by the team members themselves, it is possible to make explicit the context specific CSFs that underpin consistent project success. This may be an effective framework to better understand the dynamics of project success; how different factors reinforce or impede each other during project stages. The initial findings serve as a basis for further investigation of CSFs and how they behave and function in actual construction project setting. It also responds to the expressed need for broader research methods in construction (Bresnen et al, 2005).

2. Methods

2.1. Approach

This study was analysed within a grounded theory framework. This inductive methodology enables issues relevant to the field of enquiry to emerge from the data and for theory to be generated by being grounded within the data itself. The methodology includes systematic open and axial coding (analysis), questioning of data, explanation of categories, their properties and the relationships among them (Strauss & Corbin, 1998).

2.2 Participants

Twenty two engineers and technicians (thirteen male and eight female) took part in this study, which was conducted in a UK based multidisciplinary engineering practice over a two month period. Specifically, it was located in one of the integrated business groups (IBGs), which employs more than 90 people. Since the aim was to reflect a broad spectrum of beliefs and values across the group, the sample was stratified to include individuals from different disciplines such as structural, building services and façade engineering, but also CAD-technicians. Six job levels were represented: group manager, associates, senior engineer, engineer, graduate engineer and CAD-technician. There were eight structural engineers, three façade engineers, nine building services engineers and two CAD-technicians.

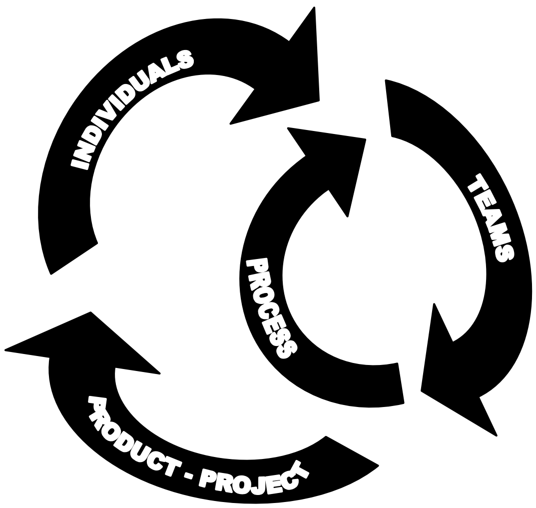
2.3 Data collection

2.3.1 Interviews

A series of semi-structured interviews were conducted with questions focusing on the informant's job role, experience of project work and examples of successful and less successful projects. The selected informants were e-mailed beforehand and asked to identify examples of a 'successful' and a 'less successful' project as the basis for discussion in the interviews. As part of the interview process, informants were asked to brainstorm critical success factors in project work. This was aimed to encourage individuals to 'make free associations' without being prompted, about factors they perceive as critical to project success. The exercise was useful because it helped to reveal two things: 1) some of the specific meanings that individuals attach to factors and, 2) their significance in context. The interviews were audio-recorded and transcribed verbatim. Categories produced by the researcher were validated through workshops, where staff from each engineering discipline including CAD-technicians, were recruited. The selected individuals were put in groups of 4-6 people according to their job level to allow data comparison across job levels. The informants were asked to group all of the initial categories (175) under larger categories so they would end up with a number of core categories. Each group was given 45 minutes to complete the task. The categorisation made by all six groups was then compared with the grounded analysis of the interview material. The analysis of the data included open coding (labelling segments of the interview material); asking questions such as 'What is going on here?' and 'What category does this incident indicate?'; axial coding to link categories and sub categories together, e.g. the category 'integration of disciplines' was placed under the larger category 'communication'; and selective coding to generate of core categories.

3. Results

Qualitative analysis of the interview material (brainstorming exercise) revealed five central constituents of project success: *individual*, *team*, *process*, *project and product*. An illustrated summary is provided in Figure 1. These core categories summarise the project team's perceptions of what is considered 'critical' in delivering successful projects or, more specifically, what needs continuous attention in day to day project implementation. Directional arrows within the model represent relationships between the categories as developed from the analysis.



INDIVIDUALS
Motivation, Values, Skills and competence, Leadership

TEAMS
Communication, Trust and mutual understanding, Respect, Wellbeing of project community, Culture, Clear roles and responsibilities, Relationships

PROCESS
Technology, Listening and feedback, Physical work environment, Supportive management, Resources and planning, Work process.

PROJECT – PRODUCT
Clear goals and project mission, Commercial awareness, Challenging project/task

Figure 1. The dynamics of five CSFs and their sub-categories

From a managerial point of view the project organisation need to have skilled, motivated and passionate individuals to carry out the task or the challenge; these individuals have to work together as a team to accomplish collaborative design that satisfy the client; the individuals and the teams need appropriate technology (tools and workspace), effective project management (planning, support and definition of roles and responsibilities) to operate in a structured way; and all these influence the central outcome of the *project*, the *product* itself. The model shows that project success relies heavily on the ability and behaviour of team members to work well together, but also how these relationships may be reinforced or impeded by other factors such as planning, availability of resources and style of leadership. Inherent in this way of thinking is the recursive interplay between the actors, e.g. project members, and the structure, e.g. organisational hierarchy and prevailing culture, which offers some important insight into how to understand project success. The interviews formed the basis for developing a preliminary hypothesis of core CSFs, which could be mapped onto the core categories created in the workshops. It is important to point out that these two sets of data are based on the open coded factors (175) elicited from the initial brainstorming exercise. In both instances, the primary task was to cluster the open coded CSFs into higher level categories and label them.

The initial set of high level categories, created by the researchers, comprised more detailed categories than those emerging from the workshops. Variations were also reflected in the number of core categories created, language used to label them and under which category each item would belong to. This can be explained as a consequence of *time*, *professional group* and *job role*. The researchers spent an unlimited time on categorising the 175 initial factors into a number of high level themes, whereas the workshop participants were given limited time. However, familiarity with the coded factors (e.g. 'effective project management', 'communication between disciplines', 'quality of contractor' etc) and an understanding what the words and sentences facilitated this task. Further, interpretation of text and talk is often influenced by background and professional discipline. For example: technicians created a high level group called 'satisfaction' and talked about it as part of being motivated, whereas managers talked about 'motivation' in terms of being motivated by the project itself. This emphasises the role of professional culture in an organisation (Kunda, 1992). In a similar vein, job role also seemed to influence the categorisation of factors. Associates talked about ‘team factors’ whereas senior engineers mentioned ‘dynamics’ which may not reflect a real difference between these two groups in terms of what they are trying to articulate. Rather, it seems that they had to make a quick negotiation amongst themselves and decide what to go for. In this way, each group constructed CSFs through discussions, debate and negotiation around the high levels categories that the CFS would fall into. Based on these observations CSFs are taken to be socially constructed and socially recognised phenomena. The analysis of the workshop outcomes can be summarised as follows:

- Project success is seen as a *process* rather than an end-state across group levels.
- There is a preference to view success factors as *interrelated* and *mutually interdependent*; ‘they cannot exist without each other’.
- Project success is seen as dependent on appreciating what lies beneath the exterior of the so called golden triangle, ‘cost, time and to specification’.
- Success factors relating to *leadership/management*, *team work* and *competency/skills* were common to all groups.
- There is a high degree of consensus across groups on factors such as *communication, motivation* and *culture.* Communication which is usually seen as a top success factors in other studies, is not a consistent factor across the groups. Instead it was talked about as an overall important factor. For example, technicians talk about communication seemed to be related to being more integrated in the project process. The senior engineers across all disciplines summarised it as follows: ’communication is the catalyst in all good project work’.
- Communication is *the success factor* that influences work relationships and acts as a ‘catalyst in good project work’.
- Variations between the groups appear to be a consequence of job roles rather than professional disciplines, indicating that junior levels (e.g. graduate engineers) perceive supportive as more critical than resource planning. Similarly, senior levels seem to place more focus on having the right people and manage the different and sometimes conflicting project demands rather than ‘time to play with ideas’. Contrary to recent studies of CSFs in project work, client focus does not emerge as a consistent factor across the groups. There was little reference to ‘the client’, ‘client satisfaction’ or ‘end-user’

The most striking observations indicate that project participants, regardless of background or role, hold an inward looking attitude of project success; mainly focusing on their own concerns such as timetables, their contribution to the project and so forth. This reflects the continuous regime of ‘getting things done’, or what has been termed the ‘tyranny of projects’; a mentality that govern much of the work in the construction industry (Koch, 2004). One senior, male building services engineer expressed an important part of this condition: *‘You just work, work, work, busy, busy, busy you know. I can organise my time but then somebody throws something in…something is coming from nowhere, which should not happen really’*. The situation is further complicated by the difficulty in juggling the demands of being involved in many projects which is common in consulting engineering (Koch & Bendixen, 2005). This presents a challenge that goes beyond time management; it is a matter of knowing where to direct attention.

Discussion

As was discussed above, the aim of this study was to explore project success as perceived by engineers and technicians in a multidisciplinary engineering practice. It is part of a number of research outputs regarding the social dynamics of construction team work. The study presents an ideal opportunity to make comparisons with existing success factors drawn from other project settings. Five core success factors emerged from the interview data: individuals, teams, processes, project and product. Analysis of these factors shows that they both reinforce and impede each other in an iterative manner during the project life cycle. These findings add a number of dimensions to the current findings in the project management literature, which go beyond the short term goals of the manager, 'on time, on budget and to specification'. Specifically, suggested model implies that human as well as contextual factors contribute to the perception of project success. Another observation is that CSFs appear to be socially constructed among individuals as well as socially recognised phenomenon. In this way, project success is taken to be a process rather than a static concept. This way of conceptualising success is part of the new generation of research stating that project organisations should be studied as social arrangements in terms of locating what is working and what is not working in them (Bresnen et al, 2005; Cicmil et al, 2005). Another important observation in the study was that when given the freedom to state any success factor the majority of them emphasised variables relating to internal characteristics of the project process such as maintaining good relationships, passion for the project, and a clear understanding of their role. External characteristics of the product or service itself such as customer focus or product performance were not emerging as critical. This pattern of responses occurred in the subsequent workshop where the participants where asked to group the success factors derived from interviews with engineers and CAD-technicians. This is surprising considering the many published articles and books on the importance of the client in project success (e.g. Meredith et al, 2006), and brings attention to the somewhat inward-looking attitude of CSFs in project work. Assessment of these observations suggest two concurrent events: 1) engineers and technicians are more focused on getting the design right than focusing on product performance which can only be measured when the building is ready to use, and 2) the naturalised culture in construction seem to emphasise 'getting things done' rather than reflecting on what is getting done. These observations are to a great extent in line with conclusions based on a number of different project environments and industries (e.g. Baker et al, 1983; Slevin & Pinto, 2004). While the pressure to deliver on time and on budget are still dominant within the project organisation, team members themselves are more interested in whether a project is worthwhile doing, satisfying and is a good learning experience (i.e. they are focused on psycho-social outcomes). The workshops demonstrate that the differences in perception of project success, is a result of job role, rather than what professional group one belongs to. This was an expected outcome, but worth investigating since professionals cultures seems to be seen as major problem in multidisciplinary work (Dougherty, 1992). An important insight provided by this research is that CSFs is a form of knowing, which is not commonly articulated within the project community. At the same time CSFs must be made explicit in an organisation to have any effect on performance. This is reflected in the study, where communication was singled out as being the 'catalyst' for all CSFs. The constraint lies in the nature of design work; the involvement of architects and other subcontractor that represent organisations that operate outside of the engineering consultancy. Construction project work is communication based; efficient collaboration relies on effective diffusion of information throughout the project (Baiden, Price & Dainty, 2006, in press; Winch, 2001). What is required is a radical change in the way CSFs are conceptualised and measured for them to be useful for practitioners looking for ways to improve current project performance.

Conclusions

Project success depends on a range of human, organisational and technical variables. Yet there is no agreement in the literature what factors exactly contribute to success. Despite this, CSFs continue to be an important method of improving performance in project work. The main conclusions from this study are that: 1) project success appears to be related to the opportunities and constraints of organisational behaviour, existing work processes and structures, causing an inward-looking view of success among project participants 2) CSFs are interrelated and mutually dependant and are likely to change across time, and 3) project success is a process rather than a static concept which relies on effective communication between individuals at all levels. Despite this, it is impossible to claim that all dimensions of project success in a multi-disciplinary project environment have been captured. Further empirical studies are needed to evaluate and further develop the presented intermediate model as basis for appropriate support to practitioners in the construction industry. An in-depth understanding of each project participant's influence and perception of project success is also beneficial.

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Contextual Platform for Advancing Management of Construction and Engineering Businesses: 52 Concepts Published between 1990-2005

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Abstract

A contextual platform of 52 concepts published in English between the years 1990-2005 is introduced for advancing both business management (BM) practices in construction and engineering (C&E) firms and related BM concepts within the four overlapping research fields, i.e. construction economics and management, real estate development, project management, and industrial management. For the review, 25 journals, 9 book publishers, and 22 international conference proceedings were relied upon. No generic landmark concepts have triggered a flow of construction-related concepts over a 16-year period. The temporal pattern is emerging and fragmented. Overall, no applied research tradition in business management exists as part of construction-related management research in the OECD countries. Nevertheless, it is claimed that this platform enables both practitioners and researchers to choose and advance their ways of managing a business in C&E, real estate, and project-based markets. Collaborative international research is called for to advance BM concepts.

Introduction

The background involves the first-ever review of a population of 38 construction-related business management (BM) concepts published in English between the years 1990-2002 (Huovinen 2003a). So far, the sub-results have been introduced as part of the CIB W55 and W65's symposiums in Singapore, Toronto, and Helsinki (Huovinen 2003b, 2004a, and 2005a) and as part of the 1st ASCE Specialty Conference on Hilton Head Island (Huovinen 2004b) as well as through the publication channels in Finland (e.g. Huovinen 2004c).

The objective of this paper is to introduce briefly the outcomes of both the first review and the second review, i.e. the original 38 BM concepts published between the years 1990-2002 are complemented with 14 new BM concepts published between 1 January 2003 and 31 December 2005. This combined 52-concept platform is promoted for both practicing business managers and management scholars alike. **The coherent nature** of managing a business has been maintained by focusing on the research on firms and business units that are based in one of the OECD countries. The exception is to allow the references originating from and dealing with Singapore or Hong Kong to be included; due to these authors' British Commonwealth heritage and interests in global businesses. Three formal publication channels have been relied upon, i.e. a population of 25 journals (Table 1) and a population of 9 publishers, complemented with the more subjective and random browsing of 22 available conference proceedings (Table 2).

52-Concept Platform Published between the Years 1990-2005

The identified platform consists of 52 business-management concepts published within 48 references between the years 1990-2005 (Table 3a-b). The authorship consists of 42 (individual, pairs or teams of) authors. There are 72 individual authors. 27 (52 %) concepts have been published via journals, 14 (27 %) concepts as part of the edited books, and 11 (21 %) concepts within the books.

The cumulative publication frequencies across the four fields of construction-related management research are as follows: 30 (58 %) concepts are related to construction economics and management, 9 (17 %) concepts are related to project management, 8 (15 %) concepts are related to real estate development, and 5 (10 %) concepts are related to industrial management. No generic landmark concepts have triggered a flow of construction-related concepts. The temporal pattern is emerging and fragmented. In this short paper, only **three contextual review questions** can be addressed as follows.

(1) For what industries, businesses, or sectors are the applied BM concepts suggested? 19 (37 %) concepts address construction or building, 15 (29 %) project-based business, contracting business, complex product systems, or combined engineering, purchasing, and construction (EPC) projects, 8 (15 %) real estate development and FM services, and 5 (10 %) capital investments-based businesses, 4 (8 %) design and consulting services, and 1 (2 %) building products supply.

(2) What degrees of business dynamism have the authors assumed in their particular contexts? Most authors have not specified this degree. It is herein interpreted that each author has considered high or at least moderate dynamism. This perception is supported by the industry or business contexts and the home-base contexts. The range of 54 home-base contexts includes 19 (35 %) worldwide or global, 12 (22 %) UK, 10 (19 %) US, 4 (7 %) Finnish, 3 (6 %) generic, 3 (6 %) Swedish, and 1 (2 %) Australian, 1 (2 %) German, and 1 (2 %) Swiss context.

(3) To what extent have the authors reported on empirical evidence? 27 (52 %) authors have conceptualized the management of a C&E business without presenting readily any new empirical evidence to validate their concepts. 17 (33 %) of the authors demonstrate their arguments or support the concepts by presenting one or more cases (and some examples, too). Most case researchers report briefly on the conduct of their studies. 5 (10 %) authors present the results of the interviews. 3 (6 %) authors present the results of the mail questionnaire survey.

Overall, **no applied research tradition** in business management exists as part of construction-related management research in any of the OECD countries.

Table 1. Browsing of the volumes (published between the years 1990-2005) of 25 construction-related journals.

Journal	No. of volumes
Building Research and Information	18-33
Construction Innovation	1-5
Construction Management and Economics	8-23
Cost Engineering	32-47
Engineering, Construction and Architectural Management	1-12
Engineering Management, IEEE Transactions on	37-52
Engineering Management Journal (1991-2005)	1-15
Facilities	8-23
International Journal for Construction Marketing (1999-2002)	1-3

International Journal of Project Management	8-23
ITcon, Electronic Journal of IT in Construction (1996-2005)	1-10
Journal of Construction Engineering and Management	116-131
Journal of Corporate Real Estate (1999-2005)	1-7
Journal of Facilities Management (2002-2005)	1-3
Journal of Management in Engineering	6-21
Journal of Real Estate Research	5-27
Journal of Real Estate Portfolio Management (1995-2005)	1-11
Leadership and Management in Engineering (2001-2005)	1-5
PM Network	4-19
Project Management (1995-2003), Project Perspectives (2004-05)	1-11
Project Management Journal	21-36
Property Management	8-23
The Australian J. of Construction Econ. and Building (2001-05)	1-5
The Building Economist (1990-2002; 2003-2005 are not browsed)	29-41
The Journal of Construction Procurement (1995-2003)	1-9

Conclusion

Readily, **the identified 52-concept platform** helps both researchers and business managers to advance their ways of managing a business in C&E, real estate, and project-based markets. Collaborative international research is called for between scholars and business managers such as within ASCE and CIB in order to advance BM concepts (e.g. Huovinen 2004a-b). However, a real 16-year platform may consist of 65-70 construction-related BM concepts. Thus, **some additional literature-review efforts** are needed. In part, these 10-15 missing concepts will be identified from among the most recent books that the nine publishers, i.e. AMA, Ashgate, McGraw-Hill, Palgrave Macmillan, Pearson Education, Reed Elsevier, Taylor & Francis Group, Thomas Telford, and John Wiley & Sons have published between the years 2003-2005. In part, it is likely that some BM concepts will be found from within the conference proceedings that have not yet been browsed. Typically, such conferences are being organized by (inter)national associations (e.g. ASCE), institutes (e.g. Project Management Institute), or research groups (e.g. The International Research Network on Organizing by Projects, IRNOP).

Table 2. Proceedings of 22 international construction-related conferences published between the years 1994-2005.

Year	Place	Organizer	Title of proceedings (volumes)
1994	Haifa	CIB W65, Tecnion	Etkin Int'l seminar on strategic ...
1996	Glasgow	CIB W65 et al.	Organization and ... (1-3)
1993-5	3 countries	IG Lean Construction	Lean construction
1997	London	I. of Structural Engs	1st conf., CE in construction
1997	Helsinki	IPMA, TKK, VTT	Managing risks in projects
1998	Helsinki	Nordic Logistics	Opening markets for logistics
1998	Leeds	U. of Leeds et al.	1st conf., Int'l constr. marketing
1999	Helsinki	PMAF et al.	NORDNET 1999 Managing bus.
1999	Espoo	CIB, VTT et al.	2nd conf., CE in construction
1999	Cape Town	CIB W92 et al.	Procurement systems
1999	Oxford	Oxford Brookes U.	4th conf., Construction marketing

2000	Helsinki	RIL	Construction in Russia today
2001	London	BRE, U. of Leeds	2nd conf., Int'l constr. marketing
2002	Cincinnati	CIB W65 et al.	Construction innovation and …
2003	Singapore	CIB W65, NUS et al.	Knowledge construction (1-3)
2004	Hilton Head	ASCE et al.	Leadership and Management
2004	Toronto	CIB and NRC	CIB World Building Congress
2004	Helsinki	PMAF et al.	NORDNET 2004 Successful PM
2005	Las Vegas	CIB W92, ASU et al.	Procurement systems
2005	Lisboa	CIB W102, IST et al.	Information and KM in a global ..
2005	Helsinki	CIB W65, VTT et al.	Combining forces (1-7)
2005	Penang	ICCREM et al.	Challenge of Innovation … (1-2)

Table 3a. 52 construction-related business-management concepts published between the years 1990-2002 (the 1st pioneering review) and the years 2003-2005 (the 2nd review).

No Author	Year	Business management concept	Context
01 Betts Ofori	1992	Porter's frameworks applied to	Construction
02 Hawk	1992	Continual learning system	Building
03 Leinberger	1993	Systems-change strategy	Real estate
04 Winch Schneider	1993	Four generic strategies (matrix)	Architecture
05 Flanagan	1994	Successful company (in 2000)	Construction
06 Veshosky	1994	Porter's 4 strategies applied to	A/E firms
07 Jennings Betts	1996	Strategy model with IT support	PQS practices
08 Lowendahl	1997	Management of 4 resource types	Service firms
09 Artto	1999	Organizational model for PM	Projectized
10 Huovinen	1999	Recursive competence-based firm	Cap.inv.markets
11 Meklin et al.	1999	Project business management	Project busin.
12 Roulac	1999	Real estate value chain	Real estate
13 Anell	2000	Project portfolio management	Project-based
14 Barrett	2000	Linking a firm's business and FM	FM services

Table 3b. 52 construction-related business-management concepts published between the years 1990-2002 (the 1st pioneering review) and the years 2003-2005 (the 2nd review), (… continued).

No	Author	Year	Business management concept	Context
15	Bennett	2000	Seven pillars of partnering	Construction
16	Chinowsky	2000	7 areas of strategic management	Civil eng.
17	Davies, Brady	2000	Organizational learning cycle	CoPS firms
18	Davies, Brady	2000	Capability building and interaction	CoPS firms
19	Hobday	2000	Project-based organization	CoPS firms
20	Love et al.	2000	Learning organization model	Construction
21	Pinto et al.	2000	Value chain of a project supplier	Contracting
22	Turner, Keegan	2000	Project-based organization	Project-based
23	Huovinen	2001	International competitive strategy	Contracting
24	Langford, Male	2001	Applied 5F framework (Porter)	Construction
25	Langford, Male	2001	International(ization) strategy	Construction
26	Langford, Male	2001	4 ways of knowledge management	Construction
27	Langford, Male	2001	Model of strategic management	Construction
28	Lampel	2001	Core competency-based model	EPC firms
29	Rapp	2001	Adapted 5F, value chain (Porter)	Construction
30	Roulac	2001	Strategy for competitive advantage	Real estate
31	Sauer et al.	2001	PM-centered organization	Construction
32	Cheng and Li	2002	Customized model of partnering	Construction
33	De Haan et al.	2002	Market-strategy-capabilities fit	Building
34	Huovinen	2002	Global competitiveness of a firm	Cap.inv.markets
35	Kale, Arditi	2002	Mode and scope of competition	Construction
36	Love et al.	2002	Construction alliance model	Construction
37	Robinson et al.	2002	Knowledge management model	Construction
38	Trejo et al.	2002	Capability assessment framework	Construction
39	Huovinen, Hawk	2003	Client-supplier relationship model	Products supply
40	Huovinen	2003b	Knowledge-based management	Cap.inv.markets
41	Kendall	2003	Support to PM office management	Project-driven
42	Mitchell-Ketzes	2003	Linking workplaces to business	Workplaces
43	Borner	2004	Project and success-oriented KM	D-B contracting
44	Huovinen	2004c	Organization-based management	Cap.inv.markets
45	Kiiras, Huovinen	2004	Virtual CM company management	CPM services
46	Osgood	2004	Strategy alignment model and map	Corporate RE
47	Kaya et al.	2004	World-class FM framework	FM services
48	Rogers	2004	High performance business unit	FM services
49	Anderson, Merna	2005	Business development process	Eng. projects
50	Huovinen	2005b	Recursive global business system	Cap.inv.markets
51	Morris, Jamieson	2005	Linked corporate/project strategies	Project-based
52	Walker	2005	Knowledge competitive advantage	Construction

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THE LEADERSHIP PROFILE OF NIGERIAN CONSTRUCTION PROJECT LEADERS

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ABSTRACT

The study aimed at presenting the leadership characteristics of Nigerian construction professionals involved in team leadership on building projects. Sixty construction project leaders who were based in the Nigerian cities of Lagos and Abuja were selected for the study. A questionnaire was designed to collect data on 11 variables pertaining to the leaders including professional grouping, age, educational and professional qualifications, industrial experience, overseas training, overall training, personality, leadership style, style range and effectiveness. Descriptive statistics were used for the analysis of the data obtained. One way analysis of variance and Chi-square were used to test the hypotheses set up for the study. Notable findings include: (1) Majority of the project leaders exhibited consensus leadership style. (2)There was no significant relationship between the project leader's professional background and his leadership style. (3) There was no significant relationship between project leader's professional background and effectiveness. (4)There was variation in the training levels (in terms of project management related courses) of the different professionals engaged in project leadership.

Keywords: Leadership styles, Nigerian construction professionals, project management, effectiveness, training.

INTRODUCTION

Building process involves teamwork. Realisation of construction projects goals requires integration of inputs from many diverse functions and disciplines. A client or building owner appoints a set of consultants – the architect who determines the form, aesthetics requirement and the likes based on the client's brief; the structural engineer who designs the structure to fulfil the architect's requirement; the building services engineer who designs the building services systems (Mechanical and Electrical) to meet the technical specification within the space and structural constraints; the quantity surveyor who prepare estimates according to the design and the builder/constructor responsible for the planning and execution of the contract to realise the project objectives. The complexity of modern construction projects has necessitated the proliferation of professionals which according to Chan and Chan (2005), has led to increased specialisation and the emergence of a variety of new disciplines, which have been added to the traditional professional structure in society. As specialisation increases, the complexity of such integration grows geometrically (Liu et al., 2003). In spit of the fact that these specialists are engaged under separate contractual arrangements with the client, most of their works are interrelated and require a close coordination between the participants. In achieving these objectives, someone among the consultant and the builder has to coordinate the activities of these participants on the client's behalf - hence a project leader. A leader, for the purpose of this study, will be defined as a person responsible for organising and coordinating the work of others. The project leader is appointed to plan, control and co-ordinate the project from inception to completion to ensure that the client's requirements are met and that the project is completed on schedule and within approved budget. Leadership has been highlighted as an important factor in successful projects in a number of studies. Hence, the leader has to change roles from being a technical expert to a manager, then a leader and finally, at the end of the project, back to being a technical expert (Mäkilouko, 2004). Most consultants in Nigerian construction industry combine project management with their primary responsibilities. The motivation for this study, therefore, is to find out the profile of these different professional groups in terms of their background training in project management related courses, leadership style and effectiveness in project management practice.

Leadership in Construction Project

Turner (1993) defines a project as a complex effort to achieve a specific objective with a schedule and a budget target, which typically cuts across organisational lines; is unique, and is usually non repetitive within a firm. A project entails the management of time and effort with a view to achieving a predefined goal. The person in charge of a project may carry one of a variety of titles (e.g. project leader or project manager) and is usually the main focal point of responsibility for the project (Harrison, 1992; Cooke-Davies, 1990).

In considering leadership style in the construction industry, the unique characteristics of the industry that can have an impact on leadership style has to be taken into consideration. These according to Harvey and Ashworth (1993) are: (a) project characteristics, (b) contractual arrangement, (c) project life – cycle and (d) environmental factors.

A construction project is composed of a multitude of organisations on temporary bases. Individuals or group from several parent organisations are all drawn together for a short time related task. This project-based nature of construction industry with its temporary multi-organisations will almost certainly have an important influence on the managerial leadership styles of professionals working in the industry.

Naoum (2001, p219) states that large capital investment projects coupled with high complexity of decision issues can require different styles of leadership, and admits that 'a participative style of leadership with bureaucratic organisation is expected to be more appropriate than a directive style'. In contrast, Nicholas (1990) suggests that a less participating, more directive style might be more appropriate when there is less time and high pressure to complete the work. Giritli and Oraz (2004) opined that the most effective style of leadership depends on project circumstance, especially project duration and intensity of work done.

The extensive use of sub-contracting is another factor that can have an impact on the leadership style of projects. Naoum (2001, p.222) suggests that 'the relationship between procurement methods and leadership style is the proportion of sub-contracting against direct labour employment on project sites'. Bresnen et al. (1986) shows that task-oriented forms of leader behaviour is more appropriate where sub-contract form the bulk of the workplace.

Different leadership styles are expected to be exhibited in different phases of the project life cycle. During the different phases of the design process, style may need to allow for more debates, fine-tuning and deliberations. Yet, during the construction phases, they may be more structured and dominant. During a concrete pour under adverse conditions for example, they may need to be tough, direct and even dictatorial. In settling disputes, they may need to be creative and conciliatory (Hopper, 1990)

In sum, it is difficult to determine the most appropriate leadership style to conform to each particular situation in the development of a project. Naoum (2001 p. 223) concludes that 'leadership may thus have to be switch from one style of leadership to another or combine elements of different style until the right balance between concerns for tasks and concern for people is reached'.

RESEARCH OBJECTIVES

The purpose of the study is to present a leadership profile of Nigerian construction professionals who are engaged in project team leadership. The objectives of the study are:

1. To present the demographic characteristics of the project leaders.
2. To investigate if there is any association between the project leader's profession and his leadership style; training level, and effectiveness.

RESEARCH HYPOTHESES

Three hypotheses were postulated for the study as follows:

1. There will be no significant relationship between the leadership style and the professional background of the project leader.
2. There will be no variation in the training level (in project management related courses) of the different professional groups involved in project team leadership.
3. There will be no variation in the effectiveness of the different professional groups involved in project team leadership.

RESEARCH METHOD

The professionals identified and selected for the study are architects, builders, civil engineers, estate surveyors and valuers, and quantity surveyors who were involved in building projects as team leaders. Other professionals like mechanical and electrical engineers, town planners and land surveyors were excluded from the study because there was little or no evidence of their involvement in team leadership on building projects. A questionnaire was designed and used to collect data from sixty project leaders on 11 variables. These project leaders were based in Nigerian cities of Lagos (the commercial nerve centre) and Abuja (the seat of power). The variables studied relate to the bio-data or characteristics of the project leaders and include their age, profession, academic and professional qualifications, industrial experience, place and level of their training, interpersonal relationship (personality) leadership style, style range and effectiveness. Descriptive statistics were used in the analysis of the data obtained. One way analysis of variance (ANOVA) and Chi-square were used to test the hypotheses set up for the study.

RESULTS

This section presents the results and analysis of the data obtained through the questionnaire distributed. The hypotheses stated were tested using appropriate statistical tools with a view to accepting or rejecting them. The results of other findings were also presented. Table 1 shows the summary of the demographic characteristics of the project leaders.

Table 1: Demographic Characteristics of the Project Leaders

		Frequency	Cumulative Frequency	%	Cumulative %
1.	**Professional Group (N = 60)**				
i.	Architects	12	12	20	20
ii.	Builders	12	24	20	40
iii.	Civil Engineers	12	36	20	60
iv.	Estate Surveyors	12	48	20	80
v.	Quantity Surveyors	12	60	20	100
2.	**Age (in years) N=60)**				
i.	21 – 30years	4	4	7	7
ii.	31 – 40 years	34	38	56	63
iii.	41 – 50 years	16	54	27	90
iv.	51 – 60 years	6	60	10	100
v.	Above 60 years	0	60	0	100
3.	**Level of Education (N=60)**				
i.	HND	4	4	7	7
ii.	Professional Diploma	5	9	8	15
iii.	Bachelor's Degree	17	26	28	43
iv.	PGD/Master's Degree	32	58	53	96
v.	Doctorate Degree	2	60	3	100
4.	**Professional Qualification (N=60)**				
i.	Graduate Member	6	6	10	10
ii.	Corporate Member	48	54	80	90
iii.	Fellow Member	6	60	10	100
5.	**Industrial Experience (N=60)**				
i.	Less than 10 years	10	10	17	17
ii.	10 – 19 years	35	45	58	75
iii.	20 – 29 years	12	57	20	95
iv.	30 – 39 years	3	60	5	100
v.	Above 40 years	0	60	0	100
6.	**Overseas Training (N=60)**				
i.	No	48	48	80	80
ii.	Yes	12	60	20	100
7.	**Training Level (N=60)**				
i	Low	1	1	2	2
ii	Moderate	32	33	53	55
iii	High	27	60	45	100
8.	**Personality (N=59)**				
i	Introvert	46	46	78	78
ii	Extrovert	13	59	22	100

9.	**Leadership Style (N= 59)**				
i	Shareholder manager	15	15	25	25
ii	Autocrat	10	25	17	42
iii	Consensus manager	30	55	51	93
iv	Consultative autocrat	4	59	7	100
10.	**Style range (N= 60)**				
i	Low relationship low task	0	0	0	0
ii	Low relationship high task	11	11	18	18
iii	High relationship low task	6	17	10	28
iv	High relationship high task	43	60	12	100
11.	**Effectiveness (N= 60)**				
i	Low Effectiveness	13	13	22	22
ii	Moderate Effectiveness	4	17	6	28
iii	High Effectiveness	43	60	72	100

Test of Hypotheses

Three hypotheses were postulated and tested for the study. The statistical level of significance for the acceptance or rejection of each hypothesis where appropriate was set at 0.05.

Hypothesis One (H1)

The first hypothesis states that "There will be no significant relationship between the leadership styles and the professional background of project leaders' Chi-square was used to test if there is any relationship between leadership styles and professional background of the project leaders as shown in Table 2.

Table 2: Relationship between leadership styles and professional background of the project leaders

Professional Group	SM	A	CM	CA	Total
Architects	2	1	8	1	12
Builders	0	1	9	1	11
Civil Engineers	4	2	6	0	12
Estate Surveyors	4	4	4	0	12
Quantity Surveyors	5	1	3	2	22
Total	15	9	30	4	58

SM = Shareholder Manager; **A**=Autocrat; **CM**= Consensus Manager; **CA**= Consultative Autocrat

Chi-square=15.580; DF=12; Significance = 0.211

From Table 2 it can be observed that the calculated χ^2 of 15.580 is less than the tabulated χ^2 of 21.026 with 12 degree of freedom at 5% significance level. It is concluded, therefore, that there is no significant relationship between the project leaders' professions and their leadership styles.

Hypothesis two (H2)

The second hypothesis states that "There will be no variation in the training level (in project management related courses) of different professional groups involved in project team leadership".

One-way analysis of variance (F-test) was used to test for the significance of difference in the training level of different professional groups involved in project team leadership.

Table 3: Relationship between training level and professional group

	N	**Training Level**		
Professional Group	60	Mean	S.D.	Rank
Quantity Surveyors	12	76.77	7.99	1
Builders	12	73.85	9.94	2
Estate Surveyors	12	70.83	10.15	3
Architects	12	66.15	14.58	4
Civil Engineers	12	63.13	8.86	5
Average		70.15	11.09	

N = No of observation

Table 4 shows one-way analysis of variance on the training level and the professional background of the project leader.

Table 4: One-way analysis of variance on the training level and the professional group of the project leader.

Source	**DF**	**SS**	**MS**	**F-Ratio**	**F-tab**	**F- Prob.**	**Sig.**
Between groups	4	1480.8854	370.2214	3.5370	2.55	0.0122	S*
Within groups	55	5756.9010	104.6709				
Total	59	7237.7865					

DF = Degree of Freedom; **SS**= Sum of Squares; **MS** = Means Square; *Significant at $p < 0.05$.

For variation in training level, the observed value of F = 3.3618 while the table value of F = 2.55 with N1 (the degree of freedom between groups) = 4 and N2 (the degree of freedom within groups) = 54 at 5 percent significance level. As the observed value of F is greater than the table value of F, there is significant difference in the variance of the training levels of the professionals in project management related courses. The null hypothesis is rejected.

Hypothesis three (H3)

The third hypothesis states that "there will be no variation in the effectiveness of different professional groups involved in project team leadership.

Table 5: Relationship between leader's effectiveness and professional group Professional group

	N	**Leader Effectiveness**		
Professional Group	60	**Mean**	**S.D.**	**Rank**

Architects	12	5.00	3.77	1
Estate Surveyors	12	4.58	4.32	2
Civil Engineers	12	4.17	5.46	3
Quantity Surveyors	12	2.67	5.21	4
Builders	12	2.00	4.34	5
Average		3.78	4.62	

N = No of observation

Table 6: One-way analysis of variance on leader effectiveness and their professional discipline.

Source	DF	SS	MS	F-Ratio	F-tab	F- Prob.	Sig.
Between groups	4	64.3401	16.0850	0.7387	2.61	0.5697	NS*
Within groups	54	1175.7955	21.7740				
Total	58	1240.1356					

NS = Not Significant

For variation in leader effectiveness of the five professional groups, the observed value of F = 0.739 is less than the table value of F= 2.55 with N1 = 4 and N2 = 54 at 5% significance level. The null hypothesis is accepted and it can be concluded that there is no variation in the leader effectiveness of the five professional groups involved in project leadership.

DISCUSSION OF FINDINGS

Relationship between leadership style and professional background of the project leader

The null hypothesis that there will be no significant relationship between the leadership styles and the professional background of the project team leaders was accepted. The hypothesis was set up to test whether there is relationship between the leadership style of the project team leader and his professional background. Specifically it is widely believed that architects are autocrats (bossy). With the result of this hypothesis, it shows that there was no significant relationship between the professional background of the project leader and his leadership styles. From the contingency table (see Table 2) majority of the architects (i.e. eight out of 12) are consensus manager; nine out of 11 builders are consensus managers, half (50%) of the civil engineers are consensus manages, one-third of the estate surveyors are shareholders managers, another one-third are autocrats while another one-third are consensus manager. Majority (five out of 11) of the quantity surveyors are shareholder managers. It can be observed that no single professional dominates a particular leadership style. Almost half of the quantity surveyors are shareholder managers while most of the other professionals are consensus managers. Therefore the notion or belief that architects are autocrats is not true, as it has been established that there was no significant relationship between leadership style and professional background of the project team leader.

Relationship between training level and professional background of the project leader

The second hypothesis was set up to find if there will be variation in the training level of the different professionals involved in project team leadership. The result of the second hypothesis shows that there was variation in the training level of the different professionals engaged in project leadership. Quantity surveyors' group showed that it is most equipped in terms of training in project management related courses. This is followed by builders' group, estate surveyors' group, architects' group and civil engineers' group. This corroborates Davis' (1983) assertion that while no one member of the design team is specifically trained towards consultant project management, the consultant quantity surveyor is better placed than most others.

In spite of the quantity surveyors' knowledge or training in project management related courses, the consensus is that any professional can act as a project leader. According to Graves (1982) and Hammond (1983), the would-be project leader should seek to undergo a postgraduate training in project management in addition to his primary qualification or discipline. What this study has been able to achieve is to highlight areas where each of the professionals is deficient in project management courses. Those areas are highlighted under the training needs of the project leaders' section. He will then seek knowledge (additional qualification) in those areas so that he will be better equipped for project leadership.

Relationship between effectiveness and professional background of the project leader.

The third hypothesis was set up to find if there would be variation in the leader effectiveness of different professionals involved in project team leadership. Leader effectiveness was measured using Hersey and Blanchard's (1973) Leader Effectiveness and Adaptability Description (LEAD self) questionnaire. The architects appeared to be most effective with means score of 5.0. The estate surveyors with mean score of 4.58 followed this. The civil engineers scored 4.17 and came third while the quantity surveyors and the builders came forth and fifth with mean scores of 2.67 and 2.00 respectively. These variations were tested statistically using one-way analysis of variance. The result shows that there was no variation in leader effectiveness of the professional groups involved in project leadership. It means all the five professional groups are equally effective which suggests that any of them can act as project leader from leader effectiveness point of view. However, because of several challenges pose by project complexity, it is advisable that those deficient in certain aspect of project management take additional management courses to improve their skill in project management.

Summary of Findings and Conclusion.

From the data analysis carried out on this study and from the hypotheses tested, the following conclusions are made:

* The modal class for industrial experience is 10 – 19 years.
* Eighty percent (80%) were trained locally.
* More than half (53%) have moderate training in project management course.
* There were more introverts than extroverts among the project leaders.
* Most of the project leaders exhibited consensus leadership style.
* Majority of the project leaders belonged to high task/high relationship (HTHR) style range.
* Majority of the project leaders were highly effective.
* There was no significant relationship between the leadership styles and professional background of project team leaders; this means that project leader's Leadership style has nothing to do with his professional background.

* There was variation in the training level of the different professional groups involved in project team leadership. All the five professionals used in the study differed in their training in project management related courses.
* There was no variation in the effectiveness of the different professional groups involved in project leadership; this means that all the professionals are effective equally.

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LEADERSHIP IN CONSTRUCTION INDUSTRY: LEARNING FROM THE PAST

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ABSTRACT

In construction industry there is often a continuous dynamic equilibrium of severeal 'forces', controlled by several stakeholders in this industry, e.g.: Contractors, clients, governments, consultants, banks, insurers, etc. This means there is a continuous need for review a company's strategy to the existent world around it. Not just only on a local scale (which is often the basis for construction activities) but increasingly on a national and international scale. However, this need for 'glocalizing' thinking (often combined with acting locally) in general is no practice by a large part of construction industry's stakeholders. This paper describes an analysis of an European situation, focussed on Dutch construction industry. In general here, leadership is considered as the ability to build up a strong construction business. Two case studies of entrepreneurs and the way they build their construction business are analysed. On the one hand it represents lessons learned for leadership, based on experiences in the recent past; whereas on the other hand it points at possible influencing factors for succesful leadership, due to e.g. globalization and/or a changing business culture. Results point e.g. in the direction that succesful leadership in construction business is not just following a standard 'format', whereas being considered as a succesful leader or not is still a part of the local (business)culture.

KEYWORDS: *Construction industry, Culture, Glocalization, Leadership, Strategy.*

1 INTRODUCTION

Due to several influences, construction industry nowadays increasingly needs to adapt itself towards the actual situation. This is represented not only in e.g. situations in developing areas like e.g. former East Europe, Far East, etc., but also in the areas of West Europe. Especially, because several companies from these Western areas see their markets increasingly changing towards the developing areas. Such developments seem to cause a need for 'reset' the mindset of those companies, to refocus themselves on a more globalizing attitude, with a local grip. This also leads to an increasing need for doing business 'glocally'.
This paper focusses on some examples of Dutch construction companies, being lead into this new 'era', having different styles of leadership. And having both advantages as well as disadvantages of the way they work.

2 RECENT DEVELOPMENTS IN THE DUTCH CONSTRUCTION MARKET

2.1 Introduction

Some recent developments in the Dutch construction market have lead to changes in several Dutch construction companies. In short, the following three levels of development are being described:

- *Industry level;*
- *Company level;*
- *Professional level.*

2.2 Industry Level

The Dutch construction industry is a dynamic business, especially during the last few years. This, because the construction industry suffered strongly due to the revaluing and restructuring actions, initiated by the Dutch government and large governmental clients. These actions were taken specific on the market for large public infrastructure projects, because the government discovered in 2002 several companies, having practiced collusion, by joining themselves illegally together in tender procedures of public projects [Tijhuis, 2004]. These companies obviously had organised themselves into 'informal groups', acting as 'market-cartels'. Especially in the field of infrastructure-projects this came out. Because of the fact that Dutch public infrastructure departments still are the main clients in these sectors, these departments joined themselves into a branch-wide investigation, organised by the Dutch government. This investation-commission (the so called 'Commissie Bouwenquête') has been investigating these illegal practices very thorougly. Main results of these investigations were as follows [Vos, 2002]:

a. *There is a need for increasing 'transparency' within procedures;*
b. *Efforts on rationalization of construction processes should be intensified;*
c. *Focus on the 'right price' instead of just focussing on the 'lowest price'.*

<u>Ad a:</u>
Most parties in Dutch construction market are convinced that the discussion about 'transparency' is a right one. They strive for an improvement of the situation as described in the investigations by the Commission Vos. Especially, because this commission pointed at the fact that the group of companies, acting according illegal procedures, was relatively small, but were still seriously influencing the functioning of the national tender market for infrastructure projects.

<u>Ad b:</u>
Rationalizing construction processes was and is still a key issue in Dutch construction industry. Although the present practices of e.g. building teams and constructability-issues are quite state-of-the-art, there is a continuous drive for improvement processes.

<u>Ad c:</u>
An increased focus on the right price instead on just on the lowest price is still practiced widely in Dutch construction industry. Also the (public) clients do accept this practice. However, until now it still seems that a sound comparison between price and quality (e.g. related to output-performance) is still difficult, despite the serious trend towards performance-based or output-related contracts by the public client, in e.g. railinfrastructure-projects [Tijhuis, 2001].

2.3 Company Level

When looking to e.g. the share-prices of (Dutch) stock-listed construction funds in general, they did not make a lot of growth nor decline between 2002 and 2003. However, in individual cases there are also companies who's stock-price really declined more than ca.20% within one year, basically due to the above described situation of discovered collusion. However, although several of the companies' stock-prices recently rose again even spectacularly (more than 50% is reported recently during the last two years [Cobouw, 2006]), individual companies still suffer in the nowadays market due to e.g. the fierce price-competition. When looking more closely to the business itself, the dynamics in the Dutch construction market are now e.g. [Tijhuis, 2004]:

(a) High demand for housing, due to low interest-rates and lack of houses;
(b) Need for impovement of procedures, due to high rate of failure costs;
(c) Decreasing need for office-buildings etc., due to the high growth of new projects finished these periods (2003-2004).

Although in general the Dutch construction market situation has somewhat cooled down recently (especially on the offices-market) the demand for housing-projects is still high.

2.4 Professional Level

When focussing more closely on individuals in construction industry, one can see that they are continuously being confronted with a changing environment and its regulations. Especially due to e.g. the above described circumstances in Dutch construction industry, regulations in tender-procedures have been adapted, and e.g. the selection procedures for specific project-types became more difficult, or at least more complex. Parallel to that e.g. technical developments have lead to new standards and norms, whereas the ongoing integration of the European Union (EU) results into a further need for harmonization (change!) of e.g. regulations. In general, several of these circumstances have influenced the career of Dutch professionals in construction industry. And not only there; due to e.g. technological developments in general, industry needs more high qualified people, combined with the providing of (low-cost?) construction workers in industry. However, developing professional expertise in industry seems to become an increasingly important item [Van der Heijden, 1998]; and not just in industry in general, but more especially also in construction industry.

3 LEADERSHIP IN CONSTRUCTION INDUSTRY: TWO CASE STUDIES

3.1 Introduction

In general, leadership is considered here as the ability to build up a strong construction business. When looking to leadership more closely, there are opinions that it cannot be teached and/or learned; the practicing of it could be part or not of people's mindset, etc. Although this may be true in several cases, the way leadership is being practiced still differs. In relationship to this, Handscombe and Norman characterize (strategic) leadership as 'managing the missing links'. They describe that leaders need the expertise to 'join' or to 'collaborate', or just being able to facilitate these expertises [Handscombe and Norman, 1993]. And several other authors on this issue are describing also factors needed for being or becoming a leader. Basic distinction between theories are e.g. the following two description types:

(a) An 'outside-in' approach;
(b) An 'inside-out' approach.

Ad (a):
This type is often desribed by academics as well as practitioners, having analysed practical situations of people who are recognised as a leader; Interesting examples of this type are e.g. the publications “Good to great” from Collins, about the way how to become a leading company [Collins, 2001] and “Built to last” from Collins and Porras [Collins and Porras, 1994].

Ad (b):
This type is often decribed as an autobiography by the leaders themselves; they give their audience an insight into their daily life and practice. However, these publications often incorporate a way of ‘no guts, no glory’ etc. An interesting recent example of this type is the publication of Baan, about his “life as an entrepreneur” [Baan, 2005], and also “Winning” from Welch and Welch [Welch and Welch, 2005]. Nevertheless, one should also bear into mind that leading persons also can make mistakes. However, that is no problem, as long as one learns from his or her own mistakes.

3.2 Analysis-structure

When looking more into detail,one still can see that practical experiences generally personally based, and may lead to different different lessons for different people in different situations. Nevertheless it is still interesting that they can add (insight)information into the interesting field of *being* or *becoming* a leader. And this introduces an important discussion theme:

- *Can someone learn to become a leader?*

Or:

- *Is leadership part of someone’s character?*

The two case-studies in this paper follow the type (a), an ‘outside-in’ approach, describing the practice of two Dutch entrepreneurs, considered in their own situations as ‘leaders’ in their construction business. The analysis describes the way they build their construction business, using the following analysis-structure:

- *Background;*
- *Practice;*
- *Process;*
- *Results.*

As described, it is considered here in general that leadership is the ability to build up a strong construction business. The descriptions focus on analyzing patterns of the behaviour of these entrepreneurs.

3.3 Case study 1: An Opportunistic Leader.

Background:
This case-study focusses on an entrepreneur in construction business in The Netherlands, being succesful in the growing of a private company. It’s roots are based in the The Netherlands, being strongly focused on entrepreneurial activities.
The basis for the expansion of the company was:

- *A small construction company, active regionally;*
- *Not just focussing on construction technology or projects, but also on ‘building business’.*

Practice:
As some of the basic attititudes of the entrepreneur, it was recognized that he has:

- *a 'feeling' for attracting the right people;*
- *the ability to have the right 'timing' for doing business;*
- *an opportunistic approach;*
- *within quite a specific company-culture.*

Parallel to that, he has a hands-on approach. And that proved to be the right attitude, although of course also leaders do need the right persons around themselves, which he has, too.

Process:
The opportunistic strategy of 'building business' had a specific history, described into a few steps as follows:

<u>Early 1980's:</u>
- *Growing capacity of the existing small contractor company (family-business), including project development; focus on housing projects;*

<u>Mid to late 1980's:</u>
- *Take-overs of (nearly) bankrupt contractor-companies;*
- *Reshaping and restructuring them from the viewpoint of own entrepreneurial approach and culture;*
- *Focus on housing, offices, etc.;*

<u>Early 1990's:</u>
- *Merging with stock-listed contractor, resulting into a stocklisting of the company;*
- *Internationalizing into the German market, buying a site-portfolio for project development and construction activities.*

<u>Mid-1990's:</u>
- *Opportunistic into new technology-business, starting in funding venture-capital;*

<u>End 1990's:</u>
- *Merging the contractor-company with another contractor;*
- *Focus on housing, offices and infrastructure;*
- *Decline of the German construction market, also leading to a decrease of the investment-value of the site-portfolio;*

<u>Early 2000's:</u>
- *Stocklisting a own participation in a new technology-company, which lead to a good return on investment; however, due to the fact that the stockprice decreased after the IPO, it also lead to some 'damaging' of the business-image of it's initial participants;*

<u>Early to mid 2000's:</u>
- *Due to the crisis in the Dutch construction industry and effects of the large-scale collusion practices within the infrastructural construction branch (investigated during the so called 'Bouwenquete' [Vos et al, 2002]), the share-price of the stock-listed contractor was decreasing; this resulted into a good timing for an opportunistic approach: Buying the company back from public to private again was interesting, and so it happened. Nowadays there is a slow recovery again, however not in every segment of the market.*
- *Parallel to that, the timing for 'moving' companies from public to private had become more interesting in general for Dutch small caps [Van der Wurf and Mertens, 2001].*

Results:
The results are being analysed and put into some key-issues below, influencing leadership positively and negatively, in the context of a Dutch business culture:

- <u>Positive influences:</u> It is considered that the leadership of this entrepreneur is especiallly based on some characteristic personal aspects: Having a (1) *'good timing'* and a good (2) *'feeling for choosing the right people'*. And encountering also economic 'dips', he obviously also possesses a (3) '*flexible'* and (4) *'opportunistic attitude'*.

- <u>Negative influences:</u> Especially due to parallel activities into other branches (not being part of the –construction- core-business), his (5) *'reputation'* in e.g. construction-branch was somewhat damaged, probably also not backed-up enough due to (6) *'lack of focus on core-business'*. However, because this 'adventure' still had a good return on investment, one can also still recognize it as an 'opportunistic' approach, being a positive aspect here.

3.4 Case study 2: An Anti-cyclic Leader

Background:
This case-study focusses on an entrepreneur in construction business in The Netherlands, also being succesful in the growing of a private company. The company's roots are based in the The Netherlands, also strongly focused on entrepreneurial activities.
The basis for the expansion of the company was:

- *A small construction company, active locally and regionally;*
- *Not just focussing on construction technology and projects, but also strongly on total site-development.*

Practice:
As some of the basic attititudes of the entrepreneur, it was recognized that he has:
- *a 'feeling' for optimizing the business-process and customer-value of the projects;*
- *the ability to act the right way of doing business in site-transactions;*
- *an anti-cyclic approach;*
- *within quite a specific company-culture.*

He has a hands-on approach, and obviously has the right people around him. The company was not active 'in the spotlights', so he did his strategic (site)transactions mostly in 'silence'. And that proved to be the right combination here for gradually building a portfolio of strategic sites in The Netherlands for project development.

Process:
The anti-cyclic strategy of forming strategic positions had a specific history. described into a few steps as follows:

<u>Early 1980's:</u>
- *Slowly growing of an existing small contractor company (family-business), including project development; focus on housing projects;*

<u>Mid to late 1980's:</u>
- *Still slowly growing of the family-business. No take-overs or whatsoever, but focus on optimizing the housing types;*

<u>Early 1990's:</u>
- *Setting-up a specialist internal department for site-development. Attracting the right people with their respective networks for this business;*

- *Not internationalizing while others were internationalizing; they still stayed focussing on buying site-positions into strategic areas into The Netherlands;*

<u>Mid-1990's:</u>

- *Steady growth of the land-portfolio; turnover into constructon business slowly growing. However, good profits due to optimized housing types and high added value in development activities;*

<u>End 1990's:</u>

- *Due to its strong strategic site-positions (while other companies had losses e.g. abroad) their Dutch site-positions became of growing value;this, because the Dutch construction and development market grew quite strong, also due to governmental housing programmes (which often needed the strategic site-positions, extra pushing the value upwards);*

<u>Early 2000's:</u>

- *Setting up strategic collaborations with other companies for reselling parts of their site-portfolio, combined with construction activities;*
- *Growing turnover in construction activities;*

<u>Early to mid 2000's:</u>

- *Because the crisis in the Dutch construction industry and effects of the large-scale collusion practices were mainly related to the infrastructural construction branch (investigated during the so called 'Bouwenquete' [Vos et al, 2002]), especially companies in the infrastructural branch were hit negatively.*
- *However, the company was hardly active in infrastructure-branch, and was also still private owned. And housing production was still were on a high level. Parallel to that, the value of the site-portfolio still raised, because (housing)projects need strategic building-sites;*
- *As a new venture, they started to invest into strategic sites abroad, joining with an experienced international partner in the market. This, because prices were still relatively low there, but from an anti-cyclic viewpoint interesting to invest in. So they started again a new (anti-cyclic) development activity, but now internationally.*

Results

The results are being analysed and put into some key-issues below, influencing leadership positively and negatively, in the context of a Dutch business culture:

- <u>Positive influences:</u> It is considered that the leadership of this entrepreneur is mainly based on some characteristic personal aspects: Having a (1) good feeling for the *'right product in the right market',* a good (2) *'feeling for choosing the right people'*. But working anticyclic, the attitude is obviously also not to work in the spotlights, but (3) *'keep focussing'* in their experienced market-segments, and (4) *'working in strategic partnerships'.*

- <u>Negative influences:</u> Especially they are used not to work in the spotlights, there may be somewwat (5) *'lack of marketing-value'*, although in specific situations the strong balance-sheet still supports the reputation of the company positively. In a dynamic world it seems that the ability of changing activities is increasingly important, although just keeping focus may be also wise. Nevertheless due to the (6) *'less opportunism'* it may reduce risks, but may also miss certain advantages, connected to expanding the business-activities. However, because this attitude still had a good return on investment, one can also still recognize it as a 'focussing' approach, being a positive aspect here.

3.5 Discussion: Lessons Learned

It can often be seen that books, written by 'leaders', are described by an 'inside-out' approach: As an example of that is the fact that they often contain several (management)'slogans', as a 'condensed form' of experiences of the author(s). However, the audience may than get the impression that it's just all about using these 'slogans' as a kind of tools and/or guarantee for being or becoming a good leader…?! And that seems to be quite often a mistake…!

Nevertheless, an interesting thing in respect of this discussion is e.g. the viewpoint of Rothschild, in which he distinguishes four types of strategic leaders [Rotschild, 1993]:
(1) *Risktakers*, (2) *Caretakers*, (3) *Surgeons* and (4) *Undertakers*.
These represent four phases of growth until decline of an enterprise, being e.g. (1) *developing new business*, (2) *systematic growth*, (3) *restructuring* and (4) *closing/liquidation*.
This indicates that leadership has to do with several essential phases of an organization's lifecycle, and it therefore should be more than just 'slogan management'. It also indicates that the key-elements of leadership may be different for each individual and/or organization, due to different environments, clients, products, timing, phases, etc.

When adding these insights to the analyzed situation within the Dutch case-studies (as part of West European business culture), one can see that in fact three main factors are important for probably becoming or being a good leader. These main-factors obviously are:

- *a good timing (=also feeling) for the market (= enviroment);*
- *a good feeling for choosing the right people (=employees, clients etc.);*
- *a focus on the core business (=core competences), balanced with an opportunistic approach (=taking chances).*

However, learning from the past does not mean that these factors cannot change. Also in Dutch (and West European?) industry probably they may change, influenced by e.g. the *globalization* (which is often on a local scale -'glocalization'- in construction business) and/or a *changing business culture*. This also means that *'positive' influences* on leadership in the one situation can also be *'negative' influences* on leadership in the other situation. Comparable to this may be more or less the statement, made by the early mathematician Blaise Pascal, who said: *'Vérité en-deça des Pyrenées, erreur au-delà'*, being translated by Hofstede in his research on business cultures, as [in: Hofstede, 1980]: '*There are thruths on this side of the Pyrenees, which are falsehoods on the other side'*.

4 CONCLUSIONS

4.1 Conclusions

Regarding the direction of the results, the following conclusions are described:

1. *Succesful leadership in construction business is not just following a standard 'format'. It can be reached by several approaches. This means that 'positive' influences on leadership in the one situation can also be 'negative' influences on leadership in the other situation.*

2. *Because also construction business is a people's business, succesful leadership has to do with having the right people available within the networks one works within. However, it needs a vision how to do this in the most suitable way.*

3. *Having a right 'timing' is considered to be an essential need for being a succesful leader. However, 'timing' without 'action' does not make a business. And in practice, 'action' means an entrepreneurial need for focus on the goal(s) set.*

4. *Although diversifying businesses may be a good strategy for spreading risk, it can also weaking its market strenght. Therefore one should still consider its own strenghts and weaknesses, and decide e.g. how to balance 'focussing' and 'opportunism'.*

5. *Being a succesful leader in construction business (or even in general), depends strongly on what one sees as 'indicators for being succesful'. And this often differs between regions and (business)cultures. This means that the way of being considered as a succesful leader or not is still a part of the local (business)culture.*

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A Review of Frameworks for Analyzing International Construction

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Abstract

Sources of national competitive advantage for international construction have long been discussed by researchers working in the field of construction management. Yet, there is no consensus on a single framework that can be used for analyzing international competitiveness. The aim of this paper is to discuss the applicability of Porter's diamond framework and its variations to the construction industry and propose an agenda for further research. It is argued that the focus of research should be on interrelations between determinants rather than discussing the determinants in isolation. Furthermore, rather than single-country assessments, researchers may be involved in a collaborative work to investigate cases from all over the world and construct a construction-specific framework to investigate international competitiveness.

Introduction

International construction is a subject which receives attention of many researchers. The patterns of international trade, level of attractiveness of specific markets, competitiveness of companies from different countries in the global construction market, future trends, risks specific to international construction and the critical success factors for management of international construction projects are among the most popular research topics. The aim of Table 1 is to summarise some of the topics that are widely covered under the heading of international construction. Three categories are defined according to type of research. According to Table 1, the term "competitive advantage", which is the focal point of the current study, falls under Group 1. As research on international construction business is mainly derived from general international business theory, researchers try to adapt the definition of competitive advantage to the construction industry. Required sources of competitive advantage are defined and usually, conceptual frameworks are utilised to explain how competitive advantage is achieved in a given international market. General theories, such as Porter's (1990) and Dunning's (2000) work, are applied to elucidate the competitive success of companies working in international markets. Usually, companies from different countries are compared and strategies are proposed to achieve/sustain competitive advantage in certain markets. Finally, Table 1 is by no means comprehensive and the grouping system depicted in Table 1 should not be considered as a general categorisation which is accepted by all researchers and applicable to all cases.

The aim of this paper is to concentrate on "conceptual frameworks" that are used to measure the level of international competitiveness and discuss their applicability to the construction industry. It is assumed that competitiveness of a company depends on two factors which are firm-specific sources of competitive advantage and national competitive advantage. Huovinen (2005) mentions applications of Porterian school on construction business management. This paper is limited to discussion of frameworks, mainly Porter's diamond framework and its variations, that are used to analyze "national sources of competitive advantage" rather than firm-specific business level competitive strategies.

Table 1. Subjects covered under the international construction research

	Subjects	Definition	Measurement/ Assessment/ Reporting	Comparison	Forecasting	Proposals
Group 1	Market attractiveness			Between markets/ countries		
	Competitive advantage			Between companies		
	Level of competition	CONCEPTUAL		Between markets	QUALITATIVE	STRATEGIES
	National comparative advantage	FRAMEWORKS	ASSESSMENT	Between companies	MODELS	
	Sources of risk			Between markets/projects		
	Level of internationalization			Between companies/ countries		
Group 2	Volume of international construction			Between countries	QUANTITATIVE	
	Number of companies in different markets		MEASUREMENT	Between countries	MODELS	STRATEGIES
	Patterns of international trade			Between countries		
Group 3	Critical success factors (procurement method, financing method, etc)	LESSONS LEARNT				
	Role of different parties/ organizations (host government, WTO etc.)	(CASE STUDY, SURVEY, INTERVIEW)	REPORTING /DISCUSSION			STRATEGIES, METHODS, DECISION SUPPORT TOOLS
	Benefits of international construction					

National competitive advantage

The role of national conditions in affecting the international competitiveness of firms is described by the term "comparative advantage". The term "comparative advantage" is used to describe differences in national efficiency and factor endowments, however whether comparative advantage is turned into an actual competitive advantage depends on many other factors. Porter (1998) explained the impact of national conditions upon firms' international success from a wider perspective and argued that the major impact of the national environment upon a firm's level of competitive advantage is not related with the resources available within the country so much, rather, it is related with the dynamic conditions that shape the firm's identity, critical managerial behaviour and innovative capability. Many researchers proposed to use conceptual and analytical frameworks to investigate "national competitive advantage" for international construction. For example, Ofori (1994) used Porter's diamond framework to guide formulation of a program for developing Singapore's construction industry. Similarly, Oz (2001) investigated the sources of competitive advantage of Turkish contractors in international markets by using Porter's diamond model. Seymour (1987) adopted Dunning's eclectic paradigm to analyse the multi-national construction industry. Pheng and Hongbin (2003) investigated internationalisation of Chinese construction enterprises using Dunning's eclectic paradigm. Cuervo and Pheng (2003) analysed the significance of ownership advantage and disadvantage factors of Singapore transnational construction corporations in the international construction market. Later, Pheng and Hongbin (2004) proposed an OLI+S model for measuring the degree of internationalisation of multinational corporations based on Dunning's eclectic paradigm. Also, some authors have modelled international construction without particular reference to existing theoretical frameworks. For example, Momaya and Selby (1998) quantified the international competitiveness of the Canadian construction industry using a model that has three components: competitive assets, competitive processes and competitive performance. Although, existing frameworks developed for analysing international competitiveness have been adapted to the construction industry, none of the frameworks is found fully capable of reflecting realities of construction, as discussed by Oz (2001) and Ofori (2003). Porter's diamond model is considered as a starting point and revisions are proposed to adapt it to international construction business. In this paper, criticisms of Porter's diamond model will be discussed as well as other frameworks proposed by different researchers as an extension to the original diamond.

Porter's diamond framework

The major idea behind Porter's diamond framework is that nations succeed in industries where their home base advantages are valuable in other nations. The main question is "Why does a nation achieve international success in a particular industry ?". According to Porter (1998), the answer lies in four broad attributes of a nation that shape the environment in which local firms compete which are called as "determinants of national competitive advantage":

1. Factor conditions: Factors of production such as skilled labor, infrastructure, etc necessary to succeed in a given industry.
2. Demand conditions: Nature of home demand for the industry's product or service.
3. Related and supporting industries: The presence or absence in the nation of supplier and related industries those are internationally competitive.
4. Firm strategy, structure, and rivalry: The conditions in the nation governing how companies are created, organized and managed and the nature of domestic rivalry.

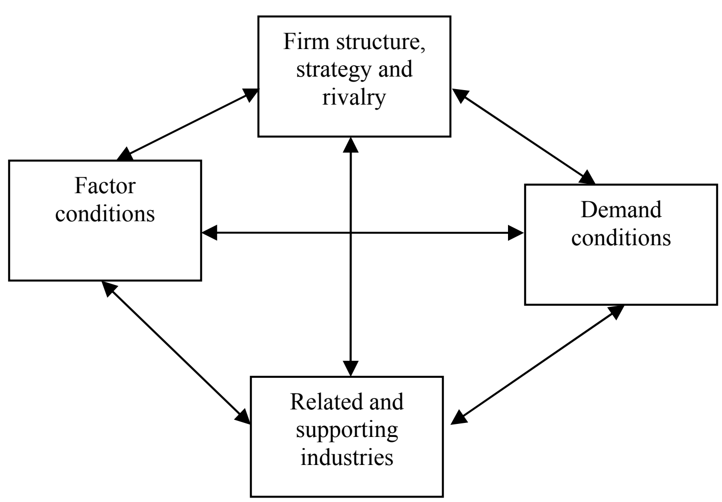

Figure 1. The determinants of national advantage (Porter, 1998)

The diamond, depicted in Figure 1, is a mutually reinforcing system. The effect of one determinant is contingent on the state of others. Advantages in one determinant can also create or upgrade advantages in others. Two additional variables can influence the national system: chance and government. Chance events are outside the control of firms and even government. Diamond framework gives firms an insight into how to set strategy in order to become more effective against international competitors. Porter states that the underlying issues of the diamond framework are broader than the role of nations. What is really explored is "the way in which a firm's proximate environment shapes its competitive advantage over time". Much is known about what competitive advantage is and how particular actions create or destroy it. Much less is known about why a company makes good choices instead of bad choices in seeking basis for competitive advantage. Porter's diamond framework aims to answer why firms from particular nations choose better strategies than those from others for competing in particular industries. Of course, all firms may not exploit national environment equally well thus, not all firms will achieve competitive advantage internationally. In Porter's study, ten nations have been selected and the industries in which the nation's firms are internationally successful were identified. During the 4-year study, focus was on gaining and sustaining competitive advantage in relatively sophisticated industries. Unit of analysis was industry or distinct segment within an industry. The international success was defined as possessing competitive advantage relative to the best worldwide competitors. However, Porter is not free from criticism. Criticisms and how new models are developed to overcome its shortcomings are discussed in the next section.

General criticisms and variations of Porter's diamond framework

Criticism 1. The diamond framework does not deal with multinational activity properly: Dunning (1993) claims that the importance of multinational enterprises is underestimated in the diamond framework. Strategies are products of a learning process, thus, companies learn from their international activities as well as their home market conditions. To eliminate this shortcoming, the multi-national activity is defined as the 3rd exogenous variable and Dunning-Porter framework is formulated. Similarly, a "Generalized Double Diamond Model" has been proposed by Moon et al. (1998) to incorporate global activity into the framework. The major idea is to formulate a generalized double diamond model which will fit all countries. The inner-most diamond in this framework is identical to Porter's original diamond. The outer-most diamond is also identical in terms of the determinants but it represents the global context. The dotted diamond in between is the result of the national diamond as well as multi-national activities. The applicability of the model to the construction industry has been tested on Korean and Singaporean cases. It may be applicable to global construction industry as competitive advantage in international markets is mainly due to "determinants of international advantage" rather than "national sources of competitive advantage". For instance, joint venturing is a widely utilized strategy by contractors doing work in the international markets. Thus, contractors learn from their foreign partners as well as the market conditions prevailing in the host country. These experiences are embedded in their "Structure, strategy and rivalry". Consequently, "Generalized Double Diamond Model" is more applicable for companies operating in international markets than Porter's original diamond framework.

Criticism 2.Role of human factors should be emphasized more: It is claimed that as human factors manage the physical factors to increase and sustain international competitiveness, human factors should have a far more important place in the diamond framework. Cho (1994) proposed an extended diamond model by incorporating the role of human factors. This framework includes four groups of human factors in addition to the four physical factors of the original diamond model in explaining a nation's competitiveness. Human factors include workers, politicians and bureaucrats, entrepreneurs, and professionals. Physical factors include endowed resources, domestic demand, related and supporting industries, and business context. Chance, an external factor, is added to these eight internal factors to make a new paradigm. This model has not been applied to the construction industry. In labor-intensive construction works, low cost of labor is a major source of competitive advantage. The extended diamond model that takes into account of the productivity and cost of labor may better explain the differences between competitive positions of construction companies from different nations.

Criticism 3. Role of government should be emphasized more: Stopford and Strange (1991) noted the important role of government. The competitiveness triangle proposed by Lall (2001) puts government policy in the centre of the action, whereas government is an exogenous factor in the original diamond. The competitiveness triangle has three determinants which are incentive markets (nation's macroeconomic management, trade policies, characteristics of the industry and home demand), factor markets and institutional markets (bodies that support technological activities and development). However, this model has not been tested on the construction industry. The competitiveness triangle may be applicable to the construction industry as the government may significantly affect the industry's success in international markets.

Criticism 4. As well as the four determinants in Porter's diamond, culture, institutional arrangements and government should be incorporated into the framework so that it can be applicable to the construction industry (Ofori, 2003): In the light of these suggestions, Ericsson et al. (2005) proposed the hexagon framework, which is an extension of Porter's diamond framework. In this framework, factor conditions are split into two determinants such as Human Resources and Factor conditions (similar to nine factor model) in order to highlight the labor intensive characteristic of the construction industry. Demand conditions are kept the same but related and supporting industries are left out. Porter's Firm strategy, structure and rivalry is also split into two determinants which are Firm strategies, management and organization and Industry characteristics. Firm strategies, management and organization is about firm specific practices whereas Industry characteristics is about competition and collaboration in the construction industry. As government is also a major client and market intervener in the construction industry, it is considered as a determinant of its own, not an exogenous factor. The two exogenous factors in the hexagon framework are chance and culture which influence the six determinants of the framework. The inner hexagon reflects the domestic construction competitiveness whereas the outer hexagon reflects the international dimension that poses opportunities and threats to the domestic construction industry. Similar to the generalized double diamond framework, hexagon framework incorporates the international activity into the model. This model is specifically developed for the construction industry, however there are no reported applications of the hexagon framework yet.

Criticism 5. Links between different countries shall be incorporated into the diamond framework: Dunning (1993) argues that for EU members, national diamonds may be replaced by supranational ones. Rugman and d'Cruz (1993) suggest that the Canadian diamond should be considered jointly with the USA, as a North American diamond. These are the "double diamond" models that take into account of links between specific markets. Actually, they form the basis of generalized double diamond model proposed by Moon et al.(1998).

Discussion

It is clear that national competitive advantage should be considered while assessing the competitiveness of construction companies in international markets but there is still no consensus on the structure of the framework which will be used for analyzing its level. Figure 2 demonstrates the unknowns associated with the variations of Porter's model. In order to design a framework applicable to international construction, the "determinants", "exogenous variables", "interrelations between variables and exogenous factors" and "number and structure of layers" have to be decided. The shape of the model (diamond, hexagon etc.) is dependent on the number of determinants and the links between them.

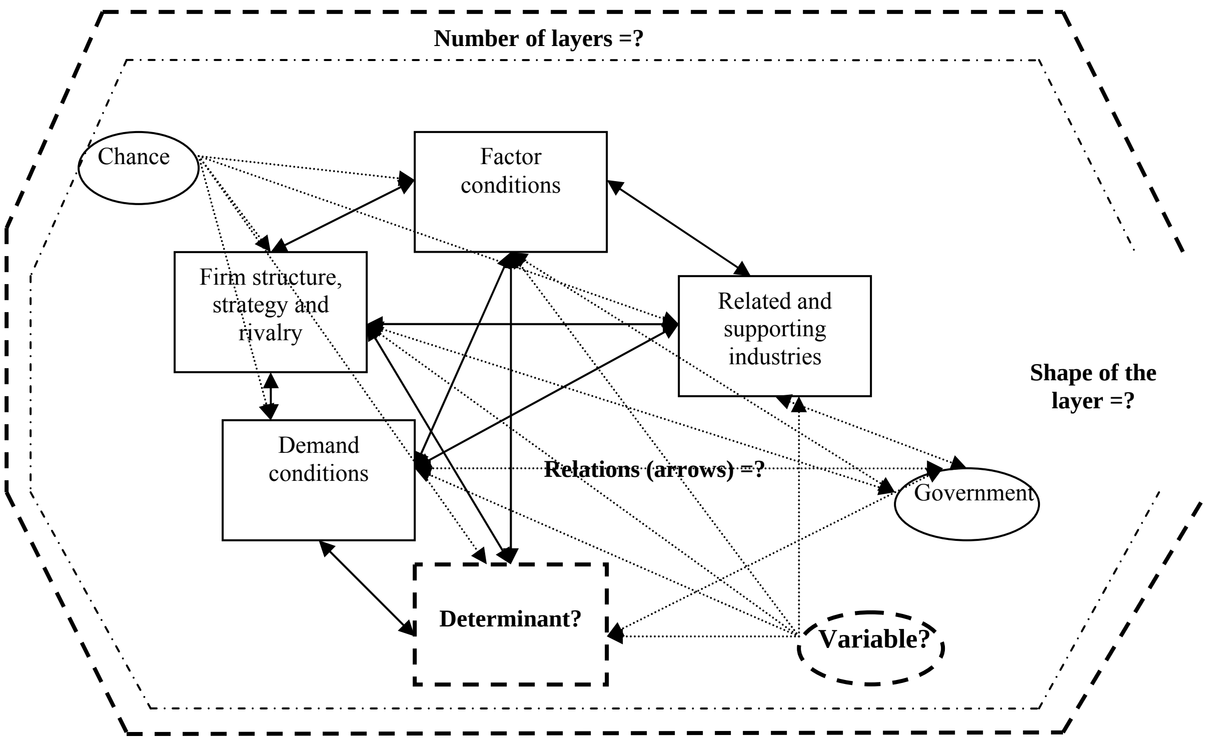

Figure 2. Unknowns in a framework for analyzing international competitiveness

1. *About the determinants and exogenous factors:* As explained in the previous part, some of the researchers (e.g. Ericsson et al. 2005, Ofori 2003) argue that government should be a determinant of its own. However, this is against the philosophy of diamond framework. There is no doubt that government has a significant role in the construction industry, however, the reason why it is not a determinant in the original diamond is not underestimation of its importance. Exogenous factors may be as important as or more important than the determinants, however they are not defined as such because their major impact is on the determinants rather than national competitive advantage. Government policy can influence or can be influenced by each determinant either positively or negatively, however, its role is inevitably "partial" because it

lacks the power to create advantage itself (Porter, 1998). Due to its indirect impact on national competitive advantage, we argue that it should be considered as an exogenous variable. Similarly, culture factors work through the determinants and have considerable impacts on the level of national competitive advantage. Thus, we propose that culture should be incorporated into the model as an exogenous factor influencing the determinants. We also propose that rather than increasing the number of determinants, each determinant in the original diamond should be divided into sub-groups that reflect the realities of the construction sector. For example, as construction industry has got various sub-markets having different characteristics, demand conditions should be considered separately for each sub-sector. The housing sector is very different from the infrastructure market due to existence of different clients, complexity of projects and required skills to gain competitive advantage. Similarly, under firm strategy, structure and rivalry, project level activities/capabilities should be differentiated from those at the corporate level.

2. *About the relationships between factors*: The factors in the diamond framework are mutually dependent, thus effect of one variable depends on the state of others. This feature of the framework makes it useful for analyzing the dynamics of national competitive advantage, understanding the “past competitive advantage” and predicting future industry evolution by creating scenarios about changes in different factors. However, in many studies (e.g. Ofori, 2003), determinants are classified as either strength or weakness factors isolated from each other and the essence of the dynamics between determinants is missed. We argue that as well as the number of determinants, relationships between determinants have to be discussed by the researchers.

3.*About the layers*: Although the home-market factors have the major role on competitive advantage of a nation, industry or a firm, it is clear that firm structure, strategy and rivalry, demand conditions, related and supporting industries and factor conditions are affected from the global market conditions. For example, as a result of international experience, companies may gain new skills such as dealing with bureaucracy, management of political risk (valid for companies from advanced industrialized countries carrying out projects in developing or less developed countries) or developing efficient quality assurance systems, management of environmental risks (valid for companies from developing countries working with partners from advanced industrialized countries) which are not required in their home market. Some of these newly acquired skills may have an impact on the home-market demand conditions, change the rules of competition and affect even the required human resources (factor conditions). One can argue that, especially for developing and underdeveloped countries, international construction experience of contractors may result in dramatic transformations in home-market conditions leading to higher competitive advantage internationally in the long run. Thus, learning as a result of international activity should be incorporated into the model by adding another layer to the diamond.

Conclusion

It is clear that proposing a framework for analyzing national competitive advantage in the global construction industry is a challenging task. Due to its project-based nature, establishment of joint ventures by firms having different nationalities and utilization of focus strategies by contractors rather than a global diversification strategy, it is difficult to define terms such as national competitive advantage and global success. Therefore, it may not be possible to design a "generalized framework" to be used by all firms and countries. Ofori (2003) emphasises the need for collaborative work to construct analytical frameworks to investigate international competitiveness and argues that research which considers panels of countries would be more beneficial than the single-country approaches. Similarly, we argue that rather than trying to create a broad theory, concrete examples may be collected from all over the world as a result of a world-wide effort of researchers to construct a construction-specific framework. Otherwise, all proposed frameworks may stay as theoretical suggestions that can not be used in practice.

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Learning Organizations In Construction

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Abstract
The transformation of organizations from production oriented entities to proactive learning entities that continuously leverage the knowledge of the workforce is a primary objective of management researchers. This focus has significant relevance to the construction industry where production-related research has predominantly overshadowed organizational development research. As one effort to change this emphasis, the authors present a research effort designed to study current organization learning techniques and technologies fielded by organizations both inside and outside of the construction industry. Through a series of exploratory case studies, the authors developed a maturity model together with the Construction Industry Institute that provides construction organizations with a framework for developing a learning organization culture. The maturity model focuses on learning organization characteristics of leadership, processes and infrastructure, communication/collaboration, education and culture at the organization, community and individual levels. This paper introduces the results of that effort including a presentation of the learning organization maturity model, framework application, and the overall characteristics of a learning organization.

Introduction
The construction industry of the 21st century is undergoing significant changes as it addresses issues such as the aging of the construction workforce, globalization, growth of the organization, and "better" client solutions. These changes are initiating a looming crisis for the construction industry, the need to both retain knowledge within the organization and focus on continuous human resource development throughout all levels of the organization. Specifically, it is imperative for construction, engineering and owner organizations to evolve into *learning organizations* where continuous knowledge enhancement and improvement of processes becomes a fundamental element of the construction business.

Although the concept of learning organizations may be new to construction organizations, the concept is well-established in the management domain. The foundation of the concept is rooted in work conducted by Peter Senge in the organizational systems domain (Senge 1990a). In this work, Senge emphasizes that organizations must focus less on day-to-day events and more on the underlying trends and forces of change that cause day-to-day events to occur. From this analysis, organizations can focus on learning new ways to address issues and adapting behavior to improve processes. This concept adopts the idea that both generative and adaptive learning must occur in a learning organization. Specifically, generative learning focuses on an organization creating new knowledge, while adaptive learning focuses on how an organization changes processes to adapt to changing environments (Senge 1990b; Garvin 1993). Reflecting the need to move in this proactive, adaptive direction, the authors and the CII research team put forward the following learning organization definition based on work by others and a focus on the needs of the construction industry (Leadership 2006).

> A **learning organization is skilled at** creating, acquiring, sharing, and applying knowledge, embracing change and innovation at all levels resulting in optimum performance and maximum competitive advantage.

Research Methodology

Given the potential benefits of moving to a learning organization, the authors focused on both the history and current thinking on learning organizations both within and outside the engineer-procure-construct (EPC) industry. These perspectives were obtained through a methodology that emphasized both the analysis of existing research and the development of new knowledge based on the research findings. The primary steps in the methodology were 1) Literature Review, 2) Survey, 3) Case Studies, 4) Maturity Model Development, and 5) Validation. Additionally, the research team developed an automated assessment tool – Learning Organization Rapid Diagnostic (LEONARDO) – to assist in the assessment and implementation of the learning organization.

The literature review focused extensively on learning from prior research in related fields. Specifically, work by Peter Senge, Peter Drucker and others was analyzed to determine how the management community has introduced learning concepts into corporate culture. The results of this analysis provided the foundation for both the survey and the learning organization maturity model presented in this paper.

The next step was to survey CII member companies to determine where the membership currently stands in terms of achieving a learning organization culture was a primary objective of this research. The CII membership is comprised the EPC industry leaders. Membership includes both public and private owners, engineers, and contractors. To achieve this objective, the CII membership was surveyed on topics relating to lessons-learned, knowledge management, learning, and organization commitment to developing a learning culture. Thirty-five of the member companies responded to the survey, giving the project team a solid understanding of current learning organization implementation within CII.

The results of the survey illustrated that EPC organizations were in the early development stage of establishing learning organizations. Therefore a case study approach was determined to be an appropriate method for collecting data and developing the maturity model. Based upon the literature review and the survey findings, a case study protocol was developed and administered to ten organizations. The case studies involved organizations both inside and outside the construction industry that had been documented as pursuing a learning culture. The case studies focused on gaining an understanding of what was required to establish a learning organization culture.

The results of the case study effort led directly to the development of a learning organization maturity model. The maturity model presents organizations with a path forward for achieving a learning organization culture. Specifically, the model outlines the characteristics of a learning organization and the levels of learning entities within an organization. The researchers applied this maturity model to an automated assessment tool, LEONARDO, which also has decision support functionality. While an explanation of the development and testing of this tool is beyond the scope of this paper, the model itself is explained in detail in the sections that follow.

The final step in the research methodology was to validate the maturity model with specific organizations and additionally to determine barriers to successfully implementing a learning organization. Validation was done in a two step process. The first step involved eight companies answering questions about each cell of the maturity model. The research team assessed each company on the maturity model. These results were then discussed with the company to determine their accuracy. The second step of the validation was to conduct a second set of in depth case studies with three additional companies using the maturity model framework to identify barriers to achieving a learning organization.

CHARACTERISTICS	**LEARNING ORGANIZATION ENTITIES**		
	ORGANIZATION	**COMMUNITY**	**INDIVIDUAL**
Leadership			
Processes and Infrastructure			
Communication/Collaboration			
Education			
Culture			

Figure 1: The Learning Organization Maturity Model

The Learning Organization Maturity Model

The primary outcome of this research is a learning organization maturity model. The drivers motivating an organization to adopt such a learning organization culture were previously discussed. As the next level of detail, the components of the learning organization maturity model are presented. These components provide the foundation for an organization to move toward a learning organization through a series of planned activities that result in the maturing of the learning organization culture. Figure 1 is a matrix that illustrates the maturity model for learning organizations as developed through this research. The learning organization entities form the horizontal axis of the matrix and the learning organization characteristics form the vertical axis of the matrix. As an organization matures, it moves from the top right corner of the matrix to the bottom left corner – ultimately achieving a learning organization culture as explained in the following sections.

Learning Organization Entities

The entities of learning across the top of the maturity model provide a reference point to the primary learning groups found within an organization. Each of these groups is dependent on each other to facilitate the exchange, development, and evaluation of knowledge.

- Organization – The organization is the overall corporate entity including all levels of management and staff personnel. The organization is a critical part of the learning organization concept since a learning organization cannot exist without the encouragement and endorsement of top executives as well as the buy-in from staff personnel throughout the organization.

- Community – The community is the entity that represents a group of individuals who are engaged in similar technical activities – referred to as a Community of Practice (COP). The COP has the responsibility for both encouraging learning within the community as well as acting as a filter for the knowledge generated within the community. In this filter role, the COP determines if the knowledge generated can be beneficial beyond the COP, if the knowledge should be translated into a new practice or procedure, and if all individuals are contributing to the sharing of knowledge.
- Individual – The individual is the cornerstone of the learning organization since it is the individual that is responsible for actively seeking new knowledge and in turn disseminating knowledge to the organization. However, it is also the individual that must be convinced that the learning organization concept has personal benefits.

Learning Organization Characteristics

The overall definition of a learning organization is further can be further defined by a series of five characteristics as follows:

- Leadership – The ability to lead the organization toward implementation of a learning organization. Attributes include:
    - Championing the integration of new knowledge into the organization:
    - Encouraging experimentation: and
    - Taking proactive steps to achieve a shared vision.
- Processes and Infrastructure – The combination of the management processes and the technical infrastructure required to implement the learning organization vision within an organization. Attributes include:
    - Facilitating the exchange and management of knowledge:
    - Institutionalizing new knowledge through new processes: and
    - Transferring a resource commitment from executive management to implementation plans and proper organization design.
- Communication – The interaction between both COPs and individuals within the organization that facilitates the free sharing of knowledge at all times and at all levels. Attributes include:
    - The sharing of knowledge in pursuit of organization improvement;
    - Supporting the establishment and continuation of COPs; and
    - Eliminating of barriers to communication.
- Education – A commitment by both management and employees to continuous education opportunities is a foundation of the learning organization concept and the key to bringing new knowledge into the organization. Attributes include:
    - Seeing education as a value to both the individual and the organization;
    - Developing a systematic approach to obtaining education and disseminating knowledge; and
    - Developing a structured approach to promoting education.
- Culture – The final characteristic of learning organizations is the development of a culture that supports, promotes, and rewards learning as a vital part of organization enhancement. Attributes include;
    - A receptiveness to new ideas and cultural integration with a culture that is open to change;
    - A desire to seek, initiate, improve, and generate new ideas and concepts; and

- A belief that the individual is part of something larger is pursuing goals that are greater than the individual.

Maturity Model Responsibilities

The combination of characteristics applied to each entity of learning generates the learning organization maturity model. Specifically, each characteristic of a learning organization can be applied to a specific entity of learning through responsibilities and actions that are required at that level. In contrast to job responsibilities, these responsibilities and actions are overall requirements that are placed on each member of the organization in an effort to establish a learning organization culture. The requirements underlie specific project responsibilities to outline the expectations that a learning organization is placing on each employee.

For example, when the Leadership characteristic is applied to the Organization learning entity, several responsibilities are defined for the organization as follows;

- Sets vision – responsible for setting a shared vision of learning that each member of the organization can adopt and follow.
- Creates proactive learning environment – establishes the environment that promotes the sharing, seeking, and adopting of knowledge.
- Empowers learning at all levels – promotes learning throughout the organization through resource commitment and reward.
- Allows/Encourages risk – creates an environment where risk taking is not only acceptable, but encouraged when managed properly and is focused on enhanced performance.
- Builds culture – responsible for establishing the underlying culture that places learning as a foundational element of the organization practice.

Similar responsibilities are defined for each cell in the matrix and provide guidelines for the organization to set expectations for each member of the organization as the move toward a learning organization is achieved (Leadership 2006).

The development of a learning organization does not occur overnight or even in a single year. Rather, this research effort discovered that the development of a full learning organization culture requires a series of steps that often takes at least five years or more to complete. With this level of effort facing an organization, a structure is required to assist in determining the appropriate actions to take at each stage of the process. To assist in this process, the matrix described above can be used to monitor the development of a learning organization throughout the process. This monitoring is referred to as a maturity model and it evaluates where an organization is during the process from first started through the mature stage. In this final stage, the organization is transformed into a learning organization complete with an associated learning culture.

Application of the Maturity Model

The evolution to a learning organization is defined in this research as a five-level approach with each level representing a stage of development towards a mature learning organization concept. Each level is defined as an organization having completed the implementation of specific concepts.. The learning organization maturity levels are described in Figure 2 below. As an organization achieves the complete range of implementation levels for each cell, the organization is considered to have achieved that level of learning organization maturity.

CHARACTERISTICS	LEARNING ORGANIZATION ENTITIES		
	ORGANIZATION	COMMUNITY	INDIVIDUAL
Leadership	**2**	**1**	**1**
Processes and Infrastructure	**3**	**2**	**2**
Communication/Collaboration	**4**	**3**	**3**
Education	**4**	**4**	**3**
Culture	**5**	**5**	**3**

Figure 2: Five Levels of the Learning Organization Maturity Model

As illustrated in Figure 2, the maturity model progresses from the upper right corner of the matrix down to the lower left corner of the matrix. This progression reflects the need for an organization to initially have individuals who are going to take the leadership of the learning organization and champion the cause within the organization. Once the leadership is established, process can be developed, communication enhanced, education programs introduced, and finally, a culture established. The failure to follow this path could lead an organization to expend significant resources without putting in place the foundation required for the learning organization. The following descriptions provide an overview of the five maturity levels and the associated matrix levels that must be achieved.

Level 0: At Level 0 it is assumed that the organization is just beginning the transformation to a learning organization concept. It is thus considered the base layer where all organizations begin. Although some activity may be occurring in individual maturity cells, the transition to a Level 1 organization is still occurring.

Level 1: A Level 1 learning organization is focused on establishing the leadership required to move the organization toward a learning organization concept. The idea that leadership is required to move the organization forward, starting from an individual level is represented by the matrix completion evaluations. Additionally at this level, the organization will begin addressing the processes and infrastructure that will be required to implement the knowledge sharing concept that is a key component of a learning organization.

Level 2: A Level 2 organization has completed the leadership transformation as well as the individual and community levels of process and infrastructure development. Additionally, the Level 2 organization is actively addressing the communication aspects of learning and the initial stages of education and culture change at the individual and community levels. At this stage, the organization is actively moving toward and supporting a new focus on knowledge sharing and open communication.

Level 3: A Level 3 organization is distinguished by its full implementation of organization-wide processes to support learning as well as a new focus on the learning culture at the individual and community levels. Learning is no longer viewed as a necessary human resources requirement, but is viewed as an integral part of an individual's job and career. A level 3 organization is shown in Figure 3 below.

CHARACTERISTICS	LEARNING ORGANIZATION ENTITIES		
	ORGANIZATION	COMMUNITY	INDIVIDUAL
Leadership			
Processes and Infrastructure			
Communication/Collaboration			
Education			
Culture			

Figure 3: Level 3 Learning Organization

Light gray - the organization is actively addressing specific concepts
Dark Gray - complete implementation of specific concepts

Level 4: The Level 4 organization has almost achieved full learning organization maturity. Communication and sharing are now part of the corporate culture and standard operating procedures. Leadership is championing learning throughout the organization and at all levels. Additionally, the culture now reflects the strong focus on learning at the community and individual levels with the organization now focusing on moving that culture throughout the organization.
Level 5: The Level 5 organization has achieved maturity in the learning organization model. Each level has adopted the complete range of learning organization characteristics and the learning organization culture now characterizes the organization.

Barriers to implementation

The learning organization maturity model is intended to provide a path for organizations to follow while undertaking a learning culture transformation. However, the path along this course contains barriers that every organization will be required to address. To obtain an indication of these barriers, the authors conducted case studies of three organizations in the construction domain that were at various stages of learning organization implementation. The focus of these case studies was to identify the barriers that were hindering or preventing the organizations from furthering the implementation of a learning organization culture.

Initially, interviews with a member of each company who was integrally involved with learning organization type initiatives were conducted. These interviews were intended to establish what the company was attempting to do in terms of creating a learning organization culture. Following these interviews, interviews were conducted with management and project management personnel within each company. The intent of these interviews was to determine if initiatives conceived at the company's executive level were being translated to the project level effectively.

Prior to answering any questions relating to learning organizations, participants were asked to briefly describe their role in the company and provide any background information to the company that they thought may be helpful. The learning organization questions were developed based on the learning organization characteristics and levels defined by the learning organization maturity model. Participants were first asked how familiar they were with the concept of a learning organization and, if they were at all familiar with the concept, how they would describe a learning organization. Following this, questions became more specific and focused on actual programs that may or may not be in place at each organization and the barriers that were encountered while implementing the programs.

The result of this case study process was the identification of six primary barriers to the successful implementation of learning organizations:

- Executive Support – The lack of support from senior executives prevented the organization from obtaining resources for the implementation effort and prevented employees from adopting a culture of learning.
- Employee Support – The lack of support from employees prevented the organization from achieving a broad base of effort from individual employees.
- Time – The lack of time prevented organization personnel from dedicating resources to obtain new knowledge.
- Money – Similar to time, the lack of money prevented organizations from investing in learning organization programs.
- Value Measurement – The lack of value measurements created doubts among senior personnel that value was obtained from investing in learning objectives.
- Knowledge Sharing Infrastructure – The lack of an infrastructure to support knowledge sharing significantly restricted individuals from exchanging knowledge and becoming a learning community.

Although these case studies represented a small sample of organizations pursuing learning objectives, they provide additional validation of the learning organization maturity model and an initial look at the barriers that organizations are facing in adopting a learning culture. Of particular significance from these studies is the finding that executive support is the key first step to a successful implementation of a learning organization culture. Similar to all change management efforts, this support is critical to both the allocation of resources and the continued support of the objective over an extended period of time.

Conclusion

Organizations as diverse as Motorola and Accenture have transformed learning organizations from a concept to an integral component of their business success. Researchers such as Peter Senge at MIT have written extensively of the benefits and challenges associated with adopting a learning organization culture. However, the existence of these resources and success cases does not automatically translate into cross-industry adoption. For the construction industry to adopt a learning organization culture the concept of *continuous learning and personal advancement* must become a fundamental operating concept within organizations at every level and throughout every project and business process.

Adopting this concept requires the construction industry to focus on a long-term outlook for learning. This paper introduced a new maturity model for organizations to follow while adopting this long-term outlook. The development of a learning organization culture requires investment at all three learning entity levels and in all five characteristics of the learning organization. The organizations that can objectively evaluate where they currently stand in the culture change process and can strategically invest in appropriate maturity levels, will be the ones that achieve this culture in a successful manner.

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