

Influence of Digital Technologies on the Process of Interior Architecture

Bahareh Lashgari Morteza pour

Submitted to the
Institute of Graduate Studies and Research
in partial fulfillment of the requirements for the Degree of

Master of Science
in
Interior Architecture

Eastern Mediterranean University
June 2014
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

Prof. Dr. Elvan Yılmaz
Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Interior Architecture.

Prof. Dr. Ugur Dagli
Chair, Department of Architecture

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Interior Architecture.

Assoc. Prof. Dr. Banu Çavuşoğlu
Supervisor

Examining Committee

1. Prof. Dr. Prof. Dr. Kutsal Öztürk

2. Assoc. Prof. Dr. Banu Çavuşoğlu

3. Assoc. Prof. Dr. Zehra Öngül

ABSTRACT

The history of interior design process goes back to Koberg with the synthesis: search for ideas, making selection and realize selection (Benzenberg, 2011). Kang quote from Jones introduced the traditional method of design process after the 'Industrial Revolution' when the design was done by drawing. Today the process of interior architecture varies based on different circumstances, tools and conditions. The achievements and development of digital technology has affected the design process (Kang, 2009).

Digital technology is growing with a rapid pace and professional interior architectural designers are obliged to keep up with and follow the latest advancements to take part in this profession. The process of interior architectural design is affected by the changes caused by the recent advancements; in today's world/saving time/create 3D and keep to feel the design interior space design almost follows digital technology; the process of which includes change and creates new opportunities for this field of architectural design. Employing digital representation, in a multi-dimensional format, or visual space and cyber space mutuality brings the design into existence before it is being implemented; thus changes the format of design process. Therefore, the problems can be pinpointed and solved, a significant amount of energy and cost can be saved and, consequently the percentage of potential error deviated, all through the process before final implementation decreased.

The relationship between digital design and interior design processes is strong. The present study intends to investigate the influence of digital wares and technologies on the process of interior architecture; where it is attempted to answer the main research aim question.

In fact, the use of digital design tools in design process has shifted design to a novel style in the 21st century. With this development, the digital wares and their role in the design process has caused new impacts, which have been themed variously as parametric, liquid, blobject. Styles in the previous advent of digital developments have created new-age design language, which their role can be found in the avant-garde and post-modern styles of the pervious era.

This study tries to offer solutions for the afford-mentioned problems and issues through digital technology, export and import, information sharing in virtual spaces and cyberspace. Furthermore, theories of “liquid” (designing by computer tools on visual world) and “parametric Architecture” (using animation software for design) are explained through this study. Both theories address the interaction of digital technology and computer with interior design for more creative and innovative projects.

Keywords: computer aided design, digital media, digital age, interior design processes, creativity and innovation.

ÖZ

İç mekan tasarım tarihi Koberg'in (1979), fikirler için araştırma, seçme ve seçimi gerçekleştirme sentezine dayanmaktadır (Benzenberg, 2011). Jones'den (1992) alıntı yapan Kang'a göre tasarımların çizimle yapıldığı Sanayi Devrimi'nden sonra geleneksel tasarım metodunu geliştirmiştir. Bugün ise iç mimarlık süreci, araçlar, koşullar ve şartlara bağlı olarak çeşitlilik göstermektedir. Dijital teknolojideki gelişmeler ve başarılar, tasarım süreci üzerinde de etkisini göstermiştir (Kang, 2009).

Dijital teknolojiler hızla gelişmekte ve değişmektedirler; iç mimarlar ise mesleklerini uygulayabilmek için alandaki en son gelişmeleri yakından takip etmek zorundadırlar. İç mimari tasarım da, teknolojideki gelişmelerle birlikte değişmekte ve etkilenmektedir; zaman kazanmak için ve tasarımların da gelişebilmesi için 3 boyutlu çalışmalar gibi dijital teknoloji süreçleri kullanılmaktadır. Bu süreçler iç mimari ve tasarım için yepyeni fırsatlara sebep vermektedir. Çok boyutlu, görsel veya sanal ortamlarda dijital temsilin kullanılmasıyla, tasarım daha yapılmadan var olabilmektedir ve tasarım süreci de ona göre şekillenmektedir. Buna bağlı olarak, tasarım süresinde sorunlar daha hızlı çözülebilir, büyük miktarlarda enerji ve masraf tasarrufu yapılabilir, olası hatalar ve yanlışlardan kaçınılabilir.

Dijital tasarım ve iç mekan tasarımı arasında güçlü ve etkili bir ilişki vardır. Bu çalışmada, dijital teknolojilerin, iç mimari süreçleri üzerinde etkisi araştırılmaktadır ve belirlenen araştırma soruları da cevaplandırılacaktır.

Dijital tasarım araçlarının tasarım süreçlerinde kullanılması, 21. yüzyılda yeni bir tasarım stiline geçilmesini de sağlamıştır. Bu gelişmeyle, dijital teknoloji ve tasarım

sürecindeki rolleri, parametrik, liquid ve blobject olarak temalanan yeni etkilere neden olmuştur. Önceden gelen geçmiş dijital gelişmelerin üslupları bir yeni çağ tasarım dili yaratmıştır; bu dilin rolleri, önceki dönemlerin avantgard ve postmodern üsluplarında da görülebilir.

Bu çalışma, dijital teknoloji, ithalat ve ihracat, sanal ve siber ortamlarda bilgi paylaşımı gibi konularda yaşanan sorun ve problemleri çözmek için kullanılacak çözümler aramayı amaçlamaktadır. Buna ek olarak çalışmada, “liquid” kuramları (görsel ortamda bilgisayar araçları ile tasarım yapmak) ve “parametrik mimari” (tasarım için animasyon yazılımları kullanmak) konuları ile ilgili açıklamalar bulunmaktadır. Her iki kuram da dijital teknoloji ve bilgisayarın, iç mimari ve tasarımla olan etkileşimiyle daha yaratıcı ve yenilikçi projelerin yapılmasına katkı koymaktadır.

Anahtar Kelimeler: Bilgisayar destekli tasarım, Dijital medya, Dijital çağ, iç mekan tasarım süreçleri, yaratıcılık ve yenilikçilik.

ACKNOWLEDGMENT

I would like to thank Assoc. Prof. Dr. Banu Çavuşoğlu for her continuous support and guidance in the preparation of this study. Without her invaluable supervision, all my efforts could have been short-sighted.

Prof. Dr. Ugur Dagli, Chair of the Department of interior architecture, Eastern Mediterranean University, helped me with various issues during the thesis and I am grateful to her.

I owe quite a lot to my family and my husband who allowed me to travel all the way from Iran to Cyprus and supported me all throughout my studies. I would like to dedicate this study to them as an indication of their significance in this study as well as in my life.

TABLE OF CONTENTS

ABSTRACT.....	iii
ÖZ	v
ACKNOWLEDGMENT.....	vii
LIST OF FIGURES	xi
LIST OF ABBREVIATIONS AND ACRONYMS.....	xiii
1 INTRODUCTION	1
1.1 Main Research Definition	1
1.2 Aim and Objectives.....	2
1.3 Limitation.....	2
1.4 Research Methodology.....	3
2 INTERIOR ARCHITECTURAL DESIGN PROCESS.....	5
2.1 Traditional interior design.....	6
2.2 Digital Design Process	7
2.2.1 The Relationship between Interior Architectural Design Process and Digital.....	7
2.2.1.1 Analysis of Interior Architectural Design Process.....	9
2.2.1.2 Development of Interior Architectural Design Process	10
2.2.1.3 Implementation of the Interior Architectural Design Process.....	12
2.2.1.4 Evaluation of Interior Architectural Design Process	13
2.3 Evaluation Comparison between Traditional vs Digital Design Process in Interior Architecture.....	14
3 LITERATURE REVIEW ON AVAILABLE DIGITAL TOOLS FOR DESIGN .	16
3.1 Digital Architecture.....	18

3.1.1 Cyberspace	18
3.1.2 Liquid Design.....	19
3.2 History of Digital Architecture Representation	21
3.2.1 Drawing.....	22
3.2.2 Modeling	23
3.2.3 Presentation Graphic	24
3.2.4 Digital Design Tools	24
3.2.4.1 The Computer Aided Design (CAD)	25
3.2.4.2 Software Product.....	25
3.2.4.3 Bim Software	27
3.2.4.4 Revit Modeling	28
3.2.4.5 Catia Modeling Andanimate	29
3.2.4.6 V-ray 3D Max Autodesk Modeling	31
3.2.5 Digital Production Tools.....	33
3.2.5.1 Fabrication.....	33
3.2.5.2 Rapid Prototyping (3d printer).....	33
3.2.5.3 Computer Numeric Control CNC	34
3.2.5.4 3D Laser Scanner	37
3.2.6 Digital Visualization	38
3.2.6.1 Two-Dimensional Drawing Technique.....	38
3.2.6.2 Three-Dimensional drawing technique	38
4 DIGITAL INTERATED INTO DESIGN PROCESS.....	38
4.1 Frank Gehry Creator of GT.....	40
4.1.1 Dancing House, Downtown Prague (1993)	41
4.1.2 Walt Disney’s Concert Hall Interior Design, Los Angeles (2003)	42

4.1.3 Marques De Riscal Vineyard Hotel (2006).....	43
4.2 Zaha Hadid creator of parametric space.....	44
4.2.1Guangzhou Opera Houses Guangzhou, China (2005)	45
4.2.2 Neil Barrett Store Tokyo Japan (2008)	46
4.2.3 Roca London Gallery Interior (2012)	47
4.3 Karim Rashid Creator of Blobject Space	48
4.3.1 Morimoto Restaurant Philadelphia (2001).....	48
4.3.2 Majik Cafe, Belgrade (2008).....	50
4.3.3 Seoul, Korea (2013)	51
4.4 Evaluation of Design Process of Selected Designers in Terms to Their Digital Projects.....	52
5 CONCLUSION	54
REFERENCES.....	57
APPENDICES	62
Appendix 1: List of Frank Gehry Works	64
Appendix 2: List of Zaha Hadid Works.....	72
Appendix 3: List of Karim Rashed Works.....	75

LIST OF FIGURES

Figure 1: Thesis organization.....	4
Figure 2: Left: Cyberpunk - Right: Virtual Reality (VR)	19
Figure 3: Sketch of Large Baths taken from Le Corbusier a Villa Adriana	23
Figure 4: Traditional modeling scale 1/100	24
Figure 5: Traditional generalized design process and IT application	25
Figure 6: Life cycle of building	26
Figure 7: Parametricist Manifesto.....	27
Figure 8: Parametric design by Autodesk REVIT BIM digital software, UAE.....	28
Figure 9: Walt-Disney-concert-hall, Los Angeles Catia Modeling (2003)	29
Figure 10: Walt-Disney-concert-hall, Los Angeles, Interior Design (2003)	30
Figure 11: Walt-Disney-concert-hall 2003, LOS ANGELES exterior design.....	30
Figure 12: Club modeling interior space, North Cyprus, Lefkosa.....	31
Figure 13: Turkish bath, North Cyprus, Kyrinia Belapais villa interior space	32
Figure 14: Bed room modeling interior space, North Cyprus, Kyrinia	32
Figure 15: Idea of walt-disney-concert-hall model by Rapid Prototyping	34
Figure 16: CNC milling	35
Figure 17: CNC Welding walt-disney-concert-hall, Los Angeles architect, Gehry ..	36
Figure 18: CNC cutting laser panel design and CNC router parametric design	36
Figure 19: Structure Sensor scan with an iPad Apple application.....	37
Figure 20: Generic schema: symbols, boundaries links.....	38
Figure 21: Dancing house by interacting with digital constructs.....	41
Figure 22: Walt Disney concert hall.....	42
Figure 23: Marqués de Riscal Vineyard Hotel interior and exterior.....	43

Figure 24: Guangzhou Opera House Guangzhou modeling	45
Figure 25: Neil Barrett store interior view	46
Figure 26: Neil Barrett store interior view	47
Figure 27: Digital representation as sketch drawing and 2D drawing	49
Figure 28: Majik Cafe, Belgrade (2008)	50
Figure 29: Seoul, Korea (2013).....	51
Figure 30: Rapid Prototyping (3D printer) process at EMU.....	76
Figure 31: CNC machine process at EMU.....	76
Figure 32: Inside the ultimarker machine.	77
Figure 33: Process of printing the object and Bio-plastic material.....	77
Figure 34: Process of printing the object by ultimarker machine	77

LIST OF ABBREVIATIONS AND ACRONYMS

2D	TWO-dimension representation of geometric models
3D	There-dimension representation of geometric models
4D	Four-dimension representation of geometric models
BIM	Building Information Modeling
CAD	Computer Aided Design (use of computer technology of the design object)
CAAD	Computer Aided Architecture Design
CAM	Computer Aided Manufacture
CNC	Computer Numerically Controlled fabrication (manufacturing process)
RP	Rapid-Prototyping
VR	Virtual Reality
GT	Powerful 3D building information modeling (BIM) and management tools
CATIA	Computer Aided Three Dimensional Interactive Application

Chapter 1

INTRODUCTION

During the modern era, Le Corbusier (1920) introduced the concept of 'house as a machine for living' and nine years later Buckminster Fuller proposed the concept of 'living machine'; both of which imply the significance and prevalence of architectural design paradigms to mechanical (Charles, 2006). Sometime later Peter Eisenman during Second World War changed the mechanical architecture paradigm to electronic paradigm with the theory of architecture in the age of electronic media (Charles, 2006). Electronic generations, advances in technology, exploring new digital tools and advents of digital era have affected the design vision through digital revolution. In fact the achievement of digital age is introducing the computer and different media to design and interior architecture. Various categorizations have been offered regarding different steps of the process of interior design. For example (Dodsworth, 2009) proposed that interior design process includes four steps as 'Analysis', 'Development', 'Implementation', and 'Evaluation'.

1.1 Main Research Definition

How can digital media affect the designer's creativity? Thus affecting the design process.

How have developments in technology, emergence of new media and digital tools affected interior designer's creativity in the design process?

The conditions today have illustrated that digital design has passed a noteworthy level, on theoretical, practical and materialization of design, but it seems that digital design as a definition of form of design still belongs to the traditional styles. Analysis of Parametric and Liquid Theories in the present study illustrates that digital technologies have led to novel style but with reference to previous Avant-garde and postmodern styles. This study focuses at concentrating on the digital possibilities and opening up discussion on the place of these possibilities in the possible changes in the design process.

1.2 Aim and Objectives

The digital age has given birth to new styles of interior architecture and the relevant design process has changed. The main aim of this study is to investigate the steps of interior design process in the 21st century and the effects of digital technology on each step, to examine several software and hardware's, and exemplar designers using new media in their design process.

1.3 Limitation

This research attempts to study advanced digital technologies in the digital age and the way they have affected the creativity of the interior architects and the design process; and to look the creativity of the interior architect is affected as a consequence. To this end, the different stages of interior design process is based on the Dodsworth's Book (The Foundation of Interior Design, 2009), which is the most recent idea for interior design process. There could be various methods to concentrate on such a subject, but it is chosen to search the available literature with a commenting perspective. Also there are many examples to check the related subjects. However, the design process/works of the most well-known three designers who are

Frank Gehry as a creator of GT open, because it is the first time you are mentioning on BIM design zaha hadid such as a Parametric; interior space designer and Karim Rashid as a creator on blobject.

1.4 Research Methodology

By reviewing previous researches and studies of digital design process, this study has ended up with the following methodological characteristic on qualitative, document survey and observation research:

- Effect of digital age on the interior architectural design process.
- Literature review on digital design based on the Oxman theory (interaction of digital designer with possibilities' technology).

This research requires gathering relevant data from the specified documents and surveying the privies of parametric, liquid and blobject theories, researches and ideas in chapter one (Figure 1). Chapter two of this research is to achieve the influence of a digital revolution and digital age on different fields; which affect the interior architecture design process by observation life cycle of interior architecture, development of this field and the designer's creativity and compering between tradition and digital interior architecture processes. Chapter three is related to evaluation of digital applications, some of which are personal observations. chapter four are analyzed in order to aid the digital designers who are working in the field of digital and parametric design. Some digital projects are chosen as case studies which belong to professionals working in this field, and the digital design process of these projects are observed. The concept of this dissertation is to highlight the important taking advantage of technology from the concept stage. The changes in technology have happened so rapidly that the concept could not be kept up with it. This research

has tried to explain the reason behind this fact by studying several examples of software and hardware, used for the technology design and digital projects.

Finally in chapter five, the analyzed digital design projects of provident designers such as Zaha Hadid as a creator of parametric space designer, Karim Rashid as a creator of Blobject interior space designer, Frank Gehry as a creator of GT, who have worked in the field of digital architecture demonstrated that in the 21st century no design is impossible for any designer with the help of technology (Figure 1). As the global creative circle enjoy the privilege of having a creative, interesting, and different world of architecture without any limitations, today. To sum up, digital architectural design is like a new age, since it influences not only architecture but value systems and aesthetics (Mahmood, 2011). By referring to previous references fundamental knowledge of new terminologies that affect the digital revolution will be discussed.

Chapter1	Chapter2	Chapter3	Chapter4	Chapter 5
Interdicting the subject and how is taken into a format.	Process of interior design.	Digital possibility and examples, evaluative.	Digital Interated Into design Process.	Conclusion

Figure 1: Thesis organization

Chapter 2

INTERIOR ARCHITECTURAL DESIGN PROCESS

What is interior architecture? According to Spankies idea, Interior architecture is the art of creating internal space. Interior architecture uses from planes for make up the interior of building and define the space. Dodsworth illustrates interior architecture as” Interior designers are generally concerned with taking existing structures and reforming them to suit new functions. They will pay a great deal of regard to the previous life of a building, and usually allow this knowledge to provide some connection between the fabric of the building and the newly created interior. (Dodsworth, 2009).

Dodsworth considers interior architectural design process the design process is a term that covers a set of operations which, when carefully undertaken by the designer, result in a thoroughly considered and well-crafted design solution. The process is not exclusive to interior design and, in one form or another, applies to all fields of design (Dodsworth, 2009). The interior architectural design process has been defined as a sequence of unique actions leading to the realization of some aim or intention Kang (2009) quote from Jones (1992) study traditional method of design process in interior architecture by drawing. Designers requirement of systematic methods, implies a step-by-step approach. They are practical ways of doing things to get from one step of the design process to another. Kang (2009) quote from Jones (1992) was one of the first to break down existing methods into collections of

individual tools that can be configured and reconfigured for different design projects. In one hand Jones (1992) considers steps of interior design process as Analysis, Synthesis, and Evaluation and on the other hand, Koberg (1979) suggested that systematic design process of analysis, synthesis, and definition as steps of design process. Advances in technology and enter media to design has been storing affect in method of design process (Benzenberg, 2011). Dodsworth (2009) considers different steps of the interior architectural design to ‘Analysis’, ‘Development’, ‘Implementation’ and ‘Evaluation’, which is the focus of the present study.

Emerging media and digital age have effects on interior design process ,media tools is one of that digital age bring for designer during the design process also that effect is changing vision of designer for design from physical to virtual and interaction between physical and virtual that means every designees before exist on physical space shown on virtual world.

2.1 Traditional Interior Design

Jones (1992) considered the most common traditional methods to be intuition, craft evolution, design by drawing and design by science (Kang, 2009). Interaction of designers with pencil and paper as a free form representation. Design by drawing idea is flowed the vernacular process, this idea make resolve the problem on process and increasing the designer creativity on comparing with vernacular process (Lawson, 2005). Jones (1992) attempted to restructure the design process on the basis of the new design methods and techniques of problem solving into three stages, namely, analysis, synthesis, and evaluation (Kang, 2009).

2.2 Digital Design Process

Peter Anders as quoted in Bermudez has described cyber as: hybrids that integrate virtual and physical space. In these settings, designers use overlapping physical and virtual artifacts and tools to reach a co-operative design resolution. Within collaborative design, these artifacts take on an additional role. As embodiments of design ideas and actions, they become media for communication (Bermudez, 2013). Architecture implies the use of digital technology and media in design stages by merging virtual competition of design and computer.

2.2.1 The Relationship between Interior Architectural Design Process and Digital Technologies

Since the process of interior architecture would vary, based on different circumstances and equipments, it cannot be defined precisely and specifically. However, there are sets of systematic procedures which are inevitable and necessary through the process of interior architecture design. The history of traditional interior architecture process dates back to after the 'Industrial Revolution' when the design was done by drawing as a traditional method (Kang, 2009).

In 1986, Cross proposed a systematic design which was based on both creativity and rational thought. The creative component was derived from the dreams and minds of the designer and after that the eye and mind. The idea was different from traditional method. On the other hand, the rational thought was the result of information, knowledge and desires of the designer (Kang, 2009).

In the contemporary era, the theory of CK has been offered, which includes 'Concept' and 'Knowledge'. The theory maintains that the integration of concept and

knowledge would lead into a rational and creative design (Holtzschue, 1997). So the process of interior architecture design can be divided into three steps: Analysis, Synthesis, and Definition. In this model, 'distribution' is regarded as a bridge between 'analysis' and 'synthesis'. Moreover, the step of 'Synthesis' consists of 'search for ideas', 'making selection', and 'implementation'.

Nowadays, as interior architecture has come up with technology and improved their understanding of digital architecture, the process of interior architecture can be divided into the following steps: 'programming', 'conceptual design', 'design development', 'contract document', and evaluation (Kang, 2009).

In a similar vein, Dodsworth (2009) proposes 'Analysis', 'Development', 'Implementation' and 'Evaluation', which is the focus of the present study, as the different steps of the interior architecture design.

In the contemporary era digital technology and new media have shed light on all aspects of the life of human beings. The influence of digital technologies on the process of interior architecture on each and every part of the process of interior architectural design cannot be ignored. The interior architects are not able to render their designs without being sufficiently knowledgeable and informed in the field of digital design (Brooker, 2010). The effects of digital technologies on the different steps of interior architecture design are tremendous; and are opened below.

2.2.1.1 Analysis of Interior Architectural Design Process

The first measure to be taken in any design is collecting information about the space and place. The designer needs to have accurate information about the place in which s/he intends to implement the design. The interior designers are not an exception in this regard after the emergence of the digital design in architecture and its influence on interior design.

Since the main concern of an interior designer is solving the problems, recognition of the existing problems is considered as one of the most important actions to be taken. However, in the world today, obtaining and transferring comprehensive and accurate information in a short time is not difficult thanks to digital technology in digital age. For example, imagine that an interior designer needs to measure a place for a design. In the past, the designer was supposed to use a metering device and spend several hours for the purpose of measuring a place (Dodsworth, 2009). The probability of making errors was high in this method besides being time consuming. However, today, due to the advances in digital technology and emergence of digital tools, the designer is able to have a precise scale of the place by using 3D scanner fabrication laser measurement as a kind of digital tool (Figure 10).

The other point to be mentioned is that any kind of information can be searched through the virtual space and cyber space and the designer is able to access the relevant information available throughout the world. In the past in order to obtain the required information about a space or place, the designer was obliged to visit the place or interview the informants, but today, there are plenty of shared information by different people which are available and easily accessible in the virtual spaces.

According to Mandor (2004), digital tools such as generative system have the potential to add great value to the design process itself active tools includes the use of algorithms cods and scripts for form making processes. It is considered as an active tool because it influences the design thinking (Mohammad, 2011). All these advancements in media and digital tools contribute to a faster and more accurate analysis of a space or place or “space and time, as elements of event, are blurred in cyberspace they are only noticed by means of information as previously discussed” (Silve, 2000).

2.2.1.2 Development of Interior Architectural Design Process

After knowing the site and collecting the required information about the space and place, it is time to initiate designing which is considered as one of the most effective steps in the process of design. To get started the designer needs to know the wants and desires of the customer and to create a concept accordingly. Silva (2000) considered design as drawing sketches by utilizing paper and pencil (traditional method) and describe it to the customer. However, nowadays, digital tools and other digital and media technologies give the customers the opportunity to understand the created concept more easily” The concept which is shaped in the mind of the designer can be illustrated as a digital visualization (as an example their dimension image, virtual reality (Figure 3) in a short time and with minimal error (Benzenberg, 2011). Digital architecture and liquid architecture as Novak describes have increased the potential of creativity and innovation in designs to a large extent (Silva, 2000) The motto of the contemporary designers is that ‘I would change the world, impossible belongs to the past’ (Rashid, 2006).

This means that the boundaries and restrictions are shrinking and designers find any concept possible to be implemented in their mind. A design is not valuable unless it is believable for those who see it. But how can we make a concept or design believable? The answer is interaction of computer and human and in design computer aided architecture design. Despite all disagreements and debarments, the use of computer and digital design have become prevalent among designers since many years ago in the to Bauhaus pedagogy. Although by refereeing to Novak “architecture today is actually the product of the convergence of science and art, of technology and art” on the other hand the opponents believe that architecture is an art and deploying computers would make it artificial. Human beings cannot evade digital technology and electronics due to time limitation and ambitiousness after digital age revaluation (Dodsworth, 2009).

The number of architecture and design digital software is increasing day by day. This implies that designers need to be familiar with the digital production fabrication, in addition to having knowledge about the direction of design. Digital Software, such as CATIA program which once was deployed for designing of plane and automobile industries, is now considered as the most accurate digital software used by Frank Gehry and Zaha Hadid. Some other programs like Autodesk modeling and animation, which are more popular, have made modeling and creating 3D possibilities for designers. This means that any design can be created in a virtual space and the potential problems can be discovered there giving the designer the opportunity to modify and revise the design (Dodsworth, 2009). Many theories such as liquid and parametric have been presented in support of the design trends in virtual spaces, digital tools and media. Liquid Theory proposed by Novak views

architecture as a technique which takes place in a virtual space and decreases the likelihood of error to the minimal amount.

2.2.1.3 Implementation of the Interior Architectural Design Process

When it comes to the implementation step in digital architectural design process, the designer is no more responsible for everything. To finalize the digital project many different experts are involved. There is no guarantee that a perfect design will be implemented while it is being designed and expected. A number of factors such as materialization, color, light, etc. have a great impact on the desired implementation of digital design. Better and easier implementation of the design will be possible if the designer is provided with the required elements with the best qualities. The interior designer needs to have sufficient and precise information about each and every contributing element to have a clear image of the end product (Brooker, 2010).

Moreover, the engineers and experts in different fields related of design such as materials, electronics, and industrial sectors have had a significant influence on the process of interior design by constructing new machines and instruments, and by producing new materials.

Nowadays, interior designer's demand materials that are cheaper, flexible, and durable to meet the desires of the users, which are made possible by the aid of (CAD) or (CAM) technology. Therefore, to respond this expectation, thanks to digital production (fabrication), techniques new and interesting materials are introduced to the market every day. One of these new inventions is the 'smart materials' which are compliant and adaptable to the environment. Another contributing invention is the rapid prototyping (RP) computer numeric control (CNC) Rapid Prototyping '3-D

printer and scanner to explore new methods of assembly, which, as its name suggests, has the ability to print the design in three dimension (Iwamoto, 2007).

In summery, all of these advancements as a technology production via cyber and virtual space help to extend the field of interior architecture, create different and various designs and explore new concepts and theories such as liquid, parametric, CK Theory and revolution in architecture as a digital design.

It should be noted that another responsibility of a designer is the appropriate selection of materials, colors, lighting solution, digital tools and digital technology. Because of limitations in the world of colors, materials, and digital tools any designer might encounter many problems. However, nowadays, different digital production, new fabrication in the world of colors, prevalence of wall papers, digital design construction materials, etc. have facilitated the progress of the implementation step for the designers and other people involved.

2.2.1.4 Evaluation of Interior Architectural Design Process

Finalizing a design implies initiation of another project; therefore, analyzing a design after implementation step helps the designer to discover his/her strengths and weaknesses. You might have seen photos titled as 'before' and 'after' in virtual spaces. These pictures, on one hand, serve commercial purposes and function as advertisements for the designer and, on the other hand, provide an opportunity to analyze the design. Due to digital technological advances, invention of digital tools such as cameras and programs for mixing images of two different times in the same frame, analyzing and evaluating have become easier. Digital software programs such

as Photoshop, Corel etc. help the designers to file a project from the very beginning steps of the design process to the time it is delivered to the customer.

2D (CAD) which is the definition of information technology in design It can be considered as a digital tool for proving the design of the architect. Computers are contributing to a faster, easier, and less deficient design in the present era. The main requirements of the world today are believed to be speed and quality (Bilalis, 2000). Therefore, computers are considered as appropriate digital tools and media to fulfill the demands of the interior architecture.

2.3 Evaluation Comparison between Traditional vs Digital Design

Process in Interior Architecture

While come to comparing between traditional (design by drawing, design by science) and digital design process (design by computer, CAD, design by mechanism CAM) reach to point that technology has been taking the new possibilities and tools for aid designer for increasing knowledge, enhancing creativity and extending memory to interaction of technology ,art ,science of today design. Drawing in traditional method is most popular method for present the design in 21 century as a base of the design, drawing is designer conversation but graphic representation is not solution to human requirements in digital period so tools, technologies possibilities and visualization come to aid designers during the design process. Although digital design via computer is regarded as a digital skill, acquiring this skill is assumed to be obligatory for any designer. In the field of interior architecture, CAD is categorized as 2D composition, vector graphics, image manipulation and 3D surface modeling, solid modeling, video editing, motion graphics, rendering, animation, parametric, drafting. 2D is used for designing the details and for measurements and it would be interesting

to mention the history of CAD and the way it started to be used in the field of design. AUTOCAD was the first seller of CAD in 1980 (Bilalis, 2000). The very first programs were used for 2D designs and were considered as the major part of the design process. In mid-1980s 3D design, which is now well-known and common, began to grow (Bilalis, 2000).

Chapter 3

LITERATURE REVIEW ON AVAILABLE DIGITAL TOOLS FOR DESIGN

In the first part of this literature review, tools for design the current literature on the terminology of digital design will be explained. Most philosophers agree that the integration of human and computer in digital age have the possibility to revolute new styles in digital design presents a discussion of “after the digital revolution, a lot of architecture babies was born, then came a period of cyberspace, cyber society and cyber world” (Saad, 2011), which causes an increase in knowledge and enhances creativity of the designer. How theoretically sound is this claim? One can look at the two theories such as liquid which is designing in cyberspace and virtual space, and parametric design which is designing in animated space. Digital design technology as a computer aided design, design software and production tools or fabrication (CNC machine) will then be explained.

The second section of this chapter surveys the history of representation in design as drawing, modeling and graphic presentation by electronic drawing tools which belong to computer technology and new media. Ganapathy Mahalingam thinks that “The key in the development of digital tools to enhance the practice of architecture has been the facility with which the various tasks involved in the practice of architecture have been represented, enabled or enhanced using computer technology. The digital representation of architectural entities and the digital manipulation of those entities have provided alternate means to produce architecture. Drawing,

modeling, performance simulation, design collaboration, construction management and building fabrication are now routinely performed using computer-based technology. This success has revealed the untapped potential of the computational representation of architecture” (Bermudez, 2013). There are many digital and electronic tools in order to assist the designer, to present their ideas.

While lots of literatures on digital design technology and design process exist, digital design in architecture is the ultimate focus of this study and the main aim is to observe this subject in interior architectural design process. Holtzschue (1997) claimed that “The computer does not change a single requirement of the design process, but it does expedite it. Design, like genius, is one percent inspiration and ninety-nine percent perspiration (Holtzschue, 1997). Computer reduces the perspiration part.

The third section explains the intersection of literatures which deal with relationships between interior architectural design process and digital technologies. This review will examine some of the studies which pertain to digital visualization.

In the final section, recent design products which have dealt with digital technologies, and some designers who are the founders of the digital design terminology will be discussed (for instance, Gehry who came up with Gehry terminology). We support the adoption of BIM (Building Information Modeling) technology and processes through project based services, allowing teams to advance their use of these critical systems while meeting project schedules. We provide training and knowledge transfer as part of every engagement. Working with Gehry Technologies, project teams can innovate with confidence, while serving shared

goals of highest quality, speed, and maximum value” (Gehry, 2013) by utilizing innovative software, CATIA program and digital electronic technology tools.

3.1 Digital Architecture

According to Saad (2011) who has studied digital architecture theory is not a new subject and in fact it is rooted in the Bauhaus pedagogy (Saad, 2011). So Cyber space and network are not constitutes of a special concept, Digital architecture theory has been maturing within the modern design theory of architecture according to Kolarevic and Malkawi (2005) .On the other hand with referring to Bermudez and Klinger (2003) digital architecture is more than a theory (Saad, 2011). However, still it is not a separate and new theory. This new reality results in expressions of Saad which ends up to the following question: Why digital architecture could not find a special concept as a new theory? Nona Hadid illustrates in her study about digital architecture that, in order to give birth to a new tool generation ten months are required, to a new theory 10-30 years, however; hundreds to thousands years are required for a technological revolution. Thus, digital architecture as new theory requires time to become a new theory and new style in architecture. In the following lines, some theories on digital architecture which are used by designers such as Zaha Hadid and Gehry will be demonstrated. They have worked in the field of digital design.

3.1.1 Cyberspace

Cyber space theory was first explained by Gibson in 1984 Figure 2. According to William Gibson “Everywhere and nowhere, a place where nothing is forgotten and yet everything change” that means losing gravity of time and space. Cyberspace illustrates a limitless world with association with computer in electronic field. Where there is connection between physical world as a virtual world and desire of refigured

embodiment takes place, as William Gibson explains, “the tablet become a page become a screen becomes a world, a virtual world”. Holtzschue presents “Cyberspace is an intangible reality of computer networks, telephones, television, satellite telecommunications links, and digital media”. Cyberspace explores software simulation algorithm such as Sutherland (1968) explored Virtual Reality (VR) which is invisible communication (Strilets, 2012) (Figure 2).



Figure 2: Left: Cyberpunk - Right: Virtual Reality (VR)
Source: (Strilets, 2012).

3.1.2 Liquid Design

Novaks (1990) considered the common “liquid architecture” as a link between architecture and cyberspace that unites virtual and physical spaces. Novak believes that architecture today is a product of a union of science, art and technology where architect would transfer breathes pulses and leaps to the beholder through electronic tools. Novak, Ascot, Krueger, and Fisher in their studies have concluded that the

result of interaction between human and computer is extending memory growing, awareness and increasing creativity (Silva, 2000).

Terminology of Digital Designer Works

Parametric Design

Parametric theory adverted by (Schumacher, 2004) a partner of architect Zaha Hadid. Parametric theory relies on digital technology when advanced computer aided design tools in architecture design are used, thus, according to the philosopher, parametric theory is a base of generation of parametric diagrams entered architecture by using animation soft wares. Schumacher defines parametric design architecture as: “creating continuously seamless surface. It has become evident that the next wave of innovations and refinements can only be achieved via scripted parametric systems” (Schumacher, 2004). In fact parametric theory is a design method not a style or AN - ISM “a profound style [that] has been maturing within the avant-garde segment of architecture” (Schumacher, 2004). In fact parametric design is not a global movement in design, rather a paradigm of avant-garde style.

Blobject

Bobject (blob object) is that organic, smooth flowing, curves and bright color design production. Today’s blobjects rely on the powers that have encouraged new low-cost exploration in form making and new option in rapid prototyping and production. Across the various avenues of design advances in building, molding, pixel capture, injection molding, and materials technology have resulted in new creative possibilities for the look of even the most ordinary (Holt, 2005). These stylists of digital fluidity were experimenting with the sculptural possibilities opened up by new

technologies such as CAD and CAM. Like a contemporary version of streamlined design, the application of a smooth and curvaceous “digital skin” onto existing products was supposed to evoke the new digital era: the 1930s metaphor of speed was replaced by the 1990s metaphor of cyberspace (Hoopes, 2007).

GT (Gehry Technology)

Twenty years ago, Gehry's architectural practice pioneered a new, technology driven approach to delivering complex building projects. By adopting methods and technologies from automotive and aerospace, working directly in a shared 3D digital environment, and collaborating across discipline lines to bring fabrication expertise forward into design, the architectural firm realized unprecedented projects with tight control of budgets, schedules and quality. Gehry Technologies was created. Since its formation in 2002, the firm has grown to an international leader in technology driven project delivery, with offices on four continents and projects around the world (Gehry, 2013).

3.2 History of Digital Architecture Representation

Architecture drawing dates back to 725 B.C. (Mohammed, 2011). Designing has become a more advanced profession in renaissance period by paper and drafting tools because the designer could utilize drafting tools to easily transfer ideas from the mind and “drawing was an accurate representation of the world around it and therefore could be a useful tool (Spankie, 2009). According to Evans year drawing in design is discussed as: “the architect never works directly on the object of their thought, always working at it through some intervening medium, almost always the drawing”. Impling and publishing the ideas, both real and imaginary, happens by drawing as a representative. In the contemporary period, equipped with and the

development of digital age the drafting tools of designer is changed into new forms of media, computer, electronic and digital tools. In the following section, three forms of aspects of contemporary digital representation are presented. It become a more advanced professions in renaissance period by paper and drafting tools because the designer could utilize drafting tools to easily transfer ideas from the mind and “drawing was an accurate representation of the world around it and therefore could be a useful tool” (Spankie, 2009). According to Evans year drawing in design is discussed as the architect never representation are presented. It become a more advanced professions in renaissance period by paper and drafting tools because the designer could utilize drafting tools to easily transfer ideas from the mind and drawing was an accurate representation.

3.2.1 Drawing

Drawing as a tool which is a form of graphic communication as the language of designer in order to present their ideas. Perspective drawing is a technique developed in renaissance period (Spankie, 2009) and the later rise of virtual reality, computer-based design and manufacturing in digital age has revolutionized the drawing era. Thinking drawing or visualization of designer, idea “can be quick, sketchy, diagrammatic, and often not to scale” (Spankie, 2009). With transforming the utilization of paper and pencil to digital ones, utilizing mouse and computer screen. Sketching is a drawing technique for the designer’s observations. Designers are “thinking aloud” with sketch drawing. Architects such as Le Corbusier carried his sketchbook everywhere and he felt a camera could not, such as concepts, underlying structure or feelings experienced in a space (Spankie, 2009) (Figure 3).



Figure 3: Sketch of Large Baths taken from Le Corbusier a Villa Adriana: Un Atlante by Eugenio Gentili Tedeschi and Giovanni Denti
Source: (Ahmad, 2013).

3.2.2 Modeling

Traditionally Physical model was three-dimensional drawing by solid material. A model is a representation of the proposal (Spankie, 2009). Modeling in interior architecture is used demonstrate the details of a space as light, scale, furniture, and materials (Figure 4).

After the creation of the digital revolution, digital modeling was emerged in the designing era. Digital models which are constructed by computer programs such as Computer Aided Design (CAD) will be explained in more details later in this study. Reid was the first creator of digital three-dimensional modeling in interior architecture with Vector works program. (Spankie, 2009). “Digitally literate generation has become more confident and the computer is being used in increasingly innovative ways to create design solutions that would not have previously been possible by hand” (Spankie, 2009).



Figure 4: Traditional modeling scale 1/100
Source: Personal observation and design by author (2008).

3.2.3 Presentation Graphic

A presentation technique is the relationship between client and designer during the process of transferring the understandings between them. After the digital age this relationship shifted from layout and printout to electronic tools as media, television, web, computer, digital tools and etc. Advanced digital tools have aided the client to observe the space before its creation by using the new digital technologies such as VR (Figure 4), and 4D presentation.

3.2.4 Digital Design Tools

Digital tools belong to the computer technology, according to Holtzschue (1997), most users approach the computer as a tool that expedites the design process. It is true that the computer is a design tool (or a whole toolbox, or even a whole staff), because it has the capacity to perform so many different tasks. Computers can be called recent representation tools which assist the design to (basic tools for product design) to represent their design ideas by drawing, modeling, and simulation.

3.2.4.1 The Computer Aided Design (CAD)

Computer Aided Design (CAD) was created by AUTODESK Company in 1980 as a 2D drafting software and was developed into 3D modeling in mid-1980 (Bilalis, 2000). Today, CAD is being used for two purposes: The first purpose is CA Manufacturing and CA Engineer, another purpose CAD is used as a representation of the design (design drawing) in the process of design. A comparison between traditional design process and CAD (IT application) in the design process shows the profound influence of CAD on design process in Figure 5.

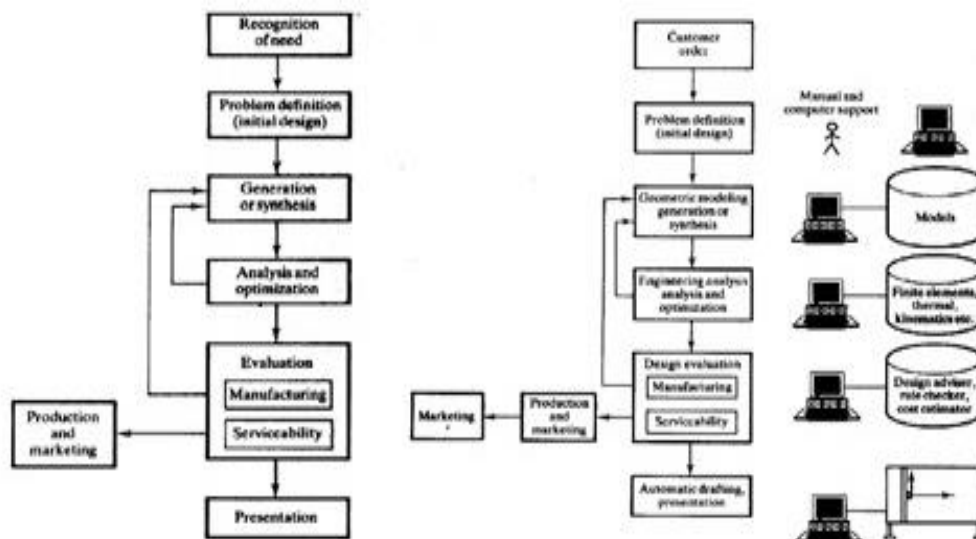


Figure 5: Left: Traditional generalized design process- Right: IT application in the design process
Source: (Bilalis, 2000).

3.2.4.2 Software Product

The most popular digital software products in the digital interior design process are drawing, modeling, simulation and animates such as 3D Max, which is also the most famous one, to the most professional one which is CATIA modeling, BIM modeling, and Rhino modeling.

3.2.3.1.1 Building Information Modeling (BIM)

BIM is the example of using technology in design. CAD can be utilized in any activity related to building such as an architecture, engineering, construction, ownership and everything related to life cycle of building (Figure 6). Smith (2006) argued that BIM makes possible the erection of the building in computer model form before putting a shovel in the ground. Thus, the problems can be pinpointed and solved, a significant amount of energy and cost can be saved, and, consequently, the percentage of potential error throughout the process of final implementation will be decreased.

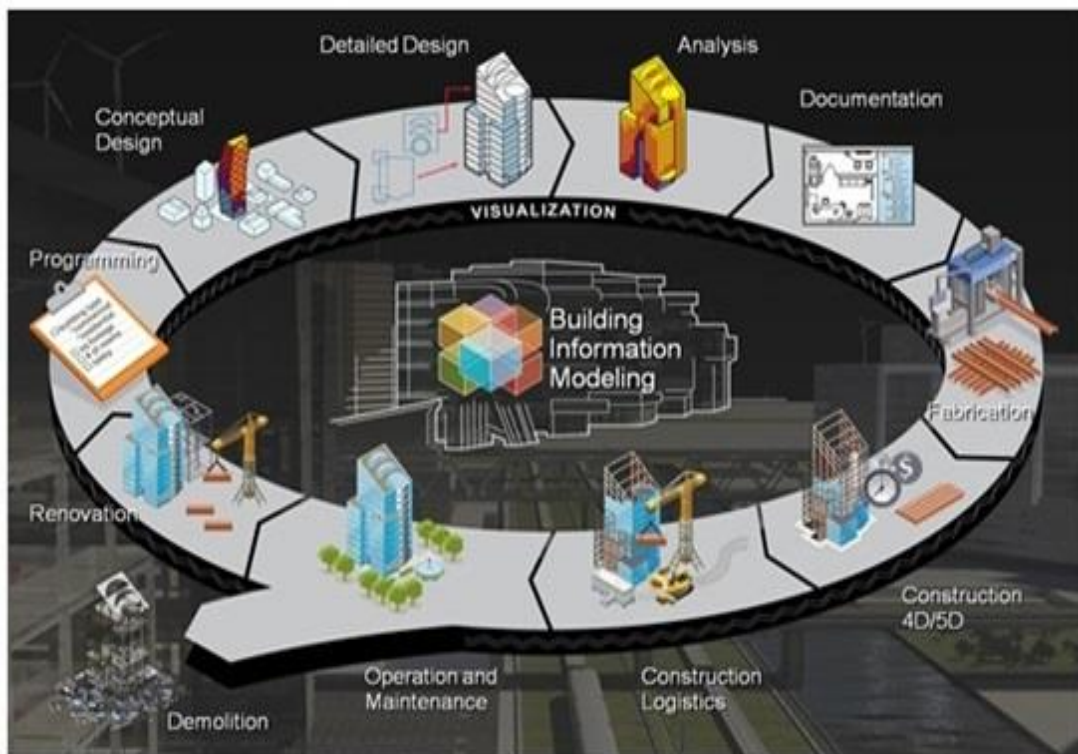


Figure 6: Life cycle of building
Source: (Cam, 2006).

3.2.4.3 Bim Software

BIM digital software tool enables the designers such as Zaha Hadid who construct the parametric modeling process for drawing more complicated forms that are not geometric (parametric form) (Figure 7).

Autodesk developed BIM software in 2003. BIM is not a drawing drafting software. It is a database. The development of digital representation software allowed the building information modeling to shift from 2D to 3D and electronic drawing. BIM software is a digital representation of the design process which is capable of calculating accurate cost estimations, simulating analyzing models and scalable engineering and designing. Partridge argued that (Partridge, 2007). BIM aids the designer to construct, navigate, comprehend and manipulate the design process. The future aim of BIM software is shifting to 4D and 5D modeling. This helps the user to observe the design product with animated modeling. (Bergin, 2012).

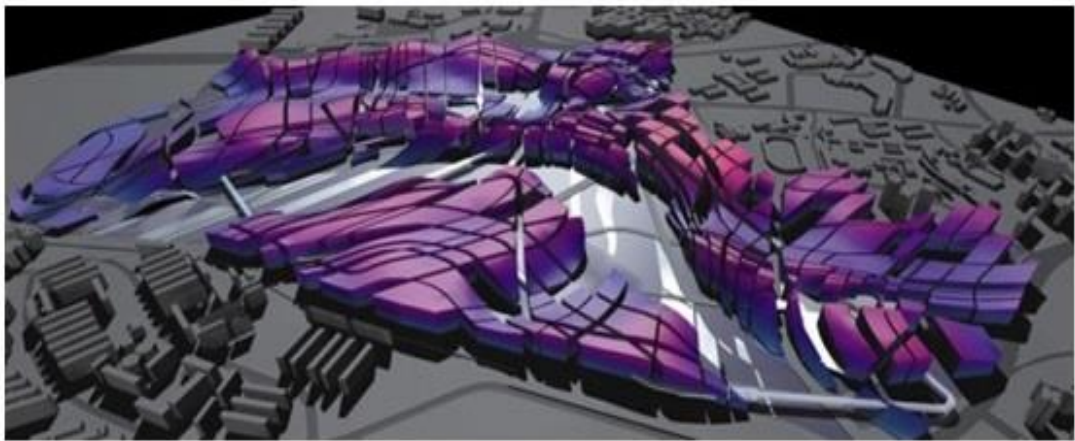


Figure 7: Parametricist Manifesto

Source: (Bergin, 2012).

3.2.4.4 Revit Modeling

REVITE was developed by Parametric Technology Corporation (PTC) company and AUTODESK has purchased REVITE in 2002 under the name of Massachusetts-based Revit Technologies (Millenium, 2008). Autodesk REVITE as foundation BIM software design is a first parametric design software. (Millenium, 2008). explained that “REVIT software can be an invaluable tool to designer when leveraged to its full potential. The iterative design process can be accomplished use spatial REVIT features such as phasing and design option. Material sections can be develops and attached to various elements in the model”.



Figure 8: Parametric design by Autodesk REVIT BIM digital software, UAE
Source: (Saad, 2011).

3.2.4.5 Catia Modeling Andanimate

CATIA (Computer Aided Three-dimensional Interactive Application) is not only a tool in digital technology rather the most remarkable features of manufacturing tools CAM, CAE and CAD. From features digital software CATIA has shifted sketching to 3D, 3D digital modeling, analysis and scalable architecture. CATIA digital software was designed by Dassault System Company and between 1981 to 1995 was used to design aircrafts and later it was used by Frank Gehry as a design tool (Bernard, 2003). CATIA software technology assisted Frank Gehry to design Walt Disney Concert Hall in Los Angeles (1990-2003), according to Gehry's interview with Dassault system Frank Gehry uses CATIA for his architecture designs and there are not any tools such as CATIA (Figure 9).

NAME	Walt Disney Concert Hall
LOCATION	Los Angeles
ARCHITECT	FRANK GEHRY
YEAR	1990-2003
APPLICATION	CATIA SOFTWARE



Figure 9: Walt-Disney-concert-hall, Los Angeles Catia Modeling (2003)
Source: (Liz, 2007)

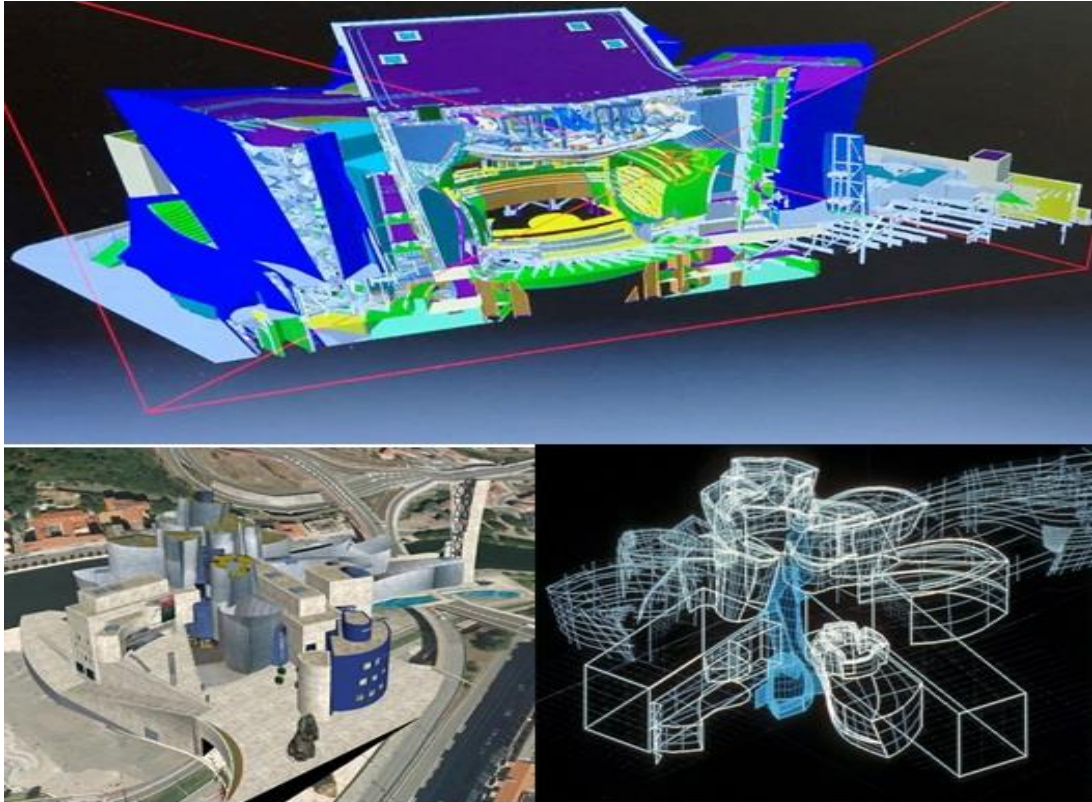


Figure 10: Walt-Disney-concert-hall, Los Angeles, Interior Design (2003)
Source: (Liz, 2007).



Figure 11: Walt-Disney-concert-hall 2003, LOS ANGELES exterior design
Source: (Liz, 2007)

3.2.4.6 V-ray 3D Max Autodesk Modeling

Autodesk 3D Max modeling and rendering was created in 1988 by Autodesk Company. 3D Max won the competition of “Visual Digital Content Creation Tools” in 2008. 3D Max assists the interior designer in modeling, rendering and animating the detail material, light, color, texture and some other elements which are vital for designing an interior space. Some of my observations on 3D Max V-ray modeling are shown in the following figures (Figure 12-14).



Figure 12: Club modeling interior space, North Cyprus, Lefkosa by V_RAY 3D Max
Source: (Design by author, 2013).



Figure 13: Turkish bath, North Cyprus, Kyrinia Belapais villa interior space by V_RAY, 3D Max
Source: (Design by author, 2013).



Figure 14: Bed room modeling interior space, North Cyprus, Kyrinia Belapais villa by V_RAY 3D max
Source: (Design by author, 2013).

3.2.5 Digital Production Tools

The digital age has radically reconfigured the relationship between the concept and production, creating a direct digital link between what can be conceived and what can be built through "file-to-factory" processes of computer numerically controlled (CNC) fabrication and Rapid Prototyping (3D printer) and 3D scanner. It was the complexity of "blobby" forms that drew architects, out of sheer necessity, back into being closely involved with the production of buildings. In the process, they discovered they have the digital information that could be used in fabrication and construction to directly drive the computer-controlled machinery, making the time-consuming production of drawings unnecessary. The introduction of digital fabrication also enabled architects to produce scale models of their designs using processes and techniques identical to those used in the industry. Thus, a valuable feedback mechanism between conception and production was established (Kucuktuna, 2014).

3.2.5.1 Fabrication

Digital revolution and the development of Computer Aided Design and Computer Aided Manufacturing have helped the designers to enhance their creativity and to work on parametric and curved forms. According to Corser (2010), "fabrication architecture addresses the broad range of issues that grows out of this emerging technology innovation". Computer numerical control (CNC) as a laser cutting or 2D fabrication technique is an example of digital fabrication and computer aided manufacturing during the building construction and physical modeling.

3.2.5.2 Rapid Prototyping (3D printer)

Rapid prototyping is a new Generation of 3D fabrication digital design that opens a whole new world of possibilities as shown in Figure 15. This machine is capable of

translating the CAM software. This technique is digital modeling of traditional modeling (Maket); by altering the speed, cost, complexity, and consistency, which physical architecture models can be crafted and shift sketching to physical model.

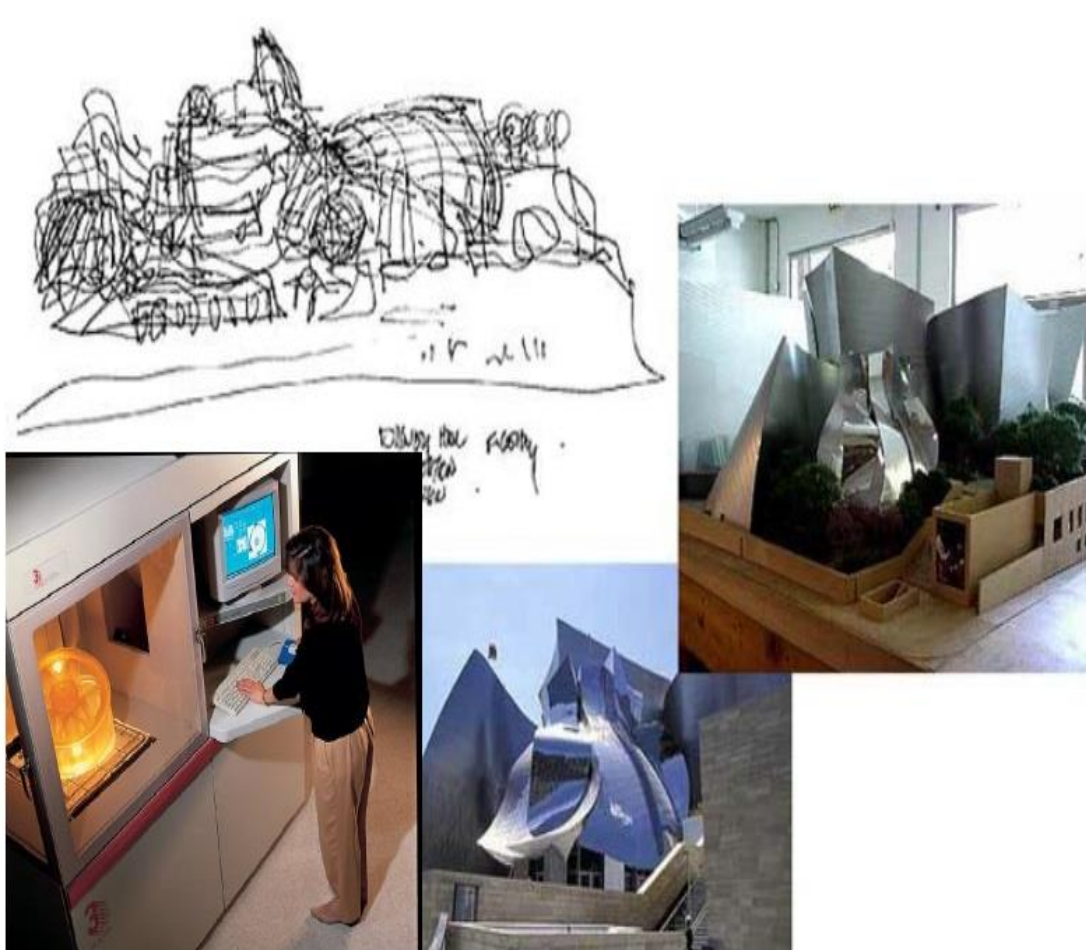


Figure 15: Idea of walt-disney-concert-hall model by Rapid Prototyping (3D printer)
Source: (Angeles, 2013).

3.2.5.3 Computer Numeric Control CNC

In 1970 CNC machine was developed. CNC machine has advanced from a laser cutting tools lead to CAD “cutting tools and high-power spindles capable of speeds exceeding 50,000 revolutions per minute” (Collins, 2011). The most important advantage of CNC is that it helps the designer to reduce time, increase speed, decrease cost, rise quality, complexity and creativity. There are various types of CNC

machines such as CNC turning, CNC milling, CNC cutting laser, CNC plasma cutting, CNC press and CNC Welding as shown in Figure 16-18. CNC helps the interior designer to design structure, furniture, decoration, panel etc.



Figure 16: CNC milling, Left: Shell structure by Stuttgart University, Right: Zmianatematu café by Polish architects
Source: (Halbe, 2013).



Figure 17: CNC Welding walt-disney-concert-hall, Los Angeles architect, Gehry
Source: (Liz, 2007).



Figure 18: Left: CNC cutting laser panel design, Right: CNC router parametric design, Washington University School of Architecture class project
Source: (Evolo, 2012)

3.2.5.4 3D Laser Scanner

3D laser scanner is a digital fabrication tool which is being developed during the last few decades. This new technology is used widely in design and construction. 3D scanner system works as a digital view point of camera for the designer. 3D scanner is a measurement tool with the ability of scanning a subject, providing a precise scale of a space. It can widely be used during the design process. This tool is capable of scanning a subject in less than 10 seconds and provides a flawless result (Figure 19).



Figure 19: Structure Sensor scan a whole room and provide measurements with an iPad Apple application
Source: (Hoops, 2013).

3.2.6 Digital Visualization

Digital visualization (computer graphics) is any technique that produce a visual (graphic) image such as: diagrams, 2D drawing or 3D modeling, rendering, animation and VR, as well as the power of digital media to permit the seamless integration of various data types are unleashing completely new ways to display architecture; communicate architectural information associated with the production of building. Visualization has been seen to the improvement of concept in design. Today digital visualization assists the interior designer to understand the concept and transfer its meaning to the client.

3.2.6.1 Two-Dimensional Drawing Technique

Two-dimensional tools transfer the concept to reality; designing has been improved since computers have been used to generate 2D drawing in the design process. create model in interior architecture from the conceptual design to construction has allowed the integration of 2D and 3D design. The earliest programs were used for 2D designs and were considered the major part of the interior design process.

3.2.6.2 Three-Dimensional drawing technique

the best assistant of interior designers. Using the computer to create hyper-real images that are more like photographs from magazines than drawings, these visualisations are created either in image-editing softwares such as Adobe Photoshop or by rendering (adding surface) effects to wireframe models to incorporate colour, light, shade, transparency and texture three-dimensional models (Spankie, 2009).

Chapter 4

4 DIGITAL INTERATED INTO DESIGN PROCESS

In the last decade, designers invented the parametric model and creative environment where exist lots of possibilities to work with. Designers can break the geometric volumes and reassemble them in original new forms of unprecedented complexity (de constructivism), also there are architects who believe in cyberspace design, consider a new role in design process by contributing to computer and media reperasantation. The designer retains the central symbolic condition of the design schema and interacts with representational media. Below are shown different kinds of interactions between designers and digital media and the classification of representational media during the digital design process (Oxman, 2006) (Figure 20).

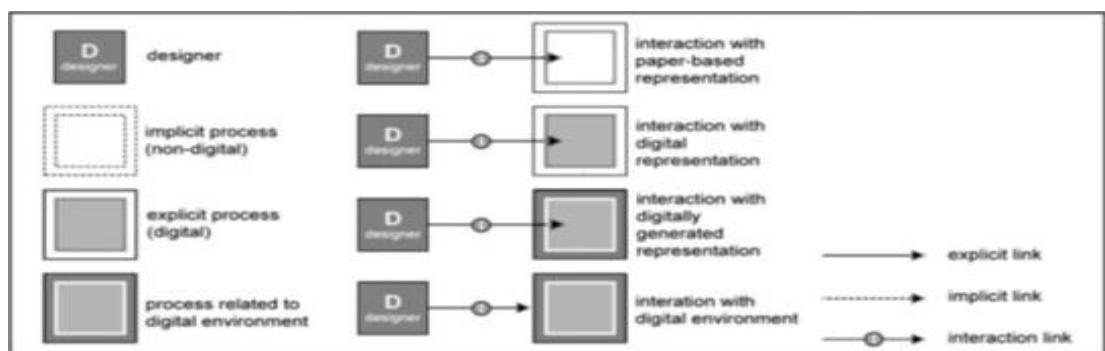


Figure 20: Generic schema: symbols, boundaries (intergrate between the designer and representational media) links

Source: (Oxman, 2006).

The study going to survey oxman theory as a base of this research in the methodology for digital designer in 21centery and interaction of them with digital

possibilities on representation for present the design during the design process. Time changing has effect on interaction of designer with each of subjects. Technology possibilities is cause of shift of interaction from free form to environment generation but is not mean the ignore of each of them.

- Interaction with a free form (paper-based non-digital) representation

This type of interaction is typical for paper-based design. In this case the designer interacts directly with a representation of the design object through a Sketch, drawing or a physical model to create his design.

- Interaction with digital constructs

This type of interaction is typical for a CAD-based design. In this case the designer interacts with a digital sketch, digital drawing or digital model. Look like Sketch with CATIA program, modeling with rapid prototyping and drawing with computer.

- Interaction with a digital representation generated by a mechanism

This type of interaction is typical of interacting with generative design mechanisms. In this case the designer interacts with a digital structure that was generated by a mechanism according to a set of predefined rules or relations. Look like a Gehry curve structure with catia software.

- Interaction with digital environment that generates a digital representation

This type of interaction is typical of interacting with the operative part of a generative design mechanism. In this case the designer can interact with the computational mechanism that generates the digital representation (Oxman, 2006). CNC machine is one of the example for present the digital design project.

4.1 Frank Gehry Creator of GT

NAME: Frank O. Gehry.

DATE OF BIRTH: February 28, 1929

BIRTH PLACE: Toronto, Canada

UNIVERSITY: He was awarded with a scholarship by the University of Southern California and graduated in 1954 with a degree in architecture.

DESIGN STYLE: De constructivism¹ breaking the familiar geometric volumes and reassemble them in original new forms of unprecedented complexity (American Academy of Achievement, 2010). Gehry is a highly sophisticated designer. He transferred his style from free form (paper-based non-digital) representation architect with only drawings of his concepts and visions to a physically realized architect or Interaction with a digital representation generated by a mechanism.

In 1989, Gehry technology as a firm of gehry was responsible in innovation architecture software and CAD/ CAD which is develop digital project on digital design field. CATIA is one of that software.

- 1993: Interacted with free form representation
- 2003: Interacted with digital environment that generates a digital representation (CATIA) by Gehry technology
- 2012: Interacted with digital environment that generates a digital representation (CATIA) by Gehry technology

¹ De constructivism: It moves walls, slides different parts of buildings where one would not expect them to go, and creates different spaces and the illusion of space using geometry. In my opinion, deconstructivism is the magician of architecture (Theclevercat, 2013).

4.1.1 Dancing House, Downtown Prague (1993)

Gehry designed the dancing house's interior space with free flowing curving surfaces that appear to fit over a rectilinear structure beneath. The style of building is deconstructivist. The cylindrical tower was constructed with 99 concrete panels, each with a different shape and dimension (Inbar, 2011) (Figure 12). When designing this building, the architect used radically sculptural organic shapes that have pronounced visual gestures and forms. The concept of this building is the sweeping curvy female figure attached to the male straight one that composes the two sections of the building. Gehry interacted with free form (paper-based non-digital) representation and interacted with digital constructs in order to design the dancing house by interacting with digital constructs (Figure 21).

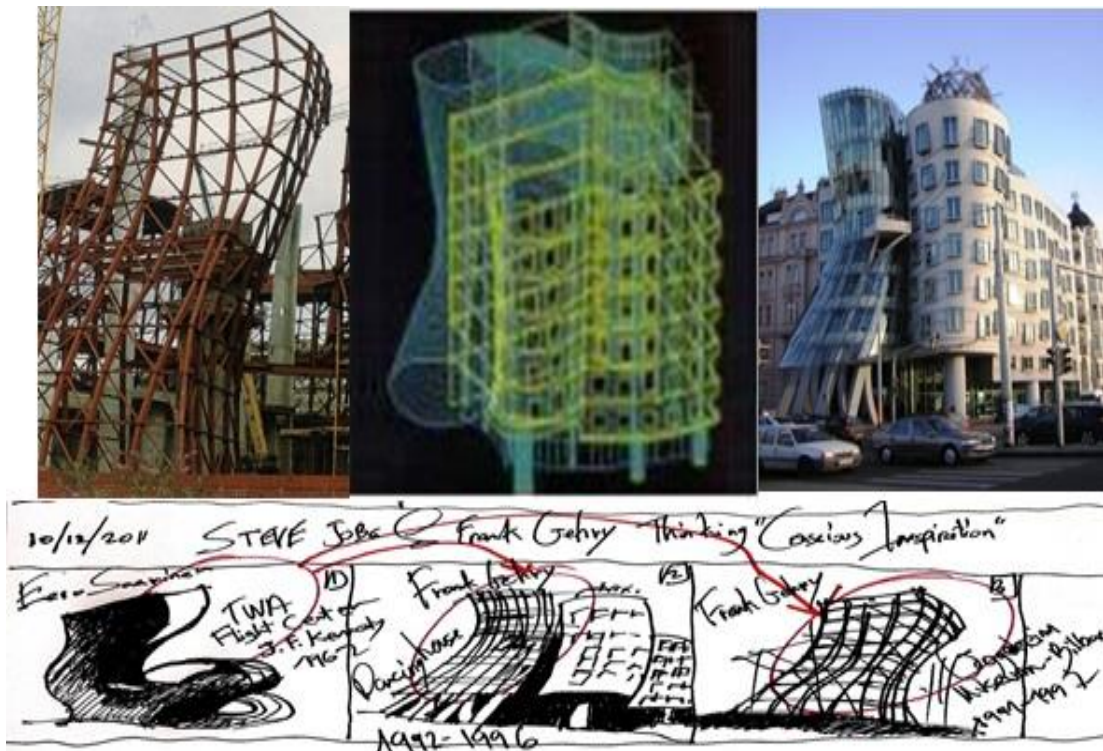


Figure 21: Dancing house by interacting with digital constructs
Source: (Inbar, 2011).

4.1.2 Walt Disney's Concert Hall Interior Design, Los Angeles (2003)

Gehry when designing the concert hall, used digital technology method during the design process. His design is clearly “driven by dynamics of new technologies and new means of production. His close interaction with appropriate technology mimics nature's relationship between form and metabolism showing how nature “intricate choreography of form and material determines the morphology of living forms and their relations to one another (Inbar, 2011) He Interacted with digital environment that generates a digital representation. Gehry uses CATIA digital software computerized design program that enables the building to be produced, within a specific budget, construction process (CNC) and within a reasonable time (Figure 22).



Figure 22: Right: Walt Disney concert hall, Gehry (2003), Left: Skach free form representation right interior shot
Source: (Inbar, 2011).

4.1.3 Marques De Riscal Vineyard Hotel, 2006

Marqués de Riscal Vineyard Hotel was designed by using advanced computer techniques during the design process. For physical modeling translated into digital form with CATIA program in three-dimension modeling and structure calculation (Figure 23). Gehry integrated with free form of design of Marqués de Riscal Vineyard Hotel for sketching and structure calculation and Gehry interacted with digital environment that generates a digital representation shown in every stage of design process.



Figure 23: Marqués de Riscal Vineyard Hotel interior and exterior
Source (Batebe, 2009).

4.2 Zaha Hadid Creator of Parametric Space

NAME: Zaha Hadid

DATE OF BIRTH: October 31, 1950 (age 63)

BIRTH PLACE: Baghdad, Iraq

Education: Architectural Association School of Architecture
(1972–1977), American University of Beirut

DESIGN STYLE: Parametric design(animated or robatic design) with her partner Patrik Schumacher. Media and digital design according to Zaha Hadid: The quest for new design media Graphic Space Post-modernism, DE constructivism, Folding Mechanisms of Invention. (Schumacher,2004). Hadid transformed her style of representation from free form (paper-based non-digital) with only drawings of her concepts and visions to a physically realized architect or Interaction with a digital representation generated by a mechanism. Zaha hadid is digital architecture from Patrick shumaher quote: Digital Hadid will explore the contribution of Zaha Hadid and of Zaha Hadid Architects to the development of the new architectural language and paradigm that is fast becoming hegemonic within avant-garde architecture today. This new language (or style) of architecture seems to be based upon the adoption of a new generation of 3D modeling tools. Indeed a lot of commentators tend to construe a direct causal link from this new paradigm back to the IT revolution that has transformed the discipline in last 10 years (Schumacher, 2004).

- 1993: Interacted with free form representation
- 2005: Interacted with digital environment that generates a digital representation (CATIA) parametric space
- 2012: Interacted with digital environment that generates a digital representation (CATIA) parametric space.

4.2.1 Guangzhou Opera Houses Guangzhou, China (2005)

The main feature of the design process for the Guangzhou Opera House is that it is designed by utilizing digital technology. The Opera House is designed with parametric element by Zaha Hadid. The first 3D models of the interior hall are desined using Rhino. The preparation of a 1:25 scale model took place at South China University of Technology (SCUT) and tests were supervised by Dr Stephen Chiles. The model was constructed from molded GRG segments (Hadid, 2014). Zaha Hadid had interacted with digital environment that generates a digital representation during the design process (Figure 24).



Figure 24: Guangzhou Opera House Guangzhou modeling
Source: (Hadid, 2014).

4.2.2 Neil Barrett Store Tokyo Japan (2008)

Neil Barrett store is designed by using fixed points, folding and pleating parameters. Hadid has used digital constructs (CAD) in order to design this store. The design was shaped by 3D computer generated models. These are processed by the manufacturer using further software to thermoform the sheet corian material into the 3D designed surfaces. A series of these surfaces will be fabricated with joints, ready to be assembled into larger sections on site (Figure 25). Using the latest 3D modeling and CNC programming solutions, we are able to guarantee a very precise and automatic translation of the design into the built structure (Hadid, 2014).

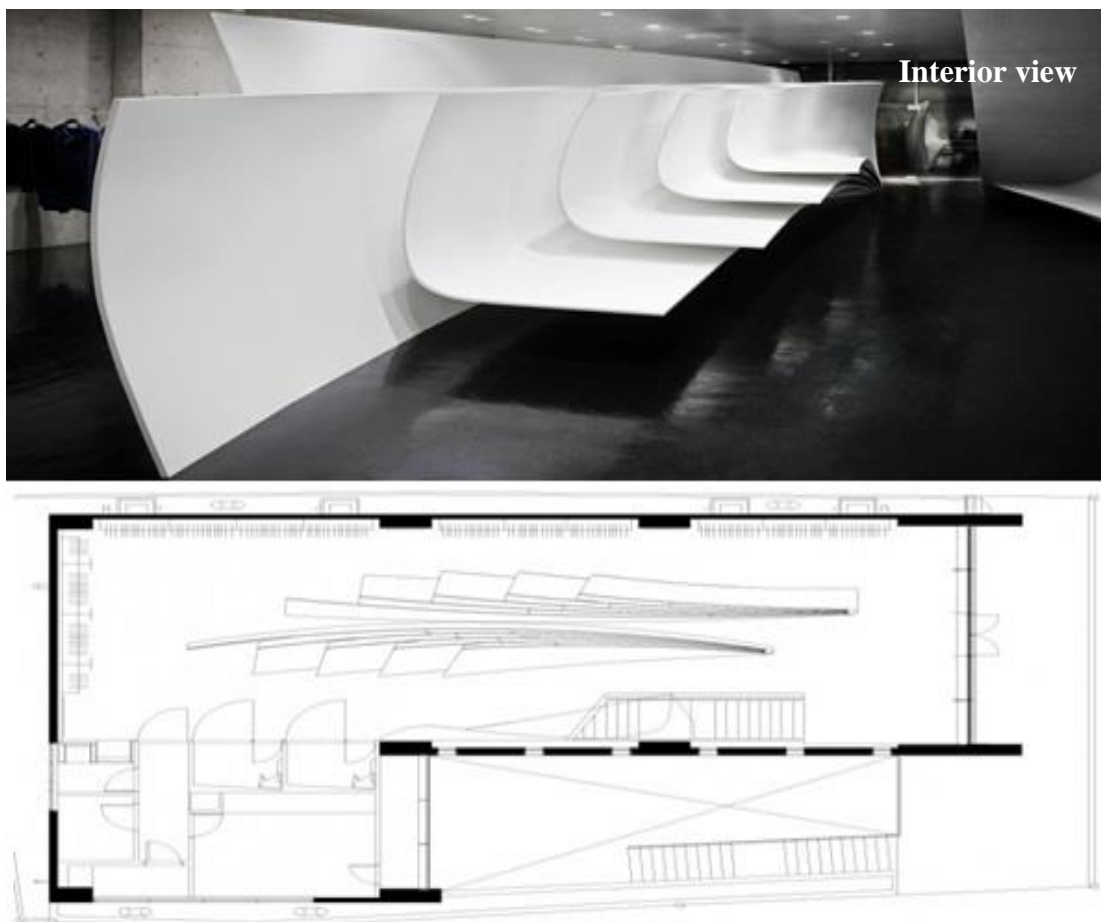


Figure 25: Neil Barrett store interior view
Source: (Hadid, 2014).

4.2.3 Roca London Gallery Interior (2012)

Roca gallery is designed using a complex free-form architectural language, reflecting fluidity and nature. It is driven by new digital design tools and constant evolution of digitally controlled manufacturing, fabrication and contemporary construction mechanisms, processes and methods. Subdivision Surface modeling in Maya is the used digital design tool (Sanitario, 2013). Hadid has used a digital environment that generates a digital representation for Roco gallery design (Figure 26).

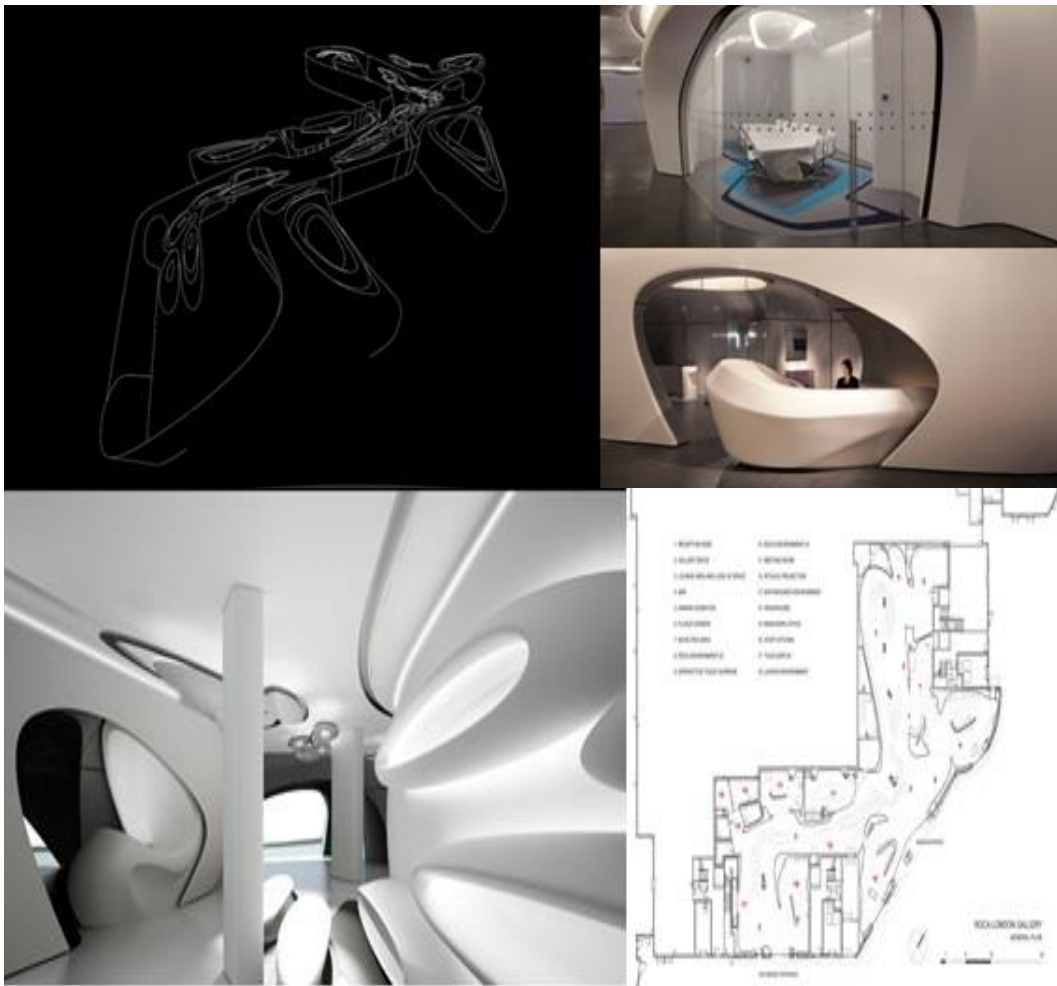


Figure 26: Neil Barrett store interior view
Source: (Hadid, 2014).

4.3 Karim Rashid Creator of Blobject Space

NAME: KARIM RASHID

DATE OF BIRTH: 1950

BIRTH PLACE: Cairo, Egypt

Education Bachelor in Industrial Design, Carleton University, Ottawa, Canada

DESIGN STYLE: "Sensual minimalism" that characterizes Rashid's style. "Form is much more seductive when the product's aesthetics are experiential, and not just visual," Rashid declares the importance of engaging senses. "Objects have to blur experience with form so that they are inseparable. It means retooling the stuff we live with to suit the way we really live. It means that if we slouch in chairs, we make chairs that let us" (Rashid, 2013) .

Rashid is digital architecture from quote of Writer. Currently professor of Design History in Melbourne. Rashid following blobject design style these stylists of digital fluidity were experimenting with the sculptural possibilities opened up by new technologies such as CAD and CAM. Like a contemporary version of streamlined design, the application of a smooth and curvaceous "digital skin" onto existing products was supposed to evoke the new digital era: the 1930s metaphor of speed was replaced by the 1990s metaphor of cyberspace (Rashid, 2013).

- 2001: Interacted with free form reperasantation
- 2008: Interaction with digital constructs.blobject space
- 2013: Interacted with digital environment that generates a digital representation blobject space.

4.3.1 Morimoto Restaurant Philadelphia (2001)

Rashid used digital tools Autodesk 3D modeling, to model the morimoto restaurant. He has utilized free form representation during the design process, he also interacted with digital constructs (CAD) for the digital representation of the project (Figure 27).

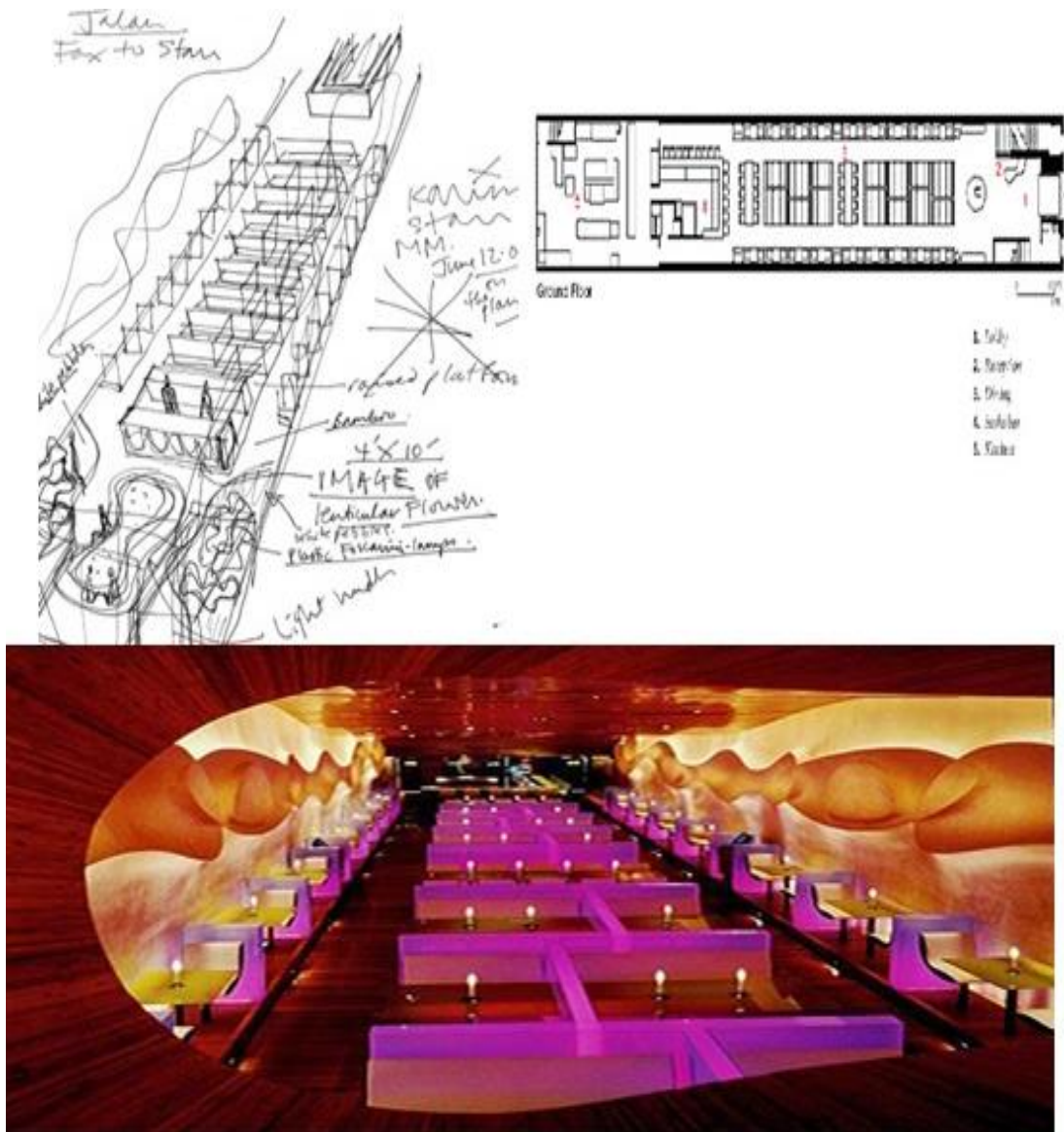


Figure 27: Right: Digital representation as sketch drawing, Left: Digital representation as a 2D drawing
Source: (Rashid, 2013)

4.3.2 Majik Cafe, Belgrade (2008)

Majik Café stems from Karim's philosophy of creating a digipop digital nature and a seamless world that excites all the senses. Karim's love of sensuous lines and brilliant hues come through in the dynamic space (Figure 28). Digital artwork made of RGB LED panels surround the bar making the space visible from down the street. The dynamic patterned glass bar changes color and mood throughout the customer's stay. The restaurant is brought into the 21st techno century with a scrolling LED message board above that displays customer's text messages. Meets west digital freedom, where technology and new social behaviors are the global proponents of a new singular seamless world (Rashid, 2013). Rashid interacted with a free form representation during the design process; he also interacted with digital constructs (CAD) for digital representation of the project.

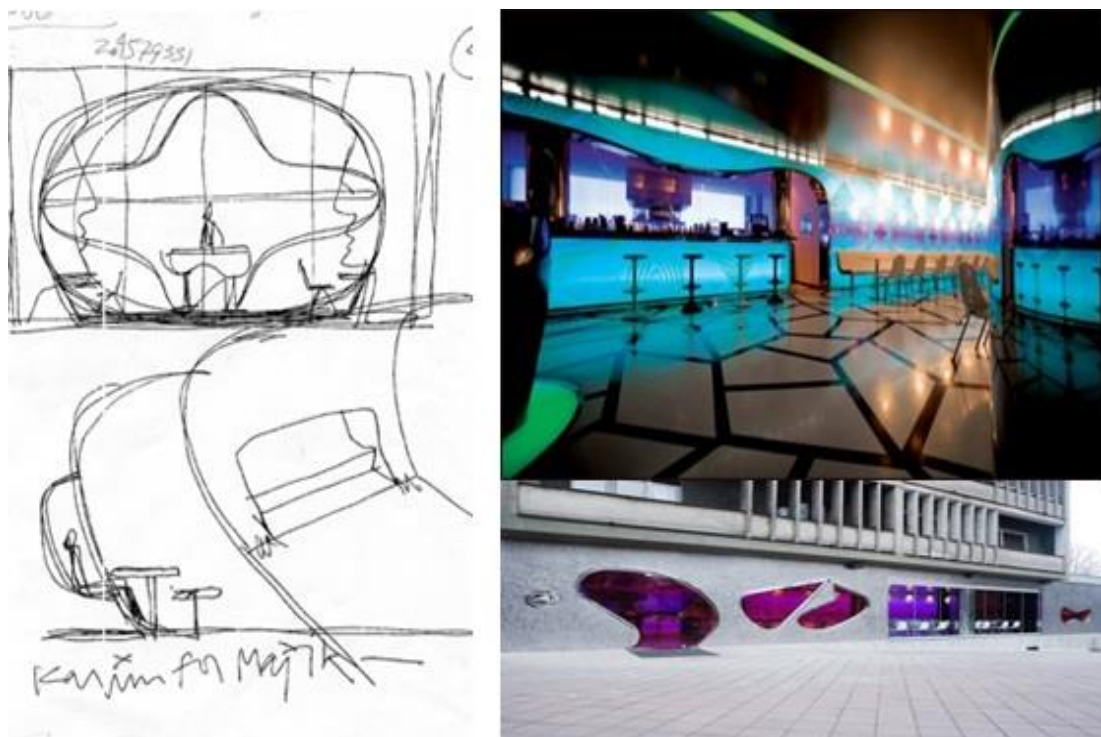


Figure 28: Majik Cafe, Belgrade (2008)
Source (Rashid, 2013).

4.3.3 Seoul, Korea (2013)

Rashid transforms a typical cafeteria into an environment of sensory experiences with eye catching colors and ‘technorganic’¹ forms, which encourage personal interactions at ‘foodcapitol’, the lotte department store’s amoje food court in seoul, South Korea. He used a free form representation during the design process, he also used digital constructs (CAD) for digital representation of the project and utilized a digital representation generated by a mechanism (Figure 29).



Figure 29: Seoul, Korea (2013)
Source: (Rashid, 2013)

¹ Technorganic describes the melding of technological and biological components into a single entity, fused at the cellular level, and generally involving the power of the Oracle (Larry DiTillio post to ATT, Feb 4 1997)

4.4 Evaluation of Design Process of Selected Designers in Terms to Their Digital Projects

This study survey three project between 1993 until 2012 by Gehry. Gehry has interaction with free form representation by pencil and paper during the design process on that period, design was on traditional process. During the time and after the digital revolution on 2003 Gehry shift the interaction from free form to interacted with digital environment that generates a digital representation with digital possibilities and technology Gehry had much more option for use from CAD, CAM, CAE on design process with Gehry technology as a firm of Gehry was responsible in innovation architecture software and CAD/CAM which is develop digital project on digital design field. CATIA is one of that software. But it is not mean Gehry ignore the traditional method on design process, based on every design work is sketching (interaction of free form representation). He used from combination of traditional and digital method on design process.

This research survey three project between 2005 until 2012 by Zaha Hadid. Hadid has interaction with free form representation by pencil and paper during the design same as another designer on beginning of work (1982). After co-operation between Hadid and Patrick Schumacher as a philosopher concept of Hadid works taken from parametric theory. Parametric Theory relies on digital technology when advanced computer aided design tools in architecture design are used. Thus, according to the philosopher, parametric theory is a base of generation of parametric diagrams entered architecture by using animation soft wares, interaction with mechanism and generative mechanism start from that point. Every parametric space needs to use from digital possibilities and technologies for production so Hadid start to interaction

with generative environment representation and CAD, CAM, CAE during the design process.

Rashid as an industrial designer and interior designer had focus on free form representation based of this designer is sketching by paper by drawing during the time Rashid combine the interaction of free form to digital environment that generates a digital representation for present of blobject space CAD, CAM, CAE help to present the blobject space for Rashid on 21 century.

Chapter 5

CONCLUSION

To conclude after though sources and theories, it is possible to conclude that the digital revolution has provided the designers with computer technology and various media. Now Computer is not only used as a tool for presentation of the projects, but rather as the basis and generative mechanism of the designing process. According to Bilalis's idea that has been into consideration in detail in chapter two, CAD, CAM, and CAE are the best examples for this word. The interior design process in action from borne in mind until creating spaces belongs to the digital design in the 21 century and every designer has to follow the digital rules during the design process, if those rules are not considered the loss of time and energy during of process occurs. According to the Dodsworth's idea which is discussed in chapter two the use of every digital tool on each steps of design action (analysis, development, implementation, and evaluation) through the possibilities of CAD, CAM, and CAE can help extending the field of interior architecture, create different and various designs and explore new concepts, theories and forms.

The influence of the digital revolution on designing is that it has ushered a new age in the designing world by introducing a new style of designing. Gehry's effect and some other concepts like parametric/liquid design are some of the resultant styles. However, up to this date it is only known as a period in designing. According to the proofs and documents that were analyzed in this thesis the reason behind this

realization is that, integration of computer technology within design process is still considered a recent phenomenon and every style in designing needs more than a period of hundred years to establish itself as a separate one thus; according to Mohhamed's idea, digital designing needs more time in order to grow into a separate style, Based on Novak's idea (cyber space), which has been described on chapter two. This comment is relevant The interaction between computers and humans has lead into creativity and innovation in the contemporary design process, which is caused by the reduction of the limits, time consumption, the ability to witness the design before production, reduction of energy consumption and designing costs and the ability of demolishing and reconstructing the design getting rid of the problems well before the implementation.

By analyzing the designs of some famous designers who were chosen as the in representations of this new age, commenting on the consideration of these new possibilities has become possible. Guangzhou opera house build by Zaha Hadid had interacted with digital environment that generated a digital representation during the design process in the dancing house, in Prague and Gehry. Gehry had interacted with free form (paper-based non-digital) representation. The other example is discussed in chapter three. By studying and comparing the designing process of traditional (meaning before the introduction of the computers to the designing world) and contemporary design, it has been found out that back then the designing process was geometric and extremely consuming while contemporary design process becomes shorter time frame and with creativity using digital equipment. However, according to the Oxman's idea, in chapter three, designer a little back to paper-based design yet but digital designs today create new forms (various topological geometries

and curvilinearity) and design thinking by digital tools during the design process. The result of interaction between traditional and digital design is innovation the today's innovation in design.

Future

The last period of digital designing is known to be a strong one in terms of designing; this period had a strong influence over the architectural styles of the contemporary designers; and despite the fact that it is still known as a mere recent theory. Many philosophers and designers have tried to make an architectural designing style out of it, and understanding the link between design and sciences, it is hoped that this goal will be reached in the future following the advancements in the digital technology field and emerge the innovative digital approaches architecture increased by future such as: digital thinking, digital tools , digital production, digital design, digital representation, digital projects and digital practice etc. on every design field which is similar to the design action, design education and design researches.

REFERENCES

Ahmad, T. F. (2013, October 2). *Le Corbusier and Hadrian's Villa: A Connection Between the Ancient and the Modern (Part I)*. mozartandgunfire: <http://mozartandgunfire.wordpress.com/2013/10/02/le-corbusier-hadrians-villa/> adresinden alınmıştır.

Angeles, M. (2013). *Why We Sketch*. Konigi: <http://konigi.com/book/sketch-book/why-we-sketch>.

Balch, K. S. (1990). Patent and Trademark Office, *U.S. Patent No. 4,958,315*. Washington, DC: U.S.

Benzenberg, E. M. (2011). Exploring Design Process Evolution in Architecture and Interior Design Firms. (Doctoral dissertation, The Ohio State University).

Bergin, M. S. (2012, December 7). *A Brief History of BIM*. <http://www.archdaily.com/302490/a-brief-history-of-bim/>
<http://www.archdaily.com/302490/a-brief-history-of-bim/> adresinden alınmıştır.

Bilalis, N. (2000). *Computer aided design cad*. Technical University of Crete.

Brooker, G., & Stone, S. (2010). What is interior design?, RotoVision.

Cam, W. C. N. (2006). *Building life cycle and integrated design process*. climatetechwiki: <http://www.climatetechwiki.org/technology/building-life-cycle-and-integrated-design-process>.

Charles, J. & Karl, K. (March, 2006). *Theories and manifestoes of contemporary architecture*. Wiley, John & Sons, Incorporated.

Dino, Í. G. (2012). Creative Design Exploration by Parametric Generative Systems in Architecture. *Metu Jfa*, 1, 207.

Dodsworth, S. (2009). *The fundamentals of interior design*. AVA Publishing.

Evolo. (2012, December 4). *Parametric Explorations for an Outdoor Sculpture*. evolo: <http://www.evolo.us/architecture/parametric-explorations>.

Hadid, Z. (2014). *Zaha hadid architecture*. Zaha hadid: <http://www.zaha-hadid.com/architecture/guangzhou-opera-house>.

Halbe, R. (2013, November 9). *Inhabitat*. Dezeen: <http://inhabitat.com/itke-constructs-new-arboskin-pavilion-with-388-recyclable-bioplastic-pyramids/>

Holtzschue, L. & Noriega, E. (1997). *Design fundamentals for the digital age*. John Wiley & Sons, Inc.

Hoopes, H. (2013, September 17). *Scanning and augmented reality for iPad*. gizmag: <http://www.gizmag.com/structure-sensor-3d-scanning-augmented-reality-ipad/29094>.

Inbar, E. (2011, December 11). *Someone has built it before*. archidialog: <http://archidialog.com/2011/12/11/frank-gehry-steve-jobs-do-they-have-something-in-common>.

Liz. (2007, July 12). *Modern british architecture*. Walt Disney Concert Hall, Downtown Los Angeles: <http://brst440.commons.yale.edu/2007/07/12/walt-disney-concert-hall-downtown-los-angeles>.

Iwamoto, L. (2013). *Digital fabrications: architectural and material techniques*. Princeton Architectural Press.

Leach, N. (Ed.). (2009). *Digital cities AD: architectural design* (Vol. 38). John Wiley & Sons.

Kang, M. (2009). *A computer database of design methodological tool patern for interior designer*. Oklahoma State University.

Rashid, k. (2013). *Space*. Karim Rashid : <http://www.karimrashid.com/> adresinden alınmıştır.

Lawson, B. (2006). *How designers think: the design process demystified*. Routledge.

Millenium, R. (2008, November 30). *Revit. Bimboom*:
<http://bimboom.blogspot.com/2012/04/revit-for-mac-2013-now-available-for.html>
adresinden alınmıştır.

Oxman, R. (2006). Theory and design in the first digital age. *Design Studies*,27(3),
229-265.

Saad, N. M. (2011). *Digital architecture theoretical study of digital design modeling*.
(Master dissertation Alexandria University).

Schumacher, P. (Ed.). (2004). *Digital Hadid*. Springer.

Silva, C. A. (2000). *Liquid Architectures: Marcos Novak's Territory Of Information*.
Brazil: B. Arch., (Master dissertation University of Brasilia).

Smith, B. L. (2006). *Foundation 3ds Max 8 architectural visualization*. Apress.

Smith, S. (2012). *10 building that change american* .
<http://interactive.wttw.com/tenbuildings/walt-disney-concert-hall>.




Spankie, R. (2009). *Basics Interior Architecture 03: Drawing Out the Interior*
(Vol.3). AVA publishing.




Strilets, I. (2012, July 13). *Will Augmented Reality Become the New Standard for E-Commerce?* business2community: <http://www.business2community.com/tech->

gadgets/will-augmented-reality-become-the-new-standard-for-e-commerce-
0217795#!6WTV1 adresinden alınmıřtır.



APPENDICES


Appendix 1: List of Frank Gehry works








NAME	CITY	COMPLETED	Interaction between GEHRY and representational media	IMAGE
David Cabin	Idyllwild, California	1958	Interaction with a free form	
Ronald Davis Studio & Residence	Malibu, California	1972	Interaction with a free form	
Exhibit Center, Merriweather Post Pavilion, and Rouse Company	Columbia, Maryland	1974	Interaction with a free form	
Sleep Train Pavilion	Concord California	1975	Interaction with a free form	
Harper House	Baltimore, Maryland	1977	Interaction with a free form	
Gehry Residence	Santa Monica, California	1971	Interaction with a free form	
Loyola Law School (various buildings)	Los Angeles, California	1978-2002	Interaction with a free form	
Santa Monica Place	Santa Monica	1980	Interaction with a free form	
Cabrillo Marine Aquarium	San Pedro	1981	Interaction with a digital representation generated by a mechanism	


Air and Space exhibit building, California Museum of Science and Industry	Los Angeles	1984	Interaction with a digital representation generated by a mechanism	
Edgemar Retail Complex	Santa Monica	1984	Interaction with a digital representation generated by a mechanism	
Norton House	Venice	1984	Interaction with a digital representation generated by a mechanism	
Frances Howard Goldwyn Hollywood Regional Library	Hollywood	1985	Interaction with a digital representation generated by a mechanism	
Information and Computer Science/Engineering Research Facility (ICS/ERF)	Irvine	1986	Interaction with a digital representation generated by a mechanism	
Sirmai-Peterson House	Thousand Oaks	1984-86	Interaction with a digital representation generated by a mechanism	
Winton Guest House	Owatonna	1987	Interaction with a digital representation generated by a mechanism	
Yale Psychiatric Institute	Yale University, New Haven	1989	Interaction with a digital representation generated by a mechanism	
Rockwell and Marna Schnabel House	Brentwood	1986-89	Interaction with a digital representation generated by a mechanism	
Herman Miller factory (currently William Jessup)	Rocklin	1987-89	Interaction with a digital representation generated by a mechanism	

University)			mechanism	
Vitra Design Museum	Weil am Rhein	1989	Interaction with a digital representation generated by a mechanism	
Chiat/Day Building	Venice	1991	Interaction with a digital representation generated by a mechanism	
Iowa Advanced Technology Laboratories	University of Iowa, Iowa City	1992	Interaction with a digital representation generated by a mechanism	
Disney Village	Disneyland Paris, Marne-la-Vallée	1992	Interaction with a digital representation generated by a mechanism	
Olympic Fish	Olympic Village, Barcelona	1992	Interaction with digital environment that generates a digital representation	
Frederick Weisman Museum of Art	University of Minnesota, Minneapolis	1993	Interaction with digital environment that generates a digital representation	
Center for the Visual Arts	Toledo	1993	Interaction with a digital representation generated by a mechanism	
Cinémathèque Française	Paris	1994	Interaction with a digital representation generated by a mechanism	

Vitra International Headquarters	Basel	1994	Interaction with a digital representation generated by a mechanism	
Siedlung Goldstein	Frankfurt	1994	Interaction with a digital representation generated by a mechanism	
Energie Forum Innovation	Bad Oeynhausen	1995		
Dancing House	Prague	1995	Interaction with a digital representation generated by a mechanism	
Disney Ice (currently Anaheim Ice)	Anaheim	1995	Interaction with a digital representation generated by a mechanism	
Team Disney Anaheim	Anaheim	1995	Interaction with a digital representation generated by a mechanism	
Guggenheim Museum Bilbao	Bilbao	1997	Interaction with digital environment that generates a digital representation	
Der Neue Zollhof	Düsseldorf	1999	Interaction with a digital representation generated by a mechanism	

University of Cincinnati Academic Health Center	University of Cincinnati, Cincinnati	1999	Interaction with a digital representation generated by a mechanism	
Condé Nast Publishing Headquarters Cafeteria	Times Square, New York City	2000	Interaction with a digital representation generated by a mechanism	
DZ Bank building	Pariser Platz, Berlin	2000	Interaction with a digital representation generated by a mechanism	
Experience Music Project	Seattle	2000	Interaction with digital environment that generates a digital representation	
Gehry Tower	Hanover	2001	Interaction with a digital representation generated by a mechanism	
Issey Miyake (flagship store)	New York City	2001	Interaction with a digital representation generated by a mechanism	
Weatherhead School of Management Peter B. Lewis building	Case Western Reserve University, Cleveland	2002	Interaction with digital environment that generates a digital representation	
Richard B. Fisher Center for the Performing Arts	Bard College, Annandale-on-Hudson	2003	Interaction with a digital representation generated by a mechanism	


Maggie's Dundee, Ninewells Hospital	Dundee	2003	Interaction with a digital representation generated by a mechanism	
Walt Disney Concert Hall	Los Angeles	2003	Interaction with digital environment that generates a digital representation	
Ray and Maria Stata Center	Massachusetts Institute of Technology, Cambridge	2004	Interaction with a digital representation generated by a mechanism	
Jay Pritzker Pavilion	Millennium Park, Chicago	2004	Interaction with a digital representation generated by a mechanism	
BP Pedestrian Bridge	Millennium Park, Chicago	2004	Interaction with a digital representation generated by a mechanism	
MARTa Herford	Herford	2005	Interaction with a digital representation generated by a mechanism	
IAC/InterActiveCorp West Coast Headquarters	West Hollywood	2005	Interaction with a digital representation generated by a mechanism	
Marqués de Riscal Vineyard Hotel	Elciego	2006	Interaction with digital environment that generates a digital representation	

IAC Building	Chelsea, New York City	2007	Interaction with a digital representation generated by a mechanism	
Mariza show stage, at the Walt Disney Concert Hall ^[35]	Los Angeles	2007	Interaction with a digital representation generated by a mechanism	
Art Gallery of Ontario	Toronto	2008	Interaction with a digital representation generated by a mechanism	
Peter B. Lewis Library	Princeton University, Princeton	2008	Interaction with a digital representation generated by a mechanism	
Serpentine Gallery 2008 Summer Pavilion	London	2008	Interaction with a digital representation generated by a mechanism	
Novartis Pharma A.G. Campus	Basel	2009	Interaction with a digital representation generated by a mechanism	
Danish Cancer Society Counseling Center	Aarhus	2009	Interaction with a digital representation generated by a mechanism	
Lou Ruvo Center for Brain Health	Las Vegas	2010	Interaction with digital environment that generates a digital representation	

Ohr-O'Keefe Museum Of Art	Biloxi	2010	Interaction with digital environment that generates a digital representation	
New World Center	Miami Beach	2011	Interaction with digital environment that generates a digital representation	
New York by Gehry at Eight Spruce Street	New York City	2011	Interaction with digital environment that generates a digital representation	
Opus Hong Kong	Hong Kong	2011	Interaction with digital environment that generates a digital representation	
Pershing Square Signature Center	New York	2012	Interaction with digital environment that generates a digital representation	
Duplex Residence	New Orleans	2012	Interaction with digital environment that generates a digital representation	
Maggie's Hong Kong	Hong Kong	2013	Interaction with digital environment that generates a digital representation	

Appendix 2: List of Zaha Hadid works




NAME	CITY	COMPLETED	Interaction between GEHRY and representational media	IMAGE
IBA housing	Berlin	1986–93	Interaction with a free form	
Moonsoon	Sapporo	1989–90	Interaction with a digital representation generated by a mechanism	
Folly 3	Osaka	1990	Interaction with a digital representation generated by a mechanism	
Vitra fire station	Weilam Rhein	1994	Interaction with a digital representation generated by a mechanism	
Serpentine Gallery Pavilion	London, UK	2000	Interaction with a digital representation generated by a mechanism	
Hoenheim-North Terminus & Car Park	Hoenheim, France	2001	Interaction with digital environment that generates a digital representation	
Bergisel Ski Jump	Innsbruck, Austria	2002	Interaction with digital environment that generates a digital representation	
Rosenthal Center for Contemporary Art	Cincinnati, Ohio	2003	Interaction with digital environment that generates a digital representation	

Ordrupgaard Museum extension	Copenhagen, Denmark	2001-05	Interaction with digital environment that generates a digital representation	
BMW Central Building	Leipzig, Germany	2005	Interaction with digital environment that generates a digital representation	
Phaeno Science Center	Wolfsburg, Germany	2005	Interaction with digital environment that generates a digital representation	
Maggie's Centres at the Victoria Hospital	Kirkcaldy, Scotland	2006	Interaction with digital environment that generates a digital representation	
Tondonia Winery Pavilion	Haro, Spain	2001-06	Interaction with digital environment that generates a digital representation	
Hungerburgbahn stations	Innsbruck, Austria	2007	Interaction with digital environment that generates a digital representation	
Bridge Pavilion	Zaragoza, Spain	2008	Interaction with digital environment that generates a digital representation	
J. S. Bach Pavilion	Manchester, UK	2009	Interaction with digital environment that generates a digital representation	
CMA CGM Tower	Marseille, France	2005-10	Interaction with digital environment that generates a digital representation	

MAXXI - National Museum of the 21st Century Arts	Rome, Italy	1998-2010	Interaction with digital environment	
			that generates a digital representation	
Guangzhou Opera House	Guangzhou, China	2005-10	Interaction with digital environment that generates a digital representation	
Evelyn Grace Academy	Brixton, London, UK	2006-10	Interaction with digital environment that generates a digital representation	
Sheikh Zayed Bridge	Abu Dhabi, United Arab Emirates	2007-10	Interaction with digital environment that generates a digital representation	
London Aquatics Centre	London, UK	2008-11	Interaction with digital environment that generates a digital representation	
Riverside Museum	Glasgow, Scotland, UK	2007-11	Interaction with digital environment that generates a digital representation	
Heydar Aliyev Cultural Center	Baku, Azerbaijan	2007-12	Interaction with digital environment that generates a	

Appendix 3: List of karim Rashid works

NAME	CITY	COMPLETED	Interaction between RASHID and representational media	IMAGE
Morimoto restaurant	Philadelphia	2002	Interaction with digital constructs Interaction with a free form	
Semiramis Hotel	Athens	2004	Interaction with digital constructs Interaction with a free form	
Nooch Noodle Bar	New York	2004	Interaction with digital constructs Interaction with a free form	
Nooch Express	Singapore	2005	Interaction with digital constructs Interaction with a free form	
Askew	New York	2005	Interaction with digital constructs Interaction with a free form	
Four Food Studio	Long Island	2005	Interaction with digital constructs Interaction with a free form	
Bosco Pi	Moscow, Russia	2008	Interaction with digital constructs Interaction with a free form	
Majik Cafe	Belgrade	2008	Interaction with a digital representation generated by a mechanism	
Kurve	New York	2008	Interaction with a digital representation generated by a mechanism	

Jean-Georges Market	Atlanta	2008	Interaction with a digital representation generated by a mechanism	
Switch Restaurant	Dubai, UAE	2009	Interaction with a digital representation generated by a mechanism	
Sweet Chill, City Center	Las Vegas	2009	Interaction with a digital representation generated by a mechanism	
Silk Road, City Center	Las Vegas	2009	Interaction with a digital representation generated by a mechanism	
Nhow Hote	Berlin, German	2010	Interaction with digital constructs Interaction with a free form	
Nhow Bar Restyling, Nhow Hotel	Milan, Italy	2013	Interaction with digital constructs Interaction with a free form	

Designs technological tendency makes it a must to include technology in education and practices

Looking around Eastern Mediterranean University north Cyprus and some places where we can find this technology:



Figure 30: Rapid Prototyping (3D printer) process at EMU university, North Cyprus mechanic department, April 2014

Source: Author's observation.



Figure 31: CNC machine process at EMU university, North Cyprus mechanic department, April 2014

Source: Author's observation.

Istunbul bilgi university has been choose another kind of this machine for design work shop studios which is small with less price, that mean every studentes has one of that machine for printing the object flowing some picture frome this process below:



Figure 32: Inside the Ultimaker machine.

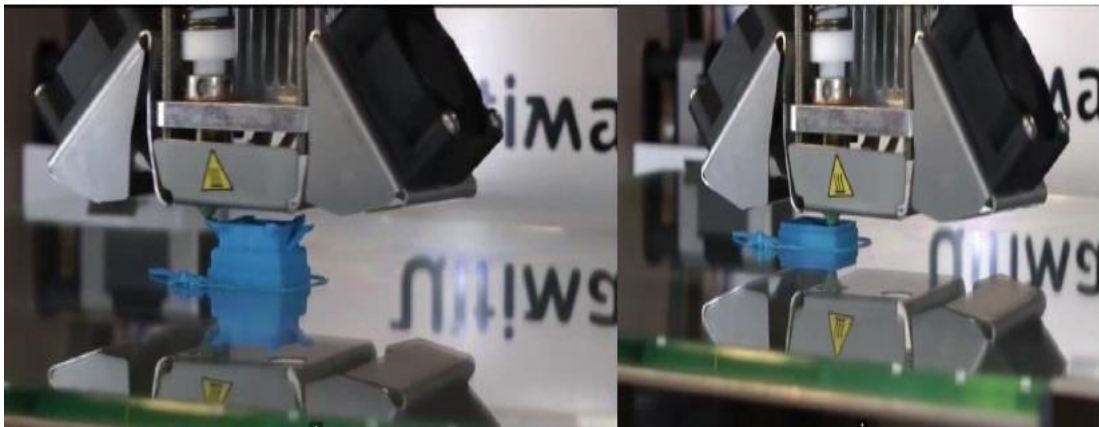


Figure 33: Left: Process of printing the object, Right: Bio-plastic material object by Salihkucuktuna Istanbul Bilgi University.



Figure 34: Process of printing the object by Ultimaker machine

Source: <http://www.3dortgen.com/U160,30,ultimaker-2-3d-printer-ultimaker.htm>.