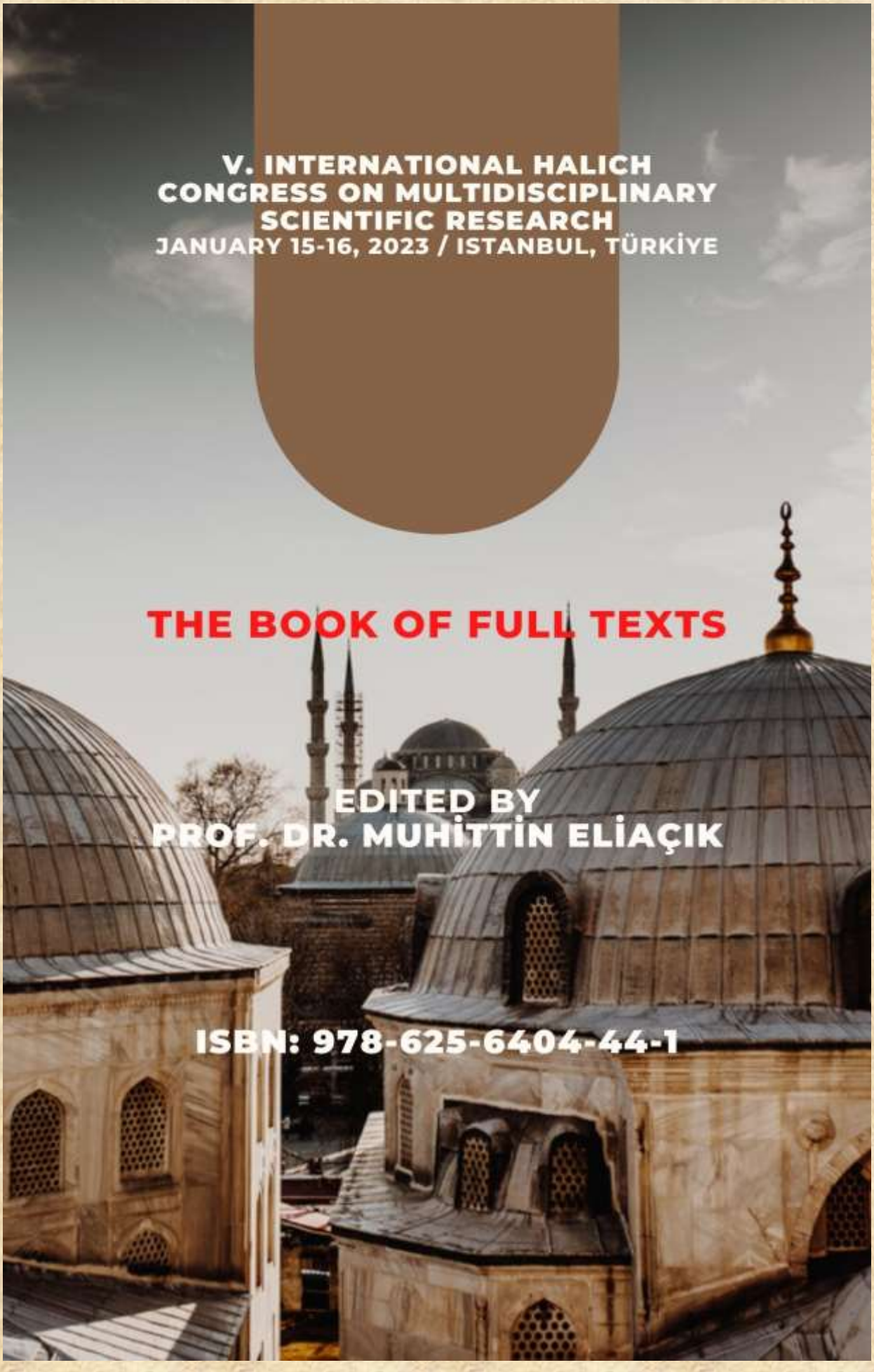
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EVOLUTION OF ARCHITECTURAL FORM

MİMARİ FORMUN EVRİMİ

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ABSTRACT

As a result of the development in information technologies, the reflections of the change environment experienced in many disciplines such as genetics, mathematics and physics have also shown themselves in the field of architecture. Thanks to computer-aided design and manufacturing techniques, design approaches in architectural design, model production processes and model products (models), technological developments and modeling capabilities offered by digital media, design methods have changed and computer has begun to play an important role in the design of architectural form.

With the introduction of the computer in form production, some form manufacturing techniques have started to be developed and, in this context, form production processes have also changed. Forms with complexity that cannot be imagined with traditional design approach can be easily designed in digital environment using these techniques.

The aim of this study is to examine the change and development in architectural form from past to present with the effect of computer technologies. Within the scope of the study, it was aimed to convey the process as a whole by including the periods up to the period when computer technologies were developed. For this purpose, with the inclusion of computer technologies in the design and manufacturing processes of the architectural form, a table (table 2) was created by selecting important buildings where the historical change of the architectural form can be clearly seen. The study is important in terms of shedding light on the change of architectural form in the historical process. As a result of the analyzes, it was seen that while the right-angled surfaces were dominant in architectural form in the periods when computer technologies were not yet developed in parallel with the previous studies, curvilinear lines and fluid forms began to come to the fore in architectural form in the 2000s with the influence of computer technologies.

Keywords: Architectural Form, Change of Architectural Form, Traditional Design, Computer-Aided Design, Design and Manufacturing Methods

ÖZET

Bilgi teknolojilerindeki gelişimin sonucunda genetik, matematik, fizik gibi birçok disiplinde yaşanan değişim ortamının yansımaları mimarlık alanında da kendini göstermiştir. Bilgisayar destekli tasarım ve üretim teknikleri, mimari tasarımda tasarım yaklaşımları, model üretim süreçleri ve model ürünler (modeller), dijital medyanın sunduğu teknolojik gelişmeler ve modelleme yetenekleri ile tasarım yöntemleri değişmiş ve bilgisayar mimari formun

tasarımında önemli bir rol oynamaya başlamıştır.

Form üretiminde bilgisayarın devreye girmesiyle, birtakım form üretim teknikleri geliştirilmeye başlanmış, bu bağlamda form üretim süreçleri de değişmiştir. Geleneksel tasarım anlayışıyla hayal edilemeyen karmaşıklığa sahip formlar, bu teknikler kullanılarak dijital ortamda kolaylıkla tasarlanabilmektedir.

Bu çalışmanın amacı, bilgisayar teknolojilerinin etkisi ile geçmişten günümüze mimari formda meydana gelen değişim ve gelişimi incelemektir. Çalışma kapsamında bilgisayar teknolojilerinin geliştiği döneme kadar olan dönemlere de yer verilerek süreç bütün olarak aktarılmak istenmiştir. Bu amaçla bilgisayar teknolojilerinin mimari formun tasarım ve üretim süreçlerine dâhil olmasıyla mimari formun tarihsel değişiminin net olarak okunabildiği önemli yapılar seçilerek bir tablo (tablo 2) oluşturulmuştur. Çalışma tarihsel süreçte mimari formun geçirdiği değişime ışık tutması açısından önem taşımaktadır. Yapılan analizler neticesinde önceki çalışmalara paralel olarak bilgisayar teknolojilerinin henüz gelişmediği dönemlerde mimari formda dik açılı yüzeyler hakimken, bilgisayar teknolojilerinin etkisiyle 2000'li yıllarda mimari formda eğrisel çizgiler ve akışkan biçimlerin öne çıkmaya başladığı görülmüştür.

Anahtar Kelimeler: Mimari Form, Mimari Formun Değişimi, Geleneksel Tasarım, Bilgisayar Destekli Tasarım, Tasarım ve Üretim Yöntemleri

INTRODUCTION

Form is one of the most fundamental phenomena of architecture which cannot be considered separately from the person who is the user of architectural form, which is the result of the act of architecture. Architecture has also been affected by the critical changes that humanity has been affected by in the historical process that has developed from the past to the present and the architectural form has also changed in this direction. This study aims to examine this change, which is going on today and to highlight the development of the form in the historical process through examples.

One of the factors which bring about the change and transformation of the architectural form is the change and diversification of the design tools used in the design process. Various tools that help design have been used in architectural design from the primitive periods to the modern period. The influence of each tool on the formation of architectural form has been different. Not only developments in the design process of the architectural form but also developments in the production process have affected the form. Construction methods have also changed and diversified with the discovery and production of new building materials over time (Grobman et al, 2009).

One of the most critical changes in the history of humanity is the technological developments that started to develop in the second half of the 20th century and made their effects felt deeply in the 21st century. With the introduction of technology into human life, there have been significant changes in the field of architecture and in every field. The architectural design tools that accompany and guide the architectural design process have begun to differ. These changes in the design tools have directly affected the architectural form. There is an accumulation of knowledge that has been formed and settled for centuries in architectural design and production methods before technological developments. A significant milestone period is being passed in architecture with the inclusion of computer technologies in the architectural design and production process. Computer-aided design tools, which were initially started to be used by pioneering architects such as Frank Gehry, are being used increasingly in the field of architectural design and are becoming widespread. Thus, the architectural form is also affected by this change and undergoes transformation.

RESEARCH AND FINDINGS

Design Process

The design process, which is basically based on visual thinking, is briefly expressed as the process of solving an existing problem. The design process begins the moment the designer encounters a problem. The design process in architecture takes place in 3 phases: "description, mental process and representation" (Table 1). These phases, which cannot be separated from each other by clear boundaries, are complementary in the process, extending from an abstract idea to a concrete reality. The process that starts with the definition of a problem continues with the mental process, which is the process of the designer's self-thinking and evaluation of data. The representation process that comes into play after this stage is the stage in which abstract ideas and thoughts formed in the mind approach the concrete by means of various tools such as diagrams, graphics, sketches, models and verbal expressions and are transmitted to others. Representation can be defined as the communication way of architecture (Hacıalibeyoğlu, 2013).

All techniques used to embody, express, test, develop and present the ideas about the design formed in the designer's mind during the architectural design process by transferring them from the mind to another environment are expressed with the concept of representation. Representation is not only a tool of conveying the idea but also the environment in which the idea is formed. The environment of architectural representation is, in a way, the environment in which architectural thought is created. Changes and developments in representation techniques or representation environment allow new ideas about the field of design. Each environment helps the designer in the process by giving various feedbacks because of its unique features. Architectural representations are the main assistants of the designer in the design process (Akipek and İnceoğlu, 2007; Atılgan 2006).

Description	Mental Process	Representation
The process of defining the design problem	The phase of designer's self thinking, generating ideas and evaluating the collected data	The process of embodying the design ideas created in the mind of the designer through various tools and conveying them to others

Table 1. Design Process

Traditional Design Method

In traditional design methods, the architects use traditional design tools such as 2D and 3D sketches, plan, section, view and perspective drawings on the paper plane and models made of varied materials while creating the form (Yıldırım et al, 2010). With the help of these tools, architects not only express the ideas in their minds about the product they have designed but also transfer them to the others and communicate with them. The model method, in which architects frequently resort to seeing the mass formation in 3D at various design stages, to intervene in forming the form and expressing the final product, is actively used in the traditional design process. Models allow to see many things in scale, such as the ratio of the building's width and height, its orientation, its interaction with the nearby structures, the characteristics of the land where the building will be located and its relationship with the land and the effect of the building materials planned to be used in the building.

Computer-Aided Design Method

The concept of computer-aided design includes computer-based technologies used for design development in architecture. In the literature, different terms such as digital architecture, digital design and design in a computer environment are used together with the concept of computer-aided design. Computer-aided design encompasses all areas at the intersection of computer science and architecture. (Akipek and İnceoğlu, 2007).

In the computer-aided design method, the tools used by the architect in the design process are distinguished from the tools used in the traditional design method. Digital drawings and digital models are usually used as communication language in computer-aided design method. With this method, the designers both embody the thoughts in their mind through computer programs and transfer them to others who take part in the design process.

While the use of computer technologies in architecture is becoming widespread, there are two significant factors that bring change in design processes. The first of these is the modeling technique in which digital technologies are used. During the design process, working on three-dimensional models, the ability to observe the effect of changes made in the process on the form and the ability to experience various alternatives give the designer important opportunities. The second key factor that brings change in the design process with the support of computer technologies is the possibility of easier manufacturability. The superiority of digital design tools in calculating numerical data ensures that many actors in the design process can speak the same numerical language. The combination of design and production with CNC (Computerized Numerically Controlled) technology, where production is carried out automatically according to computer commands, facilitates and accelerates the process (Atılgan, 2006).

In the traditional design, more independent from each other processes such as problem identification, information collection, data analysis, idea formation, project design and implementation are intertwined in computer-aided design. In the design process, a process called "file to factory", which is defined as digital continuity, has emerged. As a result of the easy and fast communication between individuals working in various branches of the design and production stages, the design becomes a global process that allows intervention from anywhere and at any time of the day and continues uninterruptedly, independent of time and space. (Turan, 2009).

The methods used in the traditional design process and the computer-aided design process can often be used at the same time. In designs in which digital technologies are used, traditional methods of expression and representation are also used, but they have a less decisive and guiding effect. Especially the sketch, which the designers apply intensively and allows them to embody their first ideas and to think in this way, is often used in both processes.

Change of the Architectural Form in the Historical Process

In the process of historical development of architecture, there have been prominent trends in the design of architectural form in certain periods. The architectural form shows the features of its period, gives clues about the social and cultural situation and architectural understanding of that period. It has common features in terms of form and formation with buildings belonging to the same period. The most important reason for this is the changes in the lifestyle of the people who are the users of the architectural form. In this section, the main trends observed in architectural form in the historical process will be discussed from a broad perspective in order to express the change and development of the architectural form.

Square, triangular and circular shapes are at the forefront of ancient Egyptian, Greek and Roman architecture. Buildings are planned to use different combinations of these shapes (Figure 1). The main reason is that these prime geometric forms are considered beautiful. Some orders and proportions have been identified for buildings. When these proportions are used, the idea that the architectural form is more beautiful has prevailed, and the buildings were designed according to these orders and proportions (Şamlıoğlu, 2019).

Figure 1. Ancient Egyptian Pyramids and Parthenon (Url 1, Url 2)

Periods such as Gothic, Renaissance, Baroque and Rococo, which can be described as the classical period, are a period in which there is a heavy and detailed understanding in architectural form. The buildings are designed in large sizes and the idea that the building is more beautiful as the rich ornamental elements in the details is widespread (Figure 2) (Borges, 2001).

Figure 2. Cologne Cathedral and Florence Cathedral (Url 3, Url 4)

One of the most significant changes in the history of architecture was experienced with the Industrial Revolution. The effect of the Industrial Revolution on the architectural form, which deeply affects society, is to move away from craft culture and move to machine production. With the De Stijl movement that emerged in the Netherlands in 1917, the effects of the Bauhaus school established in 1919, and the emergence of the International Style, the ornamentation and details in the architectural form disappeared. Simplicity and functionality came to the fore. The simple and cube-shaped forms reflect the architectural understanding of the time (Figure 3, Figure 4).

Figure 3. Schröder House and Bauhaus Dessau (Url 5, Url 6)

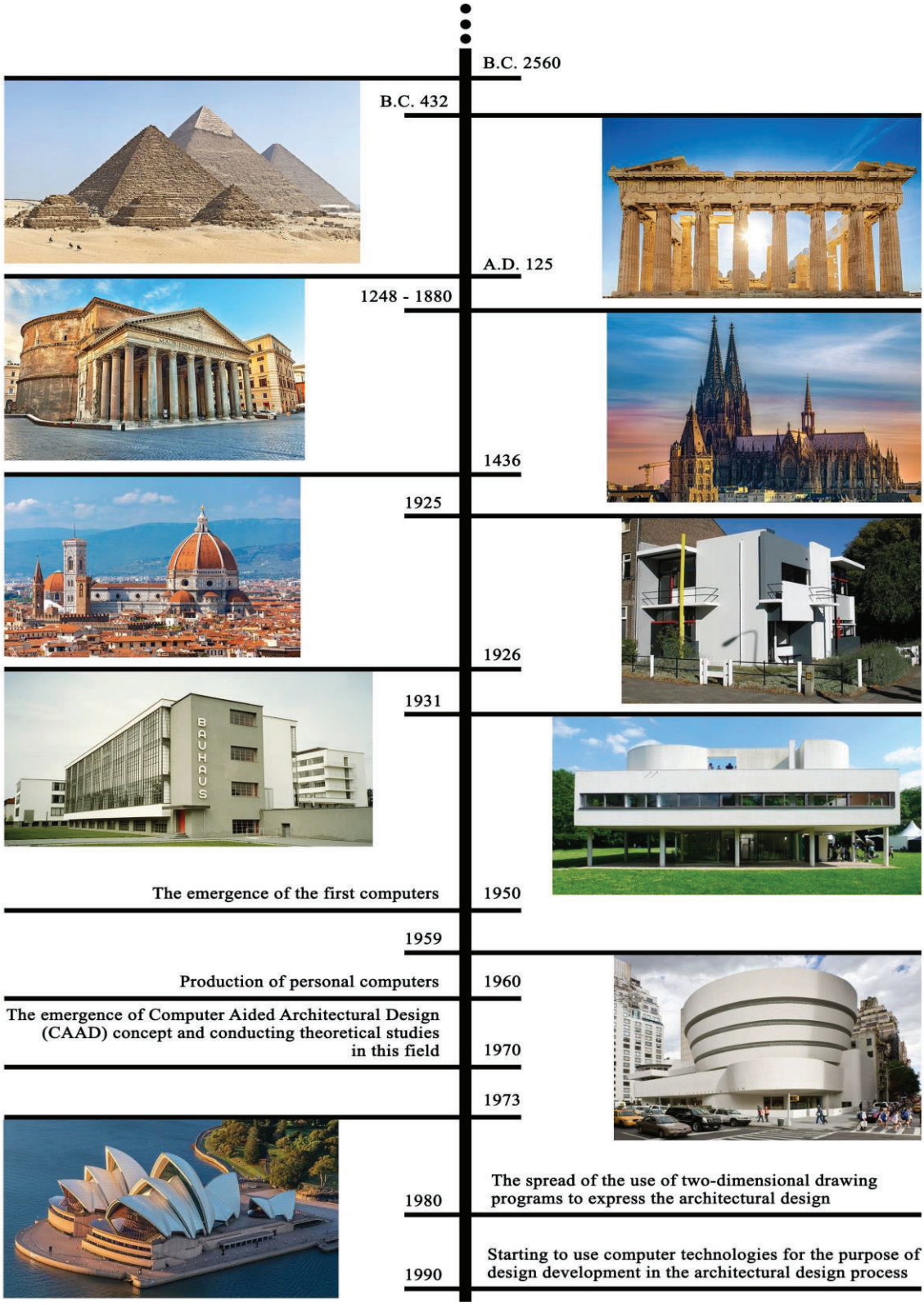
Figure 4. Villa Savoye (Url 7)

The 21st century, also known as the digital age, is an important turning point in which significant technological developments are experienced, the computer enters human life and has influenced all fields. In a period in which such extensive changes are experienced in the history of humanity, it is unthinkable that architecture, in this direction, architectural form remain outside of this change. Computer technologies, which began to develop in the second half of the 20th century, have been actively used in the design and production processes of the architectural form in the 21st century. The computer-aided design method has emerged as an alternative to the traditional design methods that have dominated architectural design until this period. Initially, the computer, which provides drawing and presentation support to architects to represent and express their designs during the design process of the architectural form, has become a partner in the design of the architectural form over time and has become a guiding factor. It is actively used not only in the design process but also in the production process and makes it easier to produce the architectural form. Thus, architectural forms that were difficult to build with traditional techniques could be produced. Deconstructive buildings that move away from horizontal and vertical lines, curvilinear and fluid architectural forms have emerged (Figure 5).

Figure 5. Guggenheim Bilbao Museum and Heydar Aliyev Center (Url 8, Url 9)

While computer technologies were not yet developing, right-angled surfaces, straight lines, basic geometric shapes and primary forms were dominant in the formation of architectural form. Curvilinear lines, fluid shapes and circular forms started to come to the fore in architectural form in the 2000s, when computer technologies were developed (Table 2).

Table 2. The Transformation of the Architectural Form with the Inclusion of Computer Technologies in the Design and Production Processes of the Architectural Form in the Historical Process Created within the Scope of the Study



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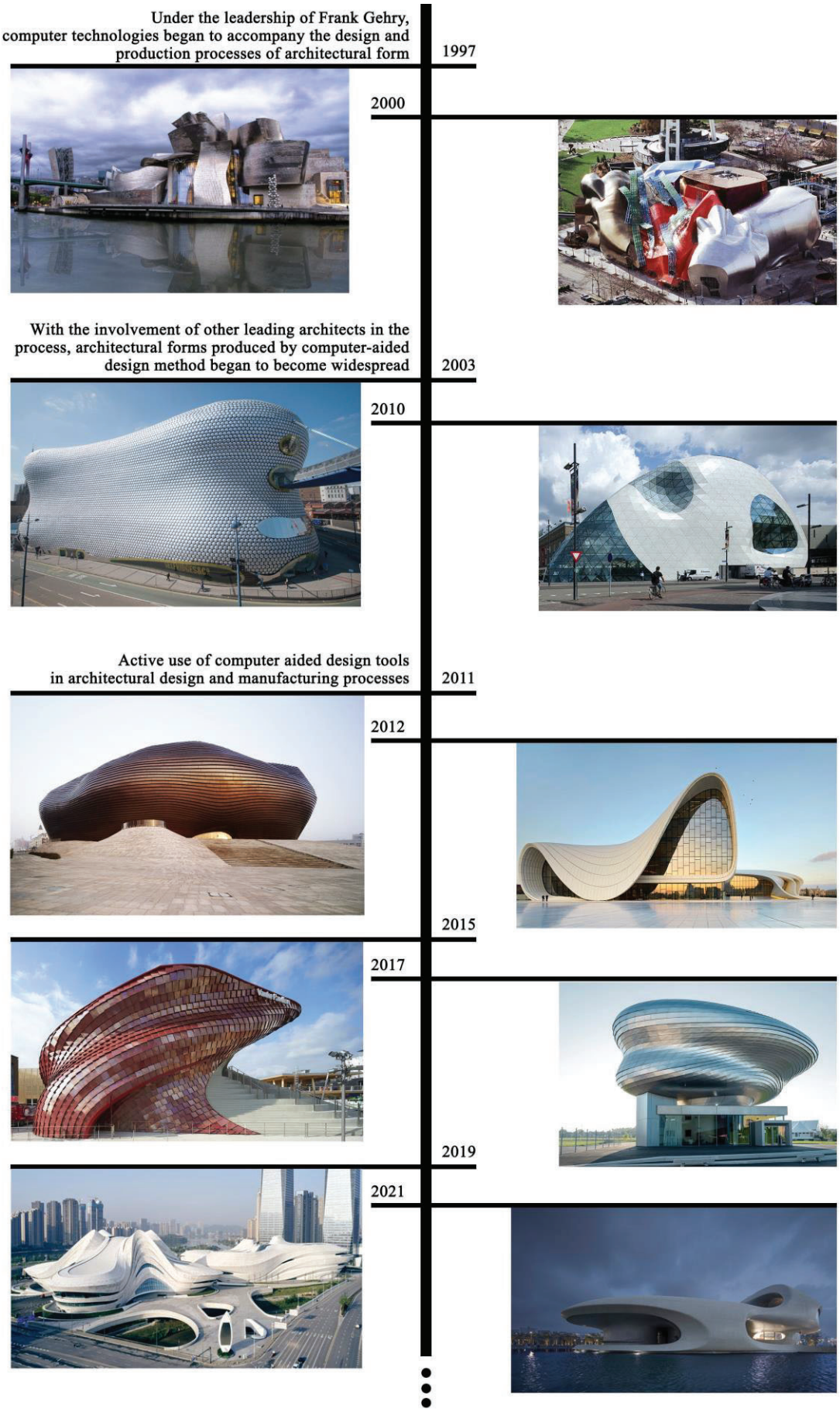
Under the leadership of Frank Gehry, computer technologies began to accompany the design and production processes of architectural form
1997
2000
With the involvement of other leading architects in the process, architectural forms produced by computer-aided design method began to become widespread
2003
2010
Active use of computer aided design tools in architectural design and manufacturing processes
2011
2012
2015
2017
2019
2021

At the end of the 20th century and the beginning of the 21st century, the changes experienced with the entry of the computers into the design, starting with the sketchpad in the 1960s, the transition from two-dimensional drawings to three-dimensional design and today the combination of design with computer technology.

The visual thinking method, which is realized by transferring the thoughts in the mind to the paper plane through representations in the traditional design process, has left its place to digital continuity with the entry of computers into the field of design. Unlike the traditional representation-based design process, computers perform operations based on numerical parameters and algorithmic relationships. As a result of all these developments, a new era began to emerge in architecture. Architecture with curvilinear and fluid lines and complex geometries is adopted as the language of contemporary architecture.

CONCLUSION

During the Industrial Revolution, developments such as mechanization and mass production and the increase in the use of iron and steel also affected the field of architecture, which interacts with every area of society. Architecture has met technology, new materials and structural systems have been started to be used. The second turning point after the Industrial Revolution, accepted as the first turning point in architectural design, is the spread of computer technologies and the introduction of computers into architectural design.

Within the scope of the study, samples of buildings from different periods were selected to observe the change of architectural form in the historical process. These buildings are the first and significant examples of their period. According to the selected buildings, it can be stated that there are common form characteristics in the buildings belonging to the period before computer technologies. During these periods, right angles and straight lines stand out in the form formations of these structures. In the 21st century, it is noticeable that with the influence of computer technologies, straight lines and right angles have been moved away from architectural form. Curvilinear lines and fluid forms have begun to be designed and produced. Computer-aided design tools allow the designers to express their ideas more easily compared to traditional design tools and facilitate the design phase of the architectural form. While traditional representation and expression methods such as sketches, models, perspective drawings and 2 and 3-dimensional drawings are used in the traditional design process, technology-based expression and representation tools such as 3D models created in digital environment and animations are mainly used in the computer-aided design process. Forms that are difficult to express with techniques such as sketches, models and 2 and 3-dimensional drawings used in the traditional design method can be easily explained to others with digital sketches and digital models used in the computer-aided design method. Thus, it can be stated that the designer is free in terms of architectural form production with the computer-aided design method. Architectural form is changing and transforming thanks to the benefits provided by computer technologies such as the ease of designing, the ability to produce alternative forms and quickly experience the difference between these alternatives and the acceleration and facilitation of the production phase of the architectural form.

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