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Parametric Design as A Creation Tool for The Memory Space

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Abstract

Purpose

This study theoretically discusses the role of parametric design in memory-space design in contemporary architecture. Subsequently, it aims to strengthen the discussion by examining three structures with different interpretations of parametric design: namely, the Abu Dhabi Louvre Museum in the UAE with its attempt to create social and cultural memory; the Yinchuan Museum in China, which has weak ties with its past due to political reasons, trying to re-create its ancient culture with its understanding of contemporary culture; and Istanbul City Museum, which uses parametric design to present the layered structure of its local and cultural memory, are the exemplary architectural structures considered. The three structures' treatment of parametric design, their differentiations of parametric-based form creation methods, and their different ways of constructing cultural memory and space relationship through parametric methods constitutes the purpose of the research.

Design/Methodology/Approach

In the study, descriptive scanning method was followed, and an interview was conducted with Alper Derinboğaz, the architect of the Istanbul City Museum.

Findings

The findings of this study are indicated as the use of information as a source of form in creating societies' cultural memories, the opportunities for cultural and environmental adaptation, and the flexible understanding of design provided by parametric design. These were deduced in all three examples where non-Euclidian and topological forms strengthen the monumentality of the museum structures.

Research Limitations/Implications

It is the fact that the parametric design approach is just developing and the number of museums that have social and cultural importance in contemporary architecture may be seen as determine the limit of this study. However, the continuous increase in the number of samples may weaken this limitation.

Social/Practical Implications

The social and cultural effects of parametric design on the creation of memory spaces are discussed.

Originality/Value

This study is the first study that researching the cultural, environmental and formal harmony that parametric design provides in contemporary museum buildings.

Keywords: memory, memory space, museum, parametric design

INTRODUCTION

While digital technologies have radically changed the architectural design methods in the last 10 years of the 20th century, design phenomena such as non-euclidean forms[1], kinetic and dynamic systems, genetic algorithms, and parametric algorithms have begun to form current digital architecture. However, the search for non-euclidean forms in architecture, which intensified with monumentalizing since the late 1980s, reached different dimensions with numerical technologies' inclusion into design and form production.

"The concepts of permanence and stasis, which are considered as a basis in the rhetoric of 20th-century architecture, are replaced by the concepts of variability and dynamism in the 21st Century" (Turan,2011, p.165). In the past, CAD tools used merely as design representation tools have transformed into tools that can produce rapid prototype forms, execute form and performance analysis, non-euclidean and topological geometries[2], which aren't preferred due to difficulty of drawing and establishing geometric relations, have become easily expressible with numerical modeling methods such as NURBS[3].

the production process were intertwined, and numerical information coalesced with production information. In parametric design, which is one of the computational design methods, the fact that data related to the structure such as environmental and cultural factors can be used as a form source has brought it to the forefront compared to other digital design methods. Designers have had the opportunity through parametric design to create complex and convoluted forms such as topological forms, isomorphic surfaces that are rediscovered together with digital architecture more easily, associate them with other forms, and modify them independently of the design process.

Nowadays, the form possibilities with unusual geometries ensured by parametric design constitute an important part of the architectural designs of commercial, cultural, and social structures in both developed and developing countries such as China, United Arab Emirates, Qatar which maintain their economic development together with cultural evolution. The parametric design method is utilized in the designs of the museum structures that monumentalize these countries' cultural memory.

In this study, parametric design's possibilities in the creation and reconsideration of memory will be assessed in the context of architectural design and memory space relations. The architectural form-artifact relationships of contemporary museum structures designed with parametric design method, their relations with surroundings are studied, how memory-based and environmental information is used in parametric design and its reflections on contemporary museum architecture are investigated. In this context, to investigate the subject from different dimensions and various understandings the Abu Dhabi Louvre Museum (LAD), located in UAE that reconsiders its economic and cultural developments, and reflects parametric design understanding

[1] Non-Euclidean Forms or Geometry: Non-Euclidean geometry is any geometry that is different from Euclidean geometry. Each Non-Euclidean geometry is a consistent system of definitions, assumptions, and proofs that describe such objects as points, lines and planes. For more information:https://www.cs.unm.edu/~joel/NonEuclid/noneuclidean.html

[2] Topology is a branch of mathematics that studies surface curves and their relationships. One of its focal points is to find the invariants of modified geometries. Forms such as Kelin Bottle,Mobius Strips are topological forms. (Kolarevic, 2003,13).

[3] NURBS: Non-uniform Rational Basis Spline: The method of drawing geometric based curves in digital environment. For Detailed Information: Kolarevic,B (2003,15-18)

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with western artifacts from a purely local cultural form and monumentality framework, the Yinchuan Museum of Contemporary Arts (MOCA), located in China that has been achieving its cultural and economic transformation together with its disconnected past, and that uses past/environment relationship as form source and the Istanbul City Museum(ICM), which presents the cultural structure of a city like Istanbul that hosted different cultures for centuries, with all its layers, have been taken as examples. For the legitimacy of the study, an interview was made with ICM's architect Alper Derinbogaz about parametric design, museum, and ICM. Apart from this, the study has a descriptive scanning model and data was collected by document review. The research focuses on the environmental and cultural impacts of parametric design on museum designs and their relationship with them. Instead of approaching parametric design and structure relations from a technical point of view, the study primarily researches the theoretical structure of the parametric design, the environmental, cultural, and formal harmony it provides and then assesses the relationship between parametric design and current museum structures in terms of cultural, environmental, formal and other factors.

In the discussion and conclusion section, the cultural and architectural effects of addressing the memory space relationship in the current museum design with the possibilities enabled by the parametric design are discussed comparatively with examples.

PARAMETRIC DESIGN; AS A MEANS OF RE-CREATION OF FORGOTTEN GEOMETRIES

...forgotten geometries lost to us because of the difficulties of their representations.
(Moneo,2001, cited Kolarevic,2003,6)

Greg Lynn's book, *The Folding in Architecture* covering merely CAD tools has been a turning point for digital design. Lynn which uses Leibniz's mathematics as root in his book, argues that there is nothing in the universe that cannot be digitized, including architecture. But Lynn is hardly interested in the repertoire of pre-determined and chosen forms of the world or its architecture, as well as "Modulorist" digitization, or deconstructivism, which makes the breaks of form a focal point. He is in pursuit of curvilinear heterogeneity, differentiations."

Fold allows unrelated elements to participate in an incessant mixture" (Şentürk,2006,p.124). The focus of Lynn's philosophy is topological forms that can be reformatted at any moment, lost because of the difficulty of their manufacture in the past.

In topology, the form's flexibility and external conditions' determination are gathered in a single fold, intertwined, and become inseparable. According to Lynn, time is the opposite of infinity and architecture's dynamism. Topology, by going beyond the space concept, is proof of the "curved" form of the architectural form consisting of infinite components. After the fold, with technological developments, digital architecture[4] has entered into expansion period both theoretically and practically. Reas describes this period as "the period when new architecture is transformed" (Reas & McWilliams, 2010, p.17).

Digital's theoretical development is achieved incrementally. For nearly a decade after the fold, digital architecture has been characterized by designers with philosophical and mathematical statements. In the second decade, tools and software that were integrated with design processes such as algorithmic and parametric design insights, biomimetic design, digital materialization, evolutionary design, which fall under the main title of computational, and sensitive to digital productive practice, which was introduced in the first decade, came into view. In his book of "Non-Standard Architecture", Frederic Migayrou states that "nature-based, complex forms attained by computational, mathematical and differentiation processes are conceptual expressions of the next generation, non-standard architectural design" (Migayrou,2012,p.26-33). Especially, computational design's integrated structure with production and design process and complex form creation facilities provided by digitization have brought forward research and discussions about this method in architectural circles. While Lynn placed the fold concept to the architectural form phenomenon's center, topological forms such as Blobs,

Klein Bottle, Möbius Strips, and isomorphic surfaces which were not preferred by architects due to calculation difficulties and production through algorithmic and parametric design, have been rediscovered by digital design. Terzidis (Terzidis,2003, p.56-57) states that; "just like everything else, the forms have also geometry, the design process in the past restricted the architect with existing tools, but computational numerical software lifts these restrictions".

In the early stages of algorithmic-based design, the difficulties of controlling limitless geometric structure inherent in topological forms have been one of the most significant problems designers experienced. While "limitlessness" improves the designer's creativity in the production of conceptual forms, it has led to difficulties in putting the design into practice in a discipline such as architecture. Despite these problems, designers have developed a parametric design method, which is based on parametric algorithms that enable the limitless geometries' production, which can treat architectural knowledge as a form source.

Parametric design is a digital design concept based on correlations of models. It relies on constraints as a means of producing a geometry in variable forms. Parametric design as a tool in the geometric relations'

[4] Although slightly different from its present meaning, the term 'digital architecture' was first used by William Gibson in his book Neuromancer as descripted with "cyberspace" term (1984). For more information: Neuromancer.(Gibson,2016, 8)

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control enables the creation and modification of the elements that constitute a design by differentiation. Numerical algorithms form the basis of parametric design tools. Thus, it increases the designer's control over the design geometry, allowing the designer to evaluate certain conditions. "Computationally speaking, there isn't a difference between algorithmic and parametric systems; algorithms by default operate on parameters, and a parametric system's fundamental component is the algorithm itself, called the schema or definition" (Dino,2012, p.210). The design's geometry is determined, designed, correlated with different geometries, and replaced at the interface called "schema". Schemas function as interfaces, where any geometric form is created, modified, and correlated with other geometries using decodes that can perform algorithmic calculations (Figure 1).

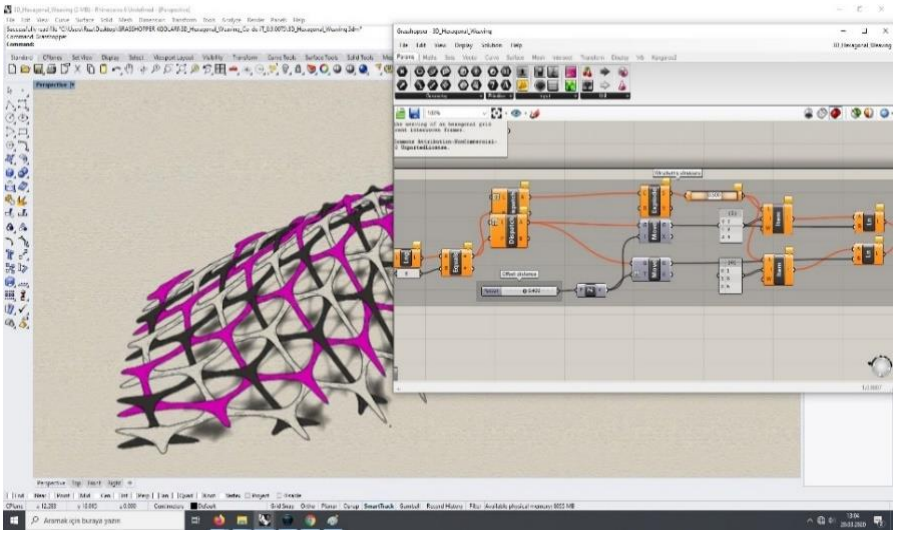

Figure-1. Models created via parametric schema can be manipulated simultaneously. (Author's design)

The elasticity of parametric design systems lies in the productive potential of infinite topological variations. This qualification enables the creation of a visual model of the design on the schema. "This model can be addressed as the main theme of a design, but, it can also bring together numerous design layers" (Derinboğaz, 2019).

Parametric Design is Adaptive

The flexibility brought by parametric design also generates the design's "adaptation" phenomenon. In a parametric design schema, one or more basic form particles that will form the design are considered. Based on the algorithm written, these form pieces multiply, differentiate, and create the main form. Thus, the designs created can adapt to another design by modification of their data or become part of it. The "adaptation" concept in parametric design can regulate not only design geometry but also its relations with the structure's environment. Parametric creation of a local pattern symbolizing a culture can provide structure's "cultural adaptation" while shaping its facade consistent with wind and topography can provide "environmental adaptation".

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"The Whale" research center and museum on the Norwegian island of Andøya, which is designed by Dorte Mandrup, is one of the important examples on this subject. It is shaped according to the strong polar winds around the structure, where the whale, which has an important place in the culture and ecology of the region, is treated as a metaphor. Strong polar winds are handled according to their direction and processed with parametric software. The use of wind as a source of form not only adapts in the formal sense but also ensures controlled use of airflow in research and ventilation of interiors (Figure 2).

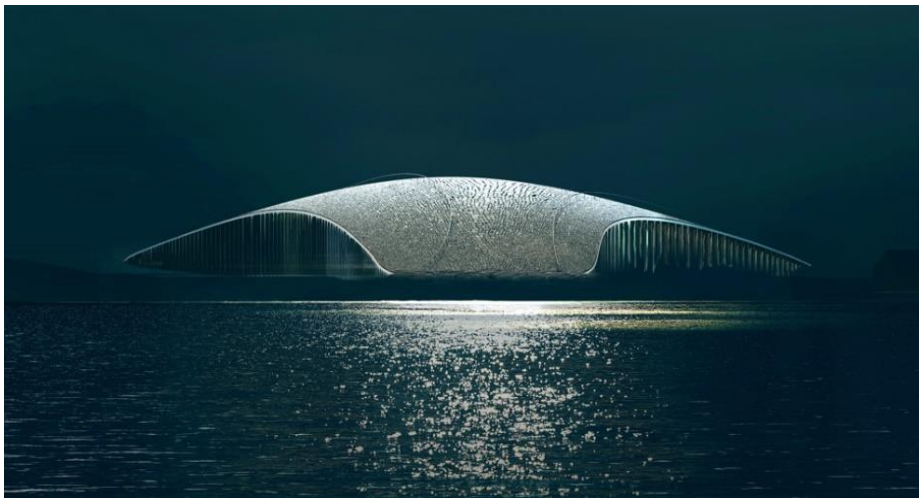

Figure.2: The Whale research center and museum has been form by enviromentally winds with parametric design method. (https://parametric-architecture .com/dorte-mandrups-aerodynamic-whale-museum-rising-in-the-arctic-circle/)

What constitutes the identity of parametric design is the designer's approach to geometries and the ability to relate them to each other. In the schema, non-euclidean, topological forms can be correlated with each other, iterated, differentiated by creating the main form (continuous differentiation and differentiation). With these operations, the same form's different variations can be derived (Figure 3). While all
of these elements compose the formal character of parametric design, it also ensures the achievement of formal harmony.

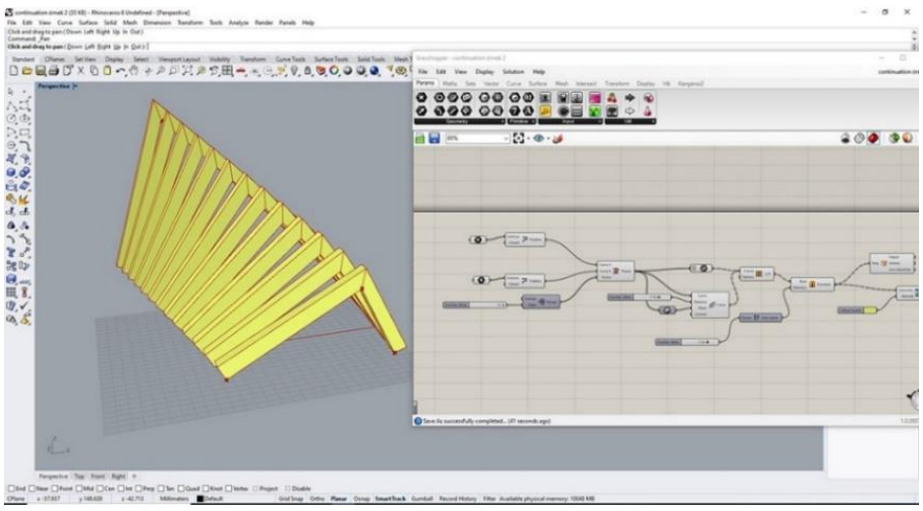

Figure 3: Producing the same form by Continuous Differentiation and iteration methods with different variables, repetition, and augmentation. (Author's Design)

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Parametric Design is Based on Data(s)

In architecture, one of the most important design components is to have tectonic information that includes mathematical and structure's three-dimensional morphology. "Parametric design implies the ability (knowledge as well as digital skills) to mediate tectonic knowledge" (Oxman & Oxman,2014, p.138).

Information's source can be representational, metaphorical, topological, or any geometric structure. Information can be processed into parametric schemas in any form, form can be produced. In parametric schema based on performance (performative) and form generation, forms that are compatible with forces affecting the structure such as sun angle, wind direction, topography can be created. These forcers can shape design, and materials and manufacturing systems can be encoded compliant with design. In his article "A New Global Style for Architecture and Urban Design", Patrik Schumacher describes the parametric design as "a paradigm of design beyond a formal style that can use purely environmental influences" (Schumacher, 2009, p.15). This paradigm enables the creation of all tectonic fabrics, from environmentally compatible facade geometry to light-controlled openings. According to Derinboğaz, "through parametric design's possibilities, it is possible to create designs in which structure and various environmental factors can come together" (Derinboğaz,2019).

"The built environment, with its complex matrix of territorial distinctions is a giant, navigable, information-rich interface of communication" (Schumacher,2013, p.2). It is a communication tool based on every environment, design, and phenomenon. The use of a space requires compliance with the code of conduct prescribed by the type of social situation, which constitutes architecture's social processes.

Parametric design is based on "data" The form-creating qualifications (rules) of parametric software such as differentiation, adaptation have now begun to diverge, while the urban and architectural subsystems have converged to represent each other. Over time, the uncontrolled stratification of urban memory resulting from increased information density can be reconsidered and refined into design geometry. A pattern or a form unique to a particular culture, i.e. the representation geometry of memory, can be considered as a form source, can be modified, transformed, presented with a new understanding. Similarly, while the artifact of memory is exhibited in museums that are the space of memory through parametric design, representative geometry that creates structure's form can be metaphorically re-formed. This is how the memory space relationship can be achieved.

PARAMETRIC DESIGN AS MEMORY SPACE CREATION TOOL

...in short, the museum is a tool for managing change and controlling difference.
(Preziosi,1989; cited Artun,2006,170)

Museums fall into the same category of architecture and art as monuments, temples, churches, shrines, and certain types of

palaces(Duncan,2006,50). Museums, like ancient ceremonial monuments, incarnate the idea of the state and make it visible.

Monumentality brings curiosity and charm. Museum's monumentality doesn't come solely from size and architecture. What brings it the monumentality is what it preserves inside. The museum doesn't only exhibit society's cultural memory, it also strengthens the culture of the civilizations it dominates by displaying the dominant society's power. The museum's subconscious function is ideological. The goal is to indoctrinate to those who benefit from or visit the museum the supreme beliefs and society's values. They persist in the power and culture of a protectorate class. Even though a museum space is perceived as a vacant shell without its exhibits, it is an ideologically vigorous structure.

Benedict Anderson (Anderson,1993,182-186), in his book *Imaginary Communities*, proposes three conditions for a nation to be formed; It must have a map, a flag, and museums. Societies at the stage of becoming a nation are strengthened by displaying their ideology, culture, and memories. A nation's ideological and cultural transformations are reflected in their museums, accordingly in of their museums' architecture.

"Museums are progressively transformed into a spectacle, penetrating popular media, everyday life, education, tourism, and the fashion industry. The most important element of this spectacle is no longer art, but architecture" (Artun,2017). Museum buildings' qualities are no longer determined by the artifacts on display, but by the architecture.

According to Vergo (Vergo,1989,p.21-27) who distinguishes museum studies as new and old understanding, the concept of "the form follows the function" in past museums' architecture, is replaced by a style and size oriented architecture in current museums in contemporary architecture, parametric design is frequently used in museum designs of countries that create or reconsider their cultural memory due to their infinite form creation qualities and the possibility of producing different geometric forms. These countries monumentalize their cultural memories through parametric design. They chose to intersect cultural data that make up their memories with digital architecture's parametric algorithmic data.

Parametric design's geometry forming qualifications such as differentiation and iteration affect not only the design geometry but also the museum's relationship with its environment. Museum's monumentality strengthens as it varies from its surrounding structures with its non-euclidean geometry. For example, while Zaha Hadid's Maxxi Museum in Rome symbolizes contemporary Italy, its design and dimensions make it distinctive from the traditional Roman urban fabric around it. Building's monumentality is ensured not only by its characteristics but also by its form (Figure 4).

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Figure 4. In Zaha Hadid's Maxxi Museum, the phenomenon of difference determines both the building's shape and its relationship with its environment. (https://www.zaha-hadid.com/architecture/maxxi/)

Parametric design's adaptation phenomenon can establish a relation between the museum with the artifacts it exhibits, local culture, and environmental factors. However, information use related with structure as a form source can strengthen these relationships. Shanghai Natural History Museum (Perkins & Will-2015) in China can be considered one of the best examples in this regard. The "Ice Crack" texture used in Shanghai's traditional architecture is performed parametrically on the museum's facade, where cultural artifacts unique to the region are exhibited along with nature artifacts, is considered parametric and it covers the entire facade of the building like Ivy (Figure 5).

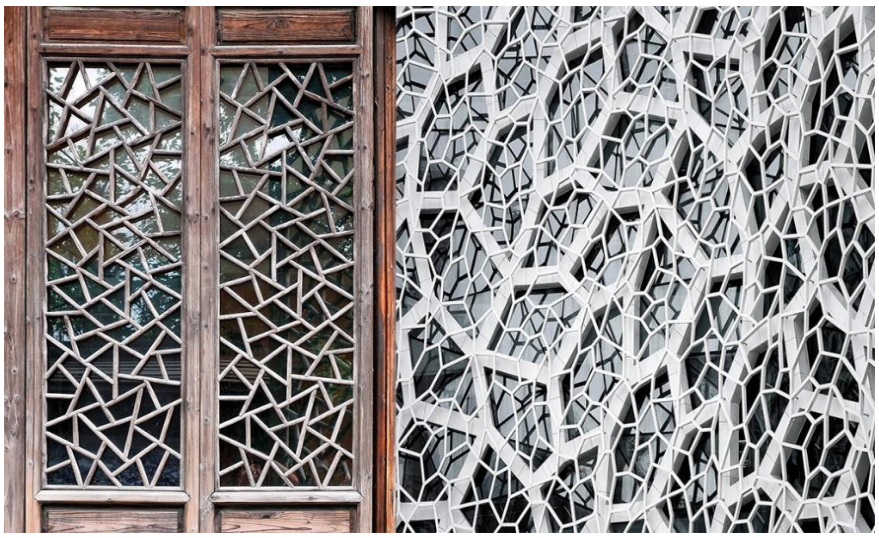

Figure 5. Traditional Ice Crack window pattern of Southern and transformation of this form with parametrical algorithms in Shanghai Natural History Museum's facade. (Brownell,,2015)

In this section, the current museum architectures of the countries endeavoring to reconstruct and reconsider their memory will be analyzed within possibilities enabled by parametric design. The results of using cultural memory and environmental data as form sources in museum buildings will be discussed. Within the scope of the study, Abu Dhabi Louvre Museum in UAE trying to create its memory, Yinchuan MOCA in China trying to bring together past and current memory, and

ICM strengthening Istanbul's multi-layered cultural memory will be studied as examples.

Abu Dhabi Louvre Museum(LAD)

The UAE, a small country whose economy was based on pearl and seafood trade in the past, has become a principal oil state with oil resources' discovery in 1971. While the discovery of oil reserves enabled the UAE to develop rapidly, on the other hand, population and multicultural problems started to emerge due to the increasing migrations.

As such problems escalated, the country introduced its Emiratization[5] policy in 2013 which included programs such as the increase of the local population, reconstruction, and preservation of the national culture and memory. In this context the emirate has decided to develop the cultural structure of Abu Dhabi, which is already an important commercial center of the country, unlike Dubai, which has become a multinational economy, culture, and trade center by itself, and in this context, the Abu Dhabi 2030 project, which includes the artificially constructed island of Saadiyat, has been prepared.

According to Ajana, it was decided to build cultural and artistic structures such as museums, art galleries, and concert halls that exhibit contemporary and classical artworks on Saadiyat Island, which is an "identity project" (Ajana,2015, p.331), to create Abu Dhabi's cultural memory (Figure. 6). In memory's construction, it was planned to build brand museums that can compete with museums such as the British Museum, Louvre, MOMA and that can promptly bring modernism to the country at monumental scales.

[5]For more information: (Üçağaç,2015,231-239) and (Karadeniz,2018,138-141)

Figure 6. Saadiyat Island is designed as an artificial culture Island with museums such as the Louvre and the Guggenheim under the policy of Emiratization. (https://www.weetas.com/gccnews/jumeira-group-runs-new

In this section, the Abu Dhabi Louvre museum, whose dome was designed through parametric design, regarded as the most important project of Saadiyat Island both symbolically and architecturally, will be addressed and parametric design's role in the creation of memory will be discussed.

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Louvre Abu Dhabi is a classical art museum designed as Saadiyat Island's cultural center. Gallery space covering 22,500 square meters, interior space, water channels designed to cool the interior, and other spaces are shaded under an iconic dome with a diameter of 180 meters, representing traditional and contemporary Arab culture (Figure 7).

Figure.7. Aerial view of Louvre Abu Dhabi Museum. (Jeannouveaul.com)

The museum was designed by Atelier Jean Nouveau and inaugurated in 2017. The dome, which forms the design's focal point, combines environmental, aesthetic, cultural, and structural functions.

Environmentally, it connects spaces in the museum and provides shade and coolness to the open spaces. Aesthetically, it serves as a canopy that filters sunlight and creates dramatic rain of light under the dome. Operationally, the canopy has certain spaces' lighting function and cooling the interiors by evaporating water in the channels.

The structure is covered by the dome used by all civilizations commonly. Jean Nouveau designed the 'mashrabiya', which was used as a cover in the Middle Eastern architecture as textures' form source that constitutes the dome. This one is made of a web of different patterns interlaced into a translucent ceiling which lets a diffuse, magical light come through in the best tradition of great Arabian architecture" (Ajana,2015, p.322). Therefore, the Abu Dhabi Louvre is not only a museum but also is a structure formed by the Arabic mashrabiya texture, an architectural element of the common culture, displaying Western artifacts under a dome. The lights enter through the dome, which represents Arab culture, are sunlight's metaphors flowing through palm leaves (Figure 8).

In order to create this effect, the design team consisting of different disciplines initially formed a parametric model using structural constraints (self-weight), aesthetic (cultural texture), and natural light (angle of the sun's rays) data. The model formed was regarded as a basis for continuous development and arrangement of its details. A geometry consisting of squares and hexagons, which is the shape that best symbolizes the filigree pattern of the region's mashrabiya origin, was determined, this model was rotated, repeated, and scaled with respect to

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the desired criteria by parametric software called SMART Sizer and SVN, and prototype textures of each canopy was created (Figure 9).

Figure 8. While LAD's dome filters the sunlight, it also directs it to the desired areas. (https://www.archdaily.com /793182/in-progress-louvre-abu-dhabi- jean-nouvel)

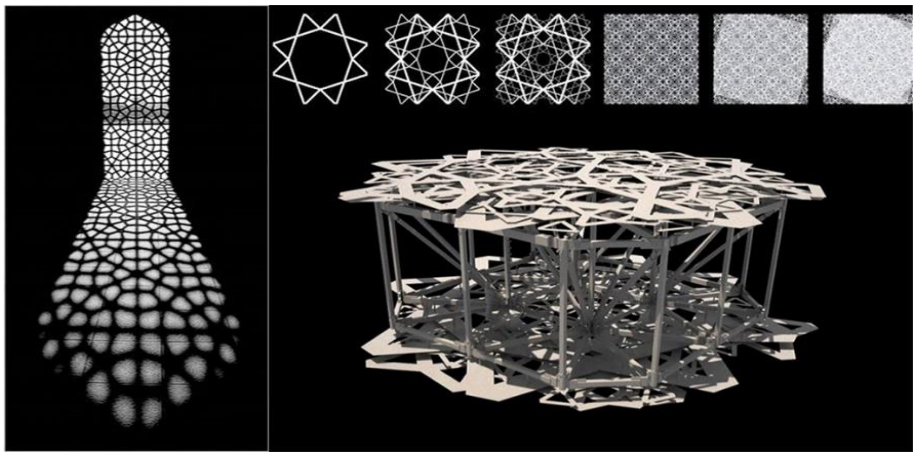

Figure 9. Traditional mashrabiya and transformation of this form with parametrical algorithms in LAD dome. (Aida,S ,2020; Imbert,F.,Frost,K.,Fisher,A., Witt,A., Tourre, V. Koren,B.,2012,79-Manupilation: by Author)

The dome is designed to minimize the disadvantage of the area receiving sunlight for 320 days. Each layer of the dome, consisting of five layers, is planned to pass 30% of the sun's rays through the top layer and 3% through the innermost layer. Each layer's structure consisting of a steel and aluminum mixture is calculated instantaneously and considering the calculations and the permeability layers' functions, the structure was formed simultaneously and with different alternatives. In this way, the central model became a responsible data-driven tool for synthesizing both external light information and structural analysis metrics. The model adapted itself to each data set, providing recipient feedback for the interrelationship between the two" (Imbert et al,2012, p.84).

Performative parametric design tools were used in the design of the dome to meet the lighting needs suitable for the functions in the interior in the most efficient way naturally. In addition to directing and filtering the sunlight of the dome, a parametric-based EEL dome prototype was used to illuminate the interiors with daylight at the desired values (Figure 10).

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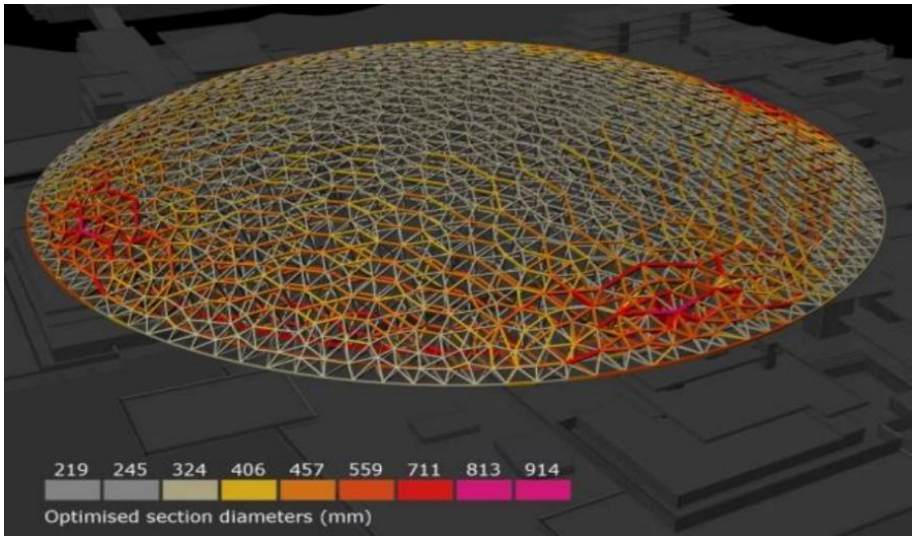

Figure 10. Light-based and Parametrically modeled EEL Lighting Dome Simulation. (Wortmann,2018,71)

On EEL, which acts as a simulation of daylight movements, 1028 triangular constituting mesh were added, forming the main texture of the dome. These openings on the prototype are adjusted by controlling the forms to ensure that sun rays provide optimal lighting of the interiors in June and December. As the model is processed parametrically, the shapes of the dimensions of the openings remain intact, and even if the texture dimensions change, they remain constant. Tourre (Tourre,2009, p.789), one of the designers of the dome explains it as follows; "The right one for the light-based parametric design allows working directly to compute the building properties. Therefore we are interested in the design tools in which the lighting intention can be represented".

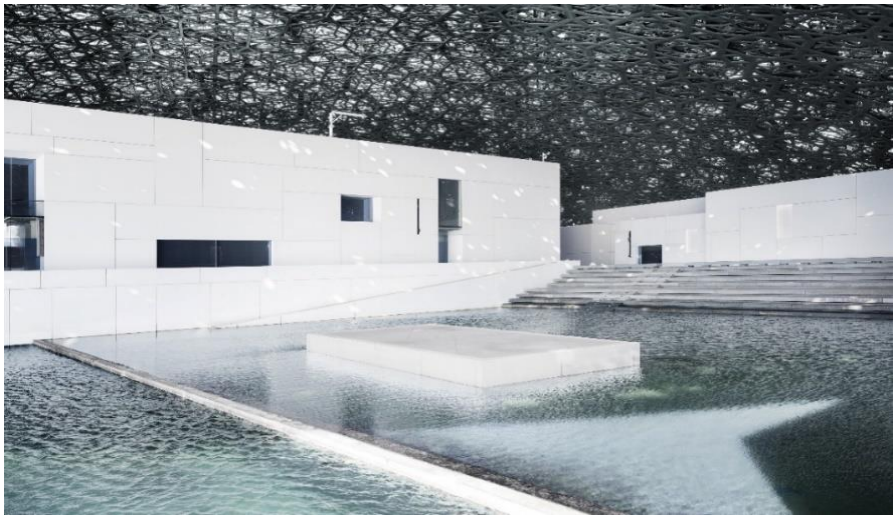

Figure 11. Sunlight filtered in LAD also supports air conditioning system by evaporating water in the internal channels.(Jean Nouveau www.jeannouvel.com/en/projects/louvre- abou-dhabi-3/)

The final textures were created by selecting models that will provide the desired structural building and geometries that will function as lighting. The geometric forms that compose each layer are different in size and have different dimensions for transmitting and directing the sun's light. By changing these openings in accordance with the desired design, it is ensured that the sunlight reaches more space in different sizes. In the

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final phase of the calculations, openings on the dome were reduced or replaced in accordance with interior spaces' heat requirements to ensure natural coolness by evaporating water in the galleries by sunlight. Synchronization with the criteria of the calculations of other functions was ensured and lights coming through the dome were directed to required water channels (Figure 11).

Yinchuan Museum of Contemporary Art (Yinchuan Moca)

Today, parallel to its rapid economic growth, the People's Republic of China is also developing rapidly in cultural areas such as architecture, contemporary arts, and fashion. Being one of the most significant countries of the world production market China strengthens its relations with the west and it changes textures of old cities such as Beijing with contemporary architectural examples through its economic power.

As collectorship became one of the most important hobbies of Chinas' new rich class, Chinese collectors started to collect "Chinese artifacts smuggled to the West in the past, valuable western civilization artifacts and contemporary art objects, and exhibit their collections through museums. In order to provide urban development through museums, to bring new memory to the regions, and to provide touristic and cultural development, the majority of recent buildings and museums in China are built in regions where urbanization has just begun and the population density is low. However, new museums are criticized by architectural and cultural circles for architectural incompatibilities with the environment, unplanned urban developments, and their collections' disqualifications. Therefore, due to these problems, several museums became dormant over time. "Since these museums are built to shape historical and cultural development, they become an architectural mirage over time" (Fournier,2016. p.82).

Owing to these problems, museum owners and architects have recently sought designs that are compatible with the museum's collection and the region's cultural structure in which it is located. Parametric design method's advantages, such as the use of environmental effects as form source and formative monumentality brought to the buildings, have made parametric design one of the most widely used design methods in contemporary museum architecture in China.

Yinchuan MOCA, built in China, is one of the first and most important examples which enables past and current relationship by using the topographic structure of its surroundings as a source of parametric form. Yinchuan MOCA is located in Ningxia rural district of Yinchuan City, China. The building in service since 2015 was designed on 13,188 square meters and 4 floors by Zhang Di and Waa Architects between 2011 and 2015.

Since the region's cartographies drawn by Jesuit priests in the 16th and 17th centuries constituted Museum's main collection, the museum was built on the banks of Yellow River in Yinchuan. Thus, it was aimed to achieve harmony between the artifact and the region and to strengthen

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the relationship between memory and space. Yellow River's surrounding area, where the structure is located, has been a region inhabited by different ethnic and religious groups, playing an influential role in embodying of Chinese culture and different cultures harmonization throughout history. The construction was built in marshy land and on a hilltop elevated for development purposes in the past (Figure 12).

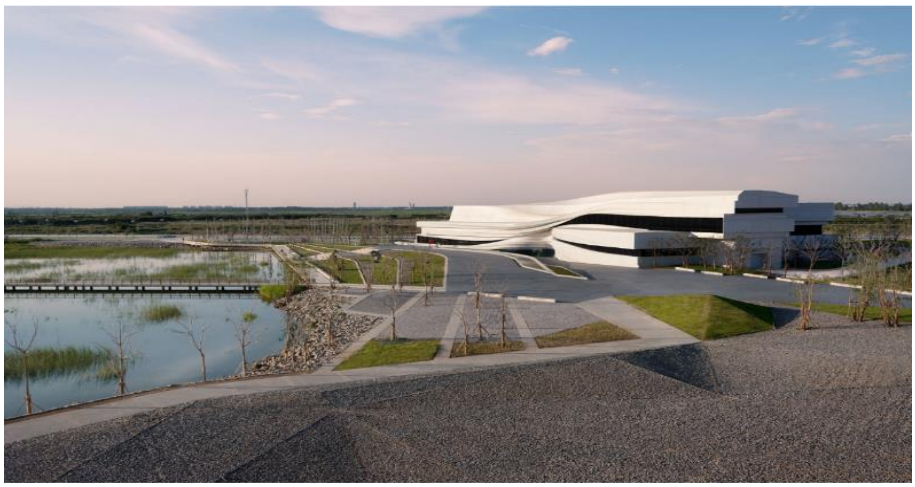

Figure 12. Yinchuan Moca is located on a hilltop, in the swamps of the Yellow River. (http://w-a-a.cn/project/moca-yinchuan /)

The building's "T" shaped schema and its facade compatible with the geographical structure and interior spaces are designed in a clear contrast (Fournier,2016, p.83). The entrance of the museum is designed as a cave entrance on the side of the road with the aim of providing contrasts, rather than being made from the green area in the rear section (Figure 13).

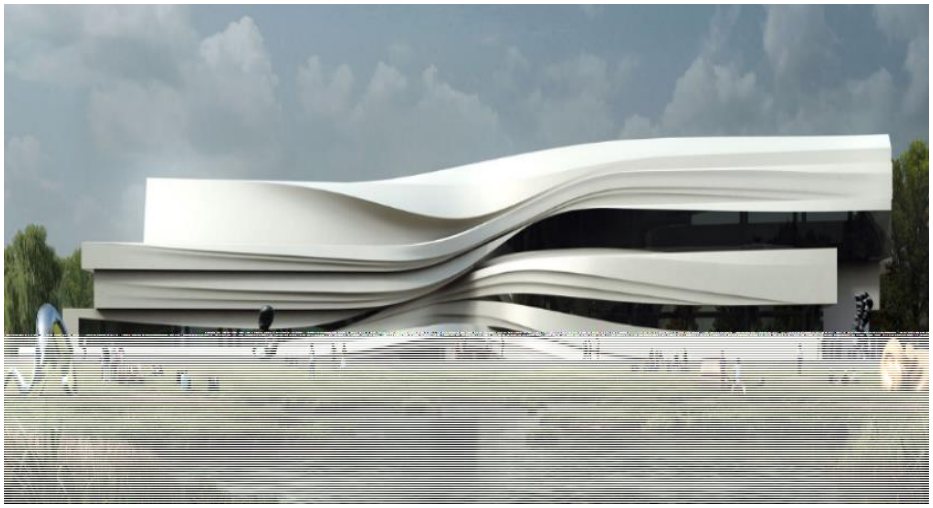

Figure13.Back facade and backyard of Yinchuan MOCA (http://w-a-a.cn/project /moca-yinchuan/)

The mentioned "cave entrance" depicts prehistoric age's people that settled in the region centuries ago, while the green areas opposite the entrance and behind the building soften the sharp contrast (Figure 14).

Figure.14.Yinchuan MOCA's narrow cave entrance. (http://w-a-a.cn/project /moca-yinchuan/)

The six main concepts of the museum (mass, split, landscape, layer, fracture, and pinch) were achieved by Buro Happold using parametric based BIM programs. Appropriate ones among different form alternatives are chosen and the carrier system is created through the memory software. Thus, form-structure harmony is achieved. (Figure 15).

Figure.15.Yinchuan MOCA's narrow cave entrance. (http://w-a-a.cn/project /moca-yinchuan/)

Building's exterior facade, which also affects its interior, takes its form from the Yellow River's sedimentary layers, which have enabled the formation of cultures of people who have settled around it for centuries. The River, with the deposition of alluvium it brought from other regions over time, enabled the emergence of fertile farmland and settlement in parallel. The formation movements of the sedimentary layers that form the structure's source spread over centuries were simulated in a computer environment, and the forms compatible with topography were processed by the method of creating a parametric model. The most compatible forms for the geographical structure were selected and lines forming the shape were combined with the parametric design method again, and main lines forming the structure were revealed (Figure.16).
Museum's structure, which takes its reference from sedimentary layers, allows visitors to feel the forgotten history. "They like to think of their building as "fossil," something that belongs to the geological history of the site and also, perhaps, to the ancient civilizations that may have lived

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there a long time ago" (Fournier,2016,p.83). River's sedimentary layers, integrated with the museum's shape, describe the "Chinese culture" that has been stratified from an early age and will continue forever. How this story will be narrated is created through the technology that forms the new face of China, namely digital design. Fiberglass concrete (GRC), which can be aged over time, has been used to strengthen the continuity of the structure in exterior cladding. This material, which can gather moss over time, was also used to strengthen the harmony of the structure with its surroundings. Although the building's exterior is effective in shaping the interiors, Zhang Di took different approaches at the entrance and atrium to change visitors' perception psychology. The main entrance, which resembles the cave, is kept narrow and dim. However, as you move across inside the museum, ceilings rise, spaces expand and the sunlight is received in certain places. The visitor entering the structure progresses from a dark rough area to a bright smooth area in a gradual process that affects consciousness The "process" concept presented to the visitor was intended to be kept alive as obfuscatory and convoluted(Figure 17).

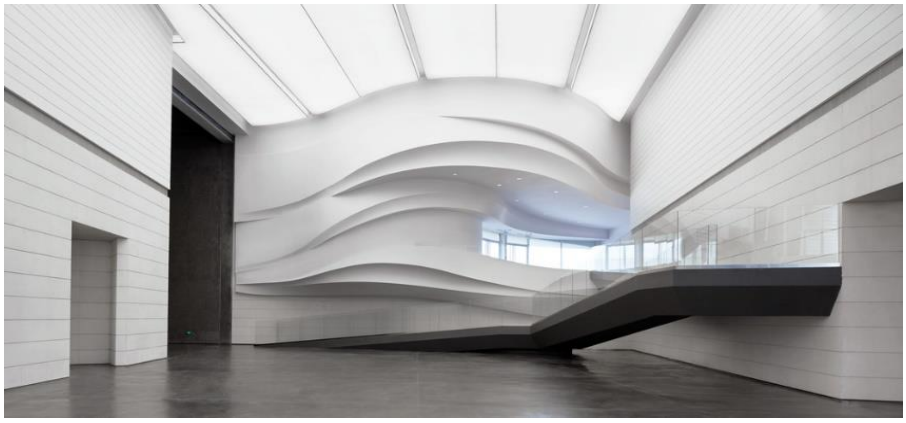

Figure.17. Yinchuan MOCA, wide and curved gallery representing Chinese culture reached through a narrow and low cave entrance. (http://w-a- a.cn/project/moca-yinchuan/)

Istanbul City Museum(ICM)

The absence of a city museum that presents ancient culture in a refined manner in Istanbul, whose archaeological history dates back to the Neolithic era and which was a noteworthy center of three empires, has been debated by the art and culture circles for years. Although there are museums of archaeological, periodical history, and contemporary arts in Istanbul, there has not been a city museum that presents the city's memory in a refined manner with all its qualities.

The "History Foundation" initiated the first studies on city museums and proposed the building of the Darphane-i Amire as the museum's location, but the proposal was not executed. With the protocol signed between the Ministry of Culture, Istanbul Metropolitan Municipality(IMM), and the History Foundation in 2005, it was decided that Sirkeci Station would be built as a city museum and conversion projects were made. However, this project was canceled due to various reasons.

The Museum's nature and the artifacts to be exhibited were decided on 17-18 November 2012 at the Istanbul City Museum Workshop, which was

attended by experts such as IMM, Ministry of Tourism and History Foundation officials, archaeologists, art historians, and academics. In the workshop, along with the museum's previous locations, Haliç, Marmara Coast, Haydarpaşa Station, and shipyards on the Haliç coast were recommended. The museum was also decided to be located in the Topçu Barrack that would be built in Gezi Park. But the decision was not implemented due to the protests.

In the workshop, the decisions regarding cultural and economic contributions to be ensured by the ICM, which has a multi-layered memory, were also taken and the works to be performed were given to the responsibility of the IMM and the Provincial Tourism Directorate.

ICM's project design and main theme ideas, which is still under construction, were created in the Venice Biennale in 2004 with the exhibition "Urban Transformation of Istanbul and Superficial Methods" prepared by Alper Derinbogaz (Derinbogaz, A,2019). Alper Derinboğaz assumed museum's consultancy and design in the process commenced after the ICM workshop. Construction of the museum began in 2017.

The museum is located in Topkapı, outside the city fortification walls, unlike the existing museums in the historical centers of Istanbul. The lands in the region located out of the city were used as an orchard and a cemetery in the past. The region was declared as a "Unesco Cultural Heritage" area due to its historical characteristics in 1986, thus possible construction in this area was avoided. The areas used as orchards and fields were later utilized as parks and green areas. The most significant reasons for choosing the museum's location were proximity to Istanbul's historical fortification walls, lack of infrastructure in the region due to the E5 highway as well as the presence of Tekfur Palace, Kariye Museum, Mihrimah Sultan Mosque, Yenikapı Mevlevi Lodge, and Yedikule Dungeons. On the other hand, the last remnants of the fortification walls, having great importance for Istanbul since the Roman period, are also located in the region. The historical buildings and the Kariye Museum have been excluded from the visitor routes since they are out of the city boundaries, there is limited settlement and transportation is difficult. However, the disuse of parks and green spaces for similar reasons has prevented the recognition of the region's historical importance. Revitalization and transformation of the region and presentation of all the details of cultural and historical texture were aimed at with ICM's construction. The museum was conceived as a key point that unites Istanbul's entire historical fabric and brings its memory together (Derinboğaz, A.2019).

The structure, designed by Alper Derinboğaz using the parametric design method, has an area of 38,880 square meters, a total of 5 floors including the ground and first floor (Figure 18).

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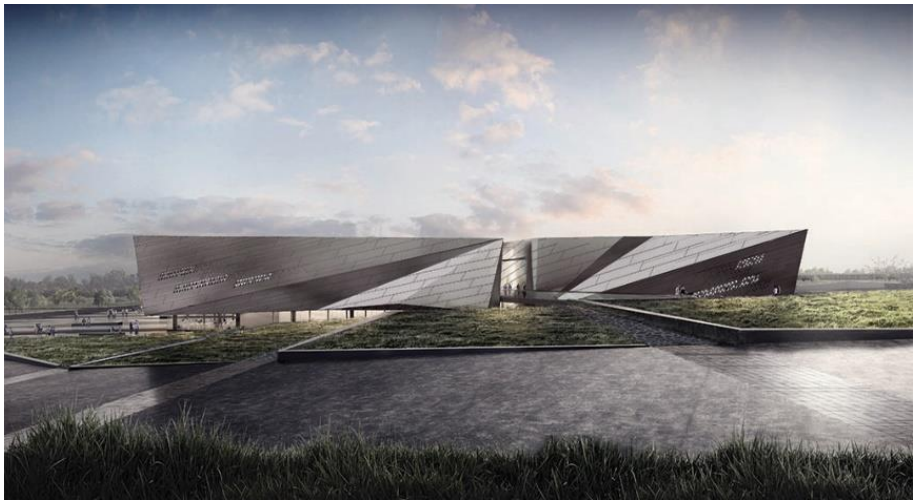

Figure 18. ICM's General View. (Salon Alper Derinboğaz's Archive)

While Istanbul's multi-layered cultural structure forms the main theme of the structure's schema, fortification walls' layered structure nearby the structure is incorporated into the theme to reinforce this idea. The spiral is considered as the reflection of the 'multi-layered' theme of the form structure. In order to maintain the spiral stratification with the historical process in it, it was twisted, broken, and distorted, torn in certain places, but its continuity has not been interrupted (Figure 19).

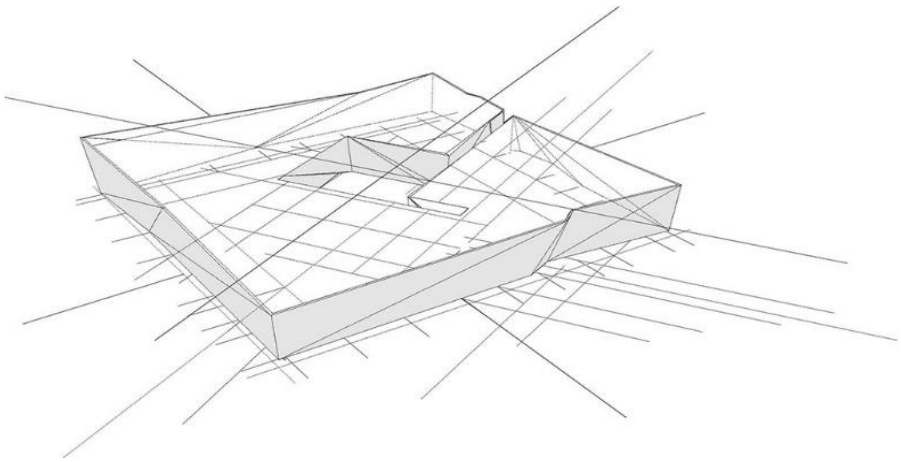

Figure 19. ICM's schema is formed by twisting, folding, and breaking in certain places of the spiral shape that represents multi-stratification. (Salon Alper Derinboğaz's Archive)

"The helical scheme also determines the museum's circulation paths and diversifies the circulation. "With this structure of the scheme, it is targeted to show visitors Istanbul's all breaking points in the symbolized form."(Derinbogaz,2019). The museum's tour which will be based on the spiral form representing the breaking periods of Istanbul will commence from the Neolithic era on the top floor and end in the atrium. Both in the atrium and certain sections of the upper floor, there will be contemporary art exhibitions that will represent Istanbul's current face (Figure 20).

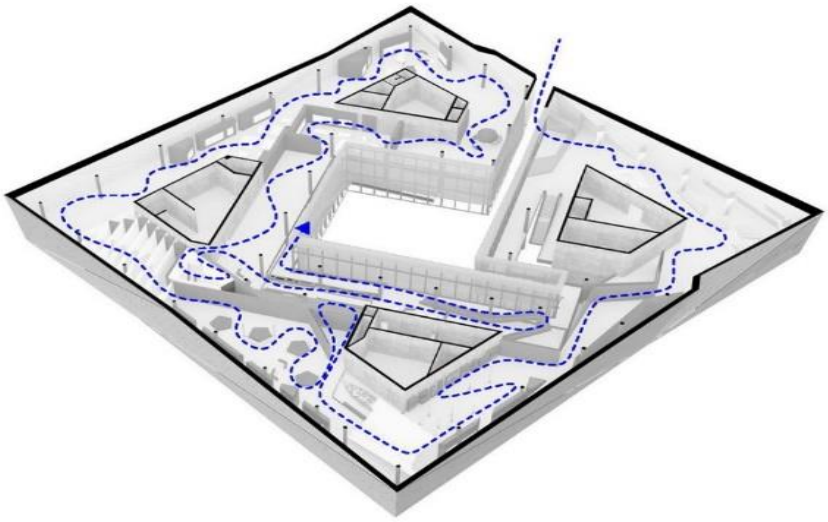

Figure 20. The ICMs cycle is designed based on the spiral schema. (Salon Alper Derinboğaz's Archive)

The atrium (Derinboğaz, 2019), which symbolizes Istanbul as a social entity, boosts this situation, gathers all visitors, and is connected to the exhibition spaces on the top floor with a ramp. The atrium has been designed to bring together the memory exhibited inside and the memory living outside, and sustain the city's memory under a single structure (Figure 21).

Alper Derinboğaz paraphrases this design as "While transparent floor (atrium) combines with green spaces around the structure and produces a functional infrastructure, it associates with the constant exhibition mass that brings all cultures together in the layered form" (Derinboğaz, 2019).

Figure 21. ICM's atrium, which symbolizes Istanbul, also ensures the museum's relationship with the city. (Salon Alper Derinboğaz's Archive)

Owing to the Wall Fortifications' repairs in the Roman, Eastern Roman, and Ottoman periods, each period's wall lining styles as well as the layers formed by different materials directly affect the building's layout. The wall, which is basically an architectural element built not only to restrict certain things but also to live inside, was considered metaphorically and aimed to pace Istanbul's walls in the museum. "Different cultures are

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symbolized both layered and intertwined, just as the stones of Istanbul's walls" (Derinboğaz,2019).

The museum's facade is designed to limit sounds coming from outside to keep the concentration of visitors and visually reflect the museum's surroundings. In order to fulfill the stated functions and reinforce the design's form integrity, the spiral geometry forming the scheme was used on facades. Unlike the schema, the spiral geometry applied for facade's shaping is designed to reflect the sound that is likely to come from the E5 highway and to change the direction of the wind. The facade's design was created by processing the data of wind speeds occurring for 12 months around the structure as a parametric algorithm, accordingly dissimilar faults, and slopes were produced on the facade (Figure 22).

Figure 22. ICM's facade formed by the parametric fracture of the spiral form is designed to display Istanbul's various views in a blurred form. (Salon Alper Derinbogaz Archive)

However, the facades were intended to reflect Istanbul with the sky and its surroundings in blurred form. The facades are not designed in a way directly to reflect their surroundings like mirrors, but to take the color of the sky at different hours of the day. Due to the façade's different angles, different appearances were aimed to be reflected at different hours instead of reflecting the same appearances continuously, thus, a facade design has emerged that symbolizes Istanbul, which produces its own diversity (Derinboğaz,2019). This feature of the facade is reinforced with grainy texture by using semi-matt anodized aluminum material on coatings.

DISCUSSION AND CONCLUSION

Simon Critchley, in his book called "Memory Theatre", focuses on memory theatre which is different from the usual theatre concept that Guilio Camillo designed as a model in 15th century. In Camillo's memory theatre, "the audience stands in the middle of the theatre and can watch both the stage and the audience" (Critchley,2014,). The theatre has a cosmic design in Vitruvius's theatrical layout. Thus it can mathematically enlarge and vary constantly. What shapes it is astronomy, geometry, logic, and philosophy, in other word is the knowledge that human history has discovered until then. Ali Artun associates Camillo's memory theater,

which is shaped by memory and exhibits the power of knowledge, with museums. “The memory theater where Camillo structured the information has been an inspiration for many museums until the modern museum period” (Artun, 2006, p.86). Memory spaces designed by current parametric design can be merely shaped with the memory itself, such as Camillo's “Memory Theater”. The geometries designated as the source of memory's format can be modified, associated with different formats, and converted.

Over three examples examined in this study, it is deduced that there are four important main criteria in museum structures designed through parametric design. These criteria are tabled as shown in Table.1 It can be seen that the four main criteria related to museum design can successfully be fulfilled thanks to the possibilities provided by parametric design. To summarize these criteria in the context of the possibilities provided by parametric design;

Form and Artifact Relation: The parametric design provides the memory-form relationship with the harmony of the museum and the artifact exhibited, and strengthens the energy represented by the museum. A symbolic geometry linked to exhibited artifacts can be used as the main source of form that can be re-addressed in a contemporary form. Thus, the metaphorical meaning of the structure can be strengthened while the relationship between form and artifact can be established. The memory of the structure identifies with its design and the memory exhibited. Structures and artifacts become one.

Environment and Form Relation

Parametric design can provide the environment identity to a museum. The facade and dome of the structure can be shaped according to environmental factors such as wind and sun. In this way, not only the harmony of form but also the efficient use of natural resources can be ensured. Thanks to the adaptation quality of parametric design, contemporary museum designs can be created in harmony with environmental factors such as climate and topography.

Cultural Memory and Form Relation:

In the parametric design concept, local cultural forms and symbols can be changed, transformed, and re-addressed with a contemporary understanding and used as forms. Using symbolic information in design as a form source of cultural memory can create a cultural memory& structure relationship and ensure that the represented culture can be maintained with a new understanding.

Monumentalism and Differentiation

Thanks to parametric design in architecture, topological, and non-euclidean geometric forms can be used in a controlled manner. The use of such forms in museum architecture can significantly separate the structure from its surroundings. While this makes the structure iconic, it strengthens the monumentality inherent in the museum.

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Table 1. The possibilities provided by parametric design in three museums' design.

MUSEUM	FORM AND ARTICAFT RELATION (MEMORY OF ARTIFACT ITSELF)	ENVIROMENT AND FORM RELATION	CULTURAL MEMORY AND FORM RELATION	MONUMENTALISM AND DIFFERANTIATION
LOUVRE ABU DHABI	Debatable. Although the museum exhibits mostly Western artifacts, the display of these artifacts under a dome representing Arab culture and power can be considered metaphorical.	The dome is shaped with regard to the angles of the sun falling into the region.	The grid structure that composes the Dome took its form source from the texture of the Arabic Mashrabiya. However, this structure of the dome also symbolizes Arabian tents.	Its large 180-meter dome immediately distinguishes it from other structures on the island.
YINCHUAN MOCA	Topographic maps of the region, which the museum exhibits and drawn by Jesuit priests, are also among the form sources of the museum.	The tide layers of the surrounding river are considered as the source of form..	The Yellow River, which shaped the Chinese culture, was also the form source of the museum	While the artifacts exhibited differ from the rural area with its different structure, it takes its source of form from its surroundings. It tries to capture both contrast and harmony..
ISTANBUL CITY MUSEUM	The museum takes its design from Istanbul, where it displays its artifacts. However, the cycle of the scheme is organized based on the historical events symbolized by the objects on display.	While it takes the form source from the walls of Istanbul, its facade is also shaped to restrict the wind and the sound coming from the highway.	Its schema and facade is. designed based on the multi-layered cultural structure of Istanbul.	Has a differentiated design than its environment. But also tries to adopt the environment with its metaphoric meanings

In the creation of societies' memory spaces, parametric tools can enable complex geometric structures to be processed flexibly, along with facts symbolized by environmental, cultural factors, and artifacts. Thus, the memory-space relationship can be established strongly. On the other hand, in the understanding that there is no relation between the artifacts exhibited and the museum, parametric design can serve as a design paradigm that monumentalizes the culture to which the museum belongs and that can regulate its relations with its surroundings. The parametric design method is a contemporary problem-solving tool that can handle architecture, topography, and cultural elements such as architecture from the past with a holistic design approach.

CONFLICT OF INTEREST
No conflict of interest was declared by the authors.

FINANCIAL DISCLOSURE
The authors declared that this study has received no financial support.

ETHICS COMMITTEE APPROVAL
Ethics committee approval was not required for this article.

LEGAL PUBLIC/PRIVATE PERMISSIONS

In this research, the necessary permissions were obtained from the relevant participants (individuals, institutions, and organizations) during the survey and in-depth interviews.

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Resume

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