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Folding : A Parametric Model To Support The Creative Stage Of Architectural Project

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Abstract

The use of architectural concepts in the designing of a project requires a combination of efforts; theoretical models are lacking in both substance and flexibility. This paper focuses on a parametric model, which has its foundation in contemporary society of information systems. This process gives structure to the decision making which then allows the creative stage of the project to occur. The process of architectural concept is subject of many studies in the field of science of drawing, or in cognitive science or informatics. Its wealth is based on its complexity and the variety of operating conditions that include during its progress. For our purposes, we will focus on the early stages of the project, the moments of conceptual research from which will flow throughout the design approach. This step is the founder of the architectural concept activity is largely associated with the creative dimension. We propose that this model will validate reconstructing the concrete steps of morphogenesis of reference objects. Then we will use the parametric model in a dedicated tool for architectural design. Our choice fell on this issue because the interactivity between the parts is a catalyst for a series of elements that helps the design process by raising the quality and operational modalities of this, creating a real "new aesthetic"

Keywords

Parametric design, 3D modeling, theoretical model, architectural concept.

FOLDING : A PARAMETRIC MODEL TO SUPPORT THE CREATIVE STAGE OF ARCHITECTURAL PROJECT

C. EL KHOURY[1]

ABSTRACT

The use of architectural concepts in the designing of a project requires a combination of efforts; theoretical models are lacking in both substance and flexibility. This paper focuses on a parametric model, which has its foundation in contemporary society of information systems. This process gives structure to the decision making which then allows the creative stage of the project to occur. The process of architectural concept is subject of many studies in the field of science of drawing, or in cognitive science or informatics. Its wealth is based on its complexity and the variety of operating conditions that include during its progress. For our purposes, we will focus on the early stages of the project, the moments of conceptual research from which will flow throughout the design approach. This step is the founder of the architectural concept activity is largely associated with the creative dimension. We propose that this model will validate reconstructing the concrete steps of morphogenesis of reference objects. Then we will use the parametric model in a dedicated tool for architectural design. Our choice fell on this issue because the interactivity between the parts is a catalyst for a series of elements that helps the design process by raising the quality and operational modalities of this, creating a real "new aesthetic".

KEYWORDS

Parametric design, 3D modeling, theoretical model, architectural concept.

1. INTRODUCTION

According to the reflection of the American sociologist Alvin Toffler (Toffler, 1980). He highlights three different waves that have changed the history of architecture and society. The first wave reaches the end of the '700 and is determined by an agricultural society rigidly divided by a decentralized economy that had the land as the basis of the same economy, life and culture; The second is characterized by the steam engine and the artificial production of energy, I mean the "industrial revolution". The period changed the way of thinking and operating, led to great social upheaval. The third wave is the "information society", the one we live in, where the information (the basic raw material) and its treatment are the protagonists of research, replacing the one based on the industry. Even the concept of model in architecture, throughout history: has passed through three eras:

1. The Renaissance period: building design works by *copies* and by *procedure*. This method provided the "recipe" that proceeded more or less effectively because they have been repeated throughout history and refined by trials, errors and corrections. (The connotation of the word model was the perfect example to imitate, to produce or to adapt);
2. The Industrial period: the design of the buildings was in the first place the realization of *products*. These models emphasized the *rationality* of the finite, addressing, first, the evidence adduced. It was the division and specialization of labor. The reasoning was organized in a linear, continuous and unidirectional, it was a mode of operation of the inductive type;

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3. The information period: these methods have a way of conceiving the projects based on *processes*, because they offer to designer the *control* constantly connected to the project; then the interests are focused on adjustments between objects over time rather than the objects themselves. This model is divided for queries; it is a process based on the interconnection of data by operating with a deductive approach.

This paper develops concepts of methodology and theoretical models in architectural culture, allowing to contextualize and to announce the issues around which articulate the "dynamic" model, understood as a support for the creative phase of the project, leaded by the contemporary society of information systems.

2. METHODOLOGY OF MODEL CONCEPT

Although many previous events marked the field, a study focused on the main theoretical models of design from 1920 is needed to describe the state of the art consists in that field. At the time of their creation, these methods and models of world architecture from different eras have provoked many reactions, positive and / or negative, but mostly exciting.

2.1 The Industrial era

In the early twentieth century avant-garde art and architectural opposed the neo-classicism of the nineteenth century, breaking the foundations of the Enlightenment, rationalist and social eighteenth century. These movements pledged to reject the definition, typically neoclassical, a set of aesthetic rules conditioned by an artistic technique or by a desire to copy nature. In rejecting aestheticism neoclassical, a "modern" architecture emerging, driven by a "desire to scientise design" (Cross 2001, pp.49-55), embody the material of architecture through scientific research, which allowed design to "products".

Alexander Klein works taking as a "unit" the man and his "size" anthropometric. He calculated and planned the spaces according to the functions of which the individual would have required. At the center of design practice manuals such Neufert imposed a whole series of models in function of the different types and scales of intervention.

This great effort of objectivity we have seen particularly in public housing: objectivity of the situation needs objectivity and objectivity of the solutions. The flow that in the field of public housing in the twenties and in the following decades is also based application socio-political when people living under standard, finally acquired a standard.

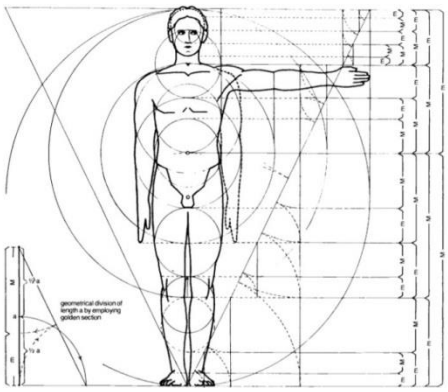

Fig. **1 The manual Neufert based on the study of man, of its measures and the right space.**

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2.2 The information technology era

- The diagrammatic thought

The diagram is a technique conceptual and formal, it does not contain precise and concrete solutions; its purpose is to disseminate the ideas in the mind of the designer, is based on the heuristics, that is not delimited ordered structures precise. The diagram delays typological definition being between form and words.

According to Deleuze, the first part of every architectural process has little to do with a process type of machinist. Usually, after having defined the program, the initial step is the production of a first diagram; this diagram can generally contain a description of functions organized according to type and further elaborated on the basis of considerations than the site. A second chart depicts all aspects of the site, defined by many factors: not just by his physical condition real, but also by his stories past and present. The diagram of the site interacts with the diagrams of function and type in an iterative process that produces a mixture of the three levels.

This organization tripartite generally works the same way in which it develops most of the conventional methods, in the sense that, similarly to them, produce the shape of a container two-dimensional planimetric. This container is usually extruded into a three-dimensional volume. The second stage is probably the most difficult, it requires the choice of an external agent, another diagram, almost a Deus ex machine which describes processes which, once overlapped to produce a first diagram blurring, a blur. Such a device may not be immanent in the first diagram but must activate a process that has the ability to change it.

Frank O. Gehry does not use diagrams to design. Start with sketches and generates plastic with simple shapes corresponding to a circuit diagram, working right model foreshadowing a starting image. Once the model has reached a level of composition considered satisfactory, it will be refined and digitized by computer (Dassault Systems Catia). It begins with a first spatial geometry primitive based on the consideration of functional constraints. Then the work of the transformations of these primitives using morphological operations.

Fig. 2 Ginger Rogers and Fred Astaire Dancing House, Prague Frank O. Gehry (1992-96)

Through the shape of the "Dancing House", Frank O. Gehry wanted to portray the couple Ginger Rogers and Fred Astaire performing a dance figure (Figure 2). He started with the modeling of the building using the "boxes" that represent functions of the program. Then he made a model, electronic, that will be the basis of many other checks, modifications and perfection.

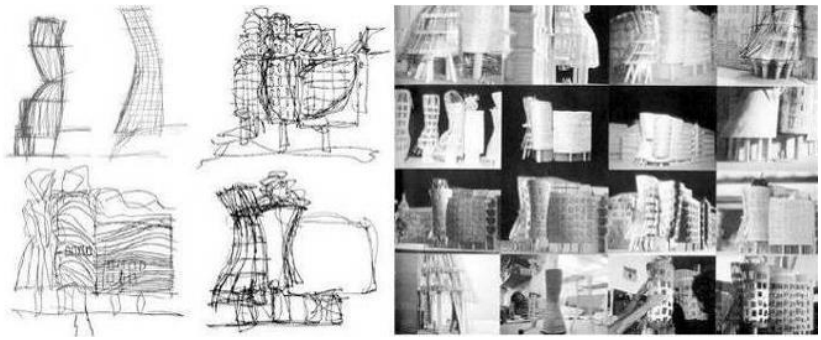

Fig. 3 Sketches and models made during the building design of Dancing House, Prague Frank O. Gehry (1992-96)

Peter Eisenman, a figure which is essential for this type of approach, he use the diagram in a different way. For him, the diagram is a sketch or the foreshadowing of a previous image but the representation of a process. In this regard, according to Antonino Saggio the diagram is the foreshadowing of the relationships that pass between architecture from DNA code generator and regulator of its development.

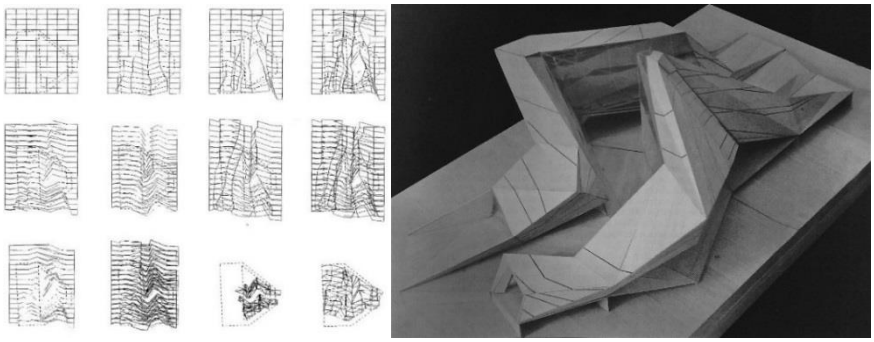

Fig. 4 Diagram and model of the Church of the year 2000 in Rome. Peter Eisenman (1997)

Table 1. Contrasts between the approaches of the Industrial era and the Information Technology one. Reference: The author

Fields	Industrial era	Information Technology era
Program	comprehensive	*Mixité*, hybrid
City	Opened and expansive	reactive
Construction	Structural points	Optimized structure
Buildings	Free composition	In between
Vision	fragmented	proactive
Methods	non-typological	diagrammatic
Expression	Abstract, analytic	Mimetic, contextual
catalyst	transparency	interactivity

We compare these new ways of the designing (paradigms) of the Information Technology era (Table 1), which overturned the previous concepts, and that led to a profound and irreversible transformation of the society, with the Industrial era.
Based on the analysis of several recent folded buildings, we proposed a parametric model based on folding.

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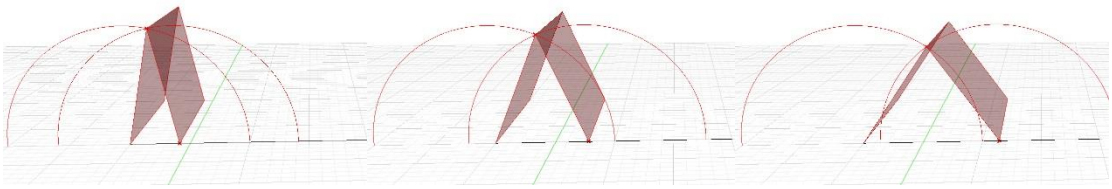
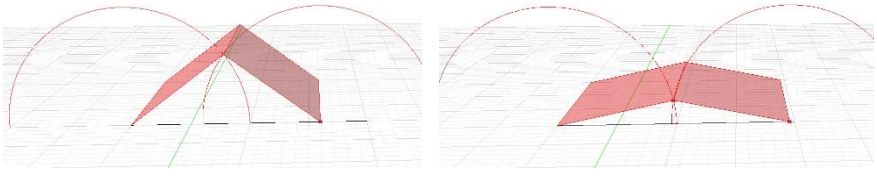
3. PARAMETRIC MODEL

The use of the term "fold" or "origami" in many architectural projects today manifests a shift in the language of contemporary forms in search of a new architectural writing.
This concept of the fold, which is at once both geometric and structural, is not new and also traces the history of architecture. We propose a model to describe and create an architectural form and structural bent. The model data is to help design this form, either via the mechanical geometrical point of view. A common model can be used as a bridge between two disciplines: architecture and engineering (Meyer, Duchanois, Bignon, 2014). This model is made in a digital modeler allowing a parametric bending geometry, in order to make compatible the requested architectural form with a satisfactory structural behavior.
The modeling of folded surface passes through successive morphological phases: the shape of the outer casing and that of the second bend its constructive geometry (profile parameter, frequency and amplitude). Geometric modeling is done in the environment of the modeler Rhinoceros coupled with Grasshopper[2].
It is possible to distinguish three structural families of folds that determine three types of configurations to which the plan is amenable.

3.1 The first fold

For first fold we mean the first subdivision of a surface according to oriented hinges that follow the same distribution rule: in this paper we analyze cases in which they are parallel so as to achieve dowels all equal among them. The easiest way to fold a sheet of paper is to create a series of parallel folds of mountain and valley. The orientation of a fold defines whether a fold is a fold mountain or a valley fold.
We indicate the mountain fold as convex and concave bends in the valley like. In a three-dimensional space with coordinates x; y and z is the direction trigonometric.
A folded paper can be manipulated, open and closed, especially by translations and rotations. These manipulations transform the shape of the folded paper. Geometric variations within a given type of model changes the folded form.





[2]Grasshopper, is a popular visual programming language created in 2007 by David Rutten from Robert McNeel & Associates company (application works on Rhinoceros), is mainly used for the construction of generative algorithms. The surfaces are described using NURBS curves. The program is now offered as a free download, with no due dates, but requires Rhinoceros version 4.0 or higher. The geometry is defined using the graphical interface without having to learn a scripting language. The generative algorithm is created by dragging components that represent data or function into the workplace.

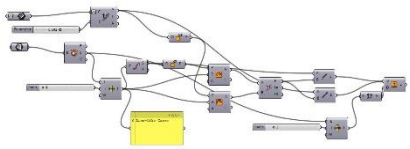


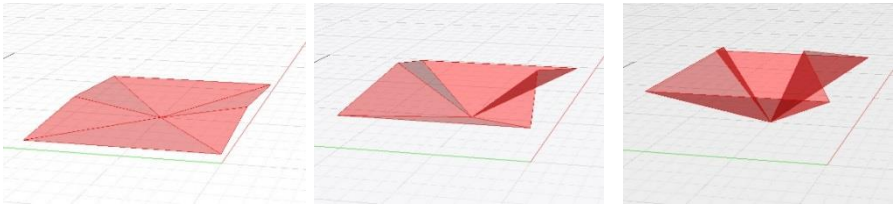
Fig. 5 Implementation and definition of the first fold

There are different geometries of the crease. In this example, we demonstrate the alternatives of folds resulting from the variation of the parameters (Figure 6).

Fig. 6 Alternative folds obtained by the variation of parameters

3.2 The second fold

The introduction of a new family of folds causes a radical change in the spatial configuration that can take on a surface. These new folds have a transversal trend compared to the first, their task is to change the direction to the first folds. The second fold that we treat is the reverse fold (reverse fold). Parallel or oblique folds can change their direction in space. The reverse folds' interests us and is the main tool that allows us to design the shape of folded structures (Figure 7). The reverse fold is widely used especially in origami. Let's see how this works in two-dimensional space (to allow you to understand the understanding of the nature), where it appears as a drop of a line, then we see the reverse bends in three-dimensional space where it appears as a drop of a plan:



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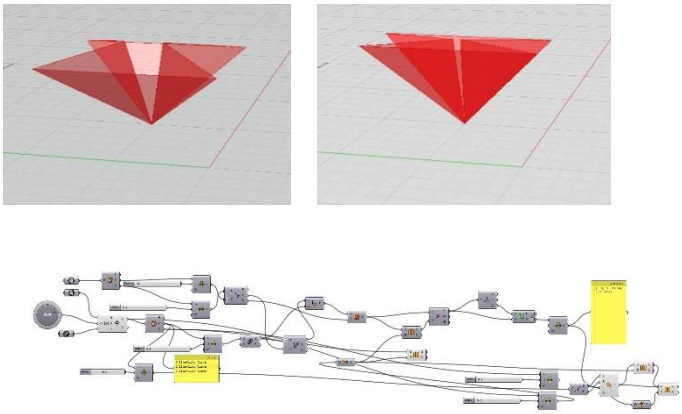

Fig. 7 Implementation and definition of the second fold

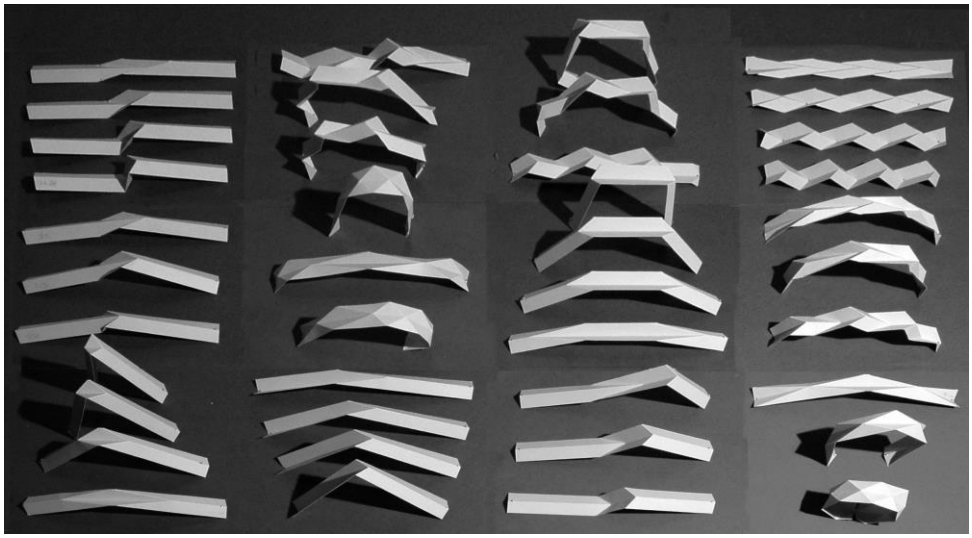

Fig. 8 Alternative folds obtained by the variation of parameters (Buri, 2010)

3.3 The third fold

This distinction of the fold takes on another meaning as an original polygonal tessellation can be transformed into triangles by the intervention of third fold.

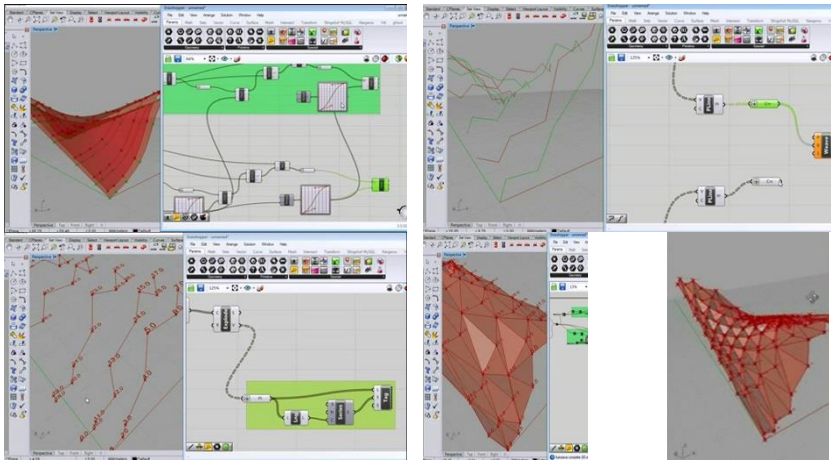

Fig. 8 Alternative folds obtained by the variation of parameters

4. VALIDATION OF THE PARAMETRIC MODEL OF ST. LOUP CHAPEL

In order to verify the validity of our model "folding", we want to redesign the chapel of St. Loup by Local architects in Lausanne. The challenge was: how to design and build very quickly a place of worship with a pragmatic solution and reasonable prices while maintaining a spatial and symbolic qualities? The studies that have been carried out on folded wooden structures have strengthened the interrelationship between the physical and environmental quality of the wood and the geometric potential of the fold, both structural and plastics. This choice was motivated by the architect morphological approach based on an expressive practice. The expressive search process adopted by Local architects detects an iterative procedure. Please note that our goal is not to model the exact procedure followed by the designer to produce the form. Our approach belongs to the field of morphogenesis of experimentation. We want to validate the feasibility of a form through the model, performing a check corresponds to a possible path at the time of conception.

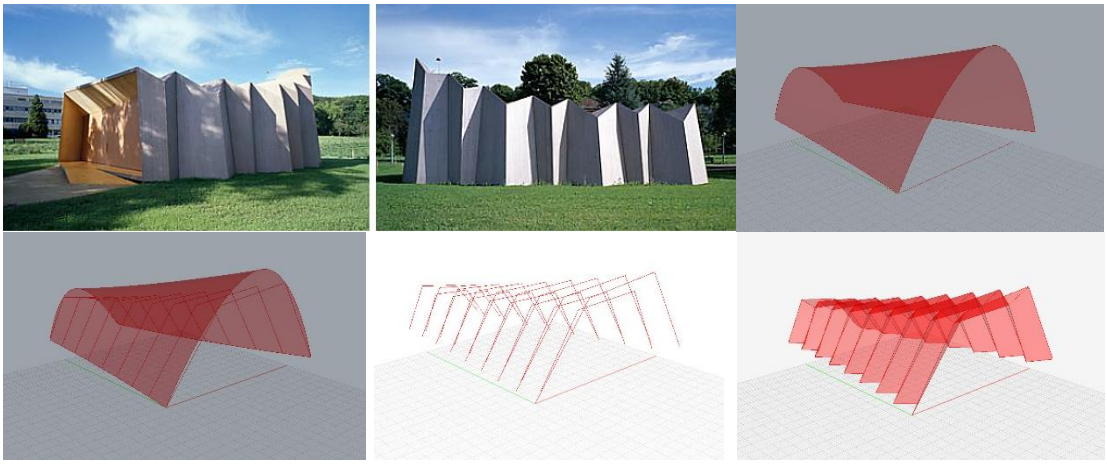

Fig. 9 Reconstruction of the project on Rhinoceros/Grasshopper

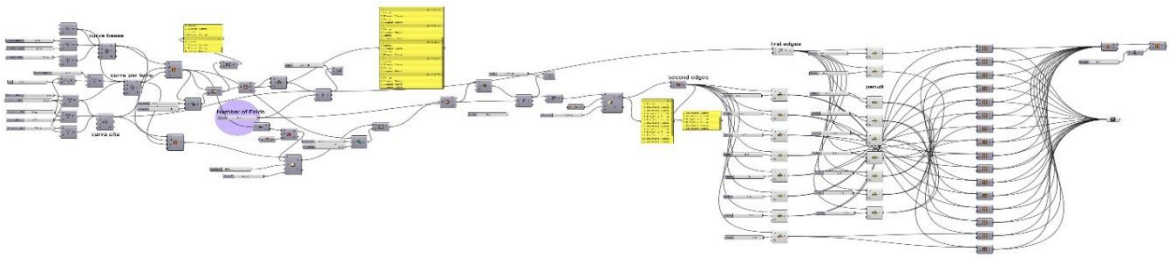

Fig. 10 Definition of the project on Rhinoceros/Grasshopper

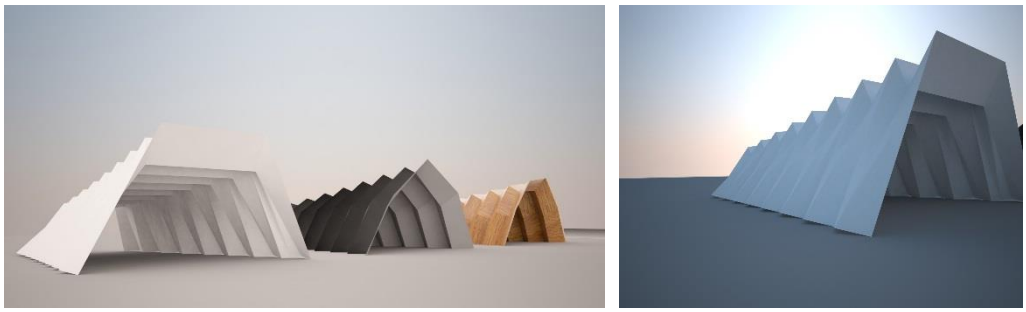

Fig. 11 Illustrations of different types of folds obtained by the variation of parameters

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5. CONCLUSIONS

The theme proposed in this paper is a kind of knowledge which we found quite relevant, exclusively in the Information Technology revolution that provides more possibilities. There are many opportunities waiting to be explored in the field of computer and our desire is that speculative way of working can still have significant external issues to the design process. We also believe that there is a possible relationship between the experimental practice and the knowledge that exist within the architectural discipline, other disciplines that involve the design in architecture. Finally, we consider that a possible starting point is to take a parametric thought based on folding within a general theoretical model. and a continuous use of such model could be used, adapted and evaluated continuously.

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