ABSTRACT

This research aims to find modeling strategies that students of architectural department used to producing and formation their architectural projects, and study the impact of modeling types (handmade model, digital model, parametric model, etc.), on the relationship between architect conception and client understanding. Research methodology: At the first section, the study examines the modeling concept, messages, Communication and the significance of model and modeling strategies. In the second section of the study discussed the modeling formation, Form production methods, modeling mechanisms types and what’s modeling methods that Adoption from the students and how that Consistent in the expression of the architecture concepts. The research presented the modeling and design methodology and that Effectiveness on development students Skills and abilities in project presentation and understanding the simple forms and the complicated forms. In the third section of the study, Research analyzes different student’s projects and find the strategies of modeling according to the equipment available to them. Multiple modeling is introduce as a key modeling strategy in architecture project formation and definition the impact of differentiation modeling type on understanding the architecture design and presentation methods.

Keywords: design; digital-model; handmade-model; modeling-strategies; parametric-model
Introduction

The representation of architectural products within the process of architectural design had many elements and inputs and abilities that made architectural design reform its mind image. This new image allows the architect to study the initial design and re-adjust it to make a perfect final product; the architectural model is the initial design of the architectural product that will define its outcome. It started in post-modern architecture and it defined its own orientations, which made a certain level of architectural culture, which tried to reflect the new and constant development in all of life's fields. This development has urged us to research and find new techniques to create new forms.(Turner, 2014) and ways especially with the digital and information developments that made its way to the world; many new forms had emerged such as Deconstruction Architecture, folding architecture. And digital architecture these new ways appeared as bright mark of many important new architects such as Zaha Hadid and Frank Gehry, these new ways also appeared in many projects like bird nest in China and the British wing in shanghai exhibition and the dancing towers in Dubai(Alshamari, Hmoud, For, & 2016).

The mental representation and the initial tests for such architectural orientations are becoming a must-have in the digital modeling to display those designs in a right manner. We can define digital modeling in the next subjects:

- 3D Modeling (Computer Graphic)
- 3D print using 3d printers
- Laser and CNC cutting
- 3d show by 3d TV (Iwamoto, Moussavi, & Kubo, 2009)

The researcher will focus on the role the modeling plays in the design process and its role in developing the abilities of the designer and his ability to test his project and develop more products coming from many complex architectural ideas.

The modeling usually uses the designer’s initial idea then tests this idea using a mini model made by the computers or handmade (drawing – model)

The problem of the research is in "The effects of modeling techniques in the architectural product design for the students of architect in Iraq ". The goal of this research is to find out the effects of those modeling techniques on the products architectural image and to define its methods by studying a group of those techniques to get a more general idea explaining those techniques.
To turn this goal into reality the research has made its hypothesis that “modeling techniques have an effect in the creation of architectural products”

Research methodology: explained through the next points:

- modeling definition
- the mechanics of model and the methods of creating a digital or handcrafted model

The concept of modeling

1. Modeling definition:

To build a full definition to what modeling means we must first present it as "An operation to build a model " meaning that it is an industrial strategy defined by the model's nature, mechanisms. The final product and the purpose of making this model whether it is experimental, standard or even just to study a group of information related to the model itself. That’s when we can re-define modeling as:" Work method determined by the nature of the product or the model ".

Valizar defines the model as " It is every realistic layout representation whether it was mental or material, represented in a literary language or in the form of charts, graphics or mathematical symbols". (Sadowski, 2009), While Doran defines it, as “the model in its indication is far more abroad it is every representation of a realistic layout regardless of the image it is displayed in The modeling according to this is the methodical process that results in producing the model, which will display an object, and the way it works. The modeling assumes that every object is somewhat a system works in a certain way. Be it - the model - a house in the mind field in which Valizar express it by saying " the layout, in reality, cannot be split from the model as a realistic layout, and every realistic layout cannot be known without going back to visual models. (Mental visuals or graphical visuals) and on the contrary of this we can consider every layout private whether it was physical or abstract. (Sadowski, 2009)

We can say that every human model in his daily life because he collects mental images in his mind, then re-form those images, and readjust the behavior resulted from these images by taking a group of behavioral decisions and reflexes according to mental inputs then reassess the model based on his experience. which is a virtual state and then it all goes back to describing a certain layout in a visual way which is the way we can evaluate the model and process it before we go into the final product.(Wren & Ames, 1965)
We know that architectural work “design and construction”. Requires testing the mental image in the designer’s imagination and transform it into a reality. Thus we must first test it in a virtual reality that could be through model or computer software and check see how accepted. It is in the eyes of the designers first and the receiver second all of this is done through the image of design that is actually in the designers mind where the model is the method in which the receiver can get the design idea and accept it as it is before actually starting to construction the project in reality. (Bass, Clements, Kazman, & Klein, 2008)

Thus, we can define modeling technically as "A technique or a strategy that enables the designer to build a model and display it to express the design initial idea through a group of variables. Elements and then reform it, it is an operation that one could build a group of complex layouts through it by creating a model that has the initial image that relays on creating a virtual reality whether it was a physical model (classic model, 3d printing, laser cut) or a model by 3d computer software .

Here the modeling is an abstract of the reality connected to it by a layout so that we can say the modeling is an industry. The industry of showing the final image of the architectural design in a visual way that could understood. This operation goes through many steps and methods to express itself and can divided into two main sections, which are:

- the handcrafted model
- the digital model

The research will try to concentrate on the second section of the operations of making the model, which is the digital model and its effect on the designer’s ability in forming the architectural object, which in turn will be the main subject of those technologies and will affect the final form. However, the research will first go through the first section in making the model to get a full idea. The second section meaning that we will go through the digital and the handmade models. (London, York, & 2003)

The creative ability of the artist is in showing and displaying his ideas from imagination to the real world using his hands, that why the older way in making the model is the handcrafted model:

1. Construction the work without any schematics with the help of the architect only who will direct the workers inside the location.
2. Making preliminary schematics and plans
3. The development in making detailed blueprints (architectural, civil, service)
4. Making a conceptual model
1.1 The indication of the model and modeling

There is many levels of solutions to apply both the designer’s ideas and the scientific ideas, because architects ideas has to be visual that's why the model is one of the architects most important tools. (Isaacson, 2008) The model finds its origins in technology, a mechanical drawing of the subject or the topic in a simplified way also helps displays the topic and make it more visual, then we can apply more mathematical and physical operations on the subject, that's why the topic serves the goals of knowledge.

The model presents solutions to the initial design such as:

- The form: (choosing the best form): by studying 3D digital and physical models.
- Functional: analyzing the functions to create creative solutions for the building on the levels of function and movement.
- Structural: by using 3D models to study the structural structure and the best ways to design it. (Bass et al., 2008)

1.2 The model and communication:

The design process concentrates on making communication on many levels starting from the design level to the post-production level, as a linear process, because of the change in the receiver and the change in the message intended to be achieve, the research concentrates on the communication process. That the design model can achieve on the level of design to achieve acceptability and to locate and choose the best. Alternative by presenting many architectural theses on the importance of the model in making the communication, which will result in being agree on what tools and methods to use that are appropriate to the time and place of the model and its building techniques (digital - physical). (Kareen, Moon, 2005)

B.J. Novitski (Novitski, 1998), refers to the importance of achieving understanding and organizing the relations between the elements of the architectural project and the architectural mass by using the 3d model in the design phase.

Based on what we already discussed we can present the model that achieves communication and the one that has these elements:

- Act (the project should represent the initial idea and make full use of the techniques available)
- Balance (to balance between the abilities of the designer and the abilities of the receiver to make the project understood on all levels)
• Usability (using technological tools and methods to build the model such as software and 3d printers and CNC machines)
• Adjustment (the model should adjust between the projects elements and the initial design idea to present the mission in a clear manner)
• Flexibility (the ability to adjust the model). (Studies & 2008)

1.3 The model and sensory reception

Many psychologists believe that we -as humans- when we walk in our surrounding environment we create our own model to understand this world, this model changes and our received images changes to build a new mental image to make sense of this world.

Abraham Pais assures us that it is the human imagination nature, which creates this. In addition, it is using a group of elements that complete the perception in its two genres:

• Internal elements: such as orientations, experience, individual needs, expectations, and mood.
• External elements: such as movement, change, order and system, fault senses, contrast, and antibiosis. Those variables are perceptiveness variables for the externals such as (architect) in result it affects how one understands the architectural products. (Garoian & Mathews, 1996)

We should understand than the model as a knowledge or cerebral unit independently and representing itself in the form or imagery relationship based on units, and the sum of hypotheses that allows the model to form its own results in formatting image (the synthetic dimension). While the experimental section the model is the epistemological level. Because we cannot look at the as pure product, neither we can look at it as a group of observances. It creates a field of concepts, flexible and adjustable. Moreover, from the procedural angle, the model has a practical and applicable status because it has elements both descriptive and normative that allow it to be successful and able to achieve the goals that it made for.

We can define scientific modeling as the ability to create models that are aware of their mental and knowable activity and related to the certain social layout. It is also useful for all the levels researcher goals through to create a model starting from the observed system, which can reduced to the following:

• Drawing detailed borders of the assumed layout
• Knowing accurately the model elements, layouts, and classifications by its properties
• Choosing a language to represent those elements and how they interact (digital, classical handcraft)
• testing the model and adjust it when necessary
• Make the goals you want to achieve from the creation of the model in relation to a context.

**Formation methods**

This section will discuss the strategies of forming the model using a group of methods used by Iraqi universities and some active digital labs in Iraq and the Middle East, which presents new solutions in the process of producing and forming of architecture that in turn helps to understand the forces that affect developing the architectural production generally.

1. **Mechanisms of forming the model**

The formation of an architectural model done through a series of steps, mechanisms and strategies that help converting the imagination of the designer into real life miniature. That helps to transfer the idea to the imagination and sense of the recipient, and this process has been through a series of developments through history. Starting by using hand drawn 2D sketches and 3D handmade models that present an alpha stage of the building, and with the development of technology came new methods of architectural rendering which helped develop the concept of the act of thinking (shaping ideas, solutions for design problems before converting them to models). To the concept of the thinking of act (researching the strategies of converting ideas to models that are a fit for evaluation and studying). (Richter & Zimmerman, 2001)Which gave the digital development a wide new range for technologies and strategies of model making through different computer software (Revit, Max, Rhino, Grasshopper, Etc...). With the appearance of 3D printers and CNC machines and other technologies. We can provide a modification to the system of the thinking of act and the potential that should be provide for the designer with figure number (1)
2. Modeling and reformation

Here lies the bigger picture question of the process of modeling, which is, what are we trying to achieve? For us, architects, it is the problem of creating a form and understanding the context and the need of the model, (Whom are we designing for, or creating a model for a test or showcase or both). The key sources that the designer depends on in understanding. This question and finding solutions for it through the process of forming and constructing in the making of the model, which the designer starts after defining the main features of the alpha version of the concept of the production, which defined by three important things, those things are:

1- The architect defines the nature of the model that connects strongly with the design concept and what they are trying to achieve.

2- The architect chooses the right formation that achieves the goal of clarification of the idea on all levels, form, function, and execution

3- The architect puts a method of forming the model, sets a timeline for production, and defines the nature of materials used and effecting visual elements, considering the form of the architectural product.
In addition, generally the architect stays most of the time restricted to two ways in the process of forming the model:

- The first way is the hand-drawn method (Hand draw perspectives and handmade model). And the connection between the ability and skill sets of the student in creating the model is a determining factor of defining the form of the architectural product and that makes a huge difference between the students which some require a special set of skills to achieve their vision, which clearly affects the end result.
- The second way is rendering using the computer (Using advanced software and 3D printers, laser cutters, VR machines, and other technologies) and this is relate to the potentials provided by the universities including methods and high-end computers, printers, laser cutters, and other modern technologies.

This conflict between the two ways in Iraqi architecture schools does not make a problem in the architectural forming and making of the architectural models, instead, it gives some elasticity and variety by including new materials and systems into the process of creating a model and the effects done by that. Which gives multiple tools for the process of forming the elements of the model through (A method of creating material, showcase method, value and balance, sensible image, planes, and structure).

Results

The modern software affected the forming elements of the architectural model significantly, but keeping up with these software and changes is variable from one architectural school to another. From one student to the other, depending on the tools provided by these architecture departments, and the abilities and skill sets of the student in imagining a design concept and transforming it into a model.

This software provided a space of freedom and elasticity in the architectural formation. So that the architect can become the form giver to the recipient with a wide range of form. Ecological, and structural analysis which helps test the model and give a live sensible image of the final production of the concept or architectural project, which empowers the form-creation abilities of the architect and create active communication with the recipient whether they were a committee to evaluate the project or a customer. The formation of the model, in this case, needs providing a number of elements to create brilliant forms, including:
The used software and its potential (Smart software like Grasshopper or rendering software like Max, or BIM software like Revit)
- The ability of the using computer
- The academic approach in expressing the model
- Providing tools for modeling (CNC, 3D printers, Laser cutters, handmade model tools (Carpentry, Blacksmith), etc...) (Liu & Lim, 2006) Generally, we can determine three main methods of the process of creating a model in Iraqi academies, these are:
- Handmade model (Using tools in creating the model such as tape measures, board, carpentry tools, hand molding, duct tape) As shown in figure (2)
- A digital model through as shown in figure (3,4):
  1- Using computers and modern software and the render is done via (Printing, digital screen, 3D screen, VR machines)
  2- Using 3D printers and CNC machines and laser cutters in an addition to handmade essential tools and tapes.
  3- The adaptive method that merges the skills and handwork with the skill of using and forming the model digitally as shown in figure (5)
Discussion

The Study focuses on making a comparative analysis between the Iraqi Architectural Schools by surveying a number of students in three Iraqi universities; the university of Baghdad, University of Technology and Al-Nahrain University, to specify the ratios and differences of those three schools in orientation and the strategies of model creation.

The samples included two segments, the first one is architectural students in three departments, first to third-year students, and the other segment consisted of students of the fourth and fifth year, the study can show briefly through the diagrams below, and that shows ratios of using every method in every segment:
Figure 6: ratios of using the hand-made method for the first segment. Source:

Figure 7: ratios of using the digital method for the first segment. Source:

Figure 8: ratios of using the adaptive method for the first segment. Source: researcher

Figure 9: ratios of using the hand-made method for the second segment. Source: researcher

Figure 10: ratios of using the digital method for the second segment. Source: researcher

Figure 11: ratios of using the adaptive method for the second segment. Source: researcher
From the previous diagrams and charts, we notice that the first segment, which includes the first three years that hand-based method, is the common method working in the University of Baghdad with a higher ratio. Than the other universities even though the ratios are close between the University of Baghdad and Al-Nahrain University as shown in figure (6) while the University of Technology has lower ratios and shows a higher ratio in the Digital method. In the first segment and that shows the dependency on the developed modern methods in the model-forming process as shown in figure (7), while the adaptive method in figure (8). We notice the approach of the results of the University of Technology and Al-Nahrain University, the ratio is close and that shows a large variety in a good way for Al-Nahrain University in the adopted methods in the model-forming process.

The second segment includes the fourth and fifth year’s students. We notice that the hand-based method in model-forming process ratio is low as we can see in figure (9) and is zero in the University of Technology. While in the figure (10, 11) show that both the adaptive method and the digital method have high ratios in all universities especially for the fifth year, students and we see a spark in adaptive method ratio in Al-Nahrain University for the fifth year students.

From the results, this study can determine how powerful and practical every method is in every university in the model-forming process through the upcoming figures (12, 13, and 14)
Conclusion

- Lack of tools that let the student be creative in the field of model-production unless doing so themselves to find a way to express their creativity through methods approved by their universities.
- The computer-related curriculum is parallel to the Design class-content which affects the production, especially in the University of Baghdad and Al-Nahrain University, while we notice the University of Technology focusing on learning the modern software and applying what they learn in Design Class.
- The architectural form of the product depends heavily on the student’s expressive skill in making the model, so the difference between the architecture schools is a result of the students themselves, regardless of the incompetence of the syllabus.
- The multiple stage of testing the model starting from Sketch Model down to the final product lets the student discover which strategy is the best fit for making a model.
- The change of elements’ value from one university to the other pushes the model towards achieving an active continuation, we notice (Act, Balance, Way of use, and Adjustment) from one level to the other, until it reaches the understandable level in the end for all the architectural schools the study handles.
- The changeable production is because of the change in methods and strategies of forming the model between the architectural schools, which gives the “Form Giver” variable interpretations to the mind of the receiver and a wide range of meanings or messages sent by the designer.
- The form morphing abilities in the digital method is more using than the form morphing abilities in the hand-made model.
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