thesis: The perception and meaning of architectural modeling has been going through a major shift for the last three decades, particularly by way of the digital technologies.[2] This shift is discussed broadly with various factors and outcomes in the realm of architecture, taking into consideration its highly interdisciplinar context with philosophy, science, and technology. To achieve this, a history of architectural modeling is studied in the final section of this chapter, and this argument leads to the shift in the late twentieth century which is studied in the following chapter.

2.1. An Overview of the Modeling Culture

2.1.1. The Meaning and the Concept of "Model"

In an etymological search, it is seen that the word model is "borrowed from the Middle French word *modèle*, from Italian *modello*, from Latin *modellus*. Modellus is a diminutive of the Latin modulus, a diminutive of modus, which signifies the word measure."[3] As observed, modeling is highly associated with measuring. As Smith defines it, "model" signifies a number of situations: It can be the representational organization of an entity, not necessarily in a scaled down form. It may propose a pattern or method that serves to produce a following item.[4] It may also "offer a tentative description of a theory or system that accounts for all its known properties."[5] Architectural models work in all these fields, and it might be additionally illustrative to evaluate architectural models within the "concept of model."

It is fundamentally important to understand the concept of "model" with its different meanings and varying contexts, because it is used to specify different means, situations and ideals in many fields. This may help to clear some ambiguities knowing the existence of such models and such classifications, in order to draw parallels between specific model types. This would illuminate a basic knowledge on the logics and conventions of model-making. Together with the dissolving boundaries between disciplines, it becomes more complex to recognize, understand and implicate a specific model. For the sake of such a

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[2] Alfredo Andia. "Integrating Digital Design and Architecture During the Past Three Decades." *Proceedings of the Seventh International Conference on Virtual Systems and Multimedia (VSMM '01), University of California, Berkeley, CA, 2001.*

[3] Albert C. Smith. *Architectural Model as Machine.* pp.61-2.

[4] *Ibid*. p.62.

[5] "Model," *Webster's Third New International Dictionary.* Springfield, MA: C. G. Meriam Co., 1967.

commencing background, following Albert C. Smith's classification, the concept of model can be studied in five categories: (1) mathematical, (2) analog, (3) qualitative, (4) engineering, (5) theoretical (sociological and philosophical.)[6]

A "mathematical model" deals with the natural systems and studies it within formal mathematical representation.[7] For the mathematician John L. Casti, "a model means an encapsulation of some slice of the real world within the confines of the relationships constituting a formal mathematical system."[8] Following with his definition of the mathematical model;

> Thus, a model is a mathematical representation of the modeler's reality, a way of capturing some aspects of a particular reality within the framework of a mathematical apparatus that provides us with a means for exploring the properties of the reality mirrored in the model.[9]

Mathematical models play an important role in architecture, with ever increasing stress in the contemporary discussions. Following the debates in complexity sciences and the recognition of computational methods, architecture has progressively been incorporating mathematical models in its processes. Together with this new mathematical background and digital technologies to process it, computational design knowledge forms this juncture as one of the key elements in the epistemological shift in contemporary architecture which is going to be discussed more in detail in the following chapter.

"Analog models" are artificial physical representations used to test and measure specific systems.[10] Some examples of scale analogs include miniature rivers, dams, aquifers[11] for hydrologic tests, miniature ship hulls for testing in water tanks, or miniature airplanes for

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[6] Albert C. Smith. *Architectural Model as Machine.* p.xviii. In his book, Albert C. Smith conceptualizes the fifth model type as "relatively subjective models," on the basis that sociologists and philosophers rely on relatively subjective views on the nature of human and society. However in the scope of this work, these kinds of models are included as "theoretical models," which may both embody objective and subjective recognitions on a conceptual level.

[7] *Ibid*. p.xviii.

[8] John L. Casti. *Reality Rules I: Picturing the World in Mathematics.* New York: John Wiley, 1992. p.1.

[9] *Ibid*.

[10] Todd Rasmussen. *Analog Models* [Course Notes]. Retrieved March 30, 2008, from the Course's Website: http://www.hydrology.uga.edu/rasmussen/class/8740/Chap3.pdf. (Last accessed on 15.05.2008.)

[11] *Ibid*.

testing in wind tunnels.[12] Analog models aim to "demonstrate known quantitative relations among governing parameters" rather than composing a discovery.[13] They are laboratory experiments which help to conduct towards design alternatives.[14] As the use of computers has increased today, computer simulations are also widely utilized in analog modeling as well as physical experiments. The types of "qualitative models" can be listed as mock-ups, prototypes and test beds.[15] They work as simulations in a more precise domain. Examples of such qualitative models can be given as scale models of high-rise buildings or bridges exposed to smoke streamers to visualize vertex patterns; or structural scale models tested for their reactions under specific loads. [16] Architects receive consultation from experts while working in such models. Engineering models, as described by Dieterich Schuring, are "experimental models structured to mirror the true physical behavior of an original phenomenon, or a prototype."[17] Following Schuring, these types of models serve as substitutes of systems that cannot be studied at the prototype level. They provide fundamental information of the studied system, which allow predictions for prototype design.[18]

Theoretical models include the models of philosophers and sociologists, assisting to comprehend and alter the human nature and its systems.[19] They work on an exceedingly conceptual level, but both hinging upon subjective and objective values.[20] In the field of architecture, they function to strengthen the theoretical and conceptual background of a

[12] Albert C. Smith. *Architectural Model as Machine.* p.xix.

[13] *Ibid*.

[14] Todd Rasmussen. "*Analog Models.*".

[15] Albert C. Smith. *Architectural Model as Machine.* p.xix.

[16] *Ibid*.

[17] Dieterich J. Schuring. *Scale Modeling in Engineering.* Elmsford, NY: Pergamon Pres, 1977. p.5.

[18] *Ibid*. p.7.

[19] Albert C. Smith. *Architectural Model as Machine.* p.xx.

[20] *Ibid*. p.xviii. Philosophical models can be defined as subjective theories of philosophers obtained through meditation. In sociology, it is seen that there are a number of different types of models. Circa late 1970s, a constructivist view in sociology tried to hold objective grounds. For such a purpose, on a micro scale they study "one-on-one and small group dynamics in regard to social patterns, socialization and communication." It can be observed that there is the will to the possession of objective measurement in both within the realm of philosophy and sociology; however subjective models are contemplated on more often than not. The information on sociological models is obtained from: Judy Lombardi. "Sociological Models," http://www4.vjc.edu/JudyLombardi/stories/storyReader$749. Last accessed on 30 April, 2008.

design proposal. The theoretical position of the architect is manifested in his design through such models. Theoretical models operate on many scales: While providing the unity in a single project, they also contribute to the consistency of the architect's attitude in the entirety of his practice. It can also be pondered that they share a part in the creation of paradigms in the context of an architectural community. It would not be going too far to regard the impulsive character of such theoretical models by mainstream architectural practitioners.

As observed, the "model" delineates a wide range of circumstances in many contexts. Construing the concept of model with its multi-faceted structure is essential since the architectural model operates in all these areas. It occasionally signifies an ideal, a canon, or a means to achieve a desired state. In this sense, it appears to be interchangeably used, though being in consciousness of the subtle disparities would help to provide terminological accuracy. Moreover, the multiple meanings of the concept are also reflected in the concept of the architectural model. In the realm of architecture, the "ideal" is extrapolated as the "design model" or the "diagram," the "canons" as "design conventions," and the "means" as the "physical or virtual architectural model" in the form of a thinking artifact. As the disciplinary boundaries are increasingly suspending, it is getting complicated to decipher and situate the architectural model. In this manifold study, it is detected that the architectural model is assuming numerous roles, particularly in its contemporary state more than ever.

2.1.2. The Architectural Model:

As observed from the study of types of models, the term "model" can be said to be a highly flexible term for architects with its many functions.[21] The architectural model simply refers to the physical or virtual representation of a design idea and can be basically defined as "a thinking and defining mechanism for understanding and demonstrating architectural concepts."[22] From the multiple definitions that can be put forward for the architectural model, as Albert C. Smith proposes, the French word *maquette* suggests the closest meaning to what is understood of the architectural model.[23] He explains that, "literally a *maquette* is a demonstration designed to gauge the general appearance or composition of the thing

[21] Mark Morris. *Models: Architecture and the Miniature.* p.8.

[22] Albert C. Smith. *Architectural Model as Machine.* p.vi.

[23] *Ibid*. p.2.

planned."[24] Today the architectural model is seen to have gained a much more flexible and versatile character with many facets whose field extends to a broader context where the boundaries of different types of models dissolve into each other. On this broad context of contemporary models, Morris defines that;

> Model applies to a whole gamut of real and virtual objects, running from what appear to be crumpled up wads of paper to models so highly finished that they appear as real full-scale buildings in photographs, and to a growing array of digital types that, by layers or in sequence, target a myriad of design concerns.[25]

It can be added that the models can be classified as old school or analogue models, which refer to touchable scale models and virtual models, or they can be categorized in terms of their performativity or functionality.[26] However, he is right in observing that with digitally fabricated models, which are cut by laser or routers or built by three-dimensional printers, this categorization is blurred. In addition to this, it can also be seen that the labels as analogue or digital models or classification by functionalities are also quite ambiguous within the context of contemporary modeling.

In contemporary design culture, modeling can be regarded to have succeeded in consolidating its grounds with its dynamism and versatility. When compared to the two-dimensional representation techniques, to which modeling was subordinated for centuries, it can be stated that by its very nature modeling outperforms two-dimensional techniques in a few topics. It can be observed that architectural sketching and drawing has always been favored by designers with its celerity and ease.[27] Porter and Neale detect that studying architectural concepts on paper at the initial stage of design is a well-disposed situation to generate design ideas, providing speed and enrichment in the process.[28] Be they efficient at this stage, it can be regarded that such two dimensional representations may carry a few handicaps.

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[24] *Ibid*.

[25] Mark Morris. *Models: Architecture and the Miniature.* p.8.

[26] *Ibid*.

[27] *Ibid*. pp.14-23.

[28] Tom Porter and John Neale. *Architectural Supermodels: Physical Design Simulation.* Oxford: Architectural Press, 2000.

Firstly, apart from sketching or generating initial drawings, it is common experience that producing the technical drawings required to completely represent a design work necessitates colossal time and labor. In addition, the orthographic set of drawings is a rather technical form of representation which requires professional training or extensive familiarity to understand.[29] Scale models are experienced to be much more communicative, easy and fast to interpret in this sense, both by designers and clients. Furthermore, during the course of design, modeling is seen to provide a strong form of penetration for the designer by illuminating all details of the building. At the same time, it is observed to hold more potential in offering several new design routes to be followed. In the context of generating new ideas, Porter and Neale have detected that "[i]f the graphic techniques are the sole method employed in design, alternative solutions which might exist beyond their capacity could remain hidden or even ignored."[30] Similarly, as Mark Morris observes, "[m]odels also help check deficiencies in design and in their refinement curb the effort of imagining various problems only in drawing."[31] It is clear that models form a more comprehensive working media and also serve to provoke the designer for diversities by permitting contemplation on all these dimensions as well.

On an epistemological level of discussion, concerning the perceptual procedures and process-related dynamics of design, it is not going too far to regard drawings and other image representations as fixative. Unlike the dynamism of three-dimensionality, two-dimensional representations are obtained by freezing a moment in design, capturing and framing the vision in image. It can be suggested that the whole perception of the final product is foreseen and planned by the producer of the image and the flexibility of the viewer's interpretation is limited. In the example of the orthographic set, there are conventions of such a standard graphical representation. The orthographic set is composed of plans, sections, elevations, in some cases accompanied by isometric or axonometric projections, and perspective drawings. Other images as model photographs, collages or computer renderings try to illuminate and visualize design with other motivations. The reason they preserve their fixity is that as soon as their advancement is complete, it can be noticed that all aspects which are dynamic in reality are frozen. For instance, when a model

[29] *Ibid*. p.2.

[30] *Ibid*. p.20.

[31] Mark Morris. *Models: Architecture and the Miniature.* p.9.

photograph or computer rendering is observed, the lighting conditions are prepared according to the scene, and the perspective is anchored by the camera.

As to directing attention to the architectural model, it can be clearly observed that the gaze of the viewer cannot be immobilized in such a sense as in the image. While observing a model, the perception is realized through a period of time. The movement of the body is also incorporated to the motion of the eyes.[32] If architects observing a model are visualized, it would surely be a scene in which they either handle the model or move around it, to obtain a perception from all angles. As Tom Porter and John Neale observe, other senses as of touch and smell also become a part of this observation. Unlike the image, it can be observed that the model and the viewer share the three dimensions and its tactility in the same reality. Opposing to the discreteness in the two dimensional representation, these interactions in the observation of a model provide a continuum. Concerning both the perceptual and design processes, models share a greater success in aiding the complex visual relationships. Based on this aid, the dialogue between the designers gains speed and non-professionals can penetrate into the design more easily. The role of the models in the design process is going to be extensively discussed in the following section, from the viewpoints of designer, designer dialogues and client relationships.

2.2. Different Roles of Architectural Models in Terms of Their Performativity

When studied closely, it is interesting to observe that there are various types of models which concentrate on different aspects of design works. This classification is far beyond the differences in the materials chosen to build a model, or the gestures of the model-maker. First, and probably the most important matter is the model's status in the course of design. Such categorizations would illuminate what certain models would mean in the process of design, and on a pragmatic degree they would help in the employment of models more effectively.[33] Secondly, the concepts of scaling, and therefore detailing, become integral to this discussion respectively. In this procedure, it becomes crucial to understand the specific utilization of the model type which directly signals the course of design as it is intended by designers. As Morris mentions that, "model types are used strategically, depending on the

[32] Porter and Neale. p.104.

[33] Mark Morris. *Models: Architecture and the Miniature.* p.8.