Entwurfsanlagen
Denken mit Modellen

Drafting Facilities
Thinking with Models

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Modelle sind Werkzeuge von Denkern und Kreativen jeder Art. Sie dienen dazu, die Vorstellungen zu konkretisieren und den Ideen eine Form zu verleihen, damit sie verhandelbar werden. In der Publikation *Entwurfsanlagen – Denken mit Modellen* geben Spezialistinnen und Spezialisten aus Architektur, Kunst und Philosophie, aus den Neurowissenschaften, der Klimaforschung, der Ökonomie sowie der Künstlichen Intelligenz Einblick in ihre Arbeit mit diesem Werkzeug. Sie legen offen, wie Modelle unseren Blick auf die Welt beeinflussen.

Models are among the working tools of creative people of all kinds. They serve to concretize ideas and give them a form so that they become negotiable. In the publication *Drafting Facilities – Thinking with Models,* specialists from architecture, art, philosophy, neuropsychology, climate science, economics and artificial intelligence reveal how they work with this tool and how it changes the way we look at the world.

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Astrid Staufer (*1963) studied architecture at ETH Zurich. She has run an architectural office in Frauenfeld together with Thomas Hasler since 1994. As a lecturer, she has taught in Zurich, Winterthur, and Lausanne. She has been Professor of Building Construction and Design at the Institute of Architecture and Design of TU Wien since 2011.

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The Model as a Notion of Space

Paolo Vitali in exchange with Astrid Staufer

„Postremo, eadem cum modulis exemplaribusque mandassem, nonnumquam singula repetenti evenit, ut me etiam numerum fefellisse deprehenderim."[1]

Leon Battista Alberti: *De re aedificatoria decem*, IX, 10

A couple of years ago I got to know the architect and professor of architecture Astrid Staufer in Vienna. The large seminar room of the Institute of Architecture and Design of the Faculty of Architecture and Planning of TU Wien, where she teaches together with her office partner Thomas Hasler, was full of models in a wide range of sizes, scales, and materials and highly differing degrees of abstraction. The mere presence of this wealth of silent, structured forms said more about the methodology behind the design and form-finding process that is taught in this institute than any image generated by a modeling software could possibly do. This space, in which we discussed the significance of the model in architecture for the very first time, is not only a place of learning but also a statement of intent.

1 "Finally, when I pass from the drawings to the model, I sometimes notice further mistakes in the individual parts, even over the numbers", Leon Battista Alberti: *On the Art of Building in Ten Books*, transl. and ed. by Joseph Rykwert et al., Cambridge, Mass.: The MIT Press 1988, p. 317.

The large seminar room of the Institute of Architecture and Design of the Faculty of Architecture and Planning of TU Wien

"Model" as terminology

As a term that is related to the representation – and the understanding – of reality, "model" is a word with many implications; it opens up a vast array of philosophical and epistemological questions, while simultaneously evoking such aspects as dimension, norm, rhythm, modus, boundary, and "ideal form" as well as "paradigm". This multiplicity of approaches incorporates numerous fields of knowledge and raises far-reaching questions, especially in terms of how we deal with the notion of "similarity".[2] A model can reproduce reality or – in the case of the design process – reproduce an idea as a reality that is merely imagined. In this sense, it constantly acts as a mediator between ideas and reality, but also as a creative yet, at the same time, cognitive and communicative strategy. Bearing this in mind, the model embodies the entire operation of representing an object or an idea, while also allowing us to visualize formal, structural, or functional hypotheses. Terminologically, it unites art, science, and technology.

Given the complexity described above, it is also difficult to clearly position the term in the field of architecture. A glance at the dictionary illustrates its multiple meanings within the discipline: "In architecture, a model is a construction, usually at a considerably reduced scale, which reproduces the precise forms and characteristics of a work during the design phase for purposes of demonstration or experimentation."[3] Hence, for example, the painter, designer, theorist, and philosopher Tomás Maldonado points out that "not all models have the same qualitative or quantitative relationship with resemblance."[4] He proposes the classification of models in three categories: homologous (vis-à-vis structure), analogous (vis-à-vis structure and function), and isomorphic (vis-à-vis structure and form). And he arrives at the conclusion that the relationship between an architectural model and the reality it is seeking to represent can only be isomorphic.[5]

2 Tomás Maldonado: *Reale e virtuale*, Milan 2015 (1992), p. 101.

3 Dizionario Treccani (www.treccani.it/enciclopedia/modello, retrieved 22.11.2022), transl. from the German translation by Rupert Hebblethwaite.

4 See note 2, Maldonado 2015 (1992), p. 101, transl. from the German translation by Rupert Hebblethwaite.

5 "Being of identical or similar form, shape, or structure": understood here in the sense of the external appearance.

"Anticipation"

So what is a model in architecture? Models have enjoyed a multitude of meanings and purposes within the discipline across the ages. But interpretations of the role of the model at least seem to agree that, at some point, it mutated from being the simple instrument of presentation that it had always been[6] into an instrument of design. Due to the way in which it permits the investigation of alternatives (by exchanging its constituent parts), the control of the building process, the organization of the building site, and communication with the builders, the model became an object, a tool, for gradually refining the project idea.[7]

According to many authors, this mutation coincides with the revolution in spatial perception that was ushered in during the Renaissance by Filippo Brunelleschi's discovery of perspective. In the wake of this new notion of space and architecture, the model becomes a means of developing ideas. Rudolf Arnheim believes that this transformation in the culture of the Renaissance is also accompanied by a recognition of the difference between a model and reality (in this context, he speaks of qualitatively different visual experiences).[8] This led to the questioning of the model's suitability for the investigation of an architecture that was principally based on proportional relationships.

6 "Greek and Roman and also, before them, Sumerian and Egyptian architects certainly presented models of proposed buildings to their clients in order to convince them and gain their approval", Claudio Piga: *Storia dei modelli. Dal tempio di Salomone alla realtà virtuale,* Bergamo 1996, p. 47, transl. from the German translation by Rupert Hebblethwaite.

7 Here, the term "project" describes the entire design and working process for realizing or altering a built object.

8 Rudolf Arnheim: *La dinamica della forma architettonica,* Milan 1977, pp. 143–44.

For example, Palladio appears to have refrained from using models in the knowledge that the difference between a model and a real building can lead to a shift in perception.

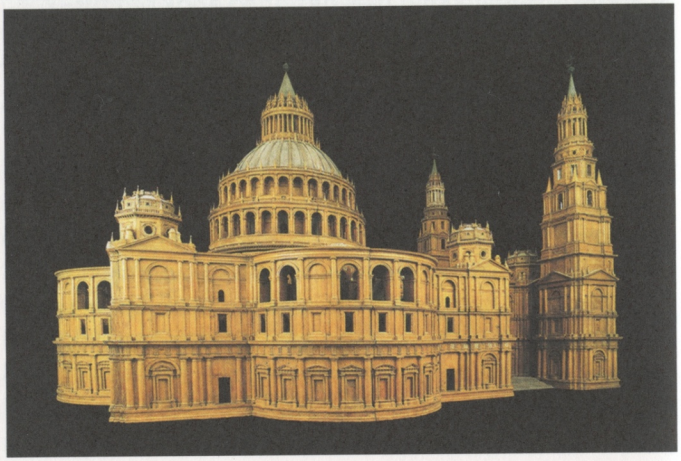
Dimension and interpretation

One of the most famous architectural models of the Renaissance is the monumental wooden model of St. Peter's Basilica that was designed and commissioned by Antonio da Sangallo the Younger between 1539 and 1546.[9] With its extraordinary dimensions – a total height of 4.68 m, a width of 6.02 m, and a length of 7.36 m – it is testimony, on the one hand, to the clients' readiness to accept the enormous cost of building such a model, not least as a means of demonstrating the huge importance of the project for Christendom. On the other hand, the size of the model opened up a further possibility: It could be entered, which led to a completely different quality of perceptual experience.

In addition to this, the model of St. Peter's also represents a new design approach. By using it to produce an almost exaggerated process of joining architectural elements, Sangallo switches the focus to connective interpretation. In doing so, he distances himself from the classical canon of a Bramante or a Michelangelo,

9 The construction of the model was supervised by the architect Antonio Labacco (Antonio d'Abaco), a close colleague of Sangallo, and cost a total of 4,800 Scudi – a huge sum, with which a medium-sized church could have been built at the time. It took seven years, from July 1539 to the end of 1546, when Sangallo was already dead, to develop this grandiose wooden model with a scale of 1:30. When Pope Paul III made Michelangelo responsible for the construction of St. Peter's on 1st January 1547, the project was suspended.

who had always seen architecture as a plastic material in the sense of the unified whole. Rather, the model of St. Peter's becomes an essay about the amalgamation of architectural elements from both the formal and conceptual points of view. At the same time, however, it also anticipates the spatial effect of the finished work, which can only be perceived internally but which one can approach sequentially via "subtle adaptations" of the model.



Wooden model of St. Peter's Basilica that was designed and commissioned by Antonio da Sangallo the Younger between 1539 and 1546

Which sort of model?

Hence, it became possible to adapt models – to add, remove, exchange, and modify elements – without damaging them, until every part was correct and fitted perfectly.[10] In this way, modelmaking became a form of "field research", which Maldonado helps us to understand by introducing the crucial notion of the "plastic": "In this context, the term 'plastic' describes the idea of a physical construct that can be modeled in the same way as a sculptor shapes a material such as clay. As a synonym for the model, 'plastic' describes not the production of a definitive and conclusively designed object, but an open process that takes the form of a sequence of interventions and constant retouching and rethinking."[11] This characteristic makes models suitable for certain purposes and unsuitable for others.

It is the sequential nature of the design process that justifies the role of the architectural model as a key driver for understanding interrelationships. Paradoxically, however, while the physical model may meet an interpretative need as it searches for its own final (built) form, it still retains an autonomous status vis-à-vis the realized architecture. And it is this that gives it its enormous potential as a didactic instrument. For the model offers an opportunity to question, in its own way, the manner in which the combined elements interact. Here, for example, the level of impact – the grammar or the syntax – of a work doesn't always

10 "It [the model] will also allow one to increase or decrease the size of those elements freely, to exchange them, and to make new proposals and alterations until everything fits together well and meets with approval", see note 1, Alberti ed. Rykwert 1988, p. 34.

11 See note 2, Maldonado 2015 (1992), p. 100.

concur with its structural function. In western architecture, the Greek temples are an interesting example of such a divergence between visual effect and geometrical built structure. The Greek architects made knowing use of optical refinements, as exemplified by the way in which they gently curved the bases and beams upwards or subtly inclined the columns towards the center of the temple in order to lend it a "more elegant" or "more correct" appearance. The great lengths to which they went to correct the form in order to achieve a specific visual appearance demonstrates both the interaction between and the autonomy of effect and geometry.

This example reveals how, in formal questions, the "truth" of perception prevails over the geometrical "truth" of structural necessity. Models are a vital instrument for planning such effects.

Hence, we can make assumptions about a "permanence of the image" in the collective memory. This is hinted at in the title of the publication *Ikonen,* which accompanies the teaching of Staufer & Hasler at TU Wien[12] and implies that architecture has always been the "material declination" of symbolic references and conceptual models. It is in this context that the architectural model demonstrates its power as a permanent intermediary, whose role is to examine and highlight the convergence of the conceptual idea and spatial reality.

12 Lorenzo De Chiffre, Thomas Hasler, Astrid Staufer (eds.): *Ikonen*, Zurich 2018.

Formal autonomy

"The building of models was clearly central to the consolidation of the role of the architect as a figure who differentiates himself from, and is even a sort of rival to, the medieval builder."[13] The Renaissance and, in particular, the writings of Alberti, marks the moment at which the model moves beyond its subservient role and achieves both autonomy and cultural dignity and, in doing so, establishes its cultural independence as a work of the creative spirit. As an instrument for evaluating the arrangement of its own parts it becomes a means of reviewing a project,[14] whereby the process of formally examining conceptual parameters also has an empirical value. Thus, the building of models in the Renaissance surpasses the purely communicative (and persuasive) dimension that has characterized it to date. Here, Alberti's words are once again highly revealing: "There is a particularly relevant consideration that I feel should be mentioned here: the presentation of models that have been colored and lewdly dressed with the allurement of painting is the mark of no architect intent on conveying the facts; rather it is that of a conceited one, striving to attract and seduce the eye of the beholder, and to divert his attention from a proper examination of the parts to be considered, toward admiration of himself. Better then that the models are not accurately finished, refined, and highly decorated, but plain and simple, so that they demonstrate the ingenuity of him who conceived the idea, and not the skill of the one who fabricated the model."[15]

13 See note 2, Maldonado 2015 (1992), p. 101.
14 See note 7.
15 See note 1, Alberti ed. Rykwert 1988, p. 34.

The research perspective that Alberti opened up with his work on models went on to become a constant feature of architectural design, in that the physical dimension of the model became synergistically intertwined with ever more sophisticated techniques of graphic representation.

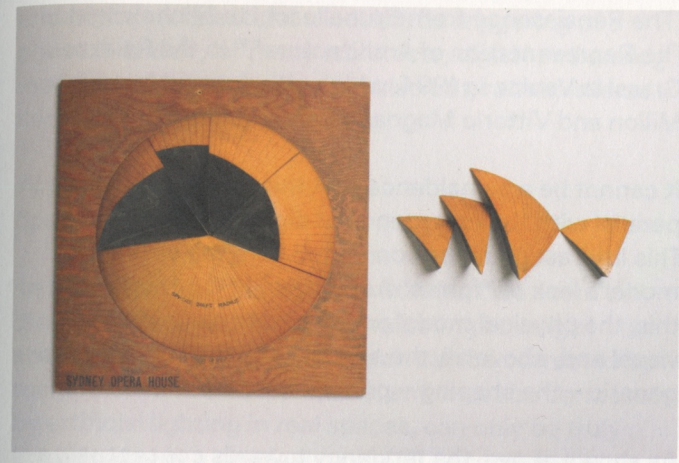
Hence, it is worthwhile trying to understand which characteristics of the physical model ensure that it is an effective working instrument. According to Staufer, models are indispensable when the nature of the space plays a significant role and they are able to demonstrate the impact of manipulating this space on how it is perceived. In this sense, modern architecture offers convincing examples of the use of models in both the design process and in teaching. Three representative examples illustrate this role, whose importance should not be underestimated:

- Modelmaking formed the basis of the design process of the architectural movement De Stijl. In his first model of the Schröder House in 1924, Gerrit Rietveld developed a basic solution that he went on to refine in a second and, finally, a third model at the scale of 1:25.

- Jean Prouvé tested the intuitive potential of his students at the Conservatoire national des arts et métiers by setting them tasks that they had to solve by directly manipulating a model. In doing this, he attributed the same importance to the hands as to the brain.

- In 1961, Jørn Utzon developed the final design for the roof structure of the Sydney Opera House by experimenting with study models. His idea was to form all the shell-like elements of the roof by cutting up a single

sphere into individual segments. It was this physical segmentation and spatial rearrangement of these elements that enabled him to find this solution.



Model by Jørn Utzon showing the design of the roof of Sydney Opera House

The return of the architectural model

Over the course of the past few decades, the development of computer-supported design methods has profoundly changed how we plan buildings. This raises the question of whether materially realized models are losing their significance in the design process: Do the renderings generated from digital 3D models not enable us to visualize the spatial effects that we previously investigated by making models at comparatively little material (and financial) cost? The opposite is the case.

In recent decades, the architectural model has regained attention through exhibitions and publications. Examples of this include the monographic edition of the journal Rassegna entitled *Maquette* (32, 1987), which was edited by Vittorio Gregotti, and the exhibition "The Renaissance from Brunelleschi to Michelangelo. The Representation of Architecture",[16] in the Palazzo Grassi in Venice in 1994, which was curated by Henry Millon and Vittorio Magnago Lampugnani.

It cannot be a coincidence that this revival took place in parallel with the emergence of digital technologies. This interest could be connected with the virtual model's lack of "formal autonomy". In contrast with this, the physical model enables us to examine the visual and, above all, the spatial impact of the morphogenetic – the shaping – principle behind a work.

As shown above, the tendency towards conceptualization and the constant aspiration of 20th-century art to capture the structure of its subject have reinvigorated the role of the physical model in the area of design and teaching.[17] The major advantages of working with models can be found in the fact that these illustrate a formal principle, while also being able to communicate an idea of space that is simultaneously visual and

16 The focus of the exhibition is both scientific and didactic. The image on the cover of the catalog features Domenico da Passignano's painting *Michelangelo shows Pope Pius IV the model of St. Peter's in the Vatican*, (1618/19).

17 "Klee says that the artist must position himself at the point at which things emerge, at which the genesis of creation takes place, at which swirling forces produce the original forms that are common to all beings, people, plants, minerals, and elements. The artist copies not the forms created by nature but, rather, the genetic process of formation, the morphogenetic principle from which they emerge; he copies nature not as a created object but *as natura naturans*, as a creative process", Giuseppe Di Napoli: *I principî della forma. Natura, percezione e arte*, Turin 2011, p. XVIII, transl. from the German translation by Rupert Hebblethwaite.

material. In the age of digital modeling, the importance of the model for contemporary architecture – beyond its communicative function of convincing the client – becomes obvious. Hence, the true impact of the emergence of the digital, which could have meant the end of the architectural model, is its triggering of a phase in which, for many architects, digital and analog models are not mutually exclusive but, rather, interactively complementary.

Space and – light!

"In the digital age," says Astrid Staufer, "we seem to disregard the importance of evaluating how light shapes space. This quality, which can be corrected by manipulation in a virtual model and must be corrected by artificial lighting in real spaces, can only be truly investigated in a physical model."[18] Accordingly, Staufer's thoughts about the architectural model and its use in design begin at the end of the process or, in other words, with the finished object. And even if it is true that the model has no clear and predetermined function in the design process, there can still be no doubt that, for many architects, it continues to play a crucial role in the development of projects, regardless of all the digital possibilities: It is the only instrument that, via a process of progressive refinement, enables us to evaluate the configuration of the parts of a project, the relationship between and hierarches of all its components, and the impact of light in the planned spaces and, finally, upon the form as a whole.

18 Astrid Staufer in a conversation with Hannes Brunner and the author, 12.9.2022.

In this sense, light becomes the actual, the true design material. It is light that gives space its essential quality and determines our expectations of and our concept for this space. In such a vision of architecture, the control of the light or, better still, the understanding of its impact upon the proposed space is fundamental. It must be aligned with our idea of the space and this can be achieved by the appropriate configuration of the architectural elements.

One essential aspect of this design method is a familiarity with architectural models in a wide range of scales and degrees of abstraction. To this end, Staufer & Hasler's foundation course at TU Wien requires a specific type of model for every step of the design process: The scaled analytical model of a detail from an "icon" in the first phase of the exercise ("understand") is followed by a scaleless conceptual model in the second phase ("interpret"), in which the aspects identified in the analytical model are taken further and transformed. The final phase ("formulate") then involves the creation of the project model, which focusses on the specific area of intervention and is, once again, true-to-scale. The process is enhanced by digital (and sketched) graphic investigations of surfaces, material effects, and atmospheres. This method has been researched by Staufer & Hasler at the Section for Building Construction and Design for more than a decade and has proved its worth in practical office situations over many years.

According to Astrid Staufer, the analog model is often more effective than the digital model during the concept development process due to the fact that the virtual model's apparent advantage – its constant 1:1 scale – often results in the disadvantage of

"over-definition". This can lead designers to lose sight of not only the hierarchy of elements, but also the hierarchy of problems. The extra work that one must invest in creating a physical model in parallel with the now customary digital 3D or BIM model is rewarded by the deeper quality and sustainability of the finished building.[19]

In its essence, the physical architectural model is thus both conceptual and material – a combination that, in the absence of the above argument, could appear paradoxical. As a conceptual model, it may often have little in common with the final project and yet it is an indispensable instrument for achieving a deeper understanding of relationships. And, finally, it becomes an "a posteriori model" that enables us to understand and capture the essence of a project, the tectonics of materials, the organization of spaces, and the relationship between structure and form.

This insistence upon the importance of the physical architectural model for an effective and efficient control of the design process brings us back to the aforementioned central role defined in the Renaissance. It revives those design practices destined for extinction due to the emergence of digital methods, and gives these practices an entirely new relevance.

19 Cf. note 17.