PAUL EMMONS
Virginia Tech, Washington-Alexandria Center

MATTHEW MINDRUP
Carleton University

Material Models and Immaterial Paradigms in the Rietveld Schröder House

In the interplay between scale models and intellectual paradigms, architectural models construct immaterial ideas. This confluence of material and immaterial in architectural modeling is explored through an examination of Gerrit Rietveld's design for the Rietveld Schröder house (1924). His first wood massing model of the project is often considered to have been created before the idea of flowing space and as an instance of Thomas Kuhn's paradigm shift. Instead, through Gaston Bachelard's concept of paradigm nesting, the model is shown to be integral to Rietveld's design process that used three mutually exclusive notions of mass across different conceptual terrains.

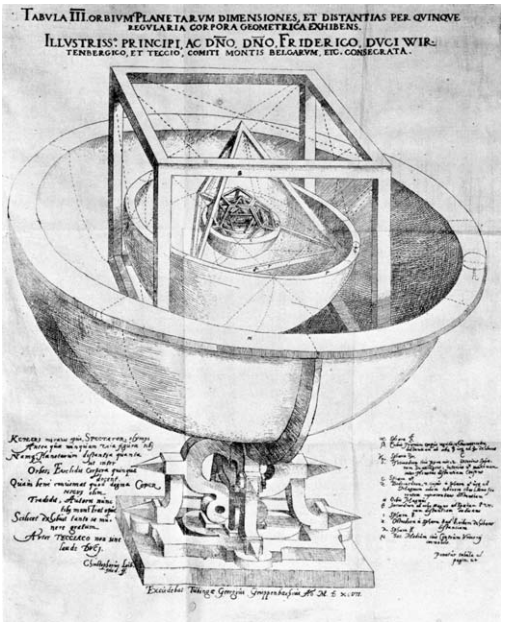
Over the millennia, architects use physical models to manifest their immaterial dreams in three dimensions.[1] More than records of already developed designs, models are integral to the creative, generative process of inventing new structures.[2] This worldmaking in architects' practices reveals the presence of the immaterial within the material not as a transcendental opposition, but conjoined, where the material is constructed through the immaterial.[3] In the sense of material as culturally mediated, we understand Aristotle's statement: ''in the case of designed objects, *we* make the matter.''[4] An emphasis on the role of the immaterial over physical appearance in architectural models was memorably upheld by Leon Battista Alberti when he warned against the allurement of models that are ''colored and lewdly dressed'' and only serve to ''seduce the eye.''[5]

The close interplay between the material and immaterial in architectural modeling is demonstrated by the words model and paradigm that have overlapping meanings. Indeed, paradigm derives from the ancient Greek *paradeigma*, which described designer's models and three-dimensional exemplars created for important architectural elements such as column capitals.[6] This definition of paradigm was extended by Aristotle in his *Physics* and *Metaphysics* to describe ideas of the mind acting as patterns for material particulars.[7] In the twentieth century, as will be discussed below, philosopher of science Thomas Kuhn defined a paradigm as an intellectual model or prevailing scientific worldview. Astronomer Johannes Kepler, for example, at the end of the sixteenth century, advocated the Copernican paradigm of a sun-centered universe and created a concentric model of harmonic planetary relationships as a series of nested platonic solids to define the distance between planets (Figure 1).[8] The complex nature of models, reverberating between intellectual and physical constructions, makes them a key source for understanding the role of the immaterial and material in architectural design. This issue is considered here through the modest massing model used in the design of an icon of modern volumetric architecture, the Rietveld Schröder house.

Massing Models and Volumetric Paradigms

By the late nineteenth and early twentieth centuries, the use of massing models made of solid material to study the relationships of exterior building forms was a common practice among architects across Europe and the United States.[9] Often in plaster, a mass model—like its cousins in clay, wood, and even bar soap—was made of a single continuous material that appeared literally as a mass.[10] To create plaster models, architects first worked out their designs in clay in order to create a mold within which to pour the wet plaster. After hardening, the cast plaster model was removed from the mold and then refined by carving on the surface; sometimes by a sculptor specially hired for the task.[11] Government-sponsored design competitions, such as that for the Berlin City Hall in the mid-nineteenth century, required plaster models in order to equally judge the different proposals. In addition to conventional practices using solid mass

1. Diagram of the universe, Johannes Kepler, *Mysterium Cosmographicum, The Cosmographical Enigma* (1596).



2. Plaster model of Citrohan House, Le Corbusier (1920). (Photo ©2008 Artists Rights Society, New York/ADAGP, Paris/FLC.)

modeling techniques, they were also used by avant-garde architects including Walter Gropius, Wassili Luckhardt, and Le Corbusier (Figure 2).[12] During the early twentieth century, the modern paradigm of open, volumetric architecture came into apparent conflict with the normative practice of modeling architecture as a mass.

In this confrontation between new volumetric approaches and existing modeling conventions, the role of representation to not only reflect an architect's conception but also affect it becomes problematic. If mass models material while form models volume, why did early twentieth century avant-garde architects continue to create models as masses to study the volume of their designs? Why did they use mass models instead of form models? This question is still relevant today, with new rapid prototyping technologies that continue in foam or starch the representational practice of mass modeling. Answering this deceptively simple question involves a reexamination of the complex intersection between two kinds of models: physical models to represent building projects and intellectual paradigms to represent models of thought. In architectural design, models and paradigms are inevitably commingling, inspiring, and challenging one another.[13] The confluence of these two modes of modeling occurs perhaps most clearly in a model for the Rietveld Schröder house (1924). This case provides valuable insights into design amidst the complex intersections between the material and the immaterial and can provoke new modes of architectural invention.

Models

Gerrit Rietveld (1888–1964) attended architecture classes from 1908 to 1915 and started his own furniture design and construction business in Utrecht, Holland, in 1917.[14] From the beginning, the structure and supports of Rietveld's furniture becomes increasingly simplified and reduced to planar elements; as evidenced most famously by his Red-Blue Chair of 1918 (Figure 3).[15] Rietveld then began extending the principles from his furniture into the design of small interiors and storefronts.[16] These designs were developed primarily in models and used drawings only to record the results.[17] El Lissitzky wrote of Rietveld: ''He does all with models, feeling things with his hands; and therefore his product is not abstract.''[18]

In 1924, Rietveld began working with Mrs. Truus Schröder-Schräder (with whom he had collaborated since 1921) on the design of her new house on the outskirts of Utrecht at the end of a block of row houses.[19] The house is famous for its flowing spatial transitions created by distinct planar elements (Figure 4). The second floor's continuous interior space is articulated and adapted to different uses by sliding and swinging surfaces that engage the inhabitants in the transformation of the house.[20] To emphasize the effect of the walls, doors, and windows as planar spatial elements, they are variously overlapped, differently colored, and physically separated to make the Rietveld Schröder house a living, changing dwelling.

While the house is remarkably dynamic, the first study model Rietveld created for the project was a painted solid wood mass (Figure 5).[21] A critic recently described the model as having ''the solid appearance of a closed cube with openings for windows and doors indicated [on the surface] as dark rectangles.''[22] When confronting the apparent inconsistency of a mass to model the house's planar/spatial design, authors typically attempt to resolve the dilemma by suggesting that the model is early and preceded the development of the final design, writing, for example, ''from this essentially closed form [of the very early model of the house] to the articulated planes of the built structure with its open, flexible spaces, one can read the process that led Rietveld to a genuinely new architectural philosophy.''[23] This justification, however, ignores Rietveld's own prior cardboard modeling and that the so-called mature paradigm of flowing space architecture was already known to Rietveld and his peers before he made this model.

The use of cardboard for models has an extensive lineage. A survey of architectural models

3. Red-Blue Chair, Gerrit Rietveld (1918). 1925 reproduction, Centraal Museum Utrecht. (Photo ©2008 Artists Rights Society, New York/ADAGP, Paris/FLC. Used with permission from the Centraal Museum Utrecht.)

4. Rietveld Schröder house, Gerrit Rietveld and Truus Schröder-Schräder (1924). (Photo ©2008 Artists Rights Society, New York/ADAGP, Paris/FLC. Used with permission from the Centraal Museum Utrecht.)

produced by German architects between 1500 and 1900 presents a tradition of constructing three-dimensional representations of buildings using cardboard as well as plaster, cork, and wood.[24] English-language architectural journals in the early 1920s frequently discuss the value of making models to test or develop ideas three dimensionally. To build paper models, architects drew each façade on a cardboard sheet and then, with tabs attached to the planes, fold the different facades together (Figure 6).[25] By the mid-1920s, there are numerous examples of modern architects using cardboard models.[26] More specifically, Rietveld was certainly aware that Theo van Doesburg in 1923—before the Rietveld Schröder house model—already built cardboard planar house models and exhibited them in a De Stijl architecture show in Paris (Figure 7).[27]

In the years before the Rietveld Schröder house, Rietveld already uses cardboard to construct models of architectural interiors for himself and his colleagues, demonstrating his full awareness of the material and its modeling properties. In 1923, Rietveld was involved with the construction of two cardboard architectural models: one with the De Stijl painter and designer, Vilmos Huszár, for an interior design, *Colour-Space Composition*, and a second for van Doesburg's *Hôtel Particulier* project that was exhibited at the same Paris De Stijl show mentioned previously.[28] Rietveld certainly could have built the original Rietveld Schröder house model in this same way, but instead, chose to build it as a mass model. Throughout the 1920s and 1930s, Rietveld continued to construct open-volume cardboard models although, as in the case of his 1930 model for Seven Dwellings in Erasmuslaan, Utrecht, they were frequently used to represent a mass. Since cardboard and its modeling techniques were very familiar and available to Rietveld prior to the Rietveld Schröder house model, an explanation as to why he built the solid mass model cannot simply be that he was not yet aware of the expressive potential of cardboard. Furthermore, van Doesburg and others created axonometric paintings of floating planes to represent the exhibited house models and wrote manifestoes for the new architecture that were also published prior to Rietveld's mass model. To explain Rietveld's use of the wood mass model rather than a cardboard form model simply as a preliminary design is inconsistent with all the other experimental ideas and representational techniques in use at the same time. Instead, this apparent contradiction is best explained through a more precise understanding of the role of paradigms in architectural thought.

5. Rietveld Schröder house model, Gerrit Rietveld (1924). (Photo ©2008 Artists Rights Society, New York/ADAGP, Paris/FLC. Used with permission from the Schröder Archives, the Rietveld Schröder House Collection, custody of the Centraal Museum Utrecht.)

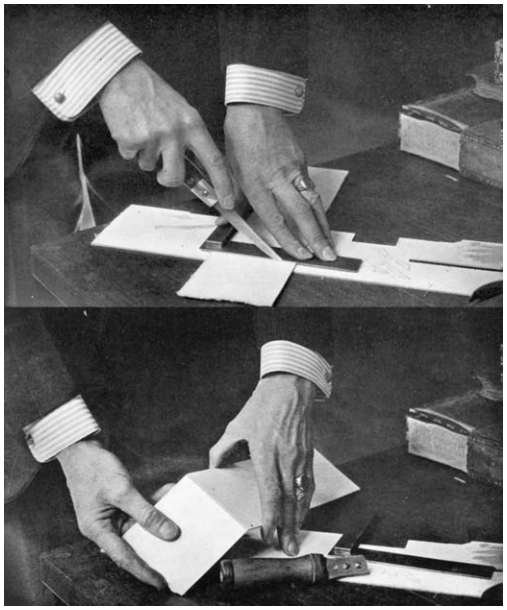
Paradigms

Perhaps the most well-known and still influential approach to conceptualizing changes in intellectual models is the ''paradigm shift'' promulgated by Thomas Kuhn in *The Structure of Scientific Revolutions* (1962). Contrary to the idea that scientific advancement was a slowly evolving inevitable progress toward increasing truth, Kuhn described a paradigm as the dominant cluster of theories under which most scientists worked at a particular time. Kuhn, rejecting scientific advancement as linear, proposed the paradigm shift as a ''series of peaceful interludes punctuated by intellectually violent revolutions'' during which ''one conceptual worldview is replaced by another.''[29] Under this meta-paradigm, normative science suppresses differences that threaten its foundations until they can no longer be resisted and, at this point, a paradigm shift occurs. This approach to describing the history of science is sympathetic with stylistic approaches to the history of architecture where one style persists until another finally overthrows and replaces it.[30] Explaining Rietveld's use of a mass model as prior to a major change in his architectural worldview derives from the notion of paradigm shift.

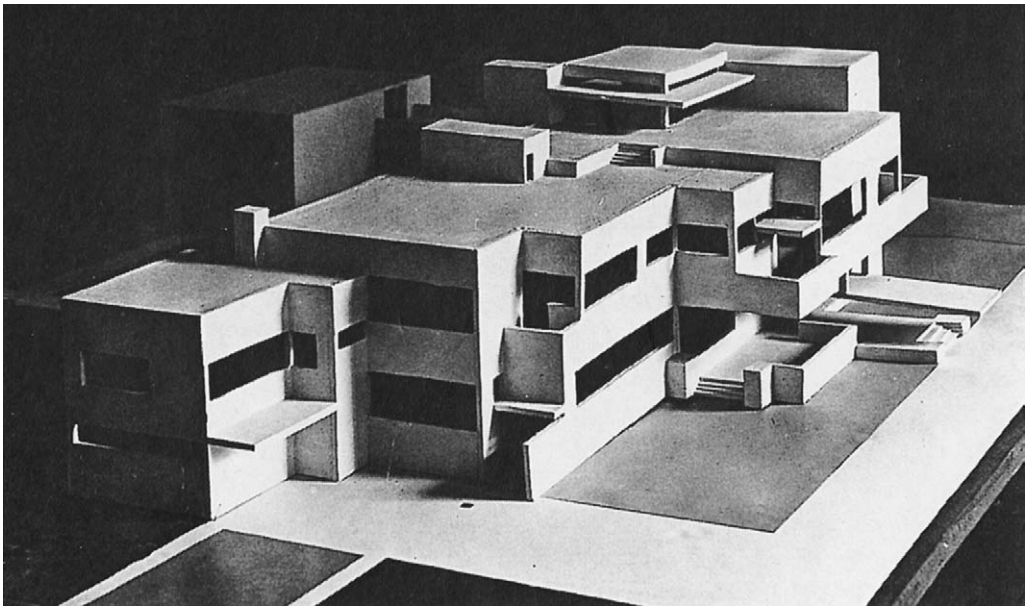
Gaston Bachelard earlier outlined an alternative and more nuanced understanding of changing paradigms. A chemist, philosopher, and historian of science, Bachelard is best known among architects for *The Poetics of Space*.[31] In another book, Bachelard proposes that new paradigms do not simply replace preceding ones; but instead, multiple paradigms coexist simultaneously in a nested relationship, one within another like the shells of a Russian matryoshka doll.[32] Old paradigms persist alongside new ones because of their ability to identify and give definition to the same phenomena in different settings. Bachelard explained that in ''the nesting of paradigms . . . two theories may belong to two different bodies of rationality and may oppose one another in certain points while remaining valid individually within their own body of rationality.''[33] For example, we describe the sun as setting when admiring the colorful sky, relying on the assumption that the sun rotates around the fixed earth, but when describing the universe, most of us also proclaim that the earth circles the sun, so the sun cannot in fact set. These two paradigms are mutually exclusive; yet, both are useful for different purposes. Similarly, despite the success of the Copernican solar-centric cosmology in astronomy, the old earth-centered Ptolemaic paradigm is invoked by architects whenever studying the solar orientation of a building by fixing it on an immobile earth about which the sun's movement is traced (Figure 8).[34] We daily operate within these sorts of mutually exclusive paradoxes that rarely become problematic precisely because the paradigms are nested into different aspects of our lives. Bachelard's alternative meta-paradigm of nesting allows a richer understanding of architectural design where multiple modes of thinking can coexist in the same project in different ways. Rietveld's mass model is best understood in this context.

Paradigms of Form and Mass

The words form and mass held different meanings for certain European and Anglo-American modern architects. In 1932, Henry-Russell Hitchcock and Philip Johnson proclaimed that the first principle of the international style is ''architecture as volume'' to emphasize the shape of a building rather than the mass of its walls. ''The effect of mass, of static



6. How to cut and fold cardboard models, Harvey Wiley Corbett (1922).



7. *Hôtel Particulier*, Theo van Doesburg and Cornelis van Esteren (1923). Model by Gerrit Rietveld. Lost. (Used with permission from The Instituut Collectie Nederland [ICN], Amsterdam, Netherlands.)

solidity, hitherto the prime quality of architecture, has all but disappeared; in its place there is an effect of volume, or more accurately, of plane surfaces bounding a volume.''[35] For Hitchcock and Johnson, mass is rejected as the remnant of past styles and ways of building where ''the massiveness of the architecture of the past was felt as gravitational.'' Whether actual or apparent, the notion of mass derived from traditional load-bearing masonry construction: ''being heavy, massive architecture demanded the appearance of support such as could be given by a piling up of the parts.''[36] Pile was the common name for a substantial late nineteenth-century building because of the stacking up of a huge mass of brick and stone. Indeed, the word construct literally means ''to pile together.''[37] A ''stately pile'' was thus a positive description of a building at the turn of the century.[38] With the international style, however, new structural systems make massive construction obsolete.

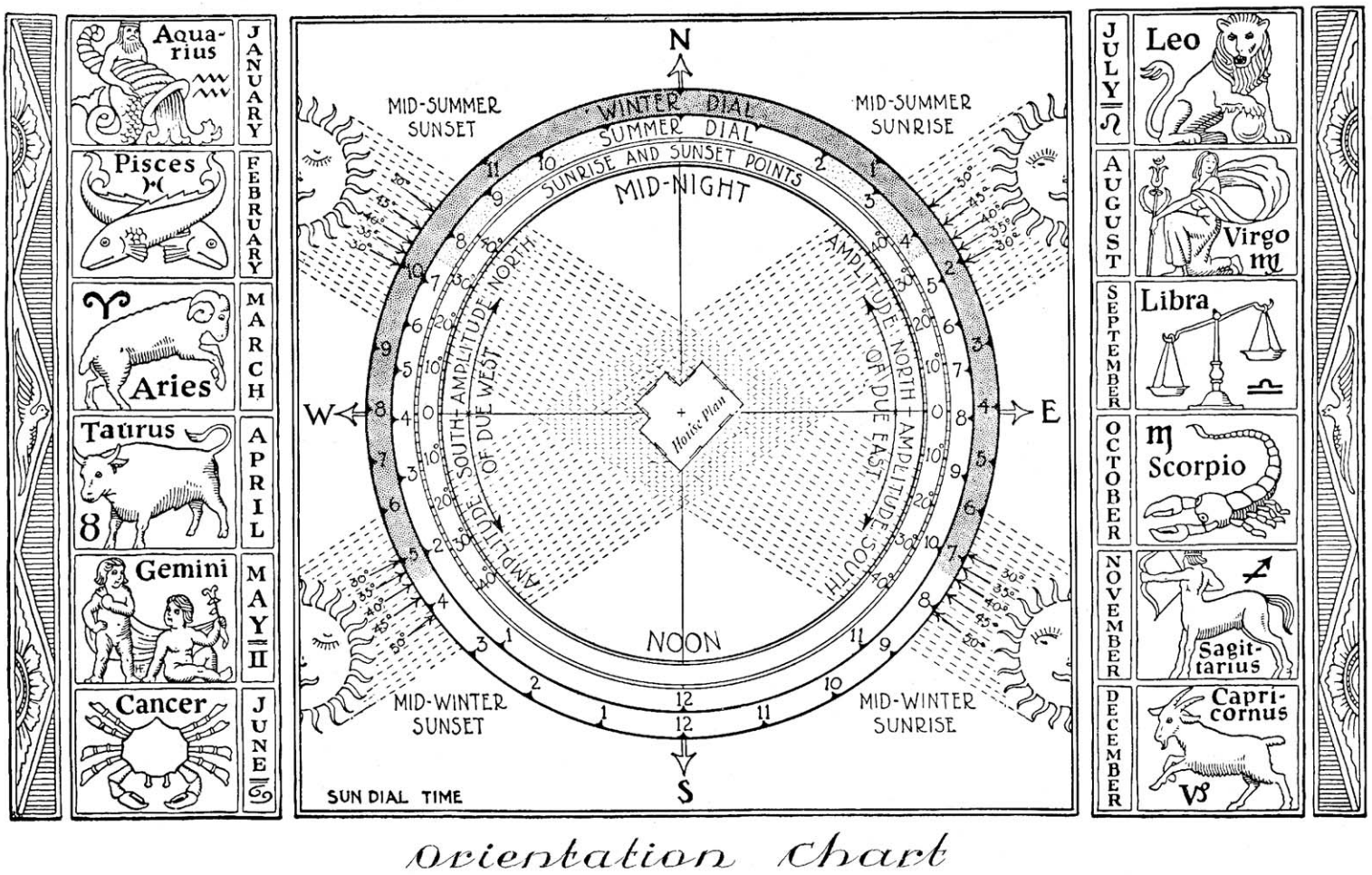
In traditional masonry construction, the walls were themselves the supports. Now the walls are merely subordinate elements fitted like screens between the supports or carried like a shell outside of them. The building is like a boat or an umbrella with strong internal support and a continuous outside covering.[39]

Hitchcock and Johnson rejected massive construction in favor of the freedom of form making suggested by new construction technologies where ''volume is felt as immaterial and weightless, a geometrically bounded space.'' The international style is promoted as the organization of form, use of available surface materials, and a handling of details that will increase rather than contradict the primary effect of volume. Hithcock and Johnson closely echo Le Corbusier in *Vers une architecture* (1927) that ''volume and surface are the elements through which architecture manifests itself'' where pure volume's formal immateriality is made present through material surfaces.[40] Form thus supersedes mass.

In planning the *Modern Architecture* exhibition at MoMA, Johnson originally requested that all the models be made of cardboard since, as he remarked, its materiality and ability to define volumes so closely mirrored that of international style architecture.[41] Frank Lloyd Wright also perceived a connection between modern European architecture and cardboard models:

> . . . Most modernistic houses look as though cut from cardboard with scissors, the sheets of cardboard folded or bent in rectangles with an occasional curved cardboard surface added to get relief.[42]

Among the architects included in the 1932 *Modern Architecture* exhibition were many that used plaster models in the design of their projects



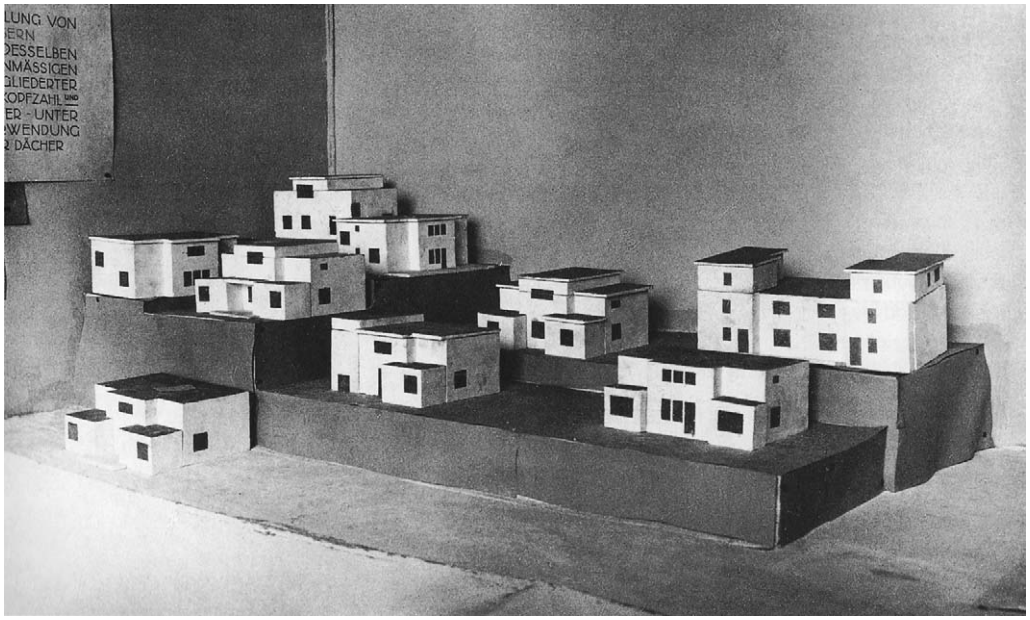
8. Orientation chart in *Architectural Graphic Standards*, Charles Ramsey and Harold Sleeper (1932). (Used with permission from John Wiley & Sons.)

including, to name only two, Le Corbusier and Walter Gropius (Figures 2 and 9). Paradoxically, the use of plaster mass models by the European architects selected for the exhibition indicates that Hitchcock, Johnson, and Wright's conceptions of international style architecture were not based upon actual modeling practices but instead indicated the emphatic American association of form with cardboard models. Perhaps Frank Lloyd Wright's critique of Le Corbusier's use of ''mass'' based upon Frederick Etchells' 1931 mistranslation of Le Corbusier's notion of volume is related to this confusion.[43] European mass modeling conventions, to which we now turn, coexisted with an increased use of cardboard modeling in England and the United States.

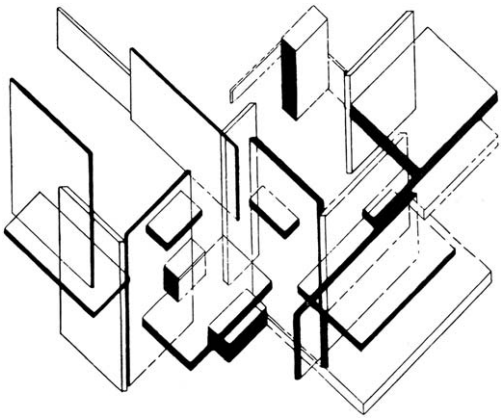
Ideas of form and mass in Europe were similar to their Anglo-American counterparts, although their associated values were opposed. Theo van Doesburg, who was close to Rietveld, rejected ''form'' as indicative of mere ''style,'' an ''aesthetic form type'' that is like a ''mould used by pastry-cooks'' because ''*form-ideas* imply a formulaic *predetermined type*.''[44] While Hitchcock and Johnson were pursuing a new style in notions of form and volume, van Doesburg rejected form for its reductive stylistic connotations. Instead, for a ''healthy development of architecture,'' van Doesburg advocated the ''suppression of all *form-ideas*'' and called for formlessness as a goal, writing ''the new architecture is formless, yet defined ....''[45] As an alternative to form, van Doesburg proposed mass, and identified the elements of architecture as ''plane, line, and mass'' (Figure 10). Yet, his concept of mass is not that of a material pile. ''In this manner architecture takes on a more or less hovering aspect . . . challenging the force of gravity in nature''; and thereby giving an entirely different interpretation to mass than Hitchcock and Johnson.[46] Van Doesburg rejected form for mass but not unambiguously. At times he claimed the new architecture ''destroys mass,'' while at other times he identified mass as a key component of the same architecture. To further explicate these concepts, we return to paradigms.

Paradigms, Again

Bachelard explained nested paradigms using different concepts of mass: naive size, Newtonian weight, and Einsteinian energy as three coexisting paradigms put to use in different situations. As the most youthful, the intuitive idea of mass is directly equated with size; allowing mass to be appreciated with the eyes. As Bachelard notes, ''for a greedy child the biggest fruit is the best . . . the notion of mass concretizes the very desire to eat.''[47] When we see two identical boxes, except one is large and the other small, we almost universally assume the larger box to be heavier. Architects use a similar intuitive approach when making mass models—that, like the uniform modeling material itself, architects project the volume as mass in a sort of naive realism. When dealing with other building



9. Plaster model of *Bauhaus Siedlungshäusern*, Walter Gropius (1921–1923). Unknown.



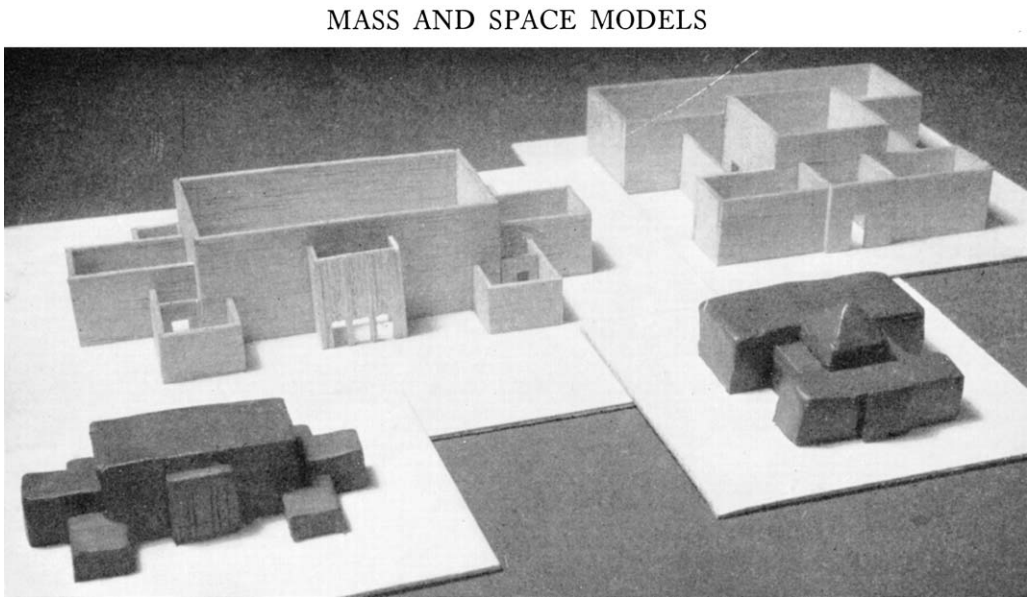
10. The elementary means of expression in architecture (*Die elementaren Ausdrucksmittel der Architektur*), Theo van Doesburg (1925). (Used with permission from The Instituut Collectie Nederland [ICN], Amsterdam, Netherlands.)

issues, like the sizing of columns in relation to building load, we consider mass in a Newtonian sense that emphasizes the unique weight of each material. At this level, according to Bachelard, ''mass correlates with prudent empirical usage and precise objective determination.''[48] But when considering advanced modern paradigms, we discuss mass in a relativistic sense of energy. Bachelard explains that after Einstein, ''the notion of absolute mass had no meaning with respect to space-time'' so that ''relativist mass is no longer different in kind from energy.''[49] All these theoretical approaches are optimized, each for their own purpose, giving us not a singular paradigm of mass, but nested theories, each of which is useful within its own realm. Words like mass can mean several different things in varied situations. Analogously, we may not have only one theory of architecture but multiple theories of architecture.

Models, Finally

The close relationship between modeling methods and conceptions regarding mass is well known. It is succinctly described and illustrated, as if self-evident, in a 1933 practical architectural design manual by Ernest Pickering: ''[Space models] . . . enable the student to study the *volumes* of the different units of the building and their relationship to each other [while] . . . small clay models show *mass* . . .'' (Figure 11).[50] For Pickering, enclosed space is a volume. Yet, Pickering is also typical in associating mass with form or volume: ''In an architectural discussion the accepted definition of form deals with shape. If a shape is . . . three-dimensional, it becomes mass. In architecture, mass is usually volume.''[51] Like Ptolemaic solar building analysis, the identification of mass with volume is a useful paradigm for modeling architectural designs despite its inconsistency with other uses of the same concept. For Bachelard, the simplest notion of mass is a direct relationship to size—the bigger something is the more mass it has. Just as we describe the sun as setting, we know that it is naive to treat mass as volume and yet we do so for certain situations. This notion retains its utility for the architectural imagination and explains why we continue to make mass models today because even though the construction of masonry mass wall is rare in North America, the myth of building volume as mass remains.

The apparent contradiction between Rietveld's solid wood mass model of the Rietveld Schröder house and the spatiality of the house itself can now be more fully understood through Bachelard's model of nesting paradigms. His wood mass model was not made before a paradigm shift of style but instead deliberately used the paradigm of form as mass to explore one aspect of the design. That the original mass model shows openings and walls almost exactly the same as the final design indicates that this was not merely an early, ill-formed version of the final project. Furthermore, Rietveld's cubic assembly of glass planes on top of the mass model clearly



11. Mass and space models, Ernest Pickering (1933). Unknown.

indicates that he was fully capable of creating the rest of the model in planar elements at that time.

The house's construction of fixed bearing walls out of brick applied another paradigm of mass, in this case the Newtonian concept of mass as weight. The appearance of floating planes is achieved through hidden contrivances of mass understood as different material weights. For example, the balconies were made of concrete to ensure a thin slab that in turn required a significant support of steel beams imbedded into the concrete and secured by bolts to the wood floor joists.[52] At the same time, Rietveld's spatial notion of Einsteinian space-time or mass as energy allowed him to conceive of the complex planar relations of the house. As seen earlier, van Doesburg's writings used the term mass in apparently inconsistent ways, but since they were applied in separate senses, this was not contradictory. For van Doesburg, and by extension Rietveld, the new architecture's claim ''to destroy mass'' assumes mass naively as volume while their embracing of mass as positive conceives of mass as Einsteinian energy. Rietveld's apparently contradictory use of a solid wood model for his house design is easily understood when using different paradigms for different situations. All three of the paradigms of mass—volume, weight, and energy—were thoughtfully nested together by Rietveld and applied simultaneously, but in different situations during the design process to create this inspired edifice.

If the architect's task is to make visible the invisible, then the immaterial is inevitably present.[53] Rather than paradigm shift historical analysis, nested paradigms allow richer insight into the architectural imagination and greater awareness of the complexity of the intermixing of ideas and materials through modes of representation. Architectural meaning is produced by the presence of immaterial ideas nested within their material interpretation. Rietveld's lewdly painted wooden model is, after all, a chiasmic manifestation of its paradigms—the painting of colored planes is an illusion on the body of the constructed wooden core. The model has a powerful material presence allowing the architect to feel all with his hands. Yet, the relationship of the material to the immaterial, in the designer's creation of the architectural microcosm, remains an enigmatic chiasm where opposites cross their boundaries: the paradigm of models is a model of paradigms.

Notes

1. There is evidence for architectural design models since the 12th Dynasty in Egypt (1991–1759 BCE). Corinna Rossi, *Architecture and Mathematics in Ancient Egypt* (Cambridge: Cambridge University Press), pp. 128–39. Lothar Haselberger, ''Architectural Likenesses: Models and Plans of Architecture in Classical Antiquity,'' *Journal of Roman Archaeology* 10 (1997): 77–94. Franz Bischoff, ''. . . das verkleinert opus recht vor Augen gestellt: zur Geschichte und Bedeutung des Architekturmodells von der Frühzeit bis zur Gegenwart,'' in Werner Helmberger and Valentin Kockel, eds., *Rom über die Alpen tragen: Fürsten sammeln antike Architektur: die Aschaffenburger Korkmodelle* (Landshut/Ergolding: Arcos Verlag, 1993), pp. 32–45. Albert Smith, *Architectural Model as Machine: A New View of Models from Antiquity to the Present Day* (Burlington, MA: Architectural Press, 2004).
2. Matthew Mindrup, *Assembling the Ineffable in Kurt Schwitters' Architectural Models* (Virginia Tech: Ph.D. Dissertation, 2007).
3. Nelson Goodman, *Ways of Worldmaking* (Indianapolis, IN: Hackett, 1978).
4. Aristotle, *Physics*, Robin Waterfield, trans. (Oxford: Oxford University Press, 1996), p. 38. Emphasis in original.
5. Leon Battista Alberti, *On the Art of Building in Ten Books*, Joseph Rykwert, Neil Leach, and Robert Tavernor, trans. (Cambridge: MIT Press, 1988), p. 34.
6. J. J. Coulton, *Ancient Greek Architects at Work: Problems of Structure and Design* (Ithaca: Cornell University Press, 1977), pp. 55ff.
7. Aristotle, *Physics*, Robin Waterfield, trans. (Oxford: Oxford University Press, 1996), p. 39; *Metaphysics*, Richard Hope, trans. (Ann Arbor: University of Michigan Press, 1960), p. 29.
8. Johannes Kepler, *Mysterium Cosmographicum, The Secret of the Universe*, A. M. Duncan, trans. (New York: Abaris, 1981 [1596]).
9. Plaster architectural models were widely used by graduates of the École des Beaux-Arts across France and the United States and were also used by Antonio Gaudi in Spain, by Kasmir Malevich in Russia, and in numerous other practices.
10. Maurice Gauthier, ''Studying in Three Dimensions,'' *Pencil Points* 7 (July 1926): 410–411. Royal Rook, ''Model Making in the Drafting Room,'' *The American Architect* 117 (August 1918): 250. Margaret J. Postgate, ''Architectural Models from Bar Soap,'' *Pencil Points* 10 (June 1929): 392–96.
11. Philip McDonnell, ''Models and Their Making,'' *The American Architect* 107 (May 1915): 282. Eugene Clute, ''Models, Their Making and Their Use,'' in *Drafting Room Practice* (New York: Pencil Points Press, 1928), pp. 56–62.

12. Mass models are pictured in numerous projects between 1920 and 1923 in *Frühlicht* edited by Bruno Taut. Other plaster models from the same time period include Le Corbusier's *Citrohan House* and *Villa La Roche,* Walter Gropius' *Einfamilienhaus* (Single Family House) and *Chicago Tribune Tower Competition,* and plaster and clay models of Hans and Wassili Luckhardt's *Königliches Opernhaus Berlin* (Royal Opera House in Berlin), *Formspiele* (Form Play), and *Volkstheater* (People's Theater).
13. Perhaps the earliest mixing of models and paradigms was architecture's influence on Anaximander's Pre-Socratic world map. Robert Hahn, *Anaximander and the Architects: The Contributions of Egyptian and Greek Architectural Technologies to the Origins of Greek Philosophy* (Albany: State University of New York Press, 2001).
14. Theodore M. Brown, *The Work of G. Rietveld Architect* (Utrecht, The Netherlands: A.W. Brauna and Zoon, 1958), p. 13.
15. Marijke Küper and Ida van Zijl, *Gerrit Th. Rietveld 1888-1964: The Complete Works* (Utrecht: Centraal Museum, 1992), pp. 59–75.
16. Ibid., pp. 83–97.
17. Brown, p. 39.
18. El Lissitzky, ''Architecture, Housing Culture,'' *Stroitel' naia Promyshlennnost*, no. 12 (December 1926): 877–81; quoted with translation by Prof. J.E. Kurland in Brown, p. 58.
19. The house is currently operated by the Rietveld Schröder House Foundation and has been open to the public since 1987. Bertus Mulder and Ida van Zijl, *The Rietveld Schröder House*, Lynn George, trans. (New York: Princeton Architectural Press, 1999).
20. Ibid., p. 98.
21. Rietveld later built a second model of cardboard, glass, and matchsticks that was unfortunately destroyed. Paul Overy et al., *The Rietveld Schröder House* (Wiesbaden: Vieweg, 1988), p. 33, n. 42.
22. Mildred Friedman, *De Stijl: 1917–1931, Visions of Utopia* (Minneapolis: Walker Art Center, 1982), p. 143.
23. Ibid., p. 143.
24. Hans Reuther, ''Wesen und Wandel des deutschen Architekturmodells,'' in Ekhart Berckenhagen and Hans Reuther, *Deutsche Architekturmodelle: Projekthilfe zwischen 1500 und 1900* (Berlin: Deutscher Verlag für Kunstwissenschaft, 1994), pp. 12, 15–18.
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