THE THERMOHELIODON

by Daniel Barber

Climatic architecture at the end of calculation.

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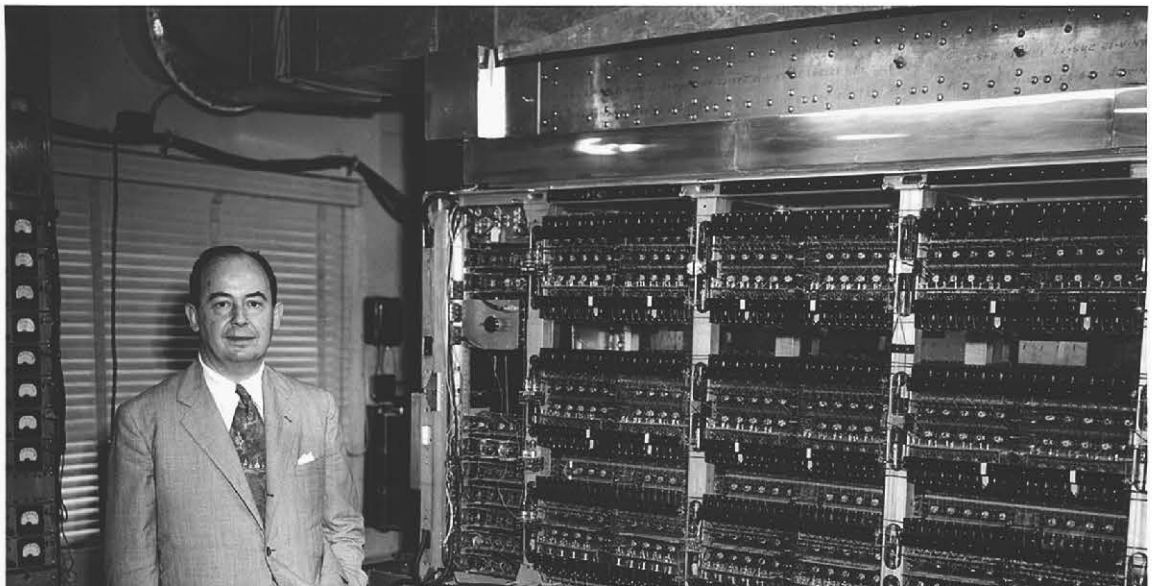
The first attempt to conceptualize climate as a system of data inputs and predictive outputs was through imagining a new kind of building. The amateur meteorologist Lewis Fry Richardson, while driving for a Friends' Ambulance Unit attached to the French army during World War I—and after years of experiments with solving partial differential equations—conceptualized a building with a domed cap that had a map of the globe painted on its interior. Below the dome, looking up at it and arranged in seating similar to that of theater boxes sat hundreds of "computers"—men and women, staring up at their specific quadrant. With data received through telex, Richardson's hypothetical "computers" were able to calculate changes in wind, temperature, humidity, and other factors within their quadrant, and in dialogue with changes being observed and calculated by their neighbors. In Richardson's fantasy, the strain of all this data was such that his "computers" would not be able to process the data any faster than changes in the weather were actually occurring—it was more of a rich record of the past than a prediction of the future.

Though the building was never constructed, and would not have worked anyway, a number of innovations were indicated. Richardson's method involved partitioning space into rectilinear cells, assuming that the variables were constant within a cell, and then solving the equations by replacing derivatives with ratios of finite differences. [1] Rather than solving a set of equations, he prescribed a set of dynamic and interactive relationships. The impact of this method, Paul Edwards has recently explained, is to reduce calculus to arithmetic: instead of a complex calculative matrix, dependent upon the precision of a specific method, a script that processes data, dependent for its accuracy on the quantity of data and the conceptualization of interrelationships between data points. Though so-called "numerical" methods can also only produce approximations, they can do so quickly, at a reasonably fine scale, and according a range of factors. [2]



John von Neumann with the ENIAC computer, Princeton University Institute for Advanced Study, c. 1947.

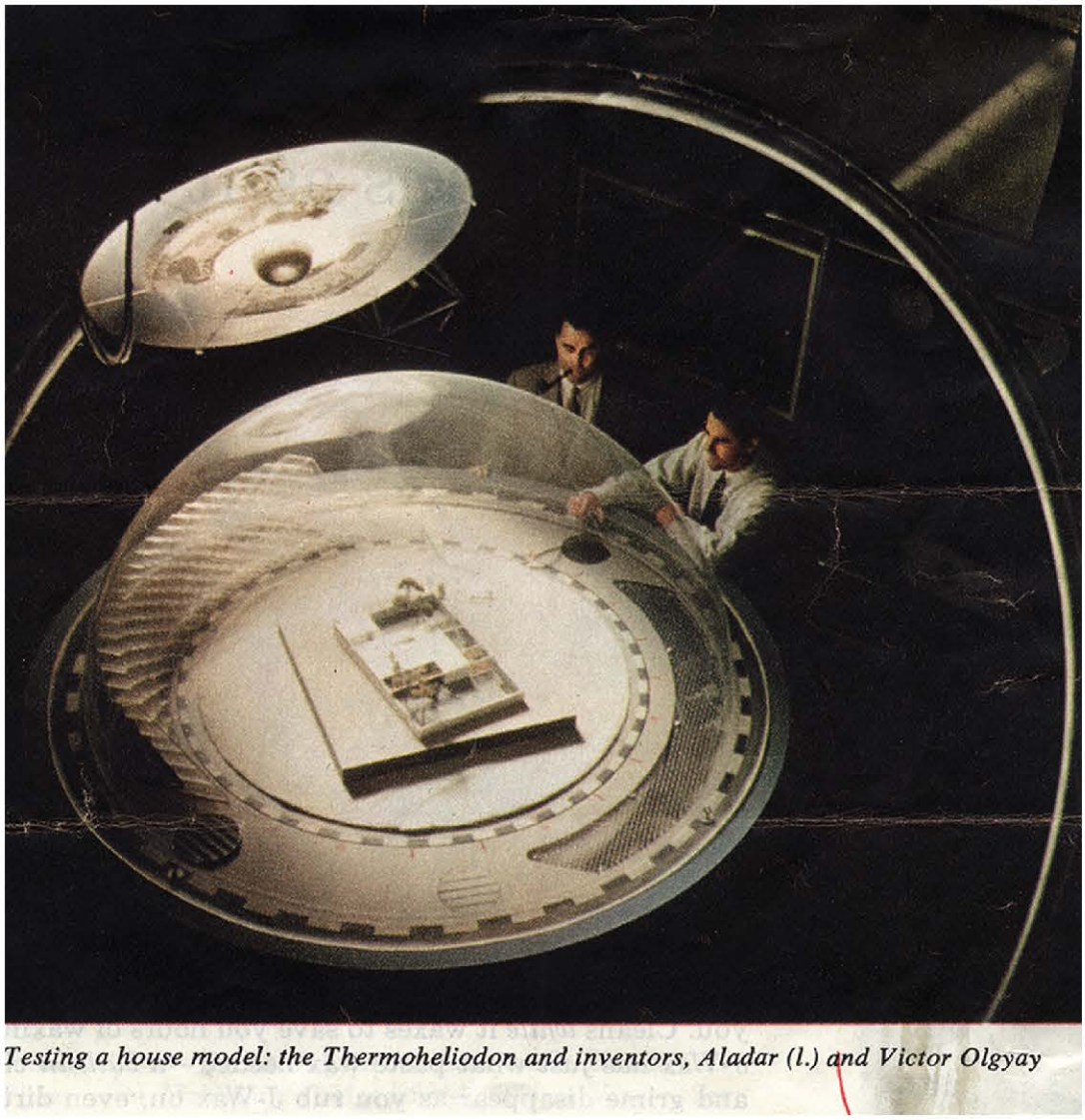
It would take some time for this shift—from calculation to computation—to have any effect on related investigations into the characteristics of atmospheric changes. After World War II, the science of meteorology was becoming climatology; by then burdened by a number of expectations, from crop management to cloud seeding to facilitating international air travel and toward a range of possible military applications, the field computerized more completely. Essential here was the "Meteorology Project" directed by the mathematician John von Neumann from the late 1940s, using ENIAC computers at the Princeton Institute for Advanced Studies to determine the viability of numerical methods —the processing of massive amounts of data—as a means to predict the weather. [3]

At some distance conceptually, though just around the corner at the Princeton Architectural Laboratory, researchers were also attempting to engage climate knowledge. The architectural interest in predicting the climatic performance of a building in the 1940s and early '50s was rich and diverse and was held together as a method by virtue of being based on modeling the movement of the sun. Based on observation of the model, architects calculated the relationship of the sun to correlate to the orientation, shading devices, and materials of the building. [4] It was not a numerical method, based on processing large amounts of data; it was relational and experiential. Heliodons and other modeling devices, while rich in data, ultimately relied on abstract equations and full-scale models to understand how a building would perform.

The Jean Labatut–designed Princeton Architectural Laboratory, consisting of an old stable building and a glass-framed addition. Note the glass dome in the center left of the image, where the Olgyays performed a number of their initial analyses. Photograph courtesy of Princeton University School of Architecture Archives, Jean Labatut Collection.

At the Princeton Architectural Laboratory, these calculative attempts reached a zenith in the mid-1950s. Of interest here are the methodological studies and climate modeling devices of Victor and Aladar Olgyay. Hungarian architects trained as modernists before emigrating to the U.S. right after World War II, the Olgyays spent their professional career exploring methods for adjusting the architectural design process to better assess the relationship between a building and its climatic surrounding. They taught at MIT and Princeton. Their two books, *Solar Control and Shading Devices* (1957) and *Design With Climate: A Bio-Climatic Approach to Architectural Regionalism* (1963), entered into the curricula of architecture schools and sat on the reference shelves of design firms around the world well into the late 1970s. [5] In the immediate postwar period, before mechanical heating, ventilation and air conditioning systems became affordable and widely available, the Olgyays were the preeminent researchers into methods for using architectural means to place a building in its climate.

Their major project at the Architectural Lab, funded by the National Science Foundation, was the design, construction, and testing of the Thermoheliodon device. It was intended as an improvement on the familiar heliodons. The Thermoheliodon was developed in order to make a significantly more detailed model of the climatic world available to the designer. It modeled the arc of the sun; it also had a set of fans behind an adjustable screen to account for wind direction. There was a shallow pit in the middle where soil from the building site was to be placed. Humidity was controlled by the jets.



Testing a house model: the Thermoheliodon and inventors, Aladar (l.) and Victor Olgyay

The Olgyay brothers with the Thermoheliodon device at the Princeton Architectural Laboratory. From *Collier's* magazine, June 1956.

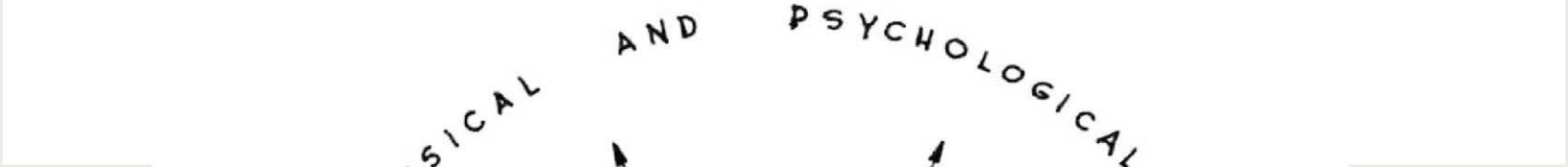
A building model was constructed and placed in the center of the device and then subjected to a number of tests, based on a remarkable amount of data about a given building site. Much of the Olgyays's work was in consulting, and the Thermoheliodon was

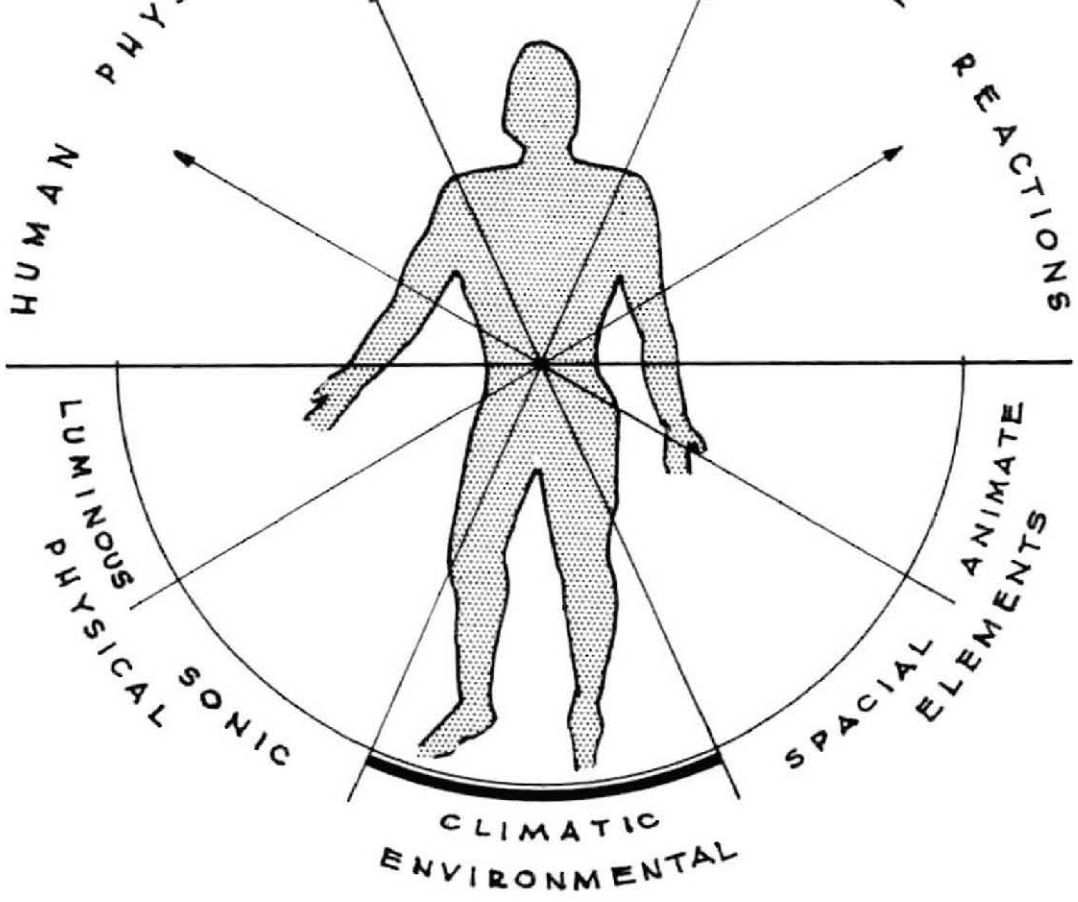
used for their assessment of Josep Lluis Sert's Peabody Terrace, Breuer's UNESCO building, Gropius's plans for the University of Baghdad, and many other projects; they also built a number of houses around Princeton. Long-term seasonal effects were explored, assisted by a number of movable trees. The device, along with the Olgyays's well-developed climatic calculation method, led to a remarkably dynamic system of adaptive and efficient building. Intricate shading systems—louvers, eaves, trees, interior shades, the strategic placement experience of thermally active materials—from masonry to chemically active phase-change heat storage containers, and a very careful attention to the relationship between solar orientation, volumetric relations, and materials, characterized their method and the buildings they worked on. The Thermoheliodon was central.

A problem had developed early on, however, that compromised the effectiveness of the device. The buildings the Olgyays inserted into the device were tested for shape and orientation, but the internal climatic conditions could not be adequately monitored because of the difficulty of scaling up the thermal capacity of materials—a small brick operates very differently, in thermal terms, than a large brick. The modeling of the radiation of stored heat was also difficult to model at scale. A significant portion of the grant report focused on their attempts to develop the right scaling formulas; it reads almost as an extended lament expressed in calculus—an implicit longing for a numerical method to predict a building's performance. When seeking continued funding, they proposed to build identical test houses in Princeton, Montreal, and Los Angeles and to maintain constant data analysis of these test sites as a means to constantly adjust their calculative matrix according to the recent historical record. [6] Their funding was not renewed.

What, exactly, was being tested in the Thermoheliodon experiments? What can be read into the distinction between calculative and computational methods for understanding climate patterns? At stake for the Olgyays, as much as increased knowledge of the climate system itself, was how a building could provide for the increased comfort of the modern subject. They participated here in a wide-ranging interest in humanism after the war—architecture, they hoped, could produce a static, refined condition of climate balance so that the occupant, at home or at work, could best realize their human potential. In the plans and sections, and diagrams and charts, that they produced, the subject is central—literally, rendered in the middle of images intending to illustrate the challenges and benefits of a climatic architectural approach, and conceptually, as the image of the new ways of living that these architectures could allow.

"Man," Victor Olgyay wrote, "with his intimate physical and emotional needs, remains the module—the central measure—in all approaches. The success of every design must be measured by its total effect on the human environment." [7] Versions of these diagrams appear all over the Olgyays's writings—similar drawings, with figures in the center, also form the diagram of other architects, sociologists, and physiologists looking at these problems. They accompany the Olgyays's methodological proposals, serving both to illustrate the method itself and to clarify that their project is to produce a universal comfort zone, a designed condition that protects the subject from climatic imbalance. Posed in these drawings is an autonomous, rational, and effectual subject—not only an inhabitant safe from changes in the weather but also an architectural subject effectual enough to understand these intricate climatic relationships and develop the right formulas, the right methods, and construct a building accordingly. [8] Posed as well in their method is a static relationship between human and natural systems, an architectural aspect of the psychoanalyst Erich Fromm's contemporaneous proposal for a "Science of Man," a set of applied principles that would lead to a stable condition between the anxieties of society and the bounty of nature, a relationship rendered static through the intervention of a well-considered architecture.





Victor Olgyay, "Man as the Central Measure" from Design With Climate, 1963.

These diagrams suggest that the transformation from calculation to computation—from the engagement of human knowledge as formula to the processing of data through scripts and algorithms—was a complicated one, with strains and anxieties that resonate across a broader spectrum of analysis and inquiry. In climatology, ecology, and other emerging fields of environmental analysis, conceptions of a human-centered world, and of balance and harmony more generally, were being upended and updated. Which is to say, if the building was going to produce a static comfort zone, it was to be through a conflict, rather than a collaboration, with the natural forces that surrounded it—forces that were increasingly understood as chaotic, unpredictable, and contingent. [9] At stake, more than a specific set of design or material variables, were the continued relevance of the modern subject as the object of architectural intervention and as the agent of historical change. It was precisely this conception of the human that would lead to a counter-theory of the disappearance of the human in the period, perhaps most aggressively in the philosophical discussions spurred by Louis Althusser and his insistence that "Man is an irrational, derisive, hollow notion...a vain, empty discourse that is in essence the diversionary tactic of a reactionary ideology." [10] Pretty definitive.

This connection, between the disappearance of man and the emergence of climate as an object of multivalent analysis, also helps to clarify more recent discussions of climate, climate change, and historical agency. One of the most effective interventions in this recent discussion has been the introduction of the term Anthropocene to describe our current era as one in which humans have become "geological agents." As Ursula Heise has recently put it: "We have always been biological agents...but we've not had the collective power to actually transform the basic...climatic structures of the planet" until recently. [11] The real crisis of the Anthropocene, as Heise also points out, is that while humans have attained geological agency and produced, through persistent atmospheric emissions, a serious threat to the continuation of our species, we have also demonstrated a relative lack of social and political collective power to respond to, mitigate, or mediate this condition. As a species, we are simultaneously exhibiting agency and impotence—central actors in this new geological age while slowly, helplessly, disappearing within it. In the end, like Richardson's computers, we aspire to an architecture that can articulate new relationships between human desires and natural systems only to find ourselves to be links in a chain. Anthropocenic subjects are now constantly being tested—every moment

is an opportunity to measure climatic risk—while also operating as test subjects, processing units to clarify and render actionable—possibly through new architectures—our increasingly specific knowledge about the changing climate.

1. Frederik Nebeker, *Calculating the Weather: Meteorology in the 20th Century* (New York: Academic Press, 1995), 64. ^

2. Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010), 94–96. ^

3. See Nebeker, *Calculating the Weather*, 135–142. ^

4. Some examples of this broader interest in architecture and climate in the period include the *Climate Control* series of articles in *House Beautiful* running from 1949 to 1951, a series of studies and conferences supported by the Building Research Advisory Board of the National Science Foundation, as well as Jeffrey Ellis Aronin, *Climate and Architecture* (New York: Reinhold, 1953) and Groff Conklin, *The Weather-Conditioned House* (New York: Reinhold, 1958). Richard Neutra's wartime research in Puerto Rico is also relevant; see Richard Neutra, *Architecture of Social Concern in Regions of Mild Climate* (Sao Paulo: Gerth Todtmann, 1948). ^

5. Aladar and Victor Olgyay, *Solar Control and Shading Devices* (Princeton, NJ: Princeton University Press, 1957) and Victor Olgyay, *Design With Climate: Bioclimatic Approach to Architectural Regionalism* (Princeton, NJ: Princeton University Press, 1963). ^

6. Victor Olgyay, "Report on the Thermoheliodon, Laboratory Machine for Testing Thermal Behavior of Buildings Through Model Structures," submitted to the National Science Foundation, June 1956. ^

7. Olgyay, *Design With Climate*, 17. ^

8. Michael Leja, *Reframing Abstract Expressionism: Subjectivity and Painting in the 1940s* (New Haven, CT: Yale University Press, 1993), 8. ^

9. See Michael G. Barbour, "Ecological Fragmentation in the Fifties" in William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature* (New York: Norton, 1995): 233–255. ^

10. Louis Althusser, "The Humanist Controversy" in *The Humanist Controversy and Other Writings* (New York: Verso, 2001), 271. See also Erich Fromm, editor, *Socialist Humanism: An International Symposium* (New York: Doubleday, 1955). ^

11. Max Fox, "How to talk about the Weather: Interview with Ursula Heise" in *The New Inquiry*, January 7, 2013; http://thenewinquiry.com/features/how-to-talk-about-the-weather/, accessed February 13, 2013. ^

Daniel A. Barber is an Assistant Professor at the University of Pennsylvania, where he teaches the history of modern architecture. His research explores relationships between design fields and the emergence of global environmental culture during the 20th century. Articles have recently been published in *Grey Room* and *Technology and Culture*.