CALCULATION AND RISK: THE RATIONAL TURN

IN WEST GERMAN ARCHITECTURE

Daniela Ursula Fabricius

A DISSERTATION

PRESENTED TO THE FACULTY

OF PRINCETON UNIVERSITY

IN CANDIDACY FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

RECOMMENDED FOR ACCEPTANCE

BY THE DOCTORAL PROGRAM IN ARCHITECTURE

IN THE SCHOOL OF ARCHITECTURE

Advisor: Spyros Papapetros

January 2017
Abstract

This dissertation follows the rise and decline of what I call the “rational turn” in West German architecture between the 1950s and ’80s. This new engagement with scientific methods emerged from the ethical and political concerns formed in West Germany’s postwar intellectual culture, including the Frankfurt School, the Darmstädter Gespräche, and the Ulm School for Design. What began as “good form” developed into the assignment of ethical values to practices based on measuring and calculating, in the hope that this could mitigate the effects of new risks that emerged with modern industrial culture.

However, as I argue, this “second-order” rationalism was from the beginning characterized by contradictions and ethical uncertainties. With the declining legitimacy of Verwissenschaftlichung (scientization) after 1968, architectural rationalism progressively mutated into a form of excess that can only be described as irrational. Examples include a preoccupation with economy as seen in the model experiments and systems of measuring and classifying structures of Frei Otto at the Institute for Lightweight Structures. These experiments with soap films and other nonstandard materials consistently resulted in incalculable forms (like those of the Pneu), excessive calculation (as in the notion of the Bic), and new types of structural risk. I also examine the work of Oswald Mathias Ungers and his students at the TU Berlin, who in Berlin 1995 experimented with calculation (and computation) to try to simulate and predict urban futures. In Ungers’s later theoretical and built work repetition and seriality
transformed from tools used for mass production to purely formal games without economic or functional concerns.

I demonstrate how these repetitive and delirious exercises in architectural rationalism revealed the futility of calculating reason. In contrast with the utopian uses of rationalism in early modernism, I characterize these exercises in calculation as melancholic, in the spirit of Albrecht Dürer’s allegory. Following this trajectory from the 1950s to the ‘80s, I hope to shed light on the question of why West German architecture continued to be invested in rationalism even after rationalism’s ethical calling and functional imperative had been denounced.
For my father,
Walter Fabricius (1937-2009),
who taught me both Leichtigkeit and Vernunft.
Acknowledgements

This dissertation was written between several places, especially New York, Princeton, and Germany, and I would like to acknowledge the personal and professional support I received along the way.

I was lucky to have worked with three exceptional scholars from the inception of this project. I have admired Reinhold Martin since I was his student sixteen years ago, and continue to do so for his combination of pessimistic intelligence and optimistic will. I met Brigid Doherty before coming to Princeton and remember feeling electrified by her intellectual intensity, as I still do today. She has been an exceptional and supportive mentor of great warmth and integrity, and I am also grateful to her for inviting me to participate in the Program in European Cultural Studies at Princeton. My gratitude above all goes to my advisor, Spyros Papapetros, who makes me wish I were not finished with this dissertation as working with him has allowed me a glimpse into a most original and joyful intellect. He has shown the greatest dedication and unusual generosity in supporting me not only in this dissertation but also every aspect of my professional life while under his guidance.

This work would not have been possible without the institutional home provided by the School of Architecture at Princeton, and I am grateful to Beatriz Colomina for her spirited leadership of the Ph.D. program. I also owe a great deal to the German Department, and the discussions and seminars I benefited from there. My thanks to Thomas Levin, Josef Vogl, Arnd Wedemeyer, Nikolaus Wegmann, and Sigrid Weigel. An especially warm thanks to Michael Jennings.
For his generosity I thank Jasper Cepl, whose knowledge of Ungers’s work is unparalleled. For conversations and Berlin adventures I thank Nikolaus Kuhnert and Hartmut Frank. I also benefited from conversations with Jörg Pampe, Arthur Ovaska, Werner Goehner, Reinhard Butter, and Jürgen Hennicke. I am especially grateful to Berthold Burkhardt and Michael Wegener for their warm hospitality and generous access to their personal archives.

I was able to pursue this research with the support of the Whiting Doctoral Fellowship in the Humanities. I also benefited from the support of the German Academic Exchange Service (DAAD) Research Fellowship, and my gratitude goes to Carsten Ruhl and the Bauhaus University Weimar for hosting me. Finally, I would like to acknowledge the support of the Canadian Center for Architecture’s CCA Collection Research Grant.

I am grateful for the numerous opportunities I have had to publish, exhibit, and present parts of this dissertation. Here I would like to especially thank Sonja Hildebrand, Elisabeth Bergmann, Daniel Barber, Nathalie Bredella, and Carolin Höfler for their insightful feedback.

I would also like to acknowledge the archives where I did my research, and those who patiently offered help there. A special thanks to Angelika Petruschat of Form+Zweck, Dr. Irina Schwab at the TU Berlin Universitätsarchiv, Anja Sieber-Albers and Sophia Ungers at the Ungers Archiv für Architekturwissenschaft, and Christian Assenbaum and Gabriela Metzger at the ILEK.
I am grateful to my colleagues and friends at Princeton, who brought humor, ideas, and sound advice to this process. I am also lucky to have had the help of Paula Woolley and her careful edits.

I also thank my family and friends in Germany, especially my grandmother Hildegard ("Mutti"), who welcomed me in her Frankfurt home during my frequent trips. I am also grateful to Louise Hirsch, Ida Schildhauer, Walter and Virginia Schildhauer, Lisa Oppenheim, and Lena and Charlie Guimont for their hospitality and friendship.

I am in so many ways in debt to Sanford Kwinter, from whom I borrowed a book on Max Weber two decades ago, which I still have.

My mother was born in Frankfurt and my father in Berlin. They met in Frankfurt and left Germany in 1976. The events and histories in this dissertation served as the backdrop to the lives they lived before my arrival into this world. I would like to thank my mother, who is the most energetic person I know, for her unwavering support and help, especially in the crucial final moments.

My final and most inexpressible gratitude goes to my two loves, Ben and Theo.
List of Archives Consulted

Bauhaus-Archiv
Ernst-Bloch-Archiv
HfG-Archiv Ulm
ILEK Archiv
Institut für Stadtgeschichte Frankfurt
Johann-Gerhard Helmcke papers, Staatsbibliothek zu Berlin
Max Horkheimer papers, Universitätsbibliothek, Goethe Universität Frankfurt am Main
Südwestdeutsches Archiv für Architektur und Ingenieurbau
Theodor Adorno papers, Akademie der Künste Archiv
TU Berlin Universitätsarchiv
TU Stuttgart Universitätsarchiv
Ungers Archiv für Architekturwissenschaft
Werkbundarchiv
# CONTENTS

Abstract  
Acknowledgements  
List of Archives Consulted  

Preface  

INTRODUCTION: Rationality without Reason  

PART ONE: CALCULATION, ETHICS, AND THE HUMAN  
I. Can the Human Be Measured?  
II. After *Gute Form*: Design and Calculation  

PART TWO: CALCULATING THE MINIMAL  
I. An Economy of Forms  
II. Thresholds of Calculation  

PART THREE: PREDICTION, REPETITION, RATIO  
I. Calculating the City: Prediction and Simulation in Berlin, 1968  
II. Ratio and Repetition  
III. The Square: With and Against Ratio  

EPILOGUE: FRANKFURT
Reflecting on the catastrophic condition of the world in 1944, Theodor Adorno and Max Horkheimer famously concluded that what they called enlightenment – the domination of nature through knowledge – had led not to reason (Vernunft) but to a barbarous irrationalism. In spite of this moment of reckoning, for many postwar West German architects the return to reason and rationality would serve as a corrective to the irrational and mythical ideologies of fascism and the resulting bombastic architecture. For these architects, a new defense of reason seemed the most fitting response to the physical ruins of the war, and the dramatic existential needs that arose with them.

Architectural rationalism – the application of scientific and logical principles to making form – was thought to avoid the arbitrary will of the architect in favor of an alignment with economic, social, and even biological needs. Suspicious of decisions made by humans, architects turned to the apparent intelligence of the world of nature and complex phenomena, borrowing experimental methods from different sciences – especially biology, systems theory, and cybernetics – and applying them to architectural objects.

---

1 Architectural historian Wolfgang Pehnt characterized the scientization of West German architecture in the mid-1960s as follows: “Intuitive form-finding . . . was suspicious from the outset. Planning should be based on the stable ground of science, subjective decision-making should be replaced by the calculated evaluation of all parameters, and the 6B pencil should be replaced by the now available computer system.” (“Intuitive Formfindung . . . war von vornherein verdächtig. Planung sollte auf den stabilen Grund der Wissenschaft gestellt, die subjektive Entscheidung durch rechnerische Bewertung aller Parameter, der 6b-Stift durch die nun verfügbare Rechneranlage ersetzt werden.”) Wolfgang Pehnt, Deutsche Architektur Seit 1900 (Munich: Deutsche Verlags-Anstalt, 2005), 375. All translations are mine unless noted otherwise.
This new political, social, and formal engagement with scientific methods by architects in West Germany is what I call the “rational turn.” This “rational turn” was of course also a return, a reframing of tools and methods that had been developed over the course of the twentieth century: in military research and development during World War II, both in Germany and the United States; in the architectural and urban planning projects of rationalists in the 1920s and ’30s; and in the scientific management of labor, government, and industry at the end of the nineteenth century. The shift that I describe here, which began in the early 1960s, was defined to some extent by architects’ adoption of new scientific knowledge, but more importantly, by a changed set of values – ethical, cultural, and political – around rationalism. It is difficult to imagine how rational and scientific methods could have been reclaimed after Adorno and Horkheimer’s devastating critique. It thus comes as no surprise that, as I will demonstrate in this dissertation, this “second-order” rationalism was from the beginning characterized by contradictions and ethical uncertainties. With the emerging conditions of a postmodern culture in the 1970s that was suspicious of scientific knowledge, architectural rationalism was unable to sustain its legitimacy, and progressively mutated into a form of excess that could only be described as irrational.

This dissertation investigates an intensified and contradictory form of rationalism that often exceeded the boundaries of reason. This is rationalism without reason in both meanings of the word: without judgment but also without justification or purpose. I will look at architectural examples that suggest that postmodernism was characterized by a transition not only from a rational to a post-rational culture, but also to a hyper-rational
one. Ulrich Beck, Anthony Giddens, and Scott Lash describe this condition as a “reflexive rationality,” where the damage caused by rationalization (environmental, social, and otherwise) is managed, paradoxically, by intensified technological means.² The rigid boundaries established by architects in the 1950s and ‘60s, which had separated the rational from the irrational and reason from emotion, were destabilized during the 1970s and ‘80s. This late rationalism that persisted in architecture became a purely formal game, characterized by futile and often delirious exercises in repetition. In contrast to the utopian uses of rationalism in early modernism, I characterize these self-referential games as melancholic.

Architectural rationality was exercised primarily through calculation (Kalkül): the translation of things into numbers, and the desire for life, events, and the human environment to be calculable. The instrumental use of calculation had been central to Max Weber’s theory that the rationality of modern Western capitalism was “dependent on the calculability of the most important technical factors.”³ For Adorno and Horkheimer, the power of calculation and numerical language was also an integral part of the problem of rationalization: “number became enlightenment’s canon.”⁴ In this dissertation, the use of calculation as a method of creating and representing architectural and urban space will be central. As examples, I will discuss Frei Otto, who tried to measure and calculate the structural properties of material objects found in

---

nature, armed with mathematical formulas and an array of scientific instruments; and Oswald Mathias Ungers, who together with his students, used information and systems theories to model complex social and economic behavior and new scales of industrial production. The goal of this calculation was a kind of architectural autopoiesis: to find an architecture built according to an internal set of rules, beyond human intelligence and will. Calculation, as discussed here, was also a form of representation, used to convert the continuous into the discrete, the material into the immaterial, and language and form into numbers. The goal was always, in some way, to achieve an optimum, some form of economy. But however accurate the numbers seemed, there was always excess in calculation: redundancies, things that are incalculable, events that are catastrophic and messy.

This dissertation begins in early-1950s West Germany, with the ethical and philosophical questions asked by the Frankfurt School and the Darmstädter Gespräche, and the intellectual and cultural atmosphere that led to the formation of the Ulm School for Design (1953–1968). The nature of architectural rationalism would change in the decades that followed, from the early anxieties about the fate of the human in a rationalized world that had characterized the immediate postwar period, to the emergence of a belief in an ethical and instrumental use of rationality by the 1960s, to the acceleration and disintegration of these concepts in the 1970s and ’80s. Theories on science, technology, and rationalism in architectural circles in West Germany were never linear and often contradictory; thus, the periodization of the shifts presented in this dissertation is schematic. In order to provide a point of orientation, the case studies
are loosely centered around 1968, which is often considered a pivotal point between modern and postmodern architecture, technology, and culture. That year marked not only the rise of the student movement, but also the closing of the Ulm School for Design, the death of Adorno, and Ungers’s departure from West Germany.

Only in recent years have histories been written of the architecture associated with the events of 1968, and they are being crafted into a new postwar narrative of an international “neo-avant-garde.” West German architecture is for the most part absent from these histories of “radical” and experimental architectures. This seems surprising given the cultural and political changes around 1968, which left their mark with particular violence and intensity in West Germany, culminating in the “German Autumn” of 1977. What role did architecture play in these political and cultural circumstances? In a historical period that was otherwise characterized by utopianism and the production of new avant-gardes, architectural culture in West Germany, even in the face of cultural revolution, seemed marked by an excess of reason.

My response to this observation was not to try to unearth marginal protagonists and movements in order to retrieve a radical history for West German architecture in and after 1968 (though this would certainly be a valuable project), but rather to look at the

---

5 A recent example is Mark Crinson and Claire Zimmerman, eds., Neo-Avant-Garde and Postmodernism: Postwar Architecture in Britain and Beyond (New Haven: Yale University Press, 2010).

6 Thilo Hilpert makes a convincing case that the influence of conservative thought and cultural isolation prevented the formation of an avant-garde in post-war West Germany. Thilo Hilpert, "Land Ohne Avantgarde," ARCH+ 186/187 (2008): 110–113. Similarly, Nikolaus Kuhnert and Anh-Linh Ngo speak of a Radikalitätsdefizite (radicality deficit). Nikolaus Kuhnert and Anh-Linh Ngo, “Editorial: Radikalitätsdefizite,” ARCH+ 186/187 (2008): 26–27. ARCH+ was founded in 1966 by students at the University of Stuttgart. The publication quickly went from being concerned with pedagogical issues to a focus on leftist politics. The first explicitly political text was on a 1967 symposium organized by Ungers at the TU Berlin on architectural theory. The publication eventually moved to West Berlin, where several of the editors were current or former students of Ungers. See Jesko Fezer, "Arch+, die Studenten und die IG Bau Steine Erden zwischen 1967 und 1977,” in ARCH+ 186/187 (2008): 96-105.
complex negotiations between architecture, culture, and politics that were taking place among central figures, and that might explain the consequences of this “rational turn.” My focus lies in practices that consciously addressed the problem of the legacy of modern architecture as a relevant cultural form. With this focus, I believe I can better observe architectural production that was both immanent to, and reflective of, changes to technology, politics, and society in postwar West Germany. I thus do not examine the generic and anonymous forms of rationalism created by Germany’s postwar building industry, though these form the backdrop, and often the antithesis to, much of the work discussed here.

To arrive at a deeper understanding of the contradictions of this new rationalism, I concentrate in particular on the work of Otto and Ungers – two of the most well-known and celebrated figures of West German architecture, and among the few familiar to historians outside of Germany. Although these architects built only a handful of buildings, their contributions came instead in the form of polemical writing, pedagogy, research, and experimentation. They also left behind rich institutional archives – especially in the case of Otto. Both architects were intensely prolific, and so there is much source material in the form of self-published books and journals, transcribed lectures, physical models and photographs, and articles appearing in German architectural journals. It is too soon to know the potential impact that Ungers’s or Otto’s personal archives will have, as their contents have not yet been made available to the public.
and researchers, who were frequently responsible for the more scientific aspects of the projects.

There were other architects in West Germany who engaged what I call the “rational turn,” but few who did so in such a self-critical and influential manner. In a context dominated by functionalist modernism, Otto and Ungers provided important alternatives: “green” architecture and experimental engineering in the case of Otto, and urban historicism and the formal use of typology in the work of Ungers. These models were for a long time almost impenetrable to critique, in part because of the ethical associations with both urban historicism and environmental sustainability.

Otto, Ungers, and the younger faculty at Ulm School for Design (which will be discussed in Part I) were of the same generation, educated during or shortly after World War II, yet too young to have participated in the prewar avant-gardes. For this generation, the cultural and technological changes that took place from the 1950s to the 1970s made a deep impression. These practices were based to a large extent in research (and the institutions where this research took place), with significant ties to scientific disciplines in fields as diverse as biology, computation, cybernetics, and sociology. In every case, the relationship to these disciplines was fraught with aesthetic and ethical questions around the role of rationalism. There were also numerous biographical connections: Otto taught at Ulm from 1958 to 1960, and continued to have exchanges

---

8 The work of the architect Ludwig Leo (1924–2012) could also be considered in this category.
9 It thus comes as little surprise that the great majority of literature available on these architects comes mostly in the form of monographic studies by adherents of their work. These studies tend not to be critical, and do not typically consider a broader theoretical and cultural context. One exception is André Bideau, Architektur und symbolisches Kapital: Bilderzählungen und Identitätsproduktion bei O.M. Ungers (Berlin: De Gruyter, 2011).
with the school through its proximity to Stuttgart. Unger, like several architects teaching at Ulm, studied with Egon Eiermann (a true rationalist himself), and had professional ties to Max Bill. Because of their visibility, and their access to funding from both government and industry, the protagonists discussed here also shared the burden of representing the culture and politics of West Germany for the benefit of an international public.

This dissertation has three parts, each focused on a distinct aspect of this “rational turn.”

Part One: Calculation, Ethics, and the Human looks at discussions of rationalism and the built environment in public intellectual culture in the German Federal Republic in the two decades immediately after World War II. These conversations were key to shaping rationalism as an ideological tool and moral imperative in opposition to the cultural aspects of fascism. During these years, which were marked by the physical destruction of German cities and landscapes and the brutality of the war, there was a great amount of uncertainty about modernization, rationalism, and technology, with deeply divided views as to what role these would play in a post-fascist democracy. Conversations like those at the Darmstädter Gespräche, organized by the Deutscher Werkbund, were defined by the tensions between Martin Heidegger’s anti-modernism, Adorno and Horkheimer’s critique of rationalism, and the emerging scientization of Max Bense.

---

10 Max Bill wrote one of the letters of recommendation for Unger in support of his position at the TU Berlin. Letter from Max Bill to Prof. K. Dübers, March 18, 1963, file 206-74, Universitätsarchiv Technische Universität Berlin.
I also look at how rationalism was applied to design at the Ulm School for Design, which emerged from a similar humanist ethos, but was at the same time a center for cybernetics, systems theory, and information theory. At Ulm, the ethical and political concerns of the post-war period were tested through design. What began with “good form” developed into the assignment of ethical values to practices based on measuring and calculating objects, images, systems, and environments. Ulm represented post-war West Germany’s “purest” experiment in rationalist design, but it was already evident that the foundations of this scientific approach were changing, with the growing complexity of social risks and the “crisis” of functionalism and the status of objects.

**Part Two: Calculating the Minimal** focuses on green architecture and experimental engineering as a continuation of the post-war ethics of rationalism. This section centers on the search for a minimum – in terms of economy, material, structure, and energy use. I look closely at the role of economy in lightweight structures and energy-efficient architecture, and the potential irrationalities of this new form of austerity. The notion of the “minimal” can be understood primarily as the result of an ethical and aesthetic preoccupation with economy in built structures. Economy was a form of austerity that can be traced to the humanism of the post-war years. And yet this search for optimization led to excess – redundant experiments, massive quantities of data, and expensive, delicate structures. The ethical project of rationalism and calculation established immediately after the war was largely intact, but the methods used were increasingly questioned. The case study here is the research of Frei Otto and the Institute for Lightweight Structures (IL). The IL was a center for experimental structures
focused on the intersections between technology and the natural world. This engagement with nature was a response to the problems of industrial building, and tied to a critique of rationalism and calculation in architecture. At the same time, these experiments were based in scientific methods that attempted to objectify and quantify nature. These methods were devised in order to avoid the use of statics and calculations, but ended up quantifying the ephemeral forms in the material and natural world. This conflicted relationship to the limits of the calculable and the incalculable is one that I characterize as melancholic.

**Part Three: Prediction, Repetition, Ratio** looks at the crisis and eventual disappearance of the ethics and politics associated with rationalism in the 1970s and ’80s. In this post-utopian period, rationalism became associated less with technology and more with a formalist practice. This transformation can be seen in the work of Unger and his students at the TU Berlin. During the late 1960s, Unger and his students experimented with calculation (and computation) to try to simulate and predict urban futures, as both an exercise of risk management and a form of utopian speculation. The split between the students’ speculative and utopian use of calculation and Unger’s more formal and technocratic interests revealed a crisis that had been building in rationalist architecture, and in scientization in general, in light of the political events surrounding the student movement.

Repetition and seriality were transformed from tools used for rationalist architecture and mass production to purely formal devices without economic or functional concerns. This meeting of formal rationality with scientific and economic
rationalism (in the forms of technocratic architecture, computation, sociology, mass production) led to what were often uncanny results. Repetition here is symptomatic of an excess; for example, Ungers’s later, “post-modern” work exhibits an obsessive use of the geometry of the square. I examine the contradiction between Ungers’s treatment of the square as a static, ideal geometry on the one hand and on the other as a repeating unit that multiplies at several scales in the manner of a pattern or sign. The appearance of this formal device was evidence of a reactionary return to humanist values associated with the mathematics of “good form,” while the repetitive implementation of the square in corporate architecture suggests the evacuation of any ethical or political project associated with mass production.

These sections describe a number of transitions that took place over the course of the three decades covered here. Perhaps most obvious is the decline of rationalism as an ethical project and of rational design methods as a source of salvation or goodness. This trend was part of an increasing skepticism towards science that was seen not only in West Germany, but in much of Europe after 1968. Also significant is how architectural rationalism itself changed. Designers moved from a focus on discrete objects with identifiable forms and boundaries to one of complex systems and environments. Through calculation and computation, real, material objects could be replaced by a number of representations, especially numerical measurements and codes, but also simulated and mediated images. It is clear that the architectural practices discussed here were historically situated on the eve of the digital revolution of the 1990s. Finally, the important historical shift from an industrial to a post-industrial society meant that
the forms of architectural rationalism associated with industrialization – like serial and mass production – began to seem outdated.

Several things are consistent across these examples. One is the use of measurement, numbers, and calculation as a way of creating and judging architectural form. The architecture and design work here can also be considered post-functional: rationalism, not function, is the primary concern, as I will discuss in the introduction.

There are few buildings discussed in this dissertation. Calculation is seen most clearly in ephemeral objects – in drawings, graphs, charts, equations, experiments, tools, spreadsheets (and publications of these) – in research and methods of research. Architects at this time hoped for continuity between the calculations that take place in the design processes and the things in the “real world” that would be the result. Just as Frei Otto believed that every scale of object in nature – from an atom to a planet – could be accounted for numerically, calculation is a design tool that can be applied to any object. Max Bill claimed that an object – a typewriter or a clock – could be the result of a calculus of optimization, function, and beauty. Architects in the 1960s believed that cities could be similarly designed. But calculation, as the examples here show again and again, is not limited to stable and coherent objects. The results of social and political calculations are seen not only in buildings but also in social relations, economies, and cities.

The dissertation begins and ends with Frankfurt: from the anti-rationalism of the Frankfurt School in the 1950s to the city itself, which through financial and real estate speculation became a case study of the irrational effects of rationality. The questions of
calculation, risk, growth, and prediction show their final transformation here from a social and moral project to a capitalist system without ends – or end. These threatened the ethical image that West Germany worked to project.

In this trajectory from the 1950s to the 1980s, I hope to shed light on the question of why post-war West German architecture was so invested in rationalism, even when its ethical as well as its functional imperative had been challenged. Did it continue to suggest values of austerity, transparency, and reason? Or did it become little more than a formal and aesthetic exercise, or even a style? Or worse: was it the expression of a new form of righteousness, with which a number of social and political programs could be masked?
Introduction:
Rationality Without Reason
In the 1970s, West Germany occupied a particular place in postwar European culture as a center of the defense of reason and the legacy of Enlightenment thought. In a 1979 lecture on neoliberalism, Michel Foucault described twentieth-century Germany as broadly defined by what he called Max Weber’s “problem of the irrational rationality of capitalist society.”¹ Jürgen Habermas would famously defend reason against Foucault’s criticism in his arguments for the “unfinished project” of modernity, but also distanced himself from what he viewed as Adorno and Horkheimer’s totalizing critique of rationality.² In spite of its condemnation of Zweckrationalität (instrumental reason), the Frankfurt School seemed to harbor an even greater suspicion of the potential irrationalities that could arise with the absence of reason.

The contradictory nature of Nazism complicated the question of rationalism. Adorno and Horkheimer had criticized the excesses of both rationalism and unreason as the basis of capitalism and fascism. The cult and mythical aspects of fascism had to be avoided and suppressed at all costs. As a result, especially in the 1950s and ‘60s, there was an ethical and political urgency to the defense of rationalism. In many institutions, including those devoted to architectural and design research, technocratic and scientific work was adopted as value-free (neutral), with generous support from corporations and

---

¹ This, he argued, was shared by both the Frankfurt School, which looked to social rationality to counter economic irrationality, and the ordoliberalists of the Freiburg School, who believed that economic rationality, in the form of a free market, could control social irrationality. Michel Foucault, “7 February 1979,” in The Birth of Biopolitics: Lectures at the College de France 1978-1979, ed. Michel Senellart (Basingstoke [England]; New York: Palgrave Macmillan, 2008), 105–106.

governments under the banner of post-fascist ethics. There was less discussion of the “rational” aspects of Nazism, such as the bureaucratized and systematic use of violence and the highly calculated, efficient administration of materials and bodies. The rational turn was thus a reframing of the tools of modern, rationalized societies towards a democratic political project.

What is meant here by the term “rationalism”? Max Weber described a spectrum of ways in which societies could be rational, but in the context of this dissertation a more simplified understanding will be used. By “reason” or “rational thought,” I mean something like the German word Vernunft – judgment, a manner of thinking associated with the Enlightenment. By “rationalism” and “rationality,” however, I mean something more specific, namely the particular form of reason produced by capitalist societies.

Here there are significant refinements that can be found in the work of Weber. What is of primary interest is Weber’s concept of Zweckrationalität and the tools and processes, especially calculation (Kalkül), on which modern Western capitalism was based.

Rationality is understood on the one hand as a process, aided largely by calculation, through which problems are solved and personal interests are represented in a way that is considered most efficient or profitable. Rationality can also, however, be described as based in formal and abstract rules and regulations that are tied not to personal interest (or persons at all) but to a universal set of structures.3 A distinction can thus be made

---

3 Stephen Kalberg explains: “In the economic sphere, formal rationality increases to the extent that all technically possible calculations within the ‘laws of the market’ are universally carried out, regardless of either their effect on individual persons or the degree to which they may violate ethical substantive rationality.” Stephen Kalberg, “Max Weber’s Types of Rationality: Cornerstones for the Analysis of Rationalization Processes in History,” The American Journal of Sociology 85, no. 5 (March 1980): 1145–1179; 1159.
between rationality guided by personal interest, as found in entrepreneurship for example, and the abstract and formal rationality that takes place “without humans.” While the former implies purpose or interest, the latter form of rationality (of which bureaucracy, for Weber, was the clearest example) becomes a kind of automatic process.4 This automatism, I will suggest, has a corollary in rational architectural principles of composition and organization, but also in coding, algorithms, and seriality.

An important aspect of this late rationalism is its withdrawal from human decision-making. What happens when there is rationality without reason? During the Cold War, technological societies were full of examples – whether in military strategy or behavioral studies – where a suspicion of the rational capacities of human beings led to a series of compensatory, automated mechanisms and technologies characterized by their absence of human judgment.5 In 1968 Habermas wrote that the scientization of political and bureaucratic life as represented a new or second stage in the rationalization described by Weber.6 Habermas viewed this new rationality as fundamentally at odds with questions of judgment:

As much as the objective knowledge of the expert may determine the techniques of rational administration and military security and thereby subject the means of political practice to scientific rules, practical decision in concrete situations cannot be sufficiently legitimated through reason. Rationality in the choice of means

---

4 “From a technical point of view, the most ‘rational’ type of domination is found in the bureaucracy simply because it aims to do nothing more than calculate the most precise and efficient means for the resolution of problems by ordering them under universal and abstract regulation.” Ibid., 1158. For a materialist reading of this idea through a history of technology, see Cornelia Vismann, Files: Law and Media Technology, trans. Geoffrey Winthrop-Young (Stanford: Stanford University Press, 2008).


accompanies avowed irrationality in orientation to values, goals, and needs.⁷

Weber also understood very clearly that rationalism is impure; it often leads to highly irrational results, even though it is based on modern science and its “technical possibilities.”⁸ A famous example of Weber’s account of irrational behavior is found in his treatment of the so-called Protestant ethic, where the constant accumulation of wealth is accompanied by an ascetic denial of whatever benefits it may provide.⁹ This ethical aspect of rational economic behavior is relevant here, as postwar economic recovery in the Federal Republic was certainly driven by actual physical need but also (and increasingly) by a sense of ethical purpose. The industrial war machine of the Nazis was resurrected and transformed into an economic machine that was stripped of its associations with industrialized terror. Foucault has pointed out that in the Federal Republic it was economic growth that produced sovereignty – in other words, economic freedom (liberalism) stood in for the state, which was still politically suspect.¹⁰ The notion of an economic “miracle” suggested, especially in the conservative Christian culture of West Germany in the 1950s, that prosperity came about as if by divine intervention. The economic minister Ludwig Erhard, considered the architect of the *Wirtschaftswunder*, assured the German public that prosperity would not lead to

---

⁷ Ibid., 63.
⁸ “Now the peculiar modern Western form of capitalism has been, at first sight, strongly influenced by the development of technical possibilities. Its rationality is today essentially dependent on the calculability of the most important technical factors. But this means fundamentally that it is dependent on the peculiarities of modern science, especially the natural sciences based on mathematics and exact and rational experiment.” Max Weber, *The Protestant Ethic and the Spirit of Capitalism*, trans. Talcott Parsons (New York: Charles Scribner’s Sons, 1958), 24.
⁹ “He gets nothing out of his wealth for himself, except the irrational sense of having done his job well.” Ibid., 33.
¹⁰ Foucault, “7 February 1979,” 84–86. “History had said no to the German state, but now the economy will allow it to assert itself” (86).

materialism, but instead would impart a sense of security that would allow for reflection on spiritual values [Fig. 0.1].

In architecture, this dual nature of rationality in modern capitalism – at once guided by personal interests and by impersonal, autonomous processes – can be understood in terms of the presence, or absence, of the architect as author. The search for autonomous ways of producing architecture, which intensified in the 1960s and ’70s, is thus a cultural expression of a rationality that already prevailed in modern capitalist societies, and one that raises the question of who is responsible for building. Similarly, the ethics of austerity suggested by capitalist reason would come to characterize postwar West German architecture in numerous ways, from an ideal of economy in the work of Otto, to the minimalist aesthetics of Unger. This austerity was in many ways economy without a particular purpose or identifiable end – a kind of Protestant ethic of architecture.

While this dissertation will focus on rationalism and architecture, and not rationalist architecture, there are clearly overlaps. Until the 1960s, “rational architecture” was generally attributed to three periods: French architecture of the Enlightenment, German modern architecture of the 1920s, and the Italian Rationalist movement associated with Giuseppe Terragni and the Gruppo 7 in the 1930s. The definition of “rationalism” changed in these centuries and cultures, but the evocation of “the rational” always implies a purity of form, an appeal to reason, and the application of scientific

---

11 Ludwig Erhard, Wohlstand für alle, 8th ed. (1957; repr., Dusseldorf: Econ, 1964), 227. He also notes, however: “In my capacity as economic minister I can’t be expected to be responsible for the salvation of the entire people” (230). All translations are mine unless noted otherwise.
principles.12 What these rationalisms also shared is that they coincided with moments of
dramatic political change. In the revolutionary years of the late 1960s, rationalism was
rediscovered, most notably in Italy, in the leftist architectural movement of neo-
rationalism, the Tendenza. The architects of the Tendenza proposed that architecture,
as a pure formal expression of power, be deployed to limit the rapidly spreading
capitalist city. Again, rationalism exhibited a return to pure form, an attempt to find an
elementary grammar of architecture.

The 1960s also marked a change in rationalism’s relationship to what Kenneth
Frampton calls “the twin chimeras of modernity – positivistic logic and a blind faith in
progress.”13 Neo-rationalism separated itself from the techno-futurist element of the
rationalism of the 1920s, which would in turn become the preferred language for
utopian and high-tech architectures, like that of Buckminster Fuller and Otto. What
remained was a catalogue of forms culled from the architectures of the eighteenth
through twentieth centuries, but divorced from the revolutions in engineering and
manufacturing that had accompanied them.14 This architecture no longer referred to

---

12 “It is this notion—that architecture is the result of the application of general rules, established by the
operation of reason—that may be taken as the most general definition of rationalism in architecture.”
Alan Colquhoun, “Rationalism: A Philosophical Concept in Architecture,” in Collected Essays in
Architectural Criticism (London: Black Dog, 2008), 163–177; 163. Originally published in German as
“Zwischen Architektur und Philosophie. Rationalismus 1750–1970,” in Das Abenteuer der Ideen:
Architektur und Philosophie seit der industriellen Revolution, ed. Josef Paul Kleihues et al. (Berlin:
295.
14 The definition and historical meaning of “neo-rationalism” was debated in the pages of Oppositions in
the 1970s by Kenneth Frampton, Mario Gandelsonas, Peter Eisenman, Anthony Vidler, and Alan
Colquhoun. See Mario Gandelsonas, “Neo-Functionalism,” Oppositions 5 (1976), and Anthony Vidler, “The
Ungers”, May 6–May 31). See Oswald Mathias Ungers, Works in Progress, ed. Kenneth Frampton and
technology or nature, but only referenced the “ecology” of architecture itself.\textsuperscript{15} Postmodern rationalism was against technological evolution, and in favor of an autonomous and enduring historical discourse.\textsuperscript{16}

Thus, the rationalist architecture of the 1920s effectively split, producing two interpretations of rationalism: one progressive and technological, and the other historicist and formalist. The diverse examples covered in this dissertation can be traced to what was a shared tradition of rationalism in the early twentieth century – I am thus not focusing on the style known as neo-rationalism.\textsuperscript{17} Furthermore, the rationalism I am writing about is larger in scope, and inextricably tied to historical technological and social changes, with profound cultural, political, and philosophical implications. In West Germany, there was no political project comparable to that of the Tendenza, even if German architects of the 1920s and ’30s inspired many Italian neo-rationalists. In fact, the radical architectural experiments of 1968 were notably absent in West Germany. German rational architecture instead follows a trajectory that began with Karl Friedrich Schinkel in the early nineteenth century and included the contributions of Peter Frei Otto, for example, was a friend of the rationalist architect Bodo Rasch, who together with his brother Heinz Rasch, proposed utopian, lightweight structures in the 1920s. Bodo Rasch was a frequent visitor to Otto’s Institute for Lightweight Structures, and Otto collaborated for years with Rasch’s son, also named Bodo. As an example of the latter, see Frei Otto and Bodo Rasch, \textit{Finding Form: Towards an Architecture of the Minimal} (Stuttgart: Axel Menges, 2005).

\textsuperscript{15} Anthony Vidler similarly describes neo-rational architecture as a “Third Typology”: “The columns, houses, and urban spaces, while linked in an unbreakable chain of continuity, refer only to their own nature as architectural elements, and their geometries are neither naturalistic nor technical but essentially architectural.” Anthony Vidler, “The Third Typology,” in \textit{Rational Architecture: The Reconstruction of the European City} (Brussels: Editions des Archives “architecture moderne,” 1978), 28–32; 31.

\textsuperscript{16} “According to such a view, the typological characteristics of a rational architecture are not those that are created by technology or by specifically modern forms of social behaviour, but those that persist through technological and social change and anchor us to a permanent image of man. There is a return to an eighteenth-century view of reason, as the faculty which is, itself, outside history.” Colquhoun, “Rationalism,” 175.

\textsuperscript{17} Frei Otto, for example, was a friend of the rationalist architect Bodo Rasch, who together with his brother Heinz Rasch, proposed utopian, lightweight structures in the 1920s. Bodo Rasch was a frequent visitor to Otto’s Institute for Lightweight Structures, and Otto collaborated for years with Rasch’s son, also named Bodo. As an example of the latter, see Frei Otto and Bodo Rasch, \textit{Finding Form: Towards an Architecture of the Minimal} (Stuttgart: Axel Menges, 2005).
Behrens, Ernst May, Mies van der Rohe, Egon Eiermann, and Ernst Neufert between 1900 and the 1960s. While the work of Unger in particular was included in several international “rationalist” publications and exhibitions in the 1970s and ’80s, I believe that this stylistic framing of his project is too limited (as is his characterization as a postmodernist). In this dissertation I propose a larger context in which to understand architectural rationalism, and its transformations with the advent of postmodernity.

Zweck

The idea of rationalism in this dissertation must also be situated within conversations on the demise or crisis of functionalism and function in the 1960s and ’70s. Here I am especially interested in the implications of architecture designed without human purpose, for which the general terms Zweck (purpose) and zweckmäßig (purposeful) are useful, and distinct from the more specific Funktionalismus (functionalism), which suggests a style of building. Zweck evokes a related term – that of the Zweckrational (instrumental reason) – which was critically discussed in Marxist philosophy and sociology in West Germany. Zweck was associated with a relationship to nature and humans determined by means-end thinking, resulting in objectification, exploitation, and domination. More concretely, this rationality expressed itself in working conditions in factories, life in mass housing projects, and the destruction of cities and landscapes through industry and development. Zweck thus became an increasingly suspect notion for both philosophers and architects.

The distinctions between rationalism, functionalism, and Zweckbau were blurred by postwar criticism of International Style modernism and Congrès International d’Architecture Moderne [CIAM]-based planning. They were still clear, however, in 1923 in Der moderne Zweckbau, in which Adolf Behne explained that functionalism wants “what is absolutely fitting and unique for the particular case,” while rationalism wants “what is most fitting for the general need, the norm.” However, even if for Behne rationalism also allowed for “play,” it was still tied to questions of “fitness” and “need,” which suggests some notion of purpose (Zweck); hence his characterization of modern architecture through the term Zweckbau.

By the 1960s, functionalism’s claims to purpose were questioned. Functionalist architecture had been particularly entrenched in postwar West Germany, where it was the official language of reconstruction and of the new capital, Bonn. Yet, at the Werkbundtag of 1965, Adorno and Ernst Bloch made one of the most critical statements on the architecture of reconstruction [Figs. 0.2 and 0.3]. It would be deeply meaningful for a younger generation of architects that these figures, who would in different ways...

---


Fig. 0.2
*Werk und Zeit* (Werkbund publication) announcing the 1965 Werkbundtag and the death of Le Corbusier.
Fig. 0.3
become central intellectual forces in the student movement that was about to explode, spoke publicly against functionalist modern architecture.\(^{21}\) The effect was even greater when, in the same year, psychoanalyst Alexander Mitscherlich published the “pamphlet” *Die Unwirtlichkeit Unserer Städte (The Inhospitability of Our Cities)*, in which he condemned the reconstructed modern cities and suburbs of West Germany, such as Ludwigshafen and Dortmund.\(^ {22}\)

The Werkbundtag of 1965 was held in West Berlin at the Akademie der Künste, in a 1960 building designed by Werner Düttman in the Hansaviertel, with an opening talk by West Berlin’s mayor (and soon-to-be chancellor of West Germany) Willy Brandt. In addition to Adorno and Bloch, the speakers included Max Bill, architect Hans Schwippert, and SPD politician Adolf Arndt.\(^ {23}\) The event took place just months after the death of Le Corbusier, and was one of the earliest and most public indictments of the modern reconstruction architecture that had characterized the Adenauer era. This critique of *Bauwirtschaftsfunktionalismus* (construction industry functionalism), as it was later called, would continue to be influential for West German architects well into the beginning of postmodernism.\(^ {24}\)

---

\(^{21}\) Bloch’s influence on the student movement continued into the 1970s until his death in 1977. For example, a public friendship formed between Bloch and the student movement leader Rudi Dutschke.


\(^{23}\) The meeting was on the topic of “Education through Design.” Other speakers included Hartmut von Hentig, Walter Jens, Claus Bremer (HfG Ulm), and Stefan Hirzel. Günter Grass was supposed to give a talk entitled “Über die Unmöglichkeit, moderne Stühle zu malen.” Neither Frei Otto nor Oswald Mathias Ungers were included on the registration of attendees; however, many Ulm professors were. Werkbundarchiv Berlin.

\(^{24}\) See, for example, Heinrich Klotz, *Das Pathos des Funktionalismus. Berliner Architektur 1920–1930* (Berlin: IDZ, 1974).
Both Adorno and Bloch took up the question of functional architecture as a category in opposition to ornament and imagination, and (rather narrowly) addressed Adolf Loos’s polemic against ornament as the root of the generic modernism that had spread across West Germany. But perhaps Loos was chosen precisely because of his moral denunciation of ornament as degenerate: it is the ideological aspect of functionalism—its self-evident nature—that they address.\(^{25}\) Loos’s position is used to explain a postwar mass housing and design industry that had been devoted to the supposedly inherent virtuousness of purpose and “good form.” In his address, “Education, Engineering Form, Ornament,” Bloch describes his suspicion of the “ornament-free honesty of pure functionalism”:

The accelerating pace, the record-breaking and restless annihilation of human interaction, all these introduced an unprecedented problematic into the emphatic clarté of the Lichtstadt (radiant city) itself. . . . But time and again, the conditions within its confines and those outside did not conform to the same ideals, and the architecture alone could not establish a small enclave of real inhabitability. The pace of work and its traffic, the objectification of the means precisely by disassociating them from any purpose, end, meaning, and humane use, have largely transformed our cities into a dangerous nightmare. In our transformed cityscapes, man has remained—or more accurately has become—at best peripheral to the measure of things.\(^{26}\)

The “inhumanity” of the modern city is tied to the loss of purpose that comes with “the objectification of the means.” In this process of “measuring,” the human has also been

\(^{25}\) In Max Bill’s short talk at the event, he touched upon the theme of ethical, moral, and aesthetic development lagging behind technological developments like the computer. “Gestaltung ist die Voraussetzung dafür, daß Bildung entstehen kann,” Werk und Zeit, 9.

pushed to the margins. The city as imagined by CIAM was no longer functional, and in architecture too there was no longer functional differentiation, but instead a monotony of forms in which “bungalow, airport, theater, university, and slaughterhouse” are “all rendered uniform in the domineering form of the glass box.”

Bloch was troubled not just by the forms of modern architecture, but by their ideological claims to transparency.

In his talk on “Functionalism Today,” Adorno similarly begins his indictment of this “mediocre modernity” with the observation that “the style of German reconstruction fills me with a disturbing discontent, one which many of you may certainly share.” He continues: “My suspicion in Minima Mora lia that the world is no longer habitable has already been confirmed.” Adorno’s approach is slightly different from Bloch’s, however: he questions the very notion that purpose can be determined and rationally planned at all, because societies themselves are irrational: “Such irrationality leaves its mark on all ends and purposes, and thereby also on the rationality of the means devised to achieve those ends.” Rationally planned architecture, in other words, is already irrational. This makes the determination of the so-called needs of human subjects highly fraught. Adorno likens this erosion of purpose to Kant’s notion of Zweckmäßigkeit ohne Zweck (purposefulness without purpose) – architecture becomes a mere matter of style or taste. The apparent usefulness of an object, then, is what gives

27 Ibid.
28 Adorno, Ohne Leitbild, 104.
29 Ibid., 114.
30 “Solche Irrationalität prägt sämtlichen Zwecken sich auf und dadurch auch der Rationalität der Mittel, die jene Zwecke erreichen sollen.” Ibid., 109.
it value as a commodity. At the same time, Adorno argues that meeting only objective needs results in “brutal oppression”; thus, the subjective needs of humans – even if they are “false” – need to be addressed.

This critique of functionalism took place during a time of experimentation and investment in a new kind of rationalism, one fueled by the possibilities of microprocessors and numerical codes. Both Bloch and Adorno were still arguing within a limited modernist framework, in which a humanist architecture such as that of Hans Scharoun could satisfy both functional and aesthetic “needs.” But this was not in keeping with the more complex technological and social needs that had emerged by the late 1960s.

The historian and curator Heinrich Klotz, who was the first and most notable champion of postmodernism in West Germany, preferred to use the term “post-functionalism.” In the 1970s, Klotz’s attacks on the “pedantic doctrine of

---

31 Adorno questions the naïveté of “a refuge of useful things which are losing their coldness. It is not only mankind that would no longer suffer from the ‘thingly’ character of the world; likewise ‘things’ would come into their own once they completely find their purpose, and are released from their own ‘thingliness.’ But in present society all usefulness is displaced, bewitched. Society deceives us when it says that it allows things to appear as if they are there by mankind’s will. In fact, they are produced for profit’s sake; they satisfy human needs only incidentally.” Als Fluchtpunkt der Entwicklung ließe sich denken, daß die ganz nützlich gewordenen Dinge ihre Kälte verlören. Nicht nur die Menschen müßten dann nicht länger leiden unter dem Dingcharakter der Welt; ebenso widerfähre den Dingen das ihre, sobald sie ganz ihren Zweck fänden, erlöst von der eigenen Dinglichkeit. Aber alles Nützliche ist in der Gesellschaft entstellt, verdreckt. Daß sie die Dinge erscheinen läßt, als wären sie um der Menschen willen da, ist die Lüge; sie werden produziert um des Profits willen, befriedigen die Bedürfnisse nur beider.“ Ibid., 123–124.

32 Ibid., 121.

33 Adorno is less explicit about a possible architectural response to the problem of purpose, stating that a recourse to imagination alone is not enough. Similarly, he argues that attempts to create a utopian architecture from the existing technological order would result in a “powerless . . . detached ornament” (Ibid., 123). In Aesthetic Theory Adorno would cite Scharoun’s Philharmonie as an example of an architecture that expresses its purpose by “transcending mere purposeness.” Theodor Adorno, Aesthetic Theory, trans. Robert Hullot-Kentor (London: Continuum, 1997), 44.

functionalism” and a “puritan” “hostility towards images” resulted in what he called a “hysterical uproar” among architects.  
His defense of form and aesthetics was viewed as a threat to orthodox modernists on the one hand, and to the students of ’68, influenced by sociology and systems theory, on the other. The postmodern critique of functionalism signified the opening of a new kind of rationality, one where Zweck was no longer the central concern.

Writing in the 1980s, Alan Colquhoun viewed functionalism as a variant of twentieth-century rationalism. A function, like the class of mathematical equations of the same name, is a relationship between two variables without a fixed value. Colquhoun argued that functionalism similarly is the interaction of elements in a closed system that has to be empirically proven. As a consequence, the results of this equation “were taken as objectively true descriptions of the real world,” when instead they should be “understood as aspects of a purely formal operation, as they are in mathematics.”

Functionalism is thus no longer tied to a “real world” purpose, but belongs to the abstract realm of calculation. In the increasingly abstract and formal architecture of the 1960s and ’70s, fundamental questions of purpose fell away. Postmodern rationalism was thus distinct from earlier forms in this near total rejection of function.

When functionalism lost its legitimacy in the 1960s, the larger scope of rationalism was once again viewed as a source for architectural objectivity. New directions were

36 Colquhoun, “Rationalism,” 172.
taking place in architecture, where the primary concern was no longer the question of function, or the human, but solving complex formal and social problems through rational means. What differentiated postmodern rationalism from the modernist version described by Weber and Adorno?

**Risk and Kalkül**

A compelling theory of what happened to rationalism in post-modernity is the idea of “reflexive modernization.” According to this argument, the critique of modernization that came with the decline of industrial society was a sign not of the failure of modernization, but of its success. Thus, criticism of progress, science, and technology in truth marks the “reflexive expansion,” not the decline, of modern rationality. This new rationalism, Beck argues, is largely built around risk management:

> If you distinguish between calculable and non-calculable threats, under the surface of risk calculation new kinds of industrialized, decision-produced incalculabilities and threats are spreading within the globalization of high-risk industries, whether for warfare or welfare purposes. Max Weber's concept of "rationalization" no longer grasps at this late modern reality, produced by successful rationalization. *Along with the growing capacity of technical options (Zweckrationalität) grows the incalculability of their consequences.*

In a Luhmannian fashion, the production of risk in capitalist development perpetually creates more need for the management of risk. Moreover, risk is often invisible (in the form of toxins or pollution) and incalculable, suggesting that it is potentially beyond the reach of scientific management or measurement.

---

37 Beck, Giddens, and Lash, eds., *Reflexive Modernization.*
According to Beck, late modern societies were no longer instrumentally rational, as they produced new risks like environmental damage and social vulnerability. Instead, they became “radically rational” when the risks associated with modernization entered a corrective process. The result is not that risks are eliminated, but that they are managed and integrated, forming a “risk society.” Risk becomes commonplace, whether in the form of post-welfare-state social vulnerabilities or the high-stakes games that come with market deregulation.

The identification of the social and environmental risks produced by modernization was a dominant topic in discussions on architecture in the Federal Republic as early as the 1950s. Reconstruction architecture was viewed as inhospitable to life and the imagination, and destructive to the social and ecological fabric of landscapes and cities. This was the beginning of a considerable crisis in the legitimacy of architecture as a discipline, which reached its peak at the end of the 1970s. Both state and private construction came under scrutiny and were met with resistance by a younger, politicized generation of architects, including the students of Unger at the TU Berlin.

West German culture in the 1970s and ’80s can be described as characterized by a reflexive rationality, and was in fact the historical context for the development of Beck’s formulation. Many of the social and architectural technologies that were developed in the 1960s and 1970s – whether environmental systems and green architecture (practiced by Frei Otto and others), cybernetic design based on “reflexive” feedback

---

40 Beck, Risk Society.
from structures and users, or participation-based social design – seemed designed to manage, through science, the risks of modernization. With the awareness of social risks produced by the decline of the welfare state and the limitations of political representation after 1968, Germany saw the rise of the Green movement and the formation of extraparliamentary politics, and with it, widespread popular resistance to building, construction, and development. This occurred notably in the Häuserkampf in Frankfurt am Main, a city where another form of risk, and appropriately, another form of calculation, was seen in the form of finance capital.

Risks are “clad in numbers and formulas.” According to Adorno and Horkheimer, “for enlightenment, anything which does not conform to the standard of calculability and utility must be viewed with suspicion.” Calculation is used for the mastery of nature, and is carried out via “blind” mental processes:

The mathematical formula is consciously manipulated regression, just as the magic ritual was; it is the most sublimated form of mimicry. In technology the adaptation to lifelessness in the service of self-preservation is no longer accomplished, as in magic, by bodily imitation of external nature, but by automating mental processes, turning them into blind sequences. . . . The camouflage used to protect and strike terror today is the blind mastery of nature.

Adorno and Horkheimer’s critique does not posit rational modern society against an ideal of nature or preindustrial society; in fact, it is the regressive element of “progress” that is the object of their criticism. Adorno and Horkheimer question the apparent neutrality and objectivity of scientific thought, “the impartiality of scientific language

---

41 Beck, Risk Society, 28.
43 Ibid., 149.
deprived what was powerless of the strength to make itself heard and merely provided
the existing order with a neutral sign for itself. Such neutrality is more metaphysical
than metaphysics.”\textsuperscript{44} This claim to neutrality is precisely what would allow scientific
language to “blindly” insert itself into the contested political landscape of post-war
West German culture. The examples in this dissertation will show that the
“metaphysics” of this neutrality also inserted itself into architectural culture.

In post-war West German architecture, calculation could claim to be free of
ambiguous and potentially suspect cultural and political meaning, of superfluous and
irrational gestures. For Adorno and Horkheimer, however, calculation is a destructive
force that attempts to assimilate difference – including the irrational – in an attempt to
exorcise mythical elements from modern culture:

When in mathematics the unknown becomes the unknown quantity in an equation, it is made into something long familiar before any value has been assigned. Nature, before and after quantum theory, is what can be registered mathematically; even what cannot be assimilated, the insoluble and irrational, is fenced in by mathematical theorems. In the preemptive identification of the thoroughly mathematized world with truth, enlightenment believes itself safe from the return of the mythical.\textsuperscript{45}

Adorno’s and Horkheimer’s assessment of a fully calculated world came before the
widespread use of computation, yet it describes a similar process of translating culture
into a language of signs or numbers. Calculating reason acts as a sort of encoder that
scatters language among signs:

For science the world is first of all a sign; it is then distributed among the various arts as sound, image, or word proper, but its unity can never be restored by the addition

\textsuperscript{44} Ibid., 17.
\textsuperscript{45} Ibid., 18.
of these arts, by synaesthesia or total art. As sign, language must resign itself to being calculation and, to know nature, must renounce the claim to resemble it.46

This process of language (and, arguably, form) becoming calculation is one that would be intensified through cybernetics and computation.

It comes as little wonder that it was Max Bense who in 1950 wrote one of the earliest and most critical reviews of *Dialectic of Enlightenment* [Fig. 0.4].47 Bense argues against what he sees as the conflation of mathematical and mythical symbols in their critique of calculation. Mythical symbols, for Bense, are representational and fixed, while mathematics always consists of “empty forms” that act as variables. He writes, “Mathematical-logical thinking and mythical-metaphorical thinking do not behave, as Hegel must have claimed, as thesis and antithesis, but are two independent forms of thought which form our active intelligence in order to express the world or relations in the world.”48 Bense’s refusal of the dialectical relationship between rationality and myth was typical of the cultural divide that would lead to the rational turn in architecture. Bense was an early protagonist in the scientization that dominated the 1960s, but during the 1950s, when the strongest influences were existentialism and humanism, his position was still marginal.49

---

46 Ibid., 13.
48 Bense, “Hegel und die Kalifornische Emigration,” 123.
49 At the time, Bense was teaching philosophy and the theory of science at the TH Stuttgart, and had published several books on the intellectual history of mathematics. Through a friend who was in exile in the United States, Bense encountered Norbert Wiener’s 1948 *Cybernetics – Or Control and Communication in the Animal and in the Machine*, which he unsuccessfully tried to publish in translation.
Fig. 0.4
For architects, awareness of the almost unimaginable level of risk in modern life led to the desire to quantify and measure almost everything. Calculation became ubiquitous in the 1960s and ‘70s, appearing in predictions of energy consumption in ecological architecture and in the quantitative language of sociology used by radical housing movements like those of Unger’s’s students in West Berlin. In West Germany, architectural calculation was used in the name of humanist values, but this was paradoxically achieved by eliminating human will. While “calculating” human behavior may have been viewed with suspicion, calculating systems were not. In Otto’s work, for instance, the optimization of built form was achieved by letting self-forming models run “on their own” to determine the best solution. Questions of agency were thus given over to systems that were not human, yet nevertheless integral to a humanist project of reason.

Calculation is a form of prediction used to manage uncertainty and risk. It is applied to poker tables, insurance policies, missile trajectories, and stock market investments. Prediction is familiar to the architectural profession: engineers are called upon to calculate potential disaster in the structure of a building, and both the architect and the historian speculate on the future of the city and the discipline. The word for “calculation,” *Kalkül*, first entered the German language through the vocabulary of sixteenth-century merchants. The word stems from the small stones (*calculi*) used in ancient Rome for business transactions and engineering. (Related terms, like

---


Berechnung and Ratio – both of which come from the verb “to reckon” – have similar origins in physical objects used for counting). But calculi were also used for games, and this ludic element is significant, as it suggests a departure from the real in favor of the fictive. It is little wonder, as sociologist Elena Esposito points out, that the mathematics of probability and the modern novel emerged at the same time.\(^5\) Esposito argues that before modernity, that which could not be known was treated as irrational; after modernity, the unknown came to be understood as phenomena with their own rational rules.\(^6\) In the course of post-modernity, this science of uncertainty became more complex through the influence of systems theory, cybernetics, and computerized and calculated simulation. For financial markets especially, the uncertainty and obscurity of the future is no longer a problem but a resource (hence the profitability of futures).\(^7\) I will demonstrate in this dissertation that this fictive relationship to the future had enormous consequences for architectural problem-solving and speculation. This was true for Otto’s modeling of real behaviors in experimental structures, but also for utopian visions like Ungers’s Berlin 1990, which used calculable evidence to speculate on the future of the city.

Calculation is distinct from mathematics in architecture, as it potentially addresses not only questions of aesthetics and form, but also those of economy, society, and politics. Mathematics, especially geometry, has traditionally held a privileged, and sometimes even mystical status in architecture, as seen, for instance, in Colin Rowe’s

---

\(^5\) Elena Esposito, Die Fiktion der wahrscheinlichen Realität (Frankfurt am Main: Suhrkamp, 2007).
\(^6\) Ibid., 21.
Fig. 0.5
“The Mathematics of the Ideal Villa” (1947).54 And when Hendrik Petrus Berlage designed the new Stock Exchange for Amsterdam in the late nineteenth century, he used the proportions of the Egyptian triangle, producing an image of order that belied the unruly and unstable calculations of market trading taking place within the building.55

Calculation, by contrast, is usually associated with the drudgeries of labor – it is the work of the engineer or bookkeeper. A scrap of paper showing Mies van der Rohe’s calculations for a building for IIT does not have the same status as drawings of the building’s symmetrical geometries [Fig. 0.5]. In some of the architectural examples that will be discussed in this dissertation, particularly the work at Ulm or of Ungers’s students in Berlin, these “marginal” forms of notation compete with, and even overtake, traditional modes of architectural representation. This was arguably in keeping with contemporaneous avant-garde practices that used the abstraction of numbers towards formal ends, with an expressive quality and proper aesthetic beyond that of mere number-crunching.56 But while the examples in this dissertation often resemble these aesthetic practices (and are, in the case of Ungers, even influenced by them), I will argue that these architectures can never fully escape the “real” mechanisms of calculation that occur on a social and economic level. Calculation replaces geometry as a new

56 Post-war examples include seriality in music and in art, the use of laborious counting and process-based work by artists like Hanne Darboven and Sol LeWitt, the chance-based procedures of John Cage, and the work of Iannis Xenakis and Karlheinz Stockhausen. See Hubertus von Amelunxen, Dieter Appelt, and Peter Weibel, eds. Notation: Kalkül und Form in den Künsten (Berlin: Akademie der Künste; Karlsruhe: ZKM, 2008).
object of mystification. The seemingly objective nature of calculation, its claims of exhaustive evidence, proof, and mastery (hence the shared etymology of accounting and accountability), make it particularly vulnerable to misplaced faith. Even in the late work of Ungers, which will be discussed in Part III, I will argue that his return to geometry is still complicated by calculation.

The emergence of the importance of calculation in architecture after the 1960s is unimaginable without the development of the computer (Rechner) and its eventual integration into architectural practice. The period covered in this dissertation marks the eve of the digital revolution in architecture, and the examples looked at here were all affected by it in some way. Calculations were no longer something scribbled into the margins of a drawing by the architect’s hand; as they surpassed the cognitive capacities of the architect, they were “outsourced” to experts and machines. It is no surprise that computers caused considerable anxiety for most architects in the 1970s. This study is thus not a history of computation in architecture, because in truth there was still little evidence of that in the Federal Republic in the 1960s through 1980s. But even if computers were barely used by West German architects at this time, the culture of computation was already widespread. Transactions could be electronically processed in the Frankfurt Stock Exchange beginning in 1969, for example. In the late 1960s, the first computer drawings were printed with a plotter in Stuttgart by students of Bense.

Big Data arrived in the 1970s with the controversial Rasterfahndung (grid profiling)

57 The rare exceptions were research centers like MIT’s Architecture Machine Group, where the computer was “trained” and domesticated to act as a sort of superego for the designer. Nicholas Negroponte, The Architecture Machine (Cambridge, MA: MIT Press, 1970).
program, a computer database on German citizens initially developed to find RAF terrorists. Even with little access to computers, the cultural effects of computation, especially the tendency to render architecture quantifiable and measurable, to convert form to data and numbers, to make the material immaterial, was already established in the projects discussed here. Even Otto’s formal experiments with physical models, while initially an attempt to move away from a reliance on mathematical engineering, would become a proto-digital form of architecture.

In the examples studied here, calculation increasingly loses its basis in the real, and approaches simulation in the form of predicted and projected futures. Numbers are abstracted from their material referent, just as they are in the financial world of futures, options, and credit. With the absence of purpose, an architecture of calculation accumulates new meanings.

Repetition, exhaustion, melancholy

What occurred in the aftermath of the rational turn and its demise? By the 1970s, the compensatory belief in the powers of reason and calculation could no longer be sustained. The loss of legitimacy of modern institutions and architecture in West Germany was accompanied by a widespread crisis of faith in rational thought. Could this account for what were often contradictory expressions of rationalism in architecture during this time, as seen in the late work of both Otto and Ungers? In this dissertation, I will characterize these late, conflicted forms of rationalism as melancholic

---

59 This database was developed by Bundeskriminalamt President Horst Herold.
60 Jürgen Habermas, *Legitimationsprobleme im Spätkapitalismus* (Suhrkamp: Frankfurt am Main, 1973).
expressions, rather than utopian. The suggestion that the limitations of the rational mind could lead to a melancholic condition had been famously allegorized in Albrecht Dürer’s engraving of 1514 (Melencolia I). In a 1971 lecture, Günter Grass compared Dürer’s etching to Germany’s political and cultural situation after 1968, describing it as an example of "stasis in progress": caught between the lightness of utopia and the heaviness of melancholy [Fig. 0.6]. For Grass, melancholia was the place where "everything is shallow, empty, calculable, mechanical."\(^{61}\)

Dürer’s angel is depicted surrounded by the tools of measurement: a saw and planning tool, a turned sphere, an irregular truncated pyramid, scales, an hourglass, and a magic square of Jupiter.\(^{62}\) While the angel has seemingly mastered complex geometries, her mood is nevertheless dark and resigned.\(^{63}\) In Erwin Panofsky’s reading, the geometric and mathematical tools represent not mastery, but limitation. Melancholy appears to those who can think in terms of mathematical concepts, but cannot move beyond these to consider metaphysical ones.\(^{64}\) Melancholia is an architect or builder whose work has become meaningless.

---


\(^{62}\) Panofsky explains that Dürer brings together two types of medieval images: depictions of “typus geometriae” showing tools, and images of melancholy as one of the four temperaments. “The result was an intellectualization of melancholy on the one hand, and a humanization of geometry on the other” (162). Melancholy was believed to come from the influence of the planet Saturn. Saturn was also the god of agriculture; the connection to geometry comes through the measuring and dividing of land. Erwin Panofsky, *The Life and Art of Albrecht Dürer*, 4th ed. (Princeton, NJ: Princeton University Press, 1955).

\(^{63}\) Panofsky points out that the disheveled keys and purse in the etching indicate further impotence: a loss of wealth and power. Ibid., 164.

\(^{64}\) “People gifted for geometry are bound to be melancholy because the consciousness of a sphere beyond their reach makes them suffer from a feeling of spiritual confinement and insufficiency.” Ibid., 168.
Fig. 0.6
Historically, “melancholy” has had a dual meaning; it is both a sinful failure of productivity and a sign of genius. In both cases, it is the mark of a certain epistemological boundary being crossed, a disturbance of equilibrium. Theoreticians of the Enlightenment viewed melancholy as a threat to the order of reason, associating it with “rapture, enthusiasm, fanaticism, piety, and mysticism.” Melancholy is the “dark sister of occidental Ratio,” serving as a reminder of its limits, and enabling forms of experience that it can’t integrate. In the neo-rationalist culture of post-war West Germany, melancholy would pose a similar threat, not only because it represented inertia and stasis, but also because of its potential mysticism. Perhaps this is why Unger adorned the back of his book Quadratische Häuser (1986) with a reproduction of the magic square of Jupiter depicted in Dürer’s engraving: as an astrological and architectural talisman against the melancholic influence of Saturn [Fig. 0.7].

Several cultural historians and critics have described post-war West German culture as characterized by melancholy. In their 1967 book The Inability to Mourn, Alexander and Margarete Mitscherlich argued that Germans’ apparent inability to empathize with the victims of Nazism was due to an unsuccessful (and thus melancholic) mourning of the loss of a narcissistic identification with the Führer. They describe the production of the Wirtschaftswunder as guided by “a manic defense mechanism.” The post-modern aesthetics of fragmentation and repetition, with its narratives of a “confrontation with

---

66 Ibid., 407.
67 Ibid., 416.
69 Mitscherlich, Die Unwirtlichkeit, 25.
Fig. 0.7
Front cover, and back cover showing detail of magic square from Albrecht Dürer, *Melencolia I*, 1514.
history,” have similarly been interpreted as part of a discourse about the process of mourning. If West German architecture indeed exhibited signs of melancholy, what would this mean for the concept of enlightenment? Was the sort of rationalism seen in the work of the 1970s a continuation of the ethical project of the 1950s and ‘60s, or was it a sign of the exhaustion of that project?

Exhaustion or fatigue seemed almost absent from twentieth-century rationalist architecture. The repeating blocks of the Zeilenbau, the grids of Ludwig Hilberseimer’s Groszstadt, and the Taylorized movements of Margarete Schütte-Lihotzky’s Frankfurt Kitchen were calculations of the variables of labor, capital, space, and form. Repetition was a way to eliminate fatigue, to speed things up, to coordinate and optimize effort, material, and energy. The repeating facades of rationalist buildings acted as mirrors of the factories and assembly lines that organized working bodies, even if they belied the human inconsistencies of the labor power that produced them.

Repetition is key to the calculus of fatigue. The body can be trained to perform tasks more efficiently through repetition, but when a critical threshold is reached – a “limit of elasticity” – boredom, stress, and exhaustion follow. In Dialectic of Enlightenment, Adorno and Horkheimer pay special attention to the effects of repetition, whether in the mass production of the culture industry or in the ritualized discipline of fascism. In a text fragment called “The Genesis of Stupidity,” they describe stupidity as a “scar” that

---

arises from the inhibited “muscle” of a stunted subjectivity. Acts of compulsive and vain repetition are symptomatic of an inhibited impulse for awakening, which leads to blindness, impotence, and fanaticism.72

Similarly, the thresholds between repetition, production, and exhaustion signal changes in post-war West German architecture from modern conceptions of repetition tied to the productive use of biological energies, to the view that repetition was symptomatic or generative of the exhaustion, and even death, of modern architecture. This changed perspective was inextricably related to the anti-modernist critique in West Germany, but also to the cooling down of the economy with the end of the Wirtschaftswunder. In the examples discussed in this dissertation, repetition appeared in seemingly “inexhaustible” processes and systems (automation, cybernetics, computation), “exhausting” formal experiments in seriality and combinatorics, and questions of energy and entropy at the larger scale of ecology.73 Architecture became an autonomous art of formal play with rule, resulting in a withdrawal into what Manfredo Tafuri called “regressive utopias.”74

This dissertation will investigate how architecture, having renounced the goals and needs of functionalism, gradually turned to exhausting its own possibilities. A preview of

72 Horkheimer and Adorno, Dialectic of Enlightenment, 213–214.
73 Anson Rabinbach speculates that in the post-war period the “human motor” disappeared along with the labor that animated it. With the replacement of physical labor by automation and cybernetic management, a new rationalism was introduced; its economics was based on communication, signal, optimization, feedback, and redundancy. Anson Rabinbach, The Human Motor: Energy, Fatigue, and the Origins of Modernity (Berkeley: University of California Press, 1992), 297.
this could be seen in the topological loops of Max Bill’s post-war sculpture, which suggest an anxious repetition. At the Ulm School for Design, pedagogy focused on problems of repetition: optimizing mass-produced consumer objects, eliminating redundancy in visual communication, and developing design systems using statistical and recursive methods. Conceptual machines for drawing and designing removed human labor; the conversion of the design process through automation and algorithm would make it more amenable to computation. Repetition was also prominent in the architecture of Ungers, who in the late 1960s proposed a series of projects called Wohnsysteme (Housing Systems) which pushed the boundaries of mass production, with surreal and seemingly endless rows of uniform facades made up of prefabricated panels. He later turned to strategies of mise en abyme and seriality, creating an obsessive, almost fractal, architecture of modular repetition. A very different result can be seen in the work of Frei Otto, where the quest to create structural optimization was paradoxically achieved through repeated, redundant experiments.

With its threshold-like nature between production and destruction, post-modern repetition is ambiguous. Was it a sign of trauma and stupidity, of stunted possibilities? A sort of architectural death drive? Was its goal and effect to break down cycles of reproduction by overheating them? Or was repetition meant to introduce difference, to avoid exhaustion, as a way of continuing the rationalist dream of productive energy?
Part I
Calculation, Ethics, and the Human
In a now notorious televised debate that took place in Düsseldorf on January 27, 1970, five men sat at a table in the thick air of an overfilled school auditorium. The men were sweating profusely under the heat of lights that had been brought in for the sake of television cameras. The protagonists in this public event were the philosopher of science Max Bense, the artist Joseph Beuys, the architect Max Bill, the anthropologist and philosopher Arnold Gehlen, and the art historian Wieland Schmied, who moderated. In the black-and-white footage, Bense and Beuys can be seen shouting at each other, while Bill quietly removes his glasses and wipes his forehead with a handkerchief [Fig. 1.1].

Roland Barthes once described the sweating faces of actors as a signifier of morality, in that their sweat is produced by the “labor of virtue.”¹ This performance in Düsseldorf was one of several public discussions in post-war West German intellectual culture where questions of rationalism were inextricably tied to political and moral values. Superficially, the event was about the relationship between the artist and society. But the crux of the issue in the rowdy exchange between Bense, the philosopher of cybernetic art, and Beuys, the charismatic artist-shaman, was an ongoing conflict about the question of rationalism.

Even the intensity and rhetorical style of the discussion reflected the questions that were at stake. Beuys emotionally proclaims his artistic program of metaphysics, emotion, revolution, human will, energy, intuition, and self-determination.² Bense acts as an aggressive interrogator, demanding evidence, definitions, and logical arguments.

---

Fig. 1.1
Max Bense, Max Bill, Joseph Beuys, Arnold Gehlen, and Wieland Schmidt.
The men interrupt and insult one another, and are themselves provoked by shouts and questions from the audience. Bill, perhaps the calmest of the participants, argues that art is not about politics, but about solving problems in the manner of a physicist – through Ratio (reason). Art made in this manner could then be subjected to a rational form of judgment, or Qualitätsurteil. Both Bill and Bense shared a belief in the importance of measuring aesthetic objects as the basis for objective judgments.

Claus Pias has described this exchange as “a paradigm shift in German post-war intellectual programs, with Bense on the losing side.” Pias is referring to the decline of the period of Verwissentschaftlichung (scientization) of German culture, during which post-war scientific thought had been widely applied to aesthetic and social questions. Bense was one of the most prominent representatives of this neo-positivism, which gained momentum with advances in computation and the social sciences during West Germany’s economic prosperity in the 1960s. By contrast, Beuys’s revival of vitalist and Romantic ideas of emotion, energy, mysticism, and human will was representative of the revolutionary political and cultural project of ’68 and its often violent mutations in the 1970s.

The debate between Beuys and Bense was the latest incarnation of several decades of public discussions of rationalism and related categories such as science, technology, technology,
and positivism, topics that were typically countered by the defense of humanism, phenomenology, and intuition. These discussions were often tinged with moral and ethical anxiety on both sides, a symptom of the fragile state of West Germany’s post-war democracy. Public dialogue and the tradition of Streitkultur (debate culture) were an intrinsic part of the establishment of West Germany’s post-war public sphere (and later, counter-public sphere), and its development as a democracy. This effect was magnified as many of these events were broadcast over radio and, later, on television.\(^6\)

Because modern architecture was one of the most visible collective symbols of the material and instrumental application of rationalism (Zweckrationalität), it was often the focal point of these discussions. A rotating cast of philosophers, architects, art historians, and sociologists debated the roles of technology, functionalism, standardization, and mathematization in the built environment. This debate would have a lasting impact on post-war architects and designers, including Otto, Ungers, and those at the Ulm School for Design. Which direction should modern architecture take in order to produce an ethical human environment that could also fulfill material needs? If the myth of arbitrary and intuitive design has become suspect, then what standards and rules can be relied on? How can the needs of society best be determined – what is measurable, and what is calculable?

Beuys’s mystical anti-rationalism could not have been further from what was perhaps the most famous denouncement of rationalism in post-war Germany – Adorno and Horkheimer’s *Dialectic of Enlightenment*. The conservative intellectual atmosphere

\(^6\) Of course the question of whether this public dialogue achieved the democratic ideal of reasonable communication imagined by Habermas can’t be answered.
to which Adorno and Horkheimer returned after their exile in the United States was dominated by what Adorno disdainfully referred to as *Heideggerei*. West Germany’s economic and material state was considerably worse than that of the Soviet-occupied zone, as West Germany had received both the greater amount of bombing and millions of displaced persons from the eastern territories. The humanism of these years was fueled by a state of perceived victimhood, which led to a call for returning to spiritual and moral values. Discourse in West Germany in the early 1950s was often heavy with moral pathos. Even Adorno and Horkheimer were not immune to using a language of poetic affect: “With the spread of the bourgeois commodity economy the dark horizon of myth is illuminated by the sun of calculating reason, beneath whose icy rays the seeds of the new barbarism are germinating.”

In 1946, architect Otto Bartning wrote: “We can only endure the fight for bare life... if we save the soul with pure thoughts and clean, valid forms.” This appeal to moral values and clean design as a compensation for material scarcity was in keeping with the language of the Christian Democratic Union and Konrad Adenauer, for whom religion was part of a Cold War campaign of separating West German identity from the secular...

---

8 Wolfgang Pehnt, *Deutsche Architektur Seit 1900* (Munich: Deutsche Verlags-Anstalt, 2005), 247.
Fig. 1.2
1947 SPD poster appealing to the “homeless.”
“All roads of Marxism lead to Moscow” 1953 CDU poster.
In 1956 the Communist Part of Germany (KPD) was outlawed.
Communist East. By 1950 however, destitution was no longer the central issue, as the rationing of food and supplies had ended, the Deutsche Mark had been introduced in 1948, and the beginnings of West Germany’s rapid economic recovery could already be seen.\(^{11}\) The *Wirtschaftswunder* that followed was less a “miracle” than it was the deliberate work of Ludwig Erhard, the Minister of Economics (and future German chancellor) who aggressively advocated for a competitive free market economy.

Adorno and Horkheimer’s resistance to both rationality and myth became more complicated when they returned to West Germany and reopened the Institute for Social Research in Frankfurt. As one of the reeducation programs supported by the Marshall Plan, the Institute was provided 435,000 DM by High Commissioner John McCloy, who also distributed funding to other universities and institutes, including the Ulm School for Design. More than half of the funds went toward the construction of a modern building at Senckenberganlage 26 in Frankfurt, just a few blocks from Hans Poelzig’s I.G. Farben building, which was the headquarters for the High Commissioner.\(^{12}\) The opening ceremony was solemnly celebrated with the performance of Schoenberg’s F-Sharp Minor Quartet, op. 10 [Fig. 1.3].\(^ {13}\)

---


\(^{12}\) Rolf Wiggershaus writes, “This energetic support sprang from a belief among those responsible for American policy in Germany that sociology, particularly when represented by American citizens and with its emphasis on empirical research, was a factor promoting democracy.” Wiggershaus, *The Frankfurt School: Its History, Theories, and Political Significance*, 434. Though Adorno was a close friend of the architect Ferdinand Kramer, who became the builder for the University of Frankfurt, the commission went to Alois Giefer and Hermann Mäckler, who were students of Martin Wagner and Hans Poelzig.

Fig. 1.3
The Frankfurt School’s critique of rationalism did not extend to its sociological practice. Adorno emphasized that empirical research and objectivity, including the collection of statistical information and survey data, were integral to the establishment of a post-fascist democracy. This was not only the case at the Frankfurt School: questionnaires and personality studies were also part of the denazification program. In 1945, for instance, all German citizens above the age of eighteen were asked to complete a survey that would help determine their level of culpability in the Nazi government.\(^\text{14}\) Until the end of the 1950s, applicants to the Ulm School for Design also had to fill out a questionnaire on their political and cultural views.\(^\text{15}\) A question like “What type of music are you interested in?” was followed by one like “What, in your opinion, are the causes of the rise of fascist forms of governance?”\(^\text{16}\)

In a similar vein, Adorno was one of the authors (along with a group of researchers at the University of California, Berkeley) of *The Authoritarian Personality*, a sociological and psychological study of traits that supposedly lead to the development of fascist and anti-democratic tendencies.\(^\text{17}\) Adorno worked in particular on the development of a personality test that could measure a subject’s “F scale” (F for “fascism”). While the authors acknowledged the limits of the study, the quantification of something as abstract as ideology shows how pervasive the use of mathematical – and one could say

\(^\text{16}\) Ibid.
\(^\text{17}\) A sample statement, with which the respondent must agree or disagree, was: “After we finish off the Germans and Japs, we ought to concentrate on other enemies of the human race such as rats, snakes, and germs.” Cited in Theodor Adorno, “Studies in the Authoritarian Personality,” in *Soziologische Schriften* (Frankfurt am Main: Suhrkamp, 1972–1975), 191. Theodor Adorno et al., *The Authoritarian Personality* (New York: Harper, 1950).
informational – reason was. This would be true again around 1968, when sociological quantification became the preferred tool of politicized students and young architects.
I. CAN THE HUMAN BE MEASURED?

The question of what is calculable and measurable – what aspects of human experience can be quantified – was a central concern in discussions of rationalism. For post-war thinkers, calculating reason and the quantification of the world had rendered the human environment “uninhabitable,” putting humans at risk. Adorno wrote of this condition in *Minima Moralia*:

*Asylum for the homeless.* – The state of private life today can be seen in its setting. One really can’t dwell anymore. . . . The destruction of European cities, as well as the work- and concentration camps, merely move forward as executors what the immanent development of technology has already decided for the fate of houses. These are now only good for being thrown out like an old tin can. . . . “It is part of my good fortune not to be a home-owner,” Nietzsche wrote in *The Gay Science*. Today we would have to add: it is part of morality not to be at home in one’s home.\(^{18}\)

Adorno is describing an architectural impasse, several decades before it would be similarly articulated at the end of the 1960s: thanks to the logic of capitalist reason, the destructive effects of war, and the condition of exile, architecture could no longer fulfill the cultural purpose of dwelling. These philosophical questions of dwelling were, of course, being asked during an acute crisis in physical dwellings in West Germany: post-war estimates of the number of housing units that needed to be replaced were almost unimaginable, ranging from 4.8 million to 10 million.\(^{19}\)

“It is part of morality not to be at home in one’s home.” This statement is Adorno’s ethical interpretation of the post-war question of habitability. While they were notorious opponents, Adorno nevertheless shared concerns about modernization and

---


\(^{19}\) Pehnt, *Deutsche Architektur Seit 1900*, 267.
the human environment with Martin Heidegger. Heidegger approached the same question from a different perspective in his famous 1951 talk, “Building, Dwelling, Thinking,” where he posited dwelling as an ontological, rather than an ethical or political problem. Heidegger’s ideal notion of Bauen (building) lay outside of rational calculation; he argued that Bauen produces places that are closer to an essence of space than those created by geometry and mathematics.

Heidegger’s talk was given at the Darmstädter Gespräche, a series of public dialogues that began in the 1950s, which were characterized by the post-war pathos that surrounded the human being and the lived environment. The dialogues covered themes like “Das Menschenbild in Unserer Zeit” (“The Image of the Human in Our Time,” 1950), “Mensch und Raum” (The Human and Space,” 1951), “Mensch und Technik” (“The Human and Technology,” 1952) [Fig. 1.4], “Individuum und Organisation” (“The Individual and Organization,” 1953), and “Ist der Mensch Messbar?” (“Is the Human Measurable?,” 1958). Here the human was treated anxiously and as if under constant threat, whether from nonfigurative modern art, rational modern architecture, the disenchantment of the secular world, or the abstraction of labor in the factory. The Gespräche were often held in conjunction with exhibitions at the Mathildenhöhe, the site of the Neue Darmstädter Secession and eventual home of the Bauhaus archive and the German Design Council. The dialogues were thus also in many ways a continuation of the work of the Werkbund and its post-war resurrection, with the majority of the organizing committee consisting of Werkbund members.

---

Fig. 1.4
Poster Stadtarchiv Darmstadt.
An anti-modernist sentiment was especially visible in the first meeting (“Das Menschenbild in Unserer Zeit”), organized by the conservative art historian Hans Gerhard Evers, which featured the art historian Hans Sedlmayr and was largely conceptualized around his arguments in *Verlust der Mitte* (1948) [Fig. 1.5]. In Sedlmayr’s view, it was the ultra-rationalistic *Menschenbild* of modern secular culture that had produced the ultra-irrationalistic tendencies of modern art. Sedlmayr defends the humanist image of man against scientific modern culture, including functionalist architecture (he cites Le Corbusier), the Bauhaus, abstract art, and atonal music. Even though Sedlmayr’s anti-modernism would determine the theme of the conference, his conservative position and past membership in the Nazi party were perhaps too radical for the German audience: during his talk the audience became increasingly restless, and began whistling and calling out “Heil Hitler!”

Sedlmayr’s dramatic division into the rational and irrational realms reinforced the idea that the human needed to be protected from both of these dangerous extremes. This division seemed to conceptually mirror the terms of both “Mensch und Raum” and “Mensch und Technik,” which focused on architecture and industrial design. These

---


22 Evers, *Das Menschenbild*, 49.

23 Ibid., 57. Adorno made several comments on music but did not respond directly to Sedlmayr.

24 The Darmstädter Gespräche were published as transcripts with notes on audience reactions.
Fig. 1.5

Left, top to bottom: Gustav Friedrich Hartlaub, Hans Sedlmayr, Gotthard Jedlicka; right, top to bottom: Willi Baumeister, Johannes Itten, Franz Roh.
Collage published in Hans Gerhard Evers, Das Menschenbild in Unserer Zeit (Darmstadt: Neue Darmstädtter Verlagsanstalt, 1950).
Right: Gerhard Marcks, Bademeister, 1947, shown in accompanying exhibition.
events were the first time since the war that architecture was discussed in a larger theoretical setting.\textsuperscript{25}

“Mensch und Raum” was held for three days in a packed hall, with keynote lectures by Heidegger and José Ortega y Gasset [Figs. 1.6, 1.7].\textsuperscript{26} It was one of the first public meetings between architects who had worked for the Nazi regime, such as Paul Bonatz and Wilhelm Kreis, and those who had stayed in Germany but found other work.\textsuperscript{27}

Putting architecture in the terms of the human \textit{Weltbild} or \textit{Lebensraum} thus framed the discussion according to seemingly universal human principles, as opposed to contentious ideological or political questions.

The dialogues were dominated by a Heideggerian tone, as seen in the exhibition’s opening text and preamble to the conference:

Building \textit{[Bauen]} is a basic activity of humans – the human builds in order to join spatial constructs and thus designs space – through building he is in accordance with

\begin{footnotesize}
\textsuperscript{25} According to Werner Durth, \textit{Deutsche Architekten: Biographische Verflechtungen 1900–1970} (Braunschweig: Vieweg, 1986), 358–359. These conversations took place within an architectural culture that was already divided on the question of rationalism. While architects like Ernst Neufert argued for a standardized building industry, there was a tide of critics including Walther Schmidt, the editor of \textit{Bauen und Wohnen}, who warned of \textit{Rasteritis} and the return of functionalism. Rudolf Schwarz, who was in charge of reconstructing Cologne at the time, associated this sort of “technicism” with the planners of the Third Reich. Walther Schmidt, “Rasteritis,” \textit{Bauen und Wohnen} 1/2 (1946): 290–292. In the incendiary 1953 article “Bilde Künstler, Rede Nicht,” which unleashed a furious debate in German architectural publications, Schwarz accused Gropius and the Bauhaus of having propagated not only this technological and functional ethos, but also the “jargon of the Comintern.” Rudolf Schwarz, “Bilde Künstler, rede nicht: Eine weitere betrachtung zum Thema ‘Bauen und Schreiben,'” \textit{Baukunst und Werkform} 1 (1953): 10–17. See also Ulrich Conrads, \textit{Die Bauhaus-Debatte 1953: Dokumente einer verdrängten Kontroverse} (Braunschweig: Vieweg, 1994).

\textsuperscript{26} Other speakers included the architects Rudolf Schwarz and Otto Ernst Schweizer. Heidegger’s talk was followed by a discussion, led by Otto Bartning, among several architects including Hans Schwippert, Sep Ruf, Paul Bonatz, Hans Scharoun, Hermann Mäckler, Wilhelm Kreis, Richard Riemerschmid, August Hoff, and Rudolf Steinbach, with the addition of the sociologist Alfred Weber (the brother of Max Weber). Egon Eiermann and Ernst Neufert were also present, but Eiermann only participated in the afternoon discussion.

\textsuperscript{27} There was also a 1951 meeting in Hannover between these two camps during the “Constructa” architecture exhibition (July 3–August 12, 1951). Pehnt, \textit{Deutsche Architektur Seit 1900}, and Dürth, \textit{Deutsche Architekten}.\end{footnotesize}
Fig. 1.6
MENSCH UND RAUM
AUSSTELLUNG 4. AUG. – 16. SEPT.
BAUKUNST 1901–1951
MEISTERBAUTEN
VORBEREITUNG PETER GRUND
WETTBEWERBE

Anfragen und Quartiersanfragen bitte an:
Stadt Darmstadt,
Geschäftsstelle Ausstellung 1951,
Hans K. T. Mayer, Darmstadt, Verwaltungsstr. 255

1951
EINLADUNG
DARMSTÄDTER GESPRÄCH 4.–6. AUGUST
AUSSTELLUNG
4. AUG.–16. SEPT.

5. August 1951 9 Uhr
STADTHALLE

VORTRÄGE:

Otto Ernst Schweizer
"Die architektonische Bewältigung unseres Lebensraumes"

Carl Friedrich Fritzius Weitzäcker
"Der physische und der technische Raum"

6. August 1951 9 Uhr
STADTHALLE

Erläuterung
.der „Meisterbauten Darmstadt 1951"
und die entsprechenden Architekten
(siehe Anhang)

Darmstädter Gespräch 1951
leitet die Ausstellung „Mensch und Raum“ ein, die in Zusammenhang
mit der Ausstellung der Darmstädter Architekturhalle vom 19.1951
im Konzertarenahalle auf der
Marktstraße vom 4. August
Es werden gezeigt fotodokumentierte
Lebensräume der Baukunst, vor
allen in Deutschland 1901–1951,
außerdem zum „Meisterbauten in
Darmstadt“ (veranstaltet durch

183

ZUR TEILNAHME AN
DER DISKUSSION HABEN
SICH BEREIT ERKLÄRT:

Paul Bonatz
Egon Eiermann
Hans G. Hartung
August Hof
Wilhelm Kreis
Hermann Steidle
Rudolf Ennemoser
Siegfried Stein
Hans Schweizer
Franz Schütte
Rudolf Schwarz
Hans Schwägger
Dolf Steinberger
Alfred Weber

Der Magistrat der Stadt Darmstadt
lädt Sie hierdurch herzlich ein
den öffentlichen Darmstädter Gespräch 1951
und zum Besuch der Ausstellung:

Fig. 1.7
Darmstädter Gespräch, “Mensch und Raum” (1951).
Exhibition invitation and program. Stadtarchiv Darmstadt.
the being of his time – our time is the time of technology – the distress of our time is homelessness.  

This passage, presumably written by Bartning, naturalizes both building and technology as basic human activities that are in accordance with “our time.” Perhaps the most striking term, however, is Heimatlosigkeit (homelessness), which in German refers to the lack of an ontological or national home, and inevitably carries the burden of cultural notions of Heimat. This homelessness was clearly not the liberated one of Nietzsche’s “children of the future,” but the Heideggerian homelessness that is a symptom of the “oblivion of being.” “Homelessness” becomes literally applied to architecture.

The ontological and theological tone of the day was established by Rudolf Schwarz, a devout Catholic who was, like Bartning, primarily devoted to reconstructing churches at this time [Fig. 1.8]. Schwarz demanded that there be a higher purpose to building, which he concludes is that of “fulfilling the will of God” and returning order to the world. Not all architects took this moral and religious approach, however. There were also attempts to merge this humanist ethos with the technologies of Neues Bauen. Hans Schwippert, the architect of the Bundeshaus in Bonn (1949), where the West German parliament met for the first time, evoked a heroic vision of a transparent, humanist architecture:

Isn’t it very strange, that we, in years in which destruction came over us, in years in which we don’t know what destruction lies ahead . . . feel a commandment to build what is anything but a refuge . . . [T]he good builders around the world are building

---


30 Rudolf Schwarz, “Das Anliegen der Baukunst,” in Mensch und Raum, 86.
Fig. 1.8
All of us, even if we had significant reasons to want something else, are yearning for the light enclosure, for brightness, for openness, for a roof, but not for the refuge and the bunker.\textsuperscript{31}

These words — with their allusions to light and space, and their self-congratulatory tone — succinctly describe the ethical and spiritual “calling” of post-war West German modernism, which would influence Frei Otto and many of his generation. Lightness, as Schwippert points out, is possible precisely because of the technologies of concrete, steel, and glass. There were also detractors of the Heideggerian tone of the conference, and a later discussion took a decidedly anti-phenomenological turn. Political scientist Dolf Sternberger mocked the idea of the “Ur-Gemütlichkeit” of an “ontological paradise,” and warned against returning to organic rootedness as a reaction to the violent displacements that had taken place during the war.\textsuperscript{32}

The conservative humanist premises of the Darmstädter Gespräche were also challenged in the 1953 conference “Individuum und Organisation,” co-organized by Adorno.\textsuperscript{33} This conference dealt specifically with questions of labor, bureaucracy, and


\textsuperscript{32}As an example, he cites the withdrawal into the domestic sphere of Henry van de Velde and the Jugendstil generation. He describes the home as an organism, a form of protection against industrial society. This organic rootedness was, for Sternberger, the result of \textit{a horror moventis} — a fear of movement. He thus criticized the call for \textit{Heimat} and security as a reaction to displacement and change. Dolf Sternberger in \textit{Mensch und Raum}, 147–153.

the legacy of the Third Reich. Here, however, the underlying thesis was the same: the human being was under threat from a rational modernity. In his introductory talk, Adorno presented a series of arguments that touched upon his concept of the verwaltete Welt (managed world). He argues that thanks to new social organizations human relationships have been tied to purpose (Zweck), leading to alienation, depersonalization, and objectification. But bureaucracy should not be the “scapegoat of the managed world,” as it is not the rational nature of organization, but its irrationality and lack of transparency, that is the problem. Perhaps the most significant thing that Adorno does, especially in the context of the Darmstädter Gespräche, is to disrobe the idea of the “threatened human” of its “metaphysical pathos.” Citing French sociologist Georges Friedmann, he argues that human interiority itself has changed with technological and social developments, and he thus specifically contests the idea of a “static” and dehistoricized image of the human whose “pure interiority” is pitted against the effects of rationalization. Adorno is thus suspicious of attempts to humanize the environment through psychological testing and the “human relations” movement. (The Nazis, he points out, also decorated their offices and factories with flower boxes and colorful posters.)

---

34 In lieu of an exhibition, there was a screening of René Clair’s 1931 film A Nous la Liberté, a left-wing satire on mechanization, prisons, and assembly lines.
36 Ibid., 28.
37 Ibid., 32. Other speakers at the conference included Horkheimer, Mitscherlich, Georges Friedmann (in absentia), and Jean Beaufret, the French philosopher to whom Heidegger’s “Letter on Humanism” was addressed. Mitscherlich, hinting at an idea that would become influential in his writing in the 1960s, asked if he and his contemporaries were in fact living in a time of “real rationalism, real reason” or if it was instead “mere rationalization . . . understood in its double sense, as it is used in psychological vocabulary.” Alexander Mitscherlich, “Diagnose des Organisierten,” in Individuum und Organisation, 65.
A more “rational turn” could be clearly seen by 1958 with the colloquium “Ist der Mensch Meßbar?” (Is the Human Measurable?). The conservative humanism of the first conferences seemed to have faded. By 1958, West Germany was also far from the existential fears that had accompanied the early dialogues. Three million units of public housing had been built by 1956, and West Germany showcased its commitment to modern architecture in the 1957 International Building Exhibition in West Berlin, and Egon Eiermann and Sep Ruf’s West German Pavilion in Brussels in 1958 [Fig. 1.9]. Consumer culture and the promise of prosperity had come to have a stronger grip on the public mind than spiritual and moral questions. A manifesto for this mindset was Ludwig Erhard’s 1957 Wohlstand für Alle (Prosperity for all), which popularized his vision of a free-market consumer culture.

In his introduction to the 1958 colloquium, Darmstadt mayor Ludwig Engel reflected on the faded moral urgency and “anxious neo-humanism” of the early conferences. These concerns, he observed, now seemed less urgent, as “the thoughts of many people have turned more and more to material wonders.” Engel also spoke at some length about concentration camps (unmentioned in earlier conferences), as if to remind the audience of the humanist “mission” of the dialogues.

All of the Darmstadt colloquia looked at the human in relation to a multitude of modern forces, with the underlying thesis that the human is endangered by these

---

40 Ludwig Engel in Ist der Mensch Meßbar?, 7.
41 These comments may have been indirectly addressed at some of the participants in the conference, including writer Erich Franzen, who was in exile in the United States during the war (and taught at Ulm); Buchenwald survivor Eugen Kogon, who had testified in Nazi trials; and Jewish philosopher Ludwig Marcuse, who had returned to Germany after exile in the US.
Fig. 1.9
Egon Eiermann and Sep Ruf, German Pavilion, Brussels, 1958.
conditions. At the 1958 conference, the titular question of the “measurability” of the human was immediately understood to refer not to the human body in any way but to the psyche. Erich Franzen, a literary critic and former HfG Ulm teacher, led the discussion, speaking with remarkable openness about the potential of psychological testing to offer an understanding of human qualities and to locate potential “deviations.” While he warns that the tests could become deterministic (for example, someone found to have a *Führernatur* [leader nature] might thus become a despot as a result), he also concludes: “since it is difficult to give form to forces that influence humans, we need to turn to numbers to understand them.”

Max Bense delivered a paper at “Ist der Mensch Meßbar?” on “Intelligence and Originality in Technological Civilization.” By 1958, Bense had already published three volumes of *Aesthetica*, and had recently left the HfG Ulm. In his talk, Bense built upon several ideas from *Aesthetica*, including the premise that there was no essential difference between artistic and scientific production, and that traditional modes of creativity would become indistinguishable from modern ones of “programming.”

Bense describes civilization as dependent on measurability and precision, and even proposes measuring human rationality itself:

> The span of our intelligence between creative and automatic activity has a communicative and measurable meaning. . . . It is thus a matter of understanding the human and his rational abilities, and to output the numerical traits of this rationality as the structure of his being, as the structure of the human image [*Menschenbild*].

---

42 Erich Franzen in *Ist der Mensch Meßbar?*, 16.
43 Max Bense, “Intelligenz und Originalität in der Technischen Zivilisation,” in *Ist der Mensch Meßbar?*, 44.
44 “Die Spanne unserer Intelligenz zwischen schöpferischer und automatischer Aktivität hat eine kommunikative und eine messbare Bedeutung. . . . Offensichtlich geht es also darum, den Menschen auf
The Menschenbild with which these dialogues had begun could now, it seemed, be output in numbers. The nature of this human intelligence is statistical and probable, which means it can even incorporate “errata” such as spontaneity:

Human rationality has begun to incorporate the essence of surprise and thus also chance, as much as the essence of validation and certainty. The rational world picture has proven itself to simultaneously be static, and empirical reality to simultaneously only be probable.45

For Bense, the quantitative approach indicates a shift from artistic freedom to constraint (Zwang). This “resolves” not only aesthetic but also moral questions:

The total process of possible human information, from the semantic to the aesthetic, as applied to perception (knowledge) and Gestaltung (the beautiful), appears to lead back to a numerically accessible measure of freedom, to a freedom of decision, whose fixing represents both a moral and aesthetic task. And thus this concept of freedom, which lies at the base of the precise concepts of information and communication at the horizon of the technological world, links in a deeper way the old spheres of the moral and the aesthetic.46

Thus, the question of the future of the human being (and its image, its art, its architecture) can be answered to the extent that it can be measured: “Every calculation, every conclusion, every measurement also has to do with the prediction, with the identification of the future. The human instinct is interested in rationality and

45 “Menschliche Rationalität hat begonnen, das Wesen der Überraschung und damit der Chance ebenso einzubeziehen, wie das Wesen der Bestätigung und der Gewißheit. Das rationale Weltbild hat sich zugleich als statisches erwiesen und die empirische Realität zugleich nur als eine wahrscheinliche.” Ibid., 37.

46 “Interessant zu sehen ist dabei, das der Gesamtprozeß möglicher menschlicher Information, von der semantischen bis zur ästhetischen, also angewendet auf Erkennen (des Wissens) und Gestaltung (des Schönen), auf ein numerisch zugängiges Maß und Freiheit zurückgeführt erschient, auf eine Freiheit der Entscheidung, deren Fixierung ja zugleich eine moralische wie auch eine ästhetische Aufgabe darstellt. Und so verknüpft dieser Freiheitsbegriff, de im Horizont der technischen Welt den exakten Begriffen der Information und der Kommunikation zugrunde liegt, auf einer vertiefte Weise die beiden alten Sphären des Moralischen und des Ästhetischen.” Ibid., 44.
measurement if it is interested in the future." Bense’s radical form of rationalism elicited surprisingly little direct reaction from the participants. One exception was artist Georg Meistermann, who described the “testing” of an artwork as a form of reduction of the human akin to the reducibility of the human being in the concentration camp.48

47 “Jede Berechnung, jede Folgerung, jede Messung hat es auch mit der Vorhersage, also mit der Identifizierung der Zukunft zu tun. Der menschliche Instinkt ist an Rationalität und Messung interessiert, sofern er an Zukunft interessiert ist.” Ibid., 35.
48 Georg Meistermann in Ist der Mensch Meßbar?, 70.
II. AFTER GUTE FORM: DESIGN AND CALCULATION

Conversations about rationalism were gradually drifting towards scientization by the late 1950s. A parallel evolution was taking place at the Ulm School for Design, where both Bense and Bill played a significant role in applying new forms of calculation and rationality to design. At Ulm, rationality was from the beginning linked to anti-fascism and the moral and physical reconstruction of West German cities and homes. Ulm had common roots with both the conservative humanism of post-war intellectual culture and the Marxist sociology of the Frankfurt School, but did not share their suspicion of scientific thought. The level of commitment to rationalism at Ulm was perhaps unique in West Germany, even though there were other research centers (like those established by Ungers and Otto) where scientific methods would become integrated with architecture and urbanism. Ulm was perhaps as important for its scientific design work as it was for the ethical and political project that became associated with these methods. Nowhere else were the claims, and stakes, as high as at Ulm, which set out to achieve nothing less than a democratization of West Germany through the design of objects and environments.

At Ulm, as in the Werkbund conferences, reconstruction would entail the design of not only a new environment but a new subject. In an unpublished essay that he wrote as a young man shortly after the end of the war, Ulm’s co-founder Otl Aicher described with something close to elation the experience of a train ride from the south of Germany towards the north, passing through several bombed cities:
The city of ruins, the pile of rubble, sent its greeting and its well wishes to us . . . .

[O]ne spoke of Dortmund and Cologne, somebody wanted to get off in Frankfurt too. All destroyed cities. . . . I felt as if we were on the flight from Egypt, on a march through the desert. . . . There is no more Heimat. Ruins have become our Heimat. And that is our whole chance. Since we have been in this desert, since we have gone hungry, we have been on the march to the promised land. . . . We are entering a new time, we are breaking down the door to a new era. . . . One day the world will envy us for our luck in having these ruins, because the old is buried under the ruins: bourgeois mentality, humanism, the modern era.49 [Fig. 1.10]

In this call for spiritual regeneration, there was none of the existential anxiety about

“homelessness” seen in the Werkbund talks, but instead a sense of liberation. The ruins of the cities, in spite of their devastation, presented a tabula rasa on which to construct a new society.

At Ulm, objectivity was seen as a way to counter the irrationalities of both fascism

and market capitalism, whether through the “good form” of Bill or the scientific

Marxism of Claude Schnaitt. Irrationality was countered through attempts to quantify

and manage increasingly complex human environments and objects through scientific means. The need for a design institute that would rationally organize the new output of

commodities in the Federal Republic was also of interest to Adorno. In a 1957 letter to

Hans Scharoun, then president of the Akademie der Künste in West Berlin, Adorno reiterated this idea:

Ich habe in mir eine neue Liebe entdeckt. Mein ganzes Herz ist in Bewegung.

Der Vorwurf, den ich mit meinem Körper getragen habe, ist unerheblich. Der Körper ist nur ein Werkzeug, das ich benutze, um meine Ideen zu vermitteln. Das Herz, das mein Gehirn ausdrückt, ist mein wahres Werkzeug.


Maybe I can take the opportunity to tell you again that I consider the idea of an institute that takes on the task of the centralization and intellectual penetration of the total complex of industrial design to be tremendously relevant and fruitful. Especially here everything will depend on escaping that bad anarchy of which we spoke in terms of the cityscape of Manhattan – without lapsing into the thinking and working methods of the managed world, which only treats humans as objects of planning. . . . And everything which can also take place in this matter, to bring this forward through self-reflection, beyond the unfruitful alternatives of abstract planning and chaotic competition, seems to be of greatest urgency, not only in the sense of the limited interests of the so-called design of functional forms, but more socially in general. I want to stress this sociological necessity most emphatically.50

Adorno could have been describing the Ulm School for Design. In promoting a philosophy of austerity, Ulm played a unique and complicated role in the Wirtschaftswunder. While the school in many ways participated in the success of West Germany’s manufacturing and export economy, it was also driven by an ethos of economy that directly contradicted the logic of disposable, mass-produced items. Ulm can in that sense be seen as design’s answer to ordoliberalism: a way of participating in West Germany’s post-war boom, but within the boundaries of a carefully prescribed set of rules and protocols. Austerity would translate quite literally into the “goodness” suggested by gute Form.

The ethical and political foundations at Ulm were rooted in the Christian socialism of the early years of the school and in the religious legacy of the White Rose movement.\textsuperscript{51} In the first years, Inge Scholl and Aicher began organizing lectures on religious and moral themes at the Martin Luther Church in Ulm. They also shared some of the humanist concerns seen at the Darmstädter Gespräche: in 1950, for instance, they had students design space-saving furniture for the apartments of refugees from eastern Prussia [Fig. 1.11].\textsuperscript{52} In addition, humanist concerns were expressed in talks given on campus: a 1949 poster by Aicher advertises a lecture entitled “What Is the Human Being?” [Fig. 1.12]. Another poster asks “How Should We Live?”\textsuperscript{53}

By contrast, the scientization of design and the total embrace of technology at Ulm were radical departures from the existential anxieties that had characterized architectural discourse in the 1950s. The only rationality to be feared, it seemed, was that of the “bad anarchy” of consumer capitalism. At Ulm the vulnerable human subject and body of humanism would find a home in its new technological milieu. From the time the school was founded, it was already clear that its political goals were to be achieved through an adherence to “objective” ideas:

Until now radicalism was completely aligned with power and thus unobjective, destructive, fraudulent. We need to confront this with the absoluteness of the objective, the real, and the true, an absolute scientific cleanliness. Otherwise we will see this time through new templates.\textsuperscript{54}

\textsuperscript{51} Christine Hikel, Sophie’s Schwester: Inge Scholl und die Weiße Rose (Munich: Oldenbourg, 2013), 43.
\textsuperscript{52} von Seckendorff, Die Hochschule, 24.
\textsuperscript{53} There were also direct connections between the HfG and the Werkbund. Otto Bartning (of the Design Council) and several other Werkbund members sat on the board of the Geschwister Scholl Stiftung. In 1956 the HfG hosted a Werkbund conference. See René Spitz, Hfg Ulm: The View behind the Foreground: The Political History of the Ulm School of Design, 1953–1968 (Stuttgart: Edition Axel Menges, 2002), 198.
\textsuperscript{54} “Bisher war der Radikalismus ganz auf die Macht ausgerichtet und damit unsachlich, zerstörerisch, verlogen. Dem müssen wir die Unbedingtheit des Sachlichen, des Echten und des Wahren entgegenstellen,
Fig. 1.11 Convertible furniture for refugee housing. Group design, Volkshochschule Ulm, around 1950. Source: Eva von Seckendorff
Fig 1.12 Otl Aicher, “Was ist der Mensch?” poster (1949)
Fig 1.13 Plaque on the Ulm School for Design building, reading: “This building was erected thanks to the help of public funds of the United States of America.”
Of course, the “scientific cleanliness” of this project was never politically neutral. While many instructors at Ulm were leftist or Marxist, the school received its funds through the Marshall Plan, West German industry, and local and state governments [Fig. 1.13].\textsuperscript{55} The school’s American funders viewed its “democratic” goals as valuable in eradicating fascism from Germany, but the production of high-quality West German consumer goods was also advantageous in a Cold War confrontation that often took the form of competition between living standards. Ulm applied research that was originally developed for American military use during World War II, such as Claude Shannon’s information theory, Norbert Wiener’s cybernetics, and other variants of systems theory and operations research. These theories, along with scientific methods such as sociology, semiotics, or perception studies, were used to design better consumer goods, advertisements, graphic design, automobiles, and industrial and scientific devices. Ulm served more explicitly as a research and development site for West German consumerism, but it was also a passive-aggressive reminder of the presence of American power at the borders of the Cold War.

One of the goals of Ulm was to eradicate mythical and magical elements from West German culture and design. The form that this new rationalism should take was not always clear, however. In discussions published in \textit{ulm}, the school’s official journal, discourse was characterized by a great degree of critical self-reflection and not, as is

\textsuperscript{55} According to Claude Schnaidt, the only “official anti-communist” at the school was Max Bense. Claude Schnaidt, “Damals stand ich im Lager der Optimisten,” \textit{form+zweck} 20 (2003): 47–57; 49.

\textsuperscript{a} eine unbedingte wissenschaftliche Sauberkeit. Sonst werden wir die Zeit durch neue Schablonen sehen.” Inge Scholl, GSH Program, 1949; quoted in von Seckendorff, \textit{Die Hochschule}, 55.
Fig. 1.14
Alexander Mitscherlich teaching at the HfG. Otl Aicher in the dean’s office with photographs of the Scholl siblings in the background, 1963. Visit to Ulm by West German president Theodor Heuss, 1957. Source: René Spitz
often the accusation, a blind devotion to scientific methods. While Ulm was optimistic in its belief in the potentials of rationalist design, it was motivated largely by an awareness of the problems of capitalist rationality in a consumer society.

Tomás Maldonado later claimed that “positivism at Ulm was never conformist, but always critical.”

Could it be that some of the critical thinking about rationalism made its way south from Frankfurt to Ulm? As Maldonado recalls:

At that time [1960s] I was particularly receptive to some of the thinking of the Frankfurt School. Although my own cultural orientation was strongly marked at that time by Neopositivism . . . , the presence of Adorno in Frankfurt represented for me, as it were, a contradictory intellectual stimulus. . . . “The useless is eroded, aesthetically inadequate. But the merely useful lays waste to the world,” [Adorno] once said to me in an attempt to cool my enthusiasm for the industrial culture of usefulness.

Adorno’s comment touched upon the subject of an internal debate at Ulm: functionalism had become less important as awareness grew of the increased complexity of design problems.

Years later, Horst Rittel would develop his theory of the “wicked problem” precisely in response to the limitations of the scientific methods at Ulm. Rittel argues that the “era of disappointment” which followed the first generation of the systems approach was tied to the “paradox of rationality”: the effort to both fully predict and limit or contain the consequences of design-making is inherently contradictory.

Maldonado similarly reflected on the importance of the concept of “bounded rationality,” an idea

---

57 Ibid., 223.
he attributes to Herbert Simon, which takes into consideration the cognitive limits of making rational decisions.\textsuperscript{59}

Despite these internal debates, the school was frequently attacked both in the popular press and in design literature for its rational approach. In 1960, Swiss sociologist and urbanist Lucius Burkhardt, who briefly taught at Ulm in 1959, criticized the school’s embrace of “absolute scientization” and the “positivism of functionalism . . . according to which every form that can’t be explained through technical facts is reprimanded as ‘formalist.’”\textsuperscript{60} Burkhardt saw these scientific claims as just another style: “The search for a style of ‘stylelessness’ is nothing more than a . . . human illusion. . . . As transitory as fashion is the Ulm supply of forms: Akzidenz-Grotesk, grey tones, orthogonality, and technical appearance are the luxury style of 1960.”\textsuperscript{61}

Kenneth Frampton wrote on Ulm in the 1970s, claiming that it demonstrated the impossibility of an “overall rational projection”:

The Hochschule was a pioneer, . . . for the crisis of identity it suffered as a consequence of its dialectical rationality. The questions that the Hochschule began to ask a decade ago are now being asked, consciously or unconsciously, by every design and architecture school throughout the country, and the crisis of identity that befell the Hochschule has now become a universal malaise.\textsuperscript{62}

As Bill put it in a later interview, at Ulm one thought that “without an ideology the result would be the chaos that we see in all the department stores today.”\textsuperscript{63} He is referring to the overproduction of consumer kitsch objects during the

\textit{Wirtschaftswunder}, which was at its height when Ulm was founded. But Bill concludes

---

\textsuperscript{59} Maldonado, “Looking Back at Ulm,” 222.
\textsuperscript{61} Ibid.
\textsuperscript{63} Max Bill, 1986 interview, in \textit{Ulm Design}, 65.
that in the end, Ulm was “no more than an attempt to use consumer goods to
democratize a society.”64 The relationship between Ulm and German industry was, as
former student Heiner Jacob puts it, “schizophrenic.”65 Design historian Michael Erlhoff
writes:

There’s one implication that may have been unthinkable then, but seems very
bothersome now. . . [A]ll that faith in rationalization, objectivity, and operational
control completely undermined the dialectic of the Enlightenment. And once Ulm
ceased to subscribe to that dialectic, it was identifying itself with the common 1950s
aspiration to be “value-free” and with what later came to be called “helpless
antifascism”: the belief that there are objects that lie outside politics.66

Of course, these assessments of Ulm were themselves hardly neutral. They suggest that
the “failure” of the school in 1968 was the result of its excessive rationality or its
conspiracy with capitalism. It is more convincing, however, that Ulm was closed due to
its apparent lack of ongoing usefulness for West German industry and government, not
to mention American interests [Fig. 1.15].67

In addition to the school’s being attacked frequently in the press, Maldonado sensed
resistance from public authorities as early as 1963: “we have been disillusioned in our
hope that post-war Germany would finally decide for an open and progressive
culture.”68 Citing the criticism that would be central to the student movement several
years later, he blames this conservative culture on the ongoing power of former Nazis

64 Ibid., 66.
65 Heiner Jacob, “HfG Ulm: A Personal View of an Experiment in Democracy and Design Education,”
67 “The closing of the Hfg . . . was due less to worries over its academic qualities than to motives of a
retaliatory adverse faction, which saw to it that none of the Hfg's permanent instructors were hired by
any of the institutions founded after its closing – a McCarthy-like campaign known as Berufsverbote
[professional ban or blacklist] that started as a reaction against the political unrest in West Germany in
the second half of the sixties.” Gui Bonsiepe and John Cullars, “The Invisible Facets of the Hfg Ulm,”
Design Issues 11, no. 2 (Summer 1995): 11–20; 11.
Fig. 1.15
Poster comparing the closing of the HfG Ulm to that of the Bauhaus under the Nazi regime.
Meeting at Ulm voting on whether to keep the school open (Ohl and Schnaidt are seen below). In the background, a poster reads “Execution 1943 – 1968,” referring to the 1943 execution of Hans and Sophie Scholl.
ulm 21 (April 1968).
and other “gentlemen who fought against the Bauhaus in the twenties until its total annihilation.”⁶⁹ Already by 1966 there was skepticism about the school’s ability to fulfill its original political objectives. In the “Comments” section in Ulm 19/20, artist Achille Perilli warns that “an institution like the Ulm school is embedded in a highly developed neocapitalist production system that is the production system of West Germany. Its chances of success are limited because it sees itself forced to use some of the instruments of neocapitalism.”⁷⁰ Schnaidt nevertheless believed that it was “the only school of its type in the western world which had an overtly anti-capitalistic doctrine.”⁷¹

The history of Ulm provides a view into a transformation that had taken place during the course of the 1960s, from a modernist to a post-modernist use of rationalism. The ethical and political imperative that had been central to the founding of the school continued to play an important role at Ulm into the 1960s. What changed was an increased emphasis on applying scientific and mathematical methods directly to the design of not just objects but systems and environments. Calculation expanded from describing the form of an object to managing and predicting the behavior of objects. This rationalism took several forms: a reinterpretation of the formal geometric approach established by Max Bill; explorations of aesthetic metrics, or the application of

---

⁶⁹ Ibid. Maldonado included images of the Bauhaus Dessau “obituary” (1932), the burning of the Reichstag (1933), and the SA marching through the Brandenburg Gate (1933) with his article. When the HfG closed in 1968 due to the withdrawal of state funding, protests by students and faculty centered on comparisons with the fate of the Bauhaus, which was at that time being feted in a major retrospective organized by Walter Gropius, 50 Jahre Bauhaus, at Württembergischer Kunstverein Stuttgart, Kunstgebäude am Schloßplatz, May 5–July 28, 1968.


mathematical formulas to the judgment of artworks or objects; the use of operations research to analyze and optimize the manufacturing and distribution process of consumer goods; and an attempt to rationally organize architecture itself, reinterpreting prewar functionalism in alignment with post-war industrial culture.

Perhaps the most obvious manifestation of calculation at Ulm was how it was applied to form. Because form could no longer be determined by arbitrary criteria like beauty, and eventually not even by function, new strategies were developed for its creation and assessment. These increasingly became linked to quantifiable information, numbers, and even equations. How did the calculation of form come to be associated with ethical concerns? Here one would have to return to the early work of Max Bill, with its combination of austerity, morality, and marketability. Bill appropriated mathematical and geometric systems to produce an “ethical” concept of form, function, and economy that had a significant impact on Ulm, as well as on post-war West German design in general.72

Bill fetishized objects, imparting them with ethical and aesthetic values that went beyond questions of “form” and “function.” 73 Mathematics – especially geometry – played an important role in this fetishization; it was not a code underlying the object so much as a surface effect that created an appeal to seemingly universal, if not cosmic

---

72 It is perhaps just as much this moral righteousness as Bill’s actual investment in scientific methods that incited Asger Jorn to found his “Imaginist Bauhaus” in opposition to Ulm in 1953. The 1959 Neo-Concrete Manifesto of Lygia Clark and other artists also specifically included “the School of Ulm” as among the examples of “dangerous hypertrophism of rationality.” See Nicola Pezolet, “Bauhaus Ideas: Jorn, Max Bill, and Reconstruction Culture,” October 141 (Summer 2012): 86–110. Lygia Clark and Yve-Alain Bois, “Nostalgia of the Body,” October 69 (Summer 1994): 85–109; 92.

values. At Ulm this emphasis on objects was gradually replaced by a focus on numbers: everything that could be calculated and quantified was – from the complexity and function of objects and systems, to the perception of patterns, to the most economic and versatile use of materials and components in buildings. Calculation itself became a new type of fetish.

In his 1949 text “The Mathematical Approach in Contemporary Art,” Bill outlined a program for a new abstraction based on mathematical calculation [Fig. 1.16]. He cites the “crudeness” of the current application of mathematical principles to art, claiming they hadn’t developed “since the days when mathematics, as a secret force unifying cosmos and cult, was fundamental to any form of art.” For Bill, mathematics was the expression of an underlying rational order between interior and exterior worlds:

The mainspring [Ur-Element] of all visual art is geometry, the correlation of elements on a surface or in space. Thus, even as mathematics is one of the essential means of primary thought and consequently the cognizance of the world that surrounds us [Umwelt], it is also intrinsically a science of the relationship of object to object, group to group, and movement to movement.

As an example, Bill mentions the mathematical models at the Institute Henri Poincaré [See Fig. 1.22].

---

75 Bill, “Die Mathematische Denkweise,” 86.
76 “Das Ur-Element jeden Bild-werks ist aber die Geo-metrie, die Beziehung der Lagen auf der Fläche oder im Raum. Und so, wie die Mathematik eines der wesentlichen Mittel zu primärem Denken und damit zum Erkennen der Umwelt ist, so ist sie auch in ihren Grundelementen eine Wissenschaft der Verhältnisse von Ding zu Ding, von Gruppe zu Gruppe, von Bewegung zu Bewegung.” Ibid., 88.
77 It is possible that Bill was familiar with these models through the photographs taken of them by Man Ray in the early 1930s. Bill makes reference to the non-Euclidean theories of mathematicians Nikolai Lobachevsky (1792–1856) and Bernhard Riemann (1826–1866). For André Breton and other surrealists,
Die mathematische Denkweise in der Kunst unserer Zeit

Von Max Bill

Unter mathematischer Denkweise in der Kunst soll hier... 

* Zu der im April/Mai 1949 im Kunsthaus Zürich stattfindenden Ausstellung Pevsner-Vantongerloo-Bill. 

Am Ende des vorigen Kapitels wurde versucht, die vielfältigen Ausdrucksrichtungen der modernen Kunst zu benennen; dabei wurde darauf hingewiesen, daß diejenigen, die sich in der Form der Malerei und der Plastik außerordentlich entwickelt haben, mit denjenigen, die sich auf tektonische und symbolische Weise ausdrückte, eine äußere Form und innere Verknüpfung von konkreten und abstrakten Vorgängen erkennen lassen. Die Perspektive brachte wohl ganz wesentliche Veränderungen in der Malerei und Plastik, aber eine echte Entwicklung der Malerei und Plastik, die in den Jahren nach dem Krieg vollzogen wurde, mußte sich auf den Gebrauchszweck einer vielfältigen, unabhängigen Kunst beziehen.

Fig. 1.16
Bill describes a kind of non-Euclidean mathematical sublime of “finite infinity” and other mysteries, writing that

These forces with which we are in contact are the elemental forces underlying all human order. . . . [T]hey are not formalism, for which they are often mistaken; they are not only form signifying beauty, but thought, idea, cognition transmuted into form. Thus not a substance that exists on the surface, but the primary thought [Ur-Gedanke] of the world’s structure. 78

While Bill’s artwork is typically interpreted as being transparent and accessible, rational and honest, here the appeal to a cosmic order indicates something closer to the cultic use of mathematics that he elsewhere disparages.

Bill explored mathematical and geometric themes in his art beginning in the 1930s. He believed Concrete Art was based on inner facts (Gegebenheiten) and rules, and not on mathematics and geometry per se. These rules have no clear origin; instead of being derived from nature, science, or the will of the artist, they claim to be a science of the artwork itself. 79 Bill’s interest in mathematics as a potential generator of artistic form is literalized in several works, including Construction on the Formula of $a^2 + b^2 = c^2$ (1937)

---


79 His 1935–1938 Fifteen Variations on a Single Theme, for instance, aspired to a sort of artistic “proof.” In the 1938 descriptions that accompany the lithographs, Bill explained that the images were created not from his personal choices, but according to a series of formal and geometric constructs. This is less a glimpse into the mind of the artist than the “mind” of the (seemingly autonomous) artwork itself, which is determined by its internal rules: “the rule of development follows only its interior facts.” Max Bill et al., Max Bill (Stuttgart: Hatje Cantz, 1987), 71.
and the drawings in his book $X=X$ (1942) [Figs. 1.17, 1.18]. In *Construction*, an ink drawing on cardboard, we see what looks like a branching structure, or the traced map of an overlapping series of splitting paths. It is the repetition of a figure, a bifurcated line that is presumably replicated according to underlying symmetries, at different scales and angles. Whatever structure may have organized the image has been erased. There is no indication that the image relates in any way to the Pythagorean Theorem referred to in its title. The drawings in $X=X$ are similarly enigmatic, with the title suggesting a mathematical formula, and yet, again, the figures do not actually correspond to mathematical formulas. Mathematics does not provide an algorithm or code that secretly lies behind the form; the works cannot be “decoded.” But this is precisely where the contradiction in Bill’s work lies: its appeal to clarity, its *apparent* clarity, which is nevertheless always oblique to mathematical laws, following instead a set of invented internal rules with a semblance of scientific authority.

In the 1930s, Bill began experimenting with topological forms, which became popular themes for his public sculptures. These sculptures reveal an association between an ideal good form and utopian notions of boundless space. A particularly charged example is *Endless Ribbon*, first shown in Bill’s award-winning Swiss pavilion at the 1936 Milan Triennale, a large plaster sculpture of a Mobius strip was suspended

---

80 Max Bill, $X=X$ (Zürich: Allianz-Verlag, 1942). Bill’s use of an equation as the title for an artwork, and his interest in mathematics in general, can be attributed in part to his close relationship to Georges Vantongerloo, which began in the 1930s. Bill wrote the preface to Georges Vantongerloo: *Paintings, Sculptures, Reflections, Problems of Contemporary Art* 5 (New York: Wittenborn Schultz, 1948).

81 This has been confirmed to me by the mathematician Philip Ording, whom I thank for his input on Bill’s work and other related aspects in this dissertation.
Fig. 1.17 Max Bill, *Construction on the Formula of a^2 + b^2 = c^2* (1937).
Fig. 1.18 Max Bill, pages from *X=X* (Zürich: Allianz-Verlag, 1942).
over a slender column, allowing the form to move in the breeze [Fig. 1.19].\(^8^2\) Over the next sixty years, Bill created a number of sculptures based on this topological form, which became increasingly larger and more monumental, like the famous plaster version (entitled *Continuity*) exhibited at the Zurich Lake in 1946 (destroyed by vandalism in 1948). An indestructible granite version was erected in front of the Deutsche Bank headquarters in Frankfurt in 1986, an image of mathematical clarity and stability that distracted from the opaque and unstable nature of financial transactions (I shall return to this artwork at the end of this dissertation). These topological forms announced the arrival of a modern scientific paradigm, a form of knowledge that impresses with its apparent complexity but can be visually appreciated by a layman. The forms have a deceptive quality; their topological “riddle” is precisely what makes them appealing as popular entertainment.

Are these good forms or bad forms? The surrealists’ embrace of non-Euclidean objects suggested that they were part of a catalogue of “bad forms.”\(^8^3\) Yet, Bill’s topological objects are again and again presented as “good.” The graceful form that


Fig. 1.19 Max Bill, Swiss pavilion at the 1936 Milan Triennale.
hovers above a column (its geometric effect doubled by the trickery of the invisible wire), too light and “modest” to even sit on its pedestal, radiates with the neutrality that could make it immune to the heavily fascist Triennale exhibition of 1936. The Continuity sculpture for Zurich, finished just after the end of the war, sat peacefully in the landscape, gently twisting on itself, suggesting the possibility of history continuing, of moving on [Fig. 1.20]. The effect was both hypnotic and reactionary; things change only to reassuringly return to the same.

Yet, for all of their formal self-referentiality, these calculated forms are not autonomous art objects in the sense of separating the purposeful from the purposeless. In fact, Bill makes an explicit connection between these sculptures and his design forms. In Bill’s famous polemic, “good” form was not only optimized in terms of function, it was also “beautiful.” Moreover, gut is not only an aesthetic judgment but a moral one: “good form” dispenses with “deceptive appearances” in favor of what is “modest, true – even good.” The migration of these values from art to commodities was most clearly

---

84 Several critics have pointed out the political implications of the “neutrality” of Bill’s work and of Concrete Art, which became Switzerland’s unofficial state art. See Philip Ursprung, “Continuity: Max Bill’s Public Sculpture and the Representation of Money,” in Charlotte Benton, ed., Figuration/Abstraction: Strategies for Public Sculpture in Europe, 1945–1968 (Aldershot, UK: Ashgate, 2004).

85 According to Philip Ursprung, the sculpture was “a symbol of Switzerland’s open-mindedness and its attachment to modernist values . . . [T]he dynamic form of the sculpture promises to transcend the collective trauma of the war and the German Zusammenbruch . . . and to express enthusiasm for post-war Wiederaufbau.” Ursprung, “Continuity,” 232–233.

86 As in architect Robert Le Ricolais’s description of the sculpture: “the spirit loses itself in the endless flow that is like the formation of waves behind a ship’s propeller. You throw a glove towards the sky, it falls down inverted, and filled with the infinite.” Robert Le Ricolais, “Max Bill ou la sculpture non euclidienne,” Arts (December 26, 1947): 3. Quoted in Werner Spies, Kontinuität: Granit-Monolith von Max Bill (Dortmund: Busche Verlagsgesellschaft, 1986), 8.


Fig. 1.20

Fig. 1.21

Fig. 1.22
expressed in Bill’s 1949 *Gute Form* exhibition, which included two photographs of mathematical models [Fig. 1.21]. In these models, unlike in Bill’s artworks, there is a direct correlation between object and formula, a transparent code through which these complex and apparently boundless objects can be read and made accessible. The recourse to mathematics seems to be a didactic attempt to tie the commodities that follow to a universal order beyond that of exchange, function, and use.

Yet, despite what seems to be a pervasive rationalism, Bill’s ethics were such that the “human” element must consistently rise to the surface. Even if good form is “the attempt to make inert matter embody perfect suitability for a given purpose in such a way that the fusion achieves beauty,” still “the form has always been determined in the last resort by the intervention of an indispensible agency, the purely human one.” The presence of the human can be seen in the 1947-48 version of the sculpture *Rhythmus im Raum*, which was displayed at the entrance of the 1949 Basel exhibition [Figs. 1.23, 1.24]. The human-scale (1.5 meter) plaster form balances precariously on the edge of a white plane, echoing the suspended object of the Milan Triennale. Its flowing tripartite form suggests the gaping eyes and mouth of a face, or alternatively, a headless torso with elongated connected limbs. It betrays a suppressed figurative impulse, coming close to a representation of a figure or face while maintaining a sense of geometric

---

89 One model is based on an elliptical function, which is now “a plastic representation of a mathematical thought that has become a sensually perceptible image, and is thus sensually accessible to anybody.” The other shows a function in which “two symmetrical peaks lie in infinity,” producing a “harmonious image.” Printed in *Form: eine Bilanz über die Formentwicklung um die Mitte des XX. Jahrhunderts* (A balance sheet of mid-twentieth-century trends in design) (Basel: K. Werner, 1952), 24-25. This publication shows panels from the 1949 exhibition. A traveling exhibition commissioned by the Swiss Werkbund, *Die Gute Form* was also shown as part of the German Werkbund’s first post-war exhibition, held in Cologne in 1949 on the theme of “Neues Wohnen.”

90 Ibid., 7, 9.
Fig. 1.23, 1.24
order. The form cannot be explained by an equation; evoking bones or shells, its
graphy seems organic.

Calculation, for Bill, is thus always tempered by a humanist ethics. Bill explicitly
distanced himself from pre-war rationalism:

Some years ago there was a tendency to believe that if a form was “rational” – by
which was meant logically and conscientiously thought out on the “fitness for
purpose” principle – it could be considered as therefore almost unexceptionable. . . .
A growing feeling that mechanically produced commodities should embody new
forms clearly proclaiming their origin raised design to a moral issue.91

Bill is thus advocating that design shift from being “moral” because it originates in
functionalism and mechanical production, to design becoming righteous because it
originates in the laws of form.

Bill’s use of mathematics was limited to the isolated object; at Ulm, it would be
applied in the broader context of an informational environment. This use raised new
questions not only about what constitutes (calculable) form, but also about what the
ethical nature of that form might be. When compared to the later use of mathematics at
Ulm, Bill’s mathematical and serial processes seem comparably crude or merely
metaphorical. His is a world of forms that can easily be calculated, that are within the
visual and conceptual grasp of the viewer. It is perhaps because of this formal simplicity
that Bense saw Bill’s work as an affirmation of his aesthetic theories: the work translates
so easily into “code.”92 With Maldonado’s growing interest in semiotics and

91 Ibid.
92 Even if Bill never took mathematics very seriously, Bense viewed his artwork as particularly appropriate
to an information-based analysis. Bill wrote: “Max Bense . . . had repeatedly laid stress on the innovative
character of my works and on their susceptibility to scientific corroboration – a corroboration which in his
mind springs from mathematics and in mine from the logic of gestalt.” In Max Bill: unendliche Schleife,
87–88.
information-based sciences, mathematics began to play a less formal and more instrumental role at Ulm.

**Geometry after good form**

Geometric experiments were central to the “purposeless” studies undertaken at Ulm to train designers. Freed from the constraints of function, and yet not merely aesthetic objects, these experiments became studies in logical, rule-based thought. Photographs show what appear to be free-floating objects that look as if they were made by machine, carefully lit to emphasize their smooth surfaces and perfect geometries [Fig. 1.25]. Maldonado named several branches of mathematics that he considered useful for educating design students: combinatorics, group theory, the study of curves, polyhedral geometry, and topology. Students in Maldonado’s course were asked to work with geometric methods like tiling and grids, using models such as the Sierpinky triangle, Peano surfaces, or Weierstrass surfaces. These were combined with Gestalt-based exercises with titles like “inexactness through exactness” or “balancing of three planes.”

In contrast with the more classical use of stable geometries of proportion, the fractal-like patterns created by these exercises resulted in a seemingly endless potential

---

93 Josef Albers, who taught the *Vorkurs* several times between 1953 and 1959, focused on Gestalt-based geometric constructions. Helmut Emde, another instructor in geometry, worked with solids, and contributed to the Industrial Design basic course of Walter Zeischegg, who had his students construct aluminum “cono-spheres” in order to “recognize the form-generating structure below the surface of solids.” *ulm* 7 (January 1963): 12.
96 Ibid.
Fig. 1.25 Cover of _ulm_ 7 (January 1963).

Fig. 1.26 Herbert Lindinger, “Results of Teaching,” _ulm_ 17/18 (June 1966): 40–47.

Fig. 1.27 Tomás Maldonado and Gui Bonsiepe, “Science and Design,” _ulm_ 10/11 (May 1965): 10–29.
for repetition. While these patterns initially appear ornamental, they have a specific “informational” function. “Minimal threshold differences” and interference patterns suggested primitive forms of binary communication [Fig. 1.26]. They were based in Gestalt theory (differentiating a sign from its environment), and studies on the relationship between perception and communication. These patterns were thought of as underlying structures that could be used for posters, signs, and television motion graphics.

Geometry was used for scientific ends, not just formal ones. Maldonado shared Bill’s fascination with topology, and had students construct models from paper or plaster that used variations of the Möbius strip and other non-orientable surfaces. Maldonado worked closely on developing design methods with Gui Bonsiepe, a former Ulm student who began teaching industrial design there in 1960. In a 1964 text Maldonado and Bonsiepe describe the possibilities of topology for architecture and product design as a way of training the designer to approach problems differently, from a perspective of “order, continuity, and proximity” as opposed to “dimension, form, and position [Fig. 1.27].” In product design, topology was a way of understanding “technological objects” as not just metric but “non-metric” – in other words, objects that depart

---

97 Herbert Lindinger, “Results of Teaching,” *ulm* 17/18 (June 1966): 40–47; 40.
98 When Ulm closed in 1968, Gui Bonsiepe (b. 1934) moved to South America where he became the lead designer for the futuristic operations room of the Cybersyn project in Chile. This 1971–1973 project, engineered by British cybernetician Stafford Beer, was designed during Salvador Allende’s presidency to help monitor and make rapid decisions in matters relating to Chile’s national economy. See Eden Medina, *Cybernetic Revolutionaries: Technology and Politics in Allende’s Chile* (Cambridge, MA: MIT Press, 2014).
100 Ibid.
from conventions of spatial measurement, and are instead defined by flexible relationships of connectivity.

        Maldonado and Bonsiepe cite the need for topological thinking in solving complex circulation problems, and lament that architecture is still constrained by “the limits of projective or differential geometry.” In student exercises using graphic tools such as tables and lattices, topological connections and networks were applied to “problems” like floor plans and transportation networks. While Bill’s fascination with these geometries seemed to be about a static aesthetic form, here there was a broader understanding of form as flexible and related to the emerging needs of modern information environments.

        One can see this approach in a 1959 course on Visual Methodology taught by Anthony Froshaug, in which topology was used for design problems like circulation patterns in houses and cities [Fig. 1.28]. The question was no longer that of an isolated formal object, but of a series of flexible relationships between objects that can take on a number of forms. Froshaug asked his students to work with networks and lattices based on systematic and “non-intuitive” approaches to problem-solving in order to achieve the “optimal transmission of information.” A matrix mapping possible spatial connections was used to arrive at a new network pattern [Fig. 1.29]. The departure from

---

101 Ibid., 14. They say that this is true even in the experimental structures of architect-engineers such as Konrad Wachsmann, Buckminster Fuller, Pier Luigi Nervi, Eduardo Torroja, and Félix Candela. Le Ricolais is cited as an exception. Curiously, Frei Otto is not mentioned, perhaps because he was not specifically interested in topology.

102 Kurd Alsleben, an early computer artist and collaborator of the cybernetics-based Quickborner Team, taught switching circuit theory and Boolean algebra at Ulm from 1965 to 1968, applying these mathematical and network exercises to a computational realm.

Work by students of Anthony Froshaug:
Top: Optimization of an urban transportation system.
Bottom: Matrix showing circulation relationships within a home.

Bill’s mathematical formalism is clear in Froshaug’s description in *ulm* about the course, in which he writes that “complicated relationships between objects . . . cannot be grasped naively and intuitively, and cannot be mastered merely with the aid of a good feeling for form.”\(^{104}\) True calculation, it seems, revealed how subjective the claims were for good form.

The rhetoric about calculation and mathematics at Ulm was based on this belief in objectivity. However, it was not always entirely clear how these complex geometries would translate into mass-produced objects. Often these exercises seemed to depart entirely from function or purpose, leaving open the question of their scientific rigor, as seen in a series of “non-functional” problems assigned to the first-year Industrial Design students by Bonsiepe in 1965-66. He specifically warns that design exercises should not be “abandoned to sheer arbitrariness which – under the token of ‘experiment’ – is favored too often as a scanty cover.”\(^{105}\) An example was a topological exercise in which models were created from paper cut according to a predetermined set of possible lines [Fig. 1.30]. Bonsiepe explains that he derived these experiments from the work on topology by Polish architect and mathematician Lech Tomaszewski, as published in the *Situationist Times*.\(^{106}\)

Tomaszewski’s piece on topology was published in one of several issues of the *Situationist Times* devoted to mathematics. These issues looked at rings, chains, and labyrinths, and were illustrated mostly with collages of primitive and symbolist

---

\(^{104}\) Ibid., 68.

\(^{105}\) Gui Bonsiepe, “Results of Teaching,” *ulm* 17/18, 21–51; 21.

\(^{106}\) Ibid., 28. *Situationist Times* 4 (1963), and *Situationist Times* 5 (1964). Maldonado and Bonsiepe also mention Tomaszewski in their 1964 article “Science and Design.”
Fig. 1.30, 1.31

Work by students of Gui Bonsiepe:
Top: Wooden lattice models used to determine degree of complexity according to Claude Shannon's formula.
Bottom: Topological exercises using paper.
“Results of Teaching,” *ulm* 17/18 (June 1966), 21–51.
appearances of these forms. The topic was apparently inspired by an essay by Asger Jorn in which he discusses the appearance of these themes in Nordic art.\textsuperscript{107} Tomaszewski cites his interest in topology as stemming from its challenge to “institutional truths,” its spatial imagination, and its “irrationality.”\textsuperscript{108} This was an entirely different approach to the same mathematical objects. Just as Bill and the surrealists shared an interest in experimental geometry, here again two different contexts overlap, revealing the fine line between rationality and myth in the 1960s. One wonders whether these geometries also reveal a certain mystification beneath Ulm’s apparently purely scientific approach.

\textit{Aesthetic metrics}

Calculation at Ulm was a method by which form was produced. But it was also a strategy for judging form. A shift had thus occurred in the ethics of rational judgment: judgment is displaced, no longer based in the ethical human subject, and instead assigned to the equation, process, or machine. As designers at Ulm looked to design complex human environments, and not just discrete objects, the question of “good” form changed. If form needed more than the arbitrary “feeling” of the designer, there also had to be more objective methods for making decisions about form.

One of these methods was derived from information theory. In the same set of 1965-66 topological exercises in which his students studied topology with cut pieces of

\textsuperscript{107} “Editor’s Note,” (220) and Jorn, “Mind and Sense” (3–5) in \textit{Situationist Times 5}.

\textsuperscript{108} \textit{Situationist Times} 4 (1963): 7. Tomaszewski was conducting these experiments at the Warsaw Technical University.
paper, Bonsiepe asked his students to come up with a module that could be repeated and combined to create a structural lattice [Fig. 1.31]. The models that the students crafted out of cut wood were humble, but were analyzed using a sophisticated mathematical formula. To determine their “formal complexity,” Bonsiepe assessed and compared the lattices with “the Shannon formula,”\textsuperscript{109} the famous set of mathematical formulas published by Claude Shannon and Warren Weaver in 1948, which were used to quantify and assess information transmissions.\textsuperscript{110} Thus, military work was being applied to design problems, for Shannon had developed these equations while he was conducting war-related research, particularly in the area of cryptography. By plugging in a number of dimensions, the students translated the “formal complexity” of their wooden modular arrangements into bits (binary digits); these numbers are published alongside the models, allowing for a “quantitative comparison.”\textsuperscript{111} Bonsiepe admits that these calculations do not necessarily correspond to the perceived optical degree of complexity, suggesting that visual and mathematical complexity do not necessarily coincide. In this exercise, it is unclear whether the goal was to reduce or increase complexity.

Bonsiepe conducted a similar experiment for the redesign of a Siemens product catalogue, though here he uses the equation to determine the degree of order rather than complexity. He streamlines the catalogue’s haphazard display of parts for

\textsuperscript{109} Bonsiepe, “Results of Teaching.”
\textsuperscript{110} Claude Shannon and Warren Weaver, “A Mathematical Theory of Communication,” \textit{The Bell System Technical Journal} 27 (July, October 1948): 379–423, 623–656. Several variants of Shannon’s equations were used by Ulm instructors, though the “diversity index” equation seems to have been used most frequently.
\textsuperscript{111} Bonsiepe, “Results of Teaching,” 23.
electronic devices into a more legible design, thus fulfilling Ulm’s mission to bring order
to Germany’s industrial output by treating it as an information problem. Bonsiepe
explains that this information-based approach indicates a shift from a mathematized
aesthetics based on proportions to one based on distributions; or, a shift from geometry
to statistics.\footnote{Bonsiepe, “A Method of Quantifying Order in Typographical Design,” ulm 21 (April 1968): 24–31.} He concedes, however, that mathematics may be more useful for
generating forms than for judging them, and questions the idea of “rationalizing”
aesthetic preference.\footnote{Ibid.} Thus, the application of the Shannon formula could determine
questions of order and meaning (in the case of the semantic analysis of advertising, for
example), but not beauty.

Bonsiepe’s method of using this formula was no doubt influenced by Bense, who
wrote his multivolume Aesthetica during the years he was teaching information theory
at Ulm (1953 to 1958), while Bonsiepe was a student.\footnote{Bense briefly returned to teach in 1966. See Max Bense, Aesthetica (I). Metaphysische Beobachtungen
am Schönen (Stuttgart: Deutsche Verlags-Anstalt, 1954); Max Bense, Aesthetica (II). Aesthetische
Information (Baden-Baden: Agis, 1956); Max Bense, Aesthetica (III). Ästhetik und Zivilisation. Theorie der
ästhetischen Zivilisation (Krefeld/Baden-Baden: Agis, 1958); Max Bense, Aesthetica (IV). Programmierung
des Schönen. Allgemeine Texttheorie und Textästhetik (Krefeld/Baden-Baden: Agis, 1960); Max Bense,
Aesthetica. Einführung in die neue Aesthetik (Baden-Baden: Agis, 1965).} Bense was also responsible for
bringing Norbert Wiener to Ulm for a lecture in 1955, and thus helped introduce
cybernetics to the school [Fig. 1.32].\footnote{Hans Christian von Herrmann, “Informationsästhetik,” in Ästhetik als Programm: Max Bense; Daten
und Streuungen, ed. Barbara Büscher (Berlin: Vice Versa, 2004), 79.} Bense saw his own theory of aesthetics as
appropriate to an “atomistic” modernity of “signals, signs, functions, forms, cells,
modulors, models, grids, fields, structures, ‘open’ and ‘closed’ systems.”\footnote{Bense, Aesthetica. Einführung in die neue Aesthetik, 188.} For Bense,
an objective aesthetics was aligned with a world based on math, physics,
Fig. 1.32
Top, left to right: Max Bense, Norbert Wiener, and Max Bill at Ulm, July 1955. Photo Hans Conrad.
Bottom: Max Bense teaching at Ulm. Photos Hans Conrad.
communications research, and information theory, as opposed to the idealist aesthetics of interpretation he associated with Hegel.\textsuperscript{117} An artwork is created in a process that generates order, he believed, and could thus be subjected to calculations of entropy: “it is the same if you take a system of physical particles called ‘Gas,’ a system of verbal signs called ‘Text,’ or a system of colored spots called ‘Image.’”\textsuperscript{118} Every aspect of an artwork could potentially have numerical value, because “every element in the text or image is subject to a yes/no decision, or a binary decision.”\textsuperscript{119} Even aesthetic indeterminacy could be mathematically calculated.

Bense drew on several theories and formulas in developing the aesthetic metrics he published in 1965 in the final composite volume of \textit{Aesthetica}. These include Peirce’s semiotics and mathematician George David Birkhoff’s 1928 formula of aesthetic measure.\textsuperscript{120} Bense reinterpreted Birkhoff’s formula using Claude Shannon’s information theory, so that the relationship of redundancy to complexity determines the degree of uncertainty versus order in an artwork.\textsuperscript{121} Again, the question is no longer one of form, but one of information distribution. Aesthetics becomes a science based on signs and communication that can be quantitatively measured and assessed.

Bense came to regard his theories as more than a means of analyzing art: they could also potentially be used to create artworks. He hints at this possibility at the end of

\textsuperscript{117} Ibid., 317–318.
\textsuperscript{118} “Es bleicht, im Verhältnis zum darauf angewendeten abstrakten Rechnungsschema völlig gleichgültig, ob man dabei einem System körperlicher Partikel namens ‘Gas,’ einem System verbaler Zeichen namens ‘Text’ oder einem System farbiger Flecken namens ‘Bild’ spricht.” Ibid., 324.
\textsuperscript{119} Ibid.
\textsuperscript{120} Where M = O/C, with O=order and C=complexity.
\textsuperscript{121} Birkhoff’s “order” becomes “redundancy”; “complexity” becomes “the volume of statistical information.” Bense, \textit{Aesthetica. Einführung in die neue Aesthetik}, 328–329.
Aesthetica, when he writes of a “generative aesthetics” based on semiotic, metric, statistical, or topological structures. Examples include the Concrete Art of Bill and Almir Mavignier, the Tachist Georges Mathieu, the compositions of Karlheinz Stockhausen and Iannis Xenakis, and various literary experiments [Fig. 1.33]. But Bense also saw this potential in early computer art, which was at the time being created at the University of Stuttgart by his student Georg Nees [Fig. 1.34].

Both judgment and the process of form-making are displaced through logical or mathematical systems. The attempt to substitute aesthetic judgment with a rational process seems particularly relevant, as the faculty of judgment was one of the foundations of reason, according to Kant. What does it mean when a school founded on the ability to identify propaganda and promote democracy turns to a mathematical process that puts rationalism before reason? This emphasis on the semiotic and communicative aspect of design eventually infiltrated almost every aspect of the curriculum at Ulm. The planned courses on propaganda fell by the wayside and were replaced by communication, as if messages could be dissected and deactivated through an analysis of their medium alone.

**Wicked problems**

At Ulm, calculation was used to translate aesthetic and formal values into numerical ones, in an attempt to develop a more objective method of design. At the same time, it

---

122 Ibid., 331. The Brazilian artist Almir Mavignier studied with Bill at Ulm, and was later associated with the ZERO group.
123 Nees produced his drawings at the nearby Siemens headquarters in Erlangen, and exhibited them as part of the Ästhetisches Colloquium organized by Bense in 1965, one of the first exhibitions of computer art.
Fig. 1.33, 1.34
became increasingly clear that the limits of the designed object had changed, along with the categories of “form” and “function.” The designer had to consider larger and more complex assemblages, such as communication; the connection between production and distribution; and relationships between objects, subjects, and environments. These aspects could not be addressed through geometry alone; it seemed they could be “managed” only through rational and scientific tools, through numerical calculation that could process the great amount of variables that were now at stake. Only in this way could a designer fulfill political and ethical commitments – by “designing” economic and social forces to resist the excesses of both fascism and market capitalism.

As early as 1958, in his polemical piece “New Developments in Industry and the Training of the Designer,” Maldonado argued that post-war industrial design should be determined by production rather than form.124 Maldonado distances Ulm from the Bauhaus past that had been associated with Bill and figures like Van de Velde, in favor of a more austere rationalism that he traces to the economy of materials of nineteenth-century utilitarian structures like the Crystal Palace and Galerie des Machines. Pointing to Henry Ford as an example, he writes: “there was a time . . . when the competitive capacity of a firm was measured by the degree of rationalization of its production and not the seductive power of its products over the consumer.”125 Maldonado’s argument

---

125 Ibid., 34.
was written during a period when the seduction of consumer society had all but dominated West Germany.

Maldonado envisions a new role for the designer as a “coordinator,” working together with specialists to maximize product fabrication and consumption. Ulm, he argues, was the first design school founded on “scientific operationalism”: objective research on the consumer using sociology, anthropology, semiotics, psychology, and behavior and perception theories. This approach, he believed, could eliminate the unpredictable and manipulative nature of consumer capitalism. In addition to this scientific approach to consumption, Maldonado imagined an increase in productivity by using operations research and automation. The designer designs the process of production itself:

If, in the past, the product to a certain extent determined the operative behavior of the machine, then in the future, it will be the operative behavior of the machine which will to a certain extent determine the product. This implies that the designer will, more than ever, have to obey factors foreign to his own individual field.

Design itself will be determined by the complexity of an automated factory, by the process of miniaturization, and the potentials of atomic energy (Maldonado shows images of printed circuits to emphasize this point).

This higher level of coordination would demand new techniques of rational management. When Maldonado wrote this text, the design theorist Horst Rittel had just arrived at Ulm, where he would teach design methodology, communication theory,

---

126 Ibid., 40, 34.  
127 Ibid., 37.
operations research, and epistemology until his departure in 1963. Rittel was best known for his concept of the “wicked problem,” a planning problem of such great complexity and urgency that it cannot be fully resolved or calculated, nor can it be adequately addressed through “tame” scientific means. The theory of the wicked problem was developed in response to Rittel’s sense of the increased social and economic complexity of planning issues. This meta-scientific approach was critical of the rigid positivism of scientific planning. While still at Ulm, Rittel wrote of the complexity of tasks “for which there is no merely intuitive solution. The objects have proportions which demand a rational penetration, because the costs of a failed design are too high.” Here he is referring above all to social costs, not to economic ones—this could mean “defense strategies, development of Third World Countries, projects of atomic technologies and space travel.” With the concept of the wicked problem, Rittel was expressing the fundamental paradox of the risk society: the awareness of uncertainty that coexists with the scientific means to try to manage it.

---

128 Rittel left Ulm in 1963 for Berkeley, where he worked with Christopher Alexander, Bruce Archer, and John Chris Jones as part of the Design Methods Group.
Gelegentlich wird unserer Hochschule vorgehalten, daß ihre Selbstverständigung nach außen verunsichert worden ist, daß wir — völlig mit unseren Problemen belastet — versäumt haben, der Öffentlichkeit ein klares Bild über Ziel und Form der HfG zu vermitteln. Aber vielleicht verbessert ließ sich die Schuld an dieser Tatsache einem produktiven Umstand zuwenden: Die lange Pause und die Unbekümmertheit am Publikum waren notwendig für die Klärung der Standpunkte und die Ganzbewusstseins eines vertretbaren Programms. Denn hierbei konnte die HfG sich kaum auf Vorbilder stützen; fast alle Erfahrungen erforderten selbst gesammelt, erarbeitet und bezahlt werden.

Die HfG ist eine Hochschule. Daraus darf sie sich nicht mit einer Rechtfertigung, einem Stil der „Schule eines Musikers“, einer nie auch immer gewahrten Formellogie oder gar einer „Mese
crischen“ identifizieren. Außer einer gemeinsamen Absicht und gemeinsamen Erfahrung vermittelt jeder Dozent einen Aspekt, eine Meinung, seine eigene Richtung. Dies muß so sein und nicht anders, weil nämlich jede Gleichberechtigung der Meinungen den Verlust der inneren Auswahlsentscheidung und der Korrige
turfähigkeit zur Folge hätte. Die Kritik gegen die Vielfalt der nebeneinander in Konkurrenz stehenden Standpunkte ist nicht das Produkt eines hyperbollen Demokratismus oder gar ein Rückzug vor der Verbindlichkeit; sie ist — wie sich

Wilm von Humboldt für die Universität fand — der Motor der Entwicklung und die Instanz der ständigen Selbstkontrolle. Dies verbindliche Prinzip der HfG ist eine gemeinsame Aufgabe und nicht eine Potenzierungsleistung.

Die Aufgabe der HfG läßt sich zufrieden, aber problematisch in einem Satz beschreiben: Ausbildung von Designern. Wir können auch von „Gestaltern“ sprechen, aber den „Wort“ Designer“ ist neutral. Wenn man Gestaltung sagt, kennt man meines Wissens eine ganze Panoplie Kultur- und Modemgeschichte mit. Gestalt hat den Klang des mystik verkörperten, des pathetischen, also des, was das Ganze in unveränderter Weise von der Summe seiner Teile unterschieden; es appelliert an das, was ungeachtet bleiben muß und nur durch das Gefühl ergriffen werden kann, das aber dennoch unendlich vorhan
den hinter den Dingen steht.

Ein Blick in das englische Wörterbuch beleuchtet, was mit „De
gner“ gemeint ist. Als deutsche Entsprechungen finden wir dort aufgeführt: Plan, Projekt, Anordnung, Verfahren, Entwie
kung, Entwurf, Konstruktion, Erscheinung, Bestimmung. „De
gner“ bedeutet also eine bestimmte Art menschlicher Tätig
tätigkeit, die sich am besten charakterisieren läßt als aktives Verhal
ten, das auf Veränderung von Gegenständen ausgerichtet ist, wobei die Konsequenzen dieses Verhaltens abgeschätzt und kalibriert werden. Es ist „bewußt eingeflochten im Gegen
satz zum unvorbereiteten, effektiven oder unkonstruktiv Verhalten. Es
ist ein planvolles Agieren mit der Absicht der Überführung von

Fig. 1.35
Horst Rittel, “Zu den Arbeitshypothesen
der Hochschule für
Gestaltung in Ulm,” Werk 48 (1961): 281-
283.

Fig. 1.36
Horst Rittel at Ulm, 1958. Photo Hans
Conrad
In 1961 Rittel, by then dean of Ulm, published a lengthy description of the school’s pedagogical goals. He describes the behavior of the designer as “conscious,” as opposed to “compulsive, affective, or uncontrolled.” The designer’s conscious approach is achieved through techniques including “data gathering, use analysis, synthesis and testing,” which “dissolve” the “dualism between rational and intuitive work.” Rittel articulates a changed relationship to functionalism, explicitly countering Bill’s position: “It is futile to strive for the absolute good form. It is not a transcendentally existing ideal image, but the result of today’s design politics.”

The nature of industrial society requires a new rational approach, he asserts:

The relevance of the problem is obvious: we live in almost exclusively industrially manufactured, highly engineered environments; we are connected to complex communications networks, such as radio, television, press and transport; we are at the same time actors in the different playing fields of our complicated social structures: consumers, tax payers, buyers, voters, etc. With the emergence of the great production and communications systems, the design of a chair becomes a difficult problem.

Information theory was thus used for more than the calculation of aesthetic analysis. Maldonado and others at Ulm focused on design questions related to the communication that takes place between humans and the “operative organs” of

---

135 Ibid.
Fig. 1.37
machines (scales, switchboards, control panels, etc.) [Fig. 1.37].\textsuperscript{137} Maldonado, who designed control panels for Olivetti in the 1960s, viewed this relationship as among the most exciting tasks for future designers. Information theorist Abraham Moles, who taught at Ulm from 1961 to 1966, approached the environment as a game of information exchange and feedback:

This conception of the external world as an opponent in an immense game, governed by certain precise rules and played against the savant or philosopher. . . . To clarify this attitude we might suppose the individual to be imprisoned in a bubble of glass upon which messages are projected from the Umwelt.\textsuperscript{138}

The subject Moles describes is hostile towards the outside world, and acts as an adversary trying to master his surroundings and the rules of the game according to which they are organized. The image evokes the center of an immense war room, where games of risk are played out, and possible scenarios tested.

In light of the potential future complexity of industrial production, Maldonado questions design techniques based on “mathematical formalization” (an oblique reference to Bill).\textsuperscript{139} As the potential scale of design could range from a coffee cup to an electronic data processing machine, Maldonado felt that the debate between rational and intuitive design had become irrelevant.\textsuperscript{140}

\textsuperscript{137} Tomás Maldonado, “Communication and Semiotics,” \textit{ulm} 5 (July 1959): 69-78. 73
\textsuperscript{139} Tomás Maldonado, “Preliminary Note,” \textit{ulm} 6 (October 1962): 3–4; 3.
\textsuperscript{140} Ibid.
However, even with this more complex and “wicked” understanding of objects and environments, the efforts to measure and calculate their relationships persisted. In the essay “Products: Their Functional and Structural Complexity,” published in ulm in 1962, Moles proposed “measuring” industrial products using both qualitative and quantitative methods derived from cybernetics.  

Like Bense and Bonsiepe, Moles turned to a communication theory method of quantifying an object by comparing levels of redundancy and originality. Moles uses Shannon’s formula to analyze machines, measuring functional complexity (the sequences of actions undertaken with the object – such as tapping letters on a typewriter) and structural complexity (its components, or what he calls “organs”). In this way, Moles developed a system of comparison based on numerical measurement, so that objects could be subject to taxonomic classification, and even coded and “transferred to a punch card.” In an illustration entitled “Chart of the World of Machines,” Moles graphs this information, showing textiles and watches at one end, and typewriters (1,000 organs), space rockets (3,000 organs), and an IBM 705 (20 million organs) at the other [Fig. 1.38].

Moles would go so far as to apply his metrics of complexity to the distribution of consumer objects across the geographies of the Cold War. Creating what he calls an

---

141 Moles refers to cybernetics as the “science of organisms.” He frequently makes biological references like this when he speaks of technological objects. Moles, “Products,” 4-5.
142 Moles’s research had many parallels with Bense’s, including applying information theory to aesthetic questions.
143 Moles, “Products,” 8.
144 Moles suggests that the method could be used for both natural and artificial “organisms” such as “biological cells, physical atoms, chemical symbols, professional categories of business life, psychological types in sociometry, etc.” Ibid., 11. This is not unlike Frei Otto’s efforts to create a universal taxonomy of organic and inorganic forms based on the calculation of a set of variables.
Fig. 1.38

Fig. 1.39
Left bottom: Graph showing “optimum of happiness” between “complexity of assortment (supply)” and “complexity of needs (demand)” Illustration from Abraham Moles, “Theory of Complexity and Technical Civilization,” ulm 12/13 (March 1965): 11–16.

Fig. 1.40
Top: An Underwood typewriter without its case, which reveals the mechanisms within; a Braun television set, also without a cover, showing its tube and wires. Illustration from Abraham Moles, “Products: Their Functional and Structural Complexity,” ulm 6 (October 1962): 4–12.
“econometrical diagram,” he used Shannon’s formula to analyze the level of
“complexity of needs” of a given society, in relationship to its “material equipment.”

[Fig. 1.39] Moles even proposes that there is an “optimum of happiness”; it appears as a
diagonal line traced across the graph. Both a consumer society like the United States
and a socialist one like the Soviet Union fall short (though Moles suggests that these
measurements could be useful for advertising or propaganda in order to nudge a society
towards its optimum). The “optimization of happiness” is an example of the attempt to
quantify and calculate even highly complex social and economic systems. With the right
formula, it seemed, there could even be a rational solution to the Cold War, or at least
those battles fought at the level of consumer culture.

**Neo-functionalism**

Adorno delivered his influential condemnation of functionalism in 1965, pointing to the
false objectivity of modernist architecture. At Ulm, function similarly came into crisis
when the singular object, where form, beauty, and function once coincided, became a
system of objects, or a system of functions within one object.\(^{146}\) As the unified object
became fragmented, the question of form receded. In “Products: Their Functional and
Structural Complexity,” Moles showed two images that suggest this: one of an
Underwood typewriter without its case, which reveals the mechanisms within, and one

---

\(^{146}\) Apparently, after Bill’s departure, “nobody talked about function anymore,” according to Eugen
Gomringer. “Interview with Eugen Gomringer,” in Martin Krampen et al., eds., *Die Hochschule für
Gestaltung Ulm – Anfänge eines Projektes der unnachgiebigen Moderne* (Ulm school of design: beginnings
of a project of unyielding modernity) (Berlin: Ernst and Sohn, 2003), 83.
of a Braun television set, also without a cover, showing its tube and wires [Fig. 1.40].

When these are compared with Bill’s Patria typewriter that was promoted as “good form,” or the Braun products created by Ulm industrial designers, it becomes clear that the discourse here is no longer about form, but about systems. With the ethical values of purpose and beauty having been distributed and fragmented across an unintelligible field of systems, calculation becomes a way of reintroducing a semblance of objectivity.

In January 1967, Moles taught a seminar at Ulm on Functionalism in Crisis. Unlike some contemporaneous thinkers in design and the social sciences, Moles did not celebrate the apparent demise of functionalism, but viewed it as a threat. He defends functionalism’s ascetic doctrine as a corrective for the excesses of consumer society:

Functionalism necessarily contradicts the doctrine of affluent society which is forced to produce and sell relentlessly. In the end functionalism tends to reduce the number of objects and to realize an optimal fit between products and needs, whereas the production machinery of affluent society follows the opposite direction. It creates a system of neokitsch by accumulating objects in the human environment. At this point the crisis of functionalism becomes manifest.

Considered in this context, the use of complexity theories can be viewed as an effort to perpetuate functionalism through new forms of calculation:

A renewal of functionalism is necessary. . . . It is wrong to consider functionalism dissociated from its social implications. A functionalism for affluent society should be conceived. . . . The practice of industrial design will have to be enriched by new instruments and their influence on the design methodology will have to be considered: the application of computers, of automatic drawing, combinatorial analysis, theory of games and listing procedures.

---

149 Ibid., 24.
150 Ibid., 25.
Moles’s defense of neo-functionalism was criticized by Jean Baudrillard at the 1972 “Universitas” conference at the Museum of Modern Art in New York.\textsuperscript{151} For Baudrillard, the entire discourse of functional objects since the Bauhaus had been founded on a false separation of utility and aesthetics. The ideal of “reuniting” form and function masks the fragmentation that had already taken place at the level of objects, which have been broken down into “simple, rational, analytical elements” that are “reassembled into functional aggregates.”\textsuperscript{152} A further level of fragmentation takes place as objects become “semiologically disarticulated,” or turned into signs.\textsuperscript{153} Baudrillard argued that the rationalism of functional design is inseparable from the rationalism of consumption; hence, he believed the crisis of functionalism as described by Moles was a false one. The crisis of functionalism also indicates a crisis for objectivity:

> Designers, urbanists, and environmental planners are confronted every day . . . with the decay of objectivity. The function(ality) of forms, of objects, becomes, from day to day, more unattainable, more illegible, more incalculable. Where is the object’s centrality, its functional equation today?\textsuperscript{154}

Baudrillard describes function as an equation, but it is one that has become “incalculable.” Here he touches upon one of the central struggles at Ulm – to find the proper calculation with which to ethically respond to the demise of functionalism:

> It serves no purpose to deplore, as does Abraham Moles, the fatal destiny of consumerism and to call upon a neo-functionalism. . . . This neo-functionalism cannot but be that of a re-semantization (a resurrection of signifiers) and, therefore, 


\textsuperscript{153} Ibid., 51.

\textsuperscript{154} Ibid., 59.
a recycling of the same contradictions. Even more likely, neo-functionalism will be in
the image of neo-capitalism, i.e., an intensification of the play of signifiers,
mathematization and cybernetization by the code. A humanist neo-functionalism
does not stand a chance against operational metadesign. The era of the signified and
of the function is over: it is the era of the signifier and of the code that begins.\footnote{155}

Baudrillard’s accusation, which came shortly after the closing of Ulm, indicates a
breakdown of the economic and moral structure that Ulm was based on. For
Baudrillard, functionalism stems from a puritan asceticism that established an ethics of
objects. Thus, if, as Baudrillard claims, the entire conceptual construct of functionalism
is already suspect, then functionalism would no longer be able to set itself apart from its
morally suspect “others”: kitsch or surrealism. Moles, like many of his colleagues at Ulm,
reacted to the anarchy of consumer culture by imposing systems. But Baudrillard argues
that this anarchy of bad objects is precisely the rationalism by which capitalism
operates.

Baudrillard, like many post-modernist theorists, believed that the objective premise
of functionalism had crumbled. Objects don’t matter anymore, as they have been
replaced by messages.\footnote{156} If there can be no differentiation within the stream of
consumer goods, if they are all part of the same rationality, then the conscious
resistance to the market practiced by many at Ulm would be futile. However, it does not
seem entirely correct to say that Moles and others at Ulm were advocating for a return
to the signified or function in a conventional sense. Many designers at Ulm were already

\footnote{155} Ibid., 61–62.
\footnote{156} “This ideology of communication reigns everywhere – cybernetics passing itself for a neo-humanism,
the profusion of messages having in some way replaced the profusion of goods (the myth of plenty),” Ibid.
seeking political and ethical uses of the products of the “era of the signifier and of the code.”

**Scientific Marxism: Industrialized Building at Ulm**

Cyberneticians like Moles sought an equation that could optimize design to meet social needs. This calculation required a high degree of abstraction in order to render material conditions mathematically calculable. An alternative approach was sought in Ulm’s Department of Building, which rejected the cybernetic approach in favor of reengagement with the material and social realities of industrial culture. Looking back to a form of rationalism familiar from early modernism, architects at Ulm called for a return to “scientific” methods based in experiential material evidence, but also in social facts and realities. Design for a fully industrialized consumer society was approached from the molecular level of components and systems that offered countless possibilities in their assemblage. Society was to be restructured from the bottom up, and without waste, through universal standardization and the careful organization of production.

While many histories of Ulm portray architecture as peripheral to its curriculum, it was the largest department after Product Design, with an average of twenty-eight students per year. The department was initially led by Bill, who had students work on the austere design for the school’s building, but its future direction would be determined by another instructor, Konrad Wachsmann, who introduced prefabricated

---

157 Gerhard Curdes, *Die Abteilung Bauen an der HfG Ulm: eine Reflexion zur Entwicklung, Lehre und Programmatik* (Ulm: Club Off Ulm, 2001). While a department for city planning was also mentioned in early brochures, it did not become a permanent part of the curriculum.
systems and components for building. Many guest lecturers also came through the department, among them Buckminster Fuller and Frei Otto, who arrived when Wachsmann left and taught two seminars on the topic of lightweight construction. Eventually, the architect Herbert Ohl took over what was now called “Building” or “Industrialized Building.” Ohl specialized in the technical design of building systems based on highly developed modular components and connections. The department was also led by Schnaidt, whose socially oriented functionalism was the counterpart to Ohl’s technical precision. Schnaidt, a dedicated Marxist, activist, and scholar of Hannes Meyer, approached building from both a political and a technical standpoint [Fig. 1.41].

In the Department of Building architecture was treated as a task of technical and material problem-solving; form was a “peripheral” issue. The department focused on

The growing volume and also the increasing anonymity of demand; the structural changes occurring within the organizations that project and construct buildings; the closer collaboration between all those involved in construction; the greater demands for precision and organization . . . the growth of standardization . . .

158 Ibid. Wachsmann taught at Ulm from 1954 to 1957. Bill was asked to leave in part because of pressure exerted by the architecture students. According to Claude Schnaidt, students in the building department started the “revolt against Bill.” Schnaidt, “Damals stand ich im Lager der Optimisten,” 51.

159 Otto taught at the school between 1958 and 1960. Other instructors included Guilio Pizetti, Giuseppe Cribini, Bruce Martin, Joseph Rykwert, Peter Sulzer (a student of Eiermann), Bern Meurer, and Günther Schmitz.

160 Herbert Ohl completed a degree in architecture at the TH Karlsruhe in 1952, where he studied with Egon Eiermann, for whom he worked until 1954. Ohl came to Ulm in 1956, and was on the council of deans several times before becoming the dean from 1966 to 1968. Ohl also contributed a project to the well-known PREVI competition for housing in Lima in 1968, and was one of six finalists.

161 Schnaidt studied at Ulm between 1954 and 1958, initially working with Bill (whose office he had also worked for in Switzerland) and then with Wachsmann. Before returning to Ulm to teach in 1962, he worked for the European Economic Commission at the UN and the Office for the Standardization of Urban Construction in Warsaw, as part of his ongoing effort to work and publish across the boundaries of the Cold War. Schnaidt authored the first monograph on Hannes Meyer in 1965, reinterpreting Meyer’s legacy of the scientific analysis of social and economic conditions within the political context of the 1960s. Claude Schnaidt, Hannes Meyer: Bauten, Projekte, und Schriften (Teufen: Niggli, 1965).

Fig. 1.41
Top left: Herbert Ohl teaching at Ulm. Photo Hans Conrad.
Bottom left: Claude Schnaidt as a student at Ulm. Photo Hans Conrad.
Top right: Claude Schnaidt lecturing in Leningrad during an HfG Ulm student trip to the USSR, 1964.
the ever more frequent recourse to scientific research and systematic experimentation.\textsuperscript{163}

This approach typically translated into designing prefabricated construction systems, modules, and parts, such as plastic sheets that were folded using mathematical patterns to create structural panels without material waste, completely prefabricated bathroom modules, and concrete cells that could be stacked or arrayed to form housing [Figs. 1.42, 1.43]. Reflecting on Ulm years later, Schnaidt characterized the school as follows:

“Route schedules instead of advertising posters, medical instruments instead of upholstered chairs. Bathroom cells instead of country houses. We emphasized providing for the public sector.”\textsuperscript{164}

When it came to architecture, calculation was applied to production, fabrication, and social needs, as opposed to form or geometry. But the building department also rejected the quantitative approach of cyberneticians like Moles and Bense. Schnaidt in particular viewed his position in relation to science as distinct from those whom he called the “methodologists”:

The most radical methodologists, who wanted to solve everything with applied mathematics and tables, were previously the most radical Billists. They became turncoats in a flash. We did not have a shared project, whether in terms of form-making, science, or pedagogy. When in addition you discover that the former apostles of “good form,” who were then reschooled into intolerant cyberneticians, then pronounce the death of functionalism, you get fed up.\textsuperscript{165}

\textsuperscript{163} From the teaching program at the HfG 1964-65, quoted in \textit{Ulm Design: The Morality of Objects}, 204.
\textsuperscript{164} Ibid.
Fig. 1.43
Herbert Ohl, Student Dormitory Utilizing Space-Unit Construction
Institute of Industrialized Building
ulm 14/15/16 (December 1965).
The department integrated studies in the social sciences – sociology, ergonomics, psychology – to determine user needs and behavior.\textsuperscript{166} However, other sciences at Ulm, like semiotics, cybernetics, or communications theory, were not applied to architecture, even though this was in vogue in West Germany in the 1960s.\textsuperscript{167} Schnaidt was particularly vehement in his critique of these “Architechnocrats”:

One meets him everywhere, in the antechambers of the ministers and in the large, air-conditioned development offices, but also in the dusty, romantic small studios. . . . He feels comfortable in so-called consumer society, but this doesn’t stop him from criticizing it. He is modern. His vocabulary is borrowed from cybernetics, structuralism, and serious publications. Although he likes playing with ideas, he is uncomfortable with ideologies and predicts their speedy demise. He wants things to be determined by rationality, achievement, and pure technology. He has an unbounded trust in the power of machines, in computers, and in organization.\textsuperscript{168}

This essay, written in 1968, parallels the suspicion of technocracy shared by the student movement and counter-culture in both Europe and the United States. But while Reyner Banham had once described Ulm as “a cool training ground for a technocratic elite,”\textsuperscript{169} Schnaidt insisted that technocratic tendencies were “under control” at Ulm.\textsuperscript{170}

Nevertheless, the technocratic claims to political neutrality – “they are against all

\textsuperscript{166} The courses listed included \emph{Soziologie, Kultur- und Fachgeschichte, Psychologie und Wahrnehmungslehre, Ergonomie, Physiologie, Methodologie, Ökonomie, Planungstechniken, Ökologie,} and \emph{Urheberrecht/Urheberrecht}. HfG Ulm Archiv.


\textsuperscript{168} “Trotzdem trifft man ihn überall, in den Vorzimmern der Minister und in der großen klimatisierten Entwicklungsbüros, aber auch in den staubigen und romantischen kleinen Ateliers. . . . Er fühlt sich in der sogenannten Konsumgesellschaft wohl, was ihn aber nicht an gelegentlicher Kritik derselben hindert. Er ist modern. Sein Wortschatz ist von der Kybernetik, dem strukturalismus und der seriösen Veröffentlichungen entliehen. Obwohl er mit ideen gern spielt, findet er Ideologien unbefanglich und sagt ihre baldige Auflösung voraus. Er möchte die Rationalität, das Leistungsprinzip und die reine Technik ans Ruder bringen. Er hat ein unbegrenztes Vertrauen in die Macht der Maschinen, in die Computer, in die Organisation.” Claude Schnaidt, “Die Architechnokraten” (1968), in Schnaidt, \emph{Umweltbürger und Umweltmacher}, 39. Originally published in \emph{Deutsche Volkszeitung}, Dusseldorf (January 3, 1968): 11. Also published in \emph{Bau} 23 (1968): 92–93. Schnaidt admitted that computers could help solve complex problems for architects, but he argued that they were only as effective as the data that was entered.


\textsuperscript{170} Schnaidt, “Damals stand ich im Lager der Optimisten,” 53.
ideologies, yet craft one for themselves in order to compensate for their powerlessness in bringing technology and reason to power” – could certainly describe some of his colleagues at Ulm.\textsuperscript{171}

In the case of Schnaidt especially, the “neutral” ethics around rationalism that had initially characterized Ulm were transformed into an openly political project.\textsuperscript{172} In a later interview, Schnaidt would explain his political commitment to scientific methods:

If you want architecture to be a weapon used for the masses of the disadvantaged, then it must be cleansed of its false secrets, healed of its tendency to fabulate. The progressive architect must adopt the scientific method, he can only lean on that which can be grounded in experimental evidence.\textsuperscript{173}

For Schnaidt, architecture must free itself of myth. He argued that architectural reactionaries were on the side of Hexereiarchitektur (witchcraft architecture), while progressives like himself were guided by science.\textsuperscript{174} In this suspicion of form that cannot be empirically “proven,” Schnaidt was still very much a participant in the ideological and moral belief in the neutrality of science.

Schnaidt’s position was one that lay at the heart of the question of rationality and myth as discussed by the Frankfurt School. The only way to banish myth from architecture was to adhere to a “true” scientific method and an austere form of functionalism. Rather than regarding these with suspicion, Schnaidt hoped for a

\textsuperscript{171} “Die sind gegen alle Ideologien, aber basteln sich selbst eine zurecht, um ihre Ohnmacht zu kompensieren, Technik und Vernunft zur Herrschaft zu bringen.” Schnaidt, “Die Architechnokraten,” 44.

\textsuperscript{172} Schnaidt was politically resistant to the American influence at Ulm. Others, like Wachsmann, were not. Wachsmann designed a traveling exhibition on industrial building for the U.S. Information Agency while teaching at Ulm. Undated proposal, HfG Ulm archive, Otl Aicher, Hi.O.520, 1–11.

\textsuperscript{173} “Will man, dass Architektur als Waffe der Masse der Benachteiligten dient, muß sie von ihren falschen Geheimnissen gereinigt, von ihrer Neigung zu fabulieren, geheilt werden. Der fortschrittliche Architekt muß sich die wissenschaftliche Methode zu eigen machen, er darf sich nur auf das stützen, was durch experimentelle Evidenz gesichert ist.” Schnaidt, “Damals stand ich im Lager der Optimisten,” 52–53.

\textsuperscript{174} Ibid., 53.
Fig. 1.44

reinvention of the rationalism that had characterized early modernism. He argues that the preceding generations never attained that degree of scientific abstraction which is essential for penetrating to the heart of social realities and thus for truly reflecting them and coming to terms with them in their entirety. Although many architects and city planners wanted to be rationalists, their actions were more a matter of social mystique than a matter of applying rational knowledge.

Even if in his defense of functionalism Schnaidt often looked to early modernists like Meyer, this was largely driven by the sense that the promises of the modern movement had not been kept. In 1968, the year in which the fiftieth anniversary of the founding of the Bauhaus was celebrated (and Ulm was closed), he wrote:

> For 50 years the destruction of our environment and the decline of our everyday life has been unrelentingly progressing. The cities are becoming monstrous traffic machines. Entire regions are becoming desolate. Modern architecture is just a caricature of itself. The “good form” of the aesthetes has become good business for the manufacturers. Thousands of things that are really useless, which soon will seem essential, are thrown into the market. We are being deceived by things: they no longer last, and the packaging fools us as to their quantity, quality, and content. Very subtle, highly-developed means of mass communication are used for the presentation of false information. The world is being chopped up, its broken pieces nourish the so-called consumer society.

---

175 Schnaidt also cites the influence of Nikita Khrushchev’s 1954 “Industrialized Building” speech, in which Khrushchev famously argued against Stalinist ornament and in favor of more economical building. Schnaidt maintained relationships with the Eastern Bloc, working in Poland in 1961-62, and collaborating with the Bauhaus University in Weimar during the 1980s. Schnaidt, “Damals stand ich im Lager der Optimisten.”


Here Schnaidt is very much in keeping with the late modern or post-modern generation of architects who viewed the modern movement as a failure. At the same time, his characterization of the unfinished project of architectural rationalism is similar in spirit to the position represented by Habermas. Schnaidt calls for a renewal of rationalism that goes beyond that of the modern movement:

What is the use of blaming rationalism, when even then it was a matter of a limited, outdated rationalism? Modern architecture is at a dead-end, not because it was too rational, but because it was too unscientific; not because of too much social consciousness, but rather because of a lack of concrete social content.\(^{178}\)

In other words, the problem with rationalism was that it was not rational enough.

What did this scientific project look like when it came to building? As an example one can look at the work produced by the department’s modest internal research and development institute, the Institut für Industrialisiertes Bauen, headed by Ohl. Funded by industry commissions, research was done on lightweight structures, but also concrete slab and modular construction. Structural and material testing was carried out at manufacturing sites as well as at the nearby Technical University of Stuttgart where Frei Otto was also based [Fig. 1.45].\(^{179}\) Ohl was particularly interested in the standardization of building components and types as a way to “introduce order” into the chaos of technical civilization and consumer culture.\(^ {180}\)

---


\(^{179}\) Frei Otto founded the Institute for Lightweight Structures at the Technical University of Stuttgart in 1964.

\(^{180}\) See “Industrialized Building with Steel.”
Herbert Ohl at a testing machine.
Perhaps this was why this research tended to focus on objects rather than buildings. In the research reports and publications created by the institute, many of them written as part of patent applications, what stands out overall is the attention to small objects. These were specially designed components that were part of building systems, which were shown in highly detailed drawings [Fig. 1.46]. The buildings themselves were anonymous assemblages of boxes, and shown with little detail. Architectural form, while suppressed in the buildings themselves, was sublimated into the intricate shapes of the components.

These components had several applications. In a 1960 publication Ohl introduced what he called “Z-Baukonstruktion,” named after a zeppelin-like system of supports for aluminum panels.181 These were designed for tropical and sub-tropical housing, a sign of the global aspirations of the researchers. In a 1960 study on “Kleinraumzellen” (cells for small spaces) Ohl produced a highly detailed report documenting his development of a system using neoprene and aluminum parts to hold together laminated honeycomb paper panels.182 The report describes an extreme economization of time and materials for the research and testing process, and includes photographs of the materials undergoing testing and manufacturing, and innumerable drawings for possible configurations of the panels. Many of these research projects concluded with highly realistic models of the finished buildings, usually photographed as if under construction,

182 Hochschule für Gestaltung Ulm. Institut für Industrialisiertes Bauen, Integrale Baukonstruktion; Versuchskonstruktion 1, Enwicklung (Ulm: 1960).
Fig. 1.46
Herbert Ohl, construction system details.
Top:
Hochschule für Gestaltung Ulm, Institut für Industrialisiertes Bauen,
*Integrale Baukonstruktion; Versuchskonstruktion 1, Enwicklung* (Ulm: HfG Ulm, 1960).
Bottom:
Institut für Industrialisiertes (Ulm: HfG Ulm, 1960).
Fig. 1.47
Photo collage showing construction of a high-rise.
Frank Geiser and Herbert Ohl, *Neue Tendenzen und Aufgaben im Wohnungs- bau.* Institut für Industrialisiertes Bauen an der Hochschule für Gestaltung Ulm (Ulm: Hfg Ulm, 1959-60).
complete with model cranes and trucks [Fig. 1.47]. The emphasis lay in the manufacturing and construction, and not human use.

One prototype of such a system was constructed at Ulm, (the so-called “Integral Building System”), which was developed under the guidance of Ohl from 1957-61 [Fig. 1.48].\(^\text{183}\) The system of sanitary-looking panels was featured on the cover of Ulm in 1965 [Fig. 1.49].\(^\text{184}\) The design apparently allowed for the construction of buildings up to six stories, based only on aluminum sandwich panels joined with neoprene seals, eliminating traditional architectural hierarchies of beam, ceiling, wall, and floor.\(^\text{185}\) The system was designed according to a 10cm module, which was then being promoted as a building standard by the OEEC (Organization for European Economic Co-Operation), established as part of the Marshall Plan to integrate European economies.\(^\text{186}\) The generic nature of the system, designed without a specific program or site, seemed appropriate for an imagined future Europe without economic or national borders.

In addition to designing small-scale components, exhaustive studies were done on standardized floor plans and possible configurations of the building systems. This aspect of adaptability and open possibility was just as important as the components

\(^\text{183}\) This system was also the subject of Claude Schnaidt’s thesis project, together with a theoretical section in which he studied the politics of Soviet housing. The thesis referees were Tomás Maldonado, Herbert Ohl. Bruce Martin was a co-referee. Claude Schnaidt, ”Industrielle Baukonstruktion/Sowjetische Architektur. Industriell gefertigte, universale und integrale Baukonstruktion. Entwicklung und Anwendung von Sandwichflächenelementen. Zu der Entwicklung der sowjetischen Architektur—die Wohnungspolitik in der UdSSR” Thesis, Ulm Hochschule für Gestaltung, 1959. HfG Ulm Archiv.

\(^\text{184}\) *ulm* 12/13 (March 1965): 57–60.

\(^\text{185}\) Ibid., 58.

\(^\text{186}\) Bruce Martin, an instructor at Ulm, was involved with the OEEC project. See Christine Wall, *An Architecture of Parts: Architecture, Building Workers and Industrialization in Britain 1940–1970* (Hoboken: Taylor and Francis, 2013). Schnaidt specifies that they were interested in standardization, but did not use Ernst Neufert’s system of building norms. Schnaidt, “Damals stand ich im Lager der Optimisten,” 52.
Fig. 1.48
Fig. 1.49
themselves. In a 1960 study on industrially-fabricated schools there are pages of data on the average height of children at various ages and the typical organization of a child’s day, indicating that there was also a biometric and social metric aspect to this approach to architecture [Fig. 1.50].

While most research in the department was focused on these sober, pragmatic building systems, there were also techno-utopian projects that glorified the possibilities of an advanced industrial society [Fig. 1.51]. Still, building at Ulm stopped short of the exuberant techno-architecture that was typical in the avant-gardes of the 1960s. While Schnaidt criticized “emotional” and “neo-baroque” forms that disguised the functional aspects of building, he was just as much against the fetishistic and idealized use of technology that he saw in the avant-garde futurist architectures of the 1960s, which resembled “space ships, packaging, computers, refineries or oil rigs.” In the 1964 essay “Prefabricated Hope” he questioned the myopic focus on technical solutions suggested by the fashion for pre-fabrication, viewing it as a form of propaganda that uses the apparent objectivity of technological design in order to cover up larger systemic issues.

This theory of building based in traditional industrial production and ideas of function came at a moment when there was a turn to post-industrial models of designing space, and anti-functionalist criticism had begun to dominate architectural discourse and public opinion. As Maldonado put it, Ulm was based on “the idea that

---

188 “This unlimited confidence in the potentialities of technology go hand in hand with a surprising degree of naivite concerning the future of humans.” Schnaidt, “Architektur und Politisches Engagement,” 29.
Clockwise from top left:
Possible combinations of 50cm units.
Table showing programmatic needs and space types for a children’s school.
Proposed unit for children’s classroom.
Fig. 1.51
Top left: Herbert Ohl, Spherical Movie Theater, 1956.
Lindinger, *Ulm Design: The Morality of Objects*

industry is culture, and that there exists the possibility (and also the necessity) of an industrial culture.”

Ulm was an example of the radical cultural transformation towards scientization in West Germany. In a little over a decade the early anxieties around rationalism and the fate of the human were translated into a political project based on the premise that the human environment could be rationally designed, measured, and calculated. Aicher’s 1949 poster “What is the Human Being?” had shown an abstract and fearful figure, unprotected from the “inhospitable” environment that surrounded it. A 1965 issue of Ulm featured a confident male figure wearing high-tech plastic suit designed to prevent the body from contamination by nuclear radiation [Fig. 1.52]. The human figure once threatened by technology was now protected against these threats by technology itself.

---

190 Ulm Design: The Morality of Objects, 223.
Fig 1.52
Protective Suit, student research project (1965).
Tutor: Tomás Maldonado.
"Development of a suit that protects the employees in reactor plants, isotope laboratories, and preparation facilities for reactor fuel against the incorporation of radioactive particles."
ulm 14/15/16 (December 1965).
Part II
Calculating the Minimal
The ethical project of the Ulm School for Design had set the precedent for the coming together of humanist and scientific ideas in design culture in West Germany. By the late 1960s, however, this humanist philosophy, the politics of the Nazi resistance movement, and the cultural influence of the Bauhaus had become less relevant.¹ These changes had already started to take place within the Ulm School for Design, with Schnaitd and Ohl addressing more global and contemporary social concerns. By this time, Verwissenschaftlichung (scientization) was firmly established in experimental architectural practices in West Germany, but was no longer directly tied to the project of democracy. Rationalist thinking was now applied to the politics of managing the emerging social risks resulting from reconstruction and urbanization. There was growing awareness that it was not only the individual human subject that was under threat, but entire human populations and the natural world. This use of science to manage risk was in some ways a continuation of the work at Ulm, which had focused on the problem of the new complexity of environments, systems of communication, and production.

The “hard” scientific culture established at Ulm softened with the new experiments in engineering and ecological architecture. It seemed that there were more technicians and scientists involved with architecture than ever before, and yet the approach to scientific research was also less orthodox. By the late 1960s, architects and planners were influenced by the politics of the student movement, and by outsider figures like Buckminster Fuller. Alternative forms of construction were sought in light of the destructive effects of industrialization on the built environment.

¹ See Frei Otto, “Eine Persönliche Stellungnahme zur Hochschule für Gestaltung in Ulm,” IL Bericht 06/69, Mitteilungen des Institute für leichte Flächentragwerke, Universität Stuttgart, 3.
Fig. 2.1
Institut für Leichte Flächentragwerke (IL) under construction, around 1968. TU Stuttgart University Archive.
One response to this new ethics was the combination of austerity, technology, and nature that characterized the work of the Institute for Lightweight Structures, founded by Frei Otto in 1964 at the Technical University of Stuttgart [Fig. 2.1]. Here Otto was at the center of a large nationally sponsored research project on wide-span structures – the so-called *Sonderforschungsbereich 64* (Special Research Area 64) – which involved some twelve institutions. The work of the institute was supported by technical facilities, scientists, and student researchers. The institute’s focus on lightness stemmed from both ethical and economical concerns, two categories that had been linked since the 1950s. Politically, however, this work still bore traces of Ulm’s anti-fascism. Otto wrote of architectural lightness as having the power to literally and instrumentally oppose violence and brutality:

Inadequate environmental measures can have a decisive influence, and can lead to murder and bloodshed. . . . The current inability of “environmental architects” [*Umweltarchitekten*] to master this problem indiscriminately affects innocents. We still have not learned to design the human earth in a “peaceful” way. . . . Still, the architect knows that through the technological means of building, aggressions can be entirely inhibited.³

Otto viewed the student movement, with which he partially sympathized, as a continuation of the political “spirit” of Ulm:

---

² The Institute was generously funded by the German government over the course of two decades through the Deutsche Forschungsgemeinschaft (DFG). The Volkswagen Foundation also provided 200,000 DM for the IL building in 1969. Letter from Frei Otto to Dr. Gambke, Volkswagen Foundation, April 3, 1969, TU Stuttgart University Archive, File 137, No 70.

The fight against the established, state power that regulates human development is also an important driving force today. The names have lost their tone through distortion. But the spirit has nevertheless almost unnoticeably become a true and deep-rooted tradition. It is part of the ideology of the modern student movement.4

The West German government shared Otto’s belief in the political message of lightweight architecture, choosing the work of the IL to be the centerpiece of the 1972 Olympics in Munich. This was a project of great symbolic importance: the last Olympics held in Germany had been in Berlin in 1936 under the Nazis. Otto’s light and ethereal yet high-tech architecture seemed to be the right image to show that West Germany was now a democratic and progressive nation. The timing of the Games was especially loaded as the event was planned during a turbulent political period in West Germany, when its democratic institutions were under scrutiny by the student movement and the government had recently passed the 1968 Notstandsgesetze (Emergency Laws), which made a state of exception constitutional. The violent terrorist attack at the 1972 Olympic Games was a humiliating reminder of the inadequacy of architecture as an instrument of peace.

The ethical project that will be discussed in this section was rarely an overtly political one, however. The central concern of this architecture was the search for a structural and material minimum – a search inspired by processes of optimization and economy that were observed in the natural world. Architectural austerity had defined the materials and methods of postwar reconstruction, including at Ulm, as seen in Bill’s

---

design of the school’s building, with its exposed, unfinished surfaces and standard parts. By the late 1960s, however, architects were no longer building on ruins, and the acute demand for housing had largely been met. West Germany was a wealthy, technologically advanced society. Ideas of scarcity and austerity were thus largely abstract, and no longer related to “real” material and economic value. I will demonstrate in this section that these concerns with economy were sublimated into the optimization of form and the philosophy of the “minimum.” Furthermore, giving design over to autonomous and self-forming architectures governed by the laws of nature was a way of addressing the political problem of architectural authority.5

These experiments in minimization also signaled a retreat from political events, for they took place in the lab, in a controlled environment with a limited number of variables. Models were built to simulate real conditions, but paradoxically, the quest to achieve minimization required a full range of scientific instruments that generated enormous and redundant amounts of information [Fig. 2.2]. Here, as at the Ulm School for Design, form no longer describes discrete objects but rather describes complex sets of relationships that are monitored, measured, and controlled. Repeated experiments, and the data gathered from them, produced excess, entropy, and noise. Defining a minimum – economically, structurally, or otherwise – proved difficult as there were limits to what could be measured. Furthermore, the very values that defined a minimum, such as material performance or energy consumption, were unstable and

5 In an interview on Deutschlandfunk radio with the architectural historian Wolfgang Pehnt, Otto suggested that plants and animals should also have authority: they should “have a seat in parliament.” “Es ist ein Gedanke, ob nicht Pflanzen und Tiere auch einen Sitz im Parlament haben sollten.” Interview on February 19, 1983, transcript p. 12, TU Stuttgart Universitätsarchiv, Bestand 137, No. 19.
Fig. 2.2  
Frei Otto (second from right) and his team next to a measuring model. IL, 1971.
prone to fluctuation. The architecture had to respond by becoming flexible and adaptable, by self-regulating.

The search for a minimum also resulted in ephemeralization. The work at Ulm had been focused on creating commodities and objects, even if systems were deployed to achieve this. In comparison, the pavilions and delicate models created at the IL were ephemeral, as was the evidence of its research: projections, photographs, time-based experiments, graphs, and publications. The tools and devices used at the IL were of particular importance – they marked the threshold between real and incalculable matter on one side, and models, equations, and systems meant to measure, calculate, simulate, and predict on the other. Calculation was used to turn material into information, to translate between the continuous and the discrete.

Adorno and Horkheimer described the domination of nature as central to rationalism, and as achieved in part through mathematical descriptions of the world: “Nature . . . is what can be registered mathematically; even what cannot be assimilated, the insoluble and irrational, is fenced in by mathematical theorems.” The experimental “green” architecture of the 1960s had a conflicted relationship to rationalism. It was reverent of the natural world as a source of knowledge and of cultural and ethical legitimation; but it was at the same time entirely based on the objectification and domination of nature through scientific methods.

---

I. AN ECONOMY OF FORMS

According to Frei Otto, he established his principle of lightweight structures while imprisoned in a French camp for German soldiers from 1945 to 1947. Otto had interrupted his architectural studies at the TU Berlin to serve in the war as a pilot and was twenty years old when he was sent to Dépôt 501 Le Coudray, near Chartres. At this large camp housing 38,000 soldiers, with the typical rationing of food and other resources, Otto became a draftsman and eventually head of the camp construction squad (with the title of Architecte et Ingénieur en Chef du Dépôt). One of his first projects was the design and construction of a cemetery for dead German soldiers. Otto describes taking apart destroyed tanks or finding “a little bit of cement,” a material scarcity that he saw as the foundation of his concept of the minimal.

The project that led to his principle of the lightweight was a bridge for crossing the Eure River, for which old railroad tracks were to be used. The bridge, which was never built, was based on the reworking of an engineer’s truss diagram to create a simple, fish-shaped structure [Fig. 2.3]. This early design became part of an origin myth for Otto, who often made reference to it, and even published a small drawing of it several times. In his retroactive idealization, the prison camp became a place for creativity: “there was

---

8 When Otto visited the cemetery fifteen years later, it had been dismantled and the remains of the soldiers returned to Germany. He later commented: “It was very ephemeral, in spite of the ‘eternal’ stones.” Heinrich Klotz, “Gespräch mit Frei Otto,” in Architektur in der Bundesrepublik (Frankfurt: Ullstein, 1977), 231.
9 Ibid.
Fig. 2.3
Frei Otto, Design for a bridge over the Eure River, Chartres, 1945.
hardly any material available, but lots of time for thought and experiments.” The rationing of materials and organization of labor were constraints to which Otto responded with form. His accounts of these formative experiences betray the true economic principle from which Otto’s work originates: the logic of the camp and its necessary aesthetics of scarcity. While Otto’s lightweight architecture was a flight from oppressive architectures, its underlying economic principle nevertheless stemmed from the most severe rationalization.

This section will look at architecture and calculation from the perspective of economy and the management of expenditure. This can take the form of attempts to find, and calculate, minimal forms but also an economy of materials and energy. Otto makes reference to economy in his writing in several ways, using terms like “minimum,” “cost-efficiency,” “least effort,” and “simple.” Economy will be examined here in two different ways. First, I will look at economy in Otto’s project to create a rational ordering and charting of all matter according to principles of lightness and energy expenditure, using an invented equation that he called the Bic. And second, I will examine economy in Otto’s experiments in “green” architecture, especially his idea of using climate and enclosure as a way to achieve energy efficiency.

For Otto, ideas of economy were intimately related to those of ecology and nature. Ecology, a term first used by Ernst Haeckel in 1866, refers to the relationship of

---

11 The German words used by Otto are Minimum, Wirtschaftlichkeit, geringsten Aufwand, and einfach.
maintenance and exchange between an organism and its environment. Haeckel described ecology as “the study of the economy, of the Haushalt of animal organisms.” Ecology and “economy” share the same origin – the Greek word oikos. These terms have since drifted apart, but one can speak of a shared preoccupation with maintaining the integrity and sustainability of a place of dwelling or, to put it differently, maintaining the balance of a “household.” In the Aristotelian model, economy is the managing of the finances of the private sphere (the oikos), and its objects and goods, which was opposed to the public sphere of the political.

The philosopher Michael Marder suggests, however, that there is a nuanced, yet important difference in how these terms stem from the oikos. Economy is based in nomos, which refers to the division, enclosure, and distribution of the oikos (through private property, for example). Ecology, which is determined by logos, is dialogical, and is a space of open, unprotected borders, or “the context of interpretative acts that unfold on the planet we share with other human and non-human beings; in the houses, households and societies we are a part of; and in the intimacy of psychic life.” This reading suggests that the two concepts may be directly at odds with one another, and may help explain the tension between “closed” systems of economic reason in Otto’s approach to nature, versus an “open” relational approach of integrating different forms of life.

By the 1950s and ’60s, ecological thinking had similarly expanded to include a far

---

12 Ernst Haeckel, quoted in Erwin Morgenthaler, Von der Ökonomie der Natur zur Ökologie: die Entwicklung Ökologischen denkens und seiner sprachlichen Ausdrucksformen (Berlin: Schmidt, 2000), 249.
more expansive and intricate balance of systems made up of environments and organisms, including humans. This systems approach would eventually be applied to not only natural but also social environments, as seen in the writings of cyberneticians and systems theorists, and of course, in the research at Ulm. Like the designers at Ulm, Otto attempted to represent vastly complex systems, specifically those that intersected with both ecological and economic realms. Otto pursued these connections during the formation of the environmental movement in West Germany in the 1960s and ’70s. In the 1960s, alarming prognoses about the future of human habitation were made by European futurologists like Ossip K. Flechtheim and Robert Jungk.15 German translations of publications such as The Limits to Growth (1972) and The Population Bomb (1968) fueled a sense of urgency, and solidified the belief that economic and ecological systems were so intricate that they could only be understood through computational simulation.16

During the course of the 1970s and ’80s, Otto became increasingly concerned about the impact of humans on the natural world and climate, and his arguments for natural structures were made in favor of global environmental concerns. He had observed the deleterious effect of humans on the built environment as early as the 1950s, however. In his 1956 article “The City of Tomorrow and the Single-Family House,” Otto writes of the disconnection of humans from “the weather” through their construction of artificial

16 Dennis Meadows et al., Die Grenzen des Wachstums, trans. Hans-Dieter Heck (Reinbek bei Hamburg: Rowohlt, 1973); Paul R. Ehrlich, Die Bevölkerungs bombe (München: C. Hanser, 1971). Through his contacts with Buckminster Fuller, Otto was likely familiar with his World Game, which Fuller began developing in 1961.
climates in homes and offices: “The human rules the earth and changes it. His influence on the weather is great, yet he seldom improves it. The creation of climates favorable for life is, however, the main task of every designer of the environment.” By 1980 Otto viewed humans as not only changing the weather but the entire cosmos of objects that surround them:

> Man has until now been a stranger to the rest of nature. He seizes, he alienates it, he makes his own world. He is the newcomer. He changes the objects of inanimate and animate nature. He changes himself. Even though he is an object of animate nature, he can be unnatural. He is, at least, unnatural towards that wholeness that was here before him.

This alien behavior puts the human at risk: “Can man really understand nature enough so that he can act naturally? I think that if he cannot learn to do this, his existence is endangered.”

Economy, then, seems to be part of a project of ecological risk management. But it was also an ideological project. Otto’s concerns with efficiency and optimization may have stemmed from the constraints posed by wartime material shortages, but in the abundant years during and after the Wirtschaftswunder, lightness increasingly became a virtue in itself. For Otto, lightness was explicitly associated with the historical and political project of rebuilding West Germany; he believed that lightweight, flexible

---

architecture “might bring about a new and open society,” and viewed it as a response to the heavy monumentality of both the architecture of the Third Reich and the cheap concrete buildings of postwar reconstruction. Otto was in some ways continuing an avant-garde tradition from the interwar period that was similarly preoccupied with lightness and dematerialization. Yet, those avant-garde calls for lightness did not carry the “heavy” ethical and economic imperative that Otto insists on. He writes of his own interpretation of the Miesian dictum “less is more”:

“Lightness” was a complicated term in Otto's work, referring not only to the weight and efficiency of a structure, but also to a moral and aesthetic principle in opposition to what he saw as the “brutality” of fascist and concrete architecture, a position that he described with the phrase “Mit leichtigkeit gegen Brutalität.” Otto identifies brutality quite specifically in the late Brutalist-style architecture that had become fashionable in West Germany by the 1970s, but also in the ascetic and “emptied out” modernism that

---

21 Frei Otto once pointed out that Germans consume 60 tons of building materials per capita, 90 percent of which was concrete. IL 24, 87.
22 Perhaps most obvious is the relationship to the work of Bruno Taut, who had similarly criticized the modern metropolis, calling for its “dissolution” and a return to the earth, which he referred to as “a good home” (eine gute Wohnung). Bruno Taut, Die Auflösung der Städte; oder, die Erde eine Gute Wohnung (Hagen: Folkwang, 1920).
had characterized reconstruction.\textsuperscript{25} He sees these as responsible for a \textit{Heimatzerstörung durch Häuser} (“Homeland destruction through houses”).\textsuperscript{26} Lightness would thus respond not only to the problems associated with monumentality, but also to the sins of late modernism.

Thus, while Otto’s intense preoccupation with lightness and economy began under conditions of scarcity, it eventually takes on a life of its own, such that rational minimization becomes an “irrational” end in itself. This minimization can be read as the form of economy that Weber described as “entirely transcendental and absolutely irrational,”\textsuperscript{27} where “the duty of the individual toward the increase of his capital” becomes an end in itself, so that what is preached is “not simply a means of making one’s way in the world, but a peculiar ethic.”\textsuperscript{28}

\textbf{A minimal equation}

As evidence of the irrational nature of Otto’s search for economy, one might look at the “Bic-Lambda” chart created at the IL between 1968 and 1985 [Fig. 2.4]. A kind of cosmology of forms, it is a comparison of the relative strength and lightness of a vast range of materials and structures, including atoms, molecules, celestial bodies, galaxies, leather, bones, hair (both dark and blonde), fluids, gasses, magnets, seashells, eggshells, straw, paper, and wood. What Otto was looking for here was economy. How much of a

\textsuperscript{25} Otto does recognize that the original founders of Brutalism – he cites James Stirling, the Smithsons, and Le Corbusier – were also driven by ethical concerns.

\textsuperscript{26} “Mit Leichtigkeit Gegen Brutalität.”


\textsuperscript{28} Ibid., 16-17.
Fig. 2.4
load can these forms and materials bear, relative to their weight and slenderness? The basis for comparison between these otherwise incongruous objects was achieved through a mathematical formula of Otto’s own invention: the Bic.

The chart was the result of decades of experiments undertaken by Otto and his team of researchers. Because seashells, magnets, and chicken bones are not typically used for building architecture, thousands of experiments had to be conducted in order to determine the values of materials such as the “mass of egg with contents; mass of boiled egg; mass of empty egg shell, etc.” [Fig. 2.5]. Small symbols fill the chart, which we are told represent eggshells, grass, or steel wire. The icons are often literal – tiny cars, bones, bridges, and magnets cover the graph. Some show not just static structures but also moving mice, fish, seagulls, bicycles, and trucks, which stand for the efficiency of transport. The feeling one gets from the resulting image is that there is a stronger desire to contain a total image or system than to actually be able to read it. While new optical instruments, like the electron microscope, had opened up the horizon of measurable objects for Otto, the graphic device with which to contain and classify them seemed not to have been invented yet.

The confusion arises in part because the Bic value was inherently scaleless. It was based on a relative, not absolute, relationship between form and material. According to Otto, “the strength of a material cannot be measured in absolute terms – and strictly

---

<table>
<thead>
<tr>
<th>Nr</th>
<th>Bel</th>
<th>Date</th>
<th>Projekt</th>
<th>Bem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K5-8520A-2</td>
<td>F</td>
<td>N</td>
<td>BEM</td>
</tr>
<tr>
<td></td>
<td>K5-8520A-4</td>
<td>F</td>
<td>N</td>
<td>BEM</td>
</tr>
<tr>
<td></td>
<td>K5-8520A-5</td>
<td>F</td>
<td>N</td>
<td>BEM</td>
</tr>
<tr>
<td></td>
<td>K5-8520A-6</td>
<td>F</td>
<td>N</td>
<td>BEM</td>
</tr>
<tr>
<td></td>
<td>K5-8520A-10</td>
<td>F</td>
<td>N</td>
<td>BEM</td>
</tr>
</tbody>
</table>

Fig. 2.5
IL experiments with eggs, late 1960s.
ILEK Archive.
Fig. 2.6
Bic testing results on bamboo, c. 1967.
ILEK Archive.
speaking, it does not really exist.\textsuperscript{30} Free from the conventional constraints of scale, the chart must contain several orders of magnitude, which are graphed by using logarithmic axes. These objects are derived from the full spectrum of scales in nature – from atoms to planets – and are otherwise incommensurable, at least to the human eye.

Otto relied on a number of self-invented tools in order to determine the economy of a structure. In his calculation of the minimal, Otto experimented with the very standards and codes that are accepted as consensus in the field of architecture. Typically, the calculation of an efficient and safe structure is achieved through a series of equations, material testing results, and accepted safety limits that are industry norms. At the IL, by contrast, the methods of arriving at these calculations were based in material experiments and nonstandard equations. Calculation was not used to test a known structure after the fact, but as a method by which "unknown forms" could be integrated into architectural language. Thousands of experiments were conducted to determine the physical properties of unusual materials like hair and bones. Otto believed that standard testing results were insufficient when it came to finding the “lowest material expenditure.” Nor could “unknown forms” be produced if a structure was first designed and then optimized; optimization had to take place beginning with the material itself.\textsuperscript{31} An efficient structure was also an aesthetic one: these two categories of value were linked through his belief in the superiority of natural structures in producing both

\textsuperscript{31} \textit{IL 21}, 5.
lightness and beauty. Otto thus reinterpreted the very criteria according to which architecture was judged.

The Bic was the most significant standard used by Otto. This invented variable was his attempt to translate his theory of lightweight construction to a quantifiable value that could be tested, compared, and calculated. The Bic equation, and Otto's principle of lightweight construction in general, were based on the interrelationship between three elements: form, force, and mass. As a unit of measurement, the Bic allows for a quantifiable assessment of the efficiency of a structure, taking into consideration not just these variables, but also a number of other potential factors, like material and transportation costs. This standard served mainly to “compare objects of a same form and material, but of differing sizes, or objects of differing form and differing materials, but of the same relative slenderness.”

The equation was thus used as an ordering framework that allowed for comparisons between vastly heterogeneous objects.

According to Otto, the name for the Bic was coined in 1965 at the IL, and was derived by randomly selecting combinations of Scrabble letters. The use of what was essentially a language game – allowing letters to assemble by chance – seems appropriate for the establishment of a variable that was both universal and arbitrary. It also suggests that the Bic was a concept that was difficult for Otto to define, and thus demanded a neologism.

---

32 As he also describes in his essay “Das Ästhetische,” IL 21, 125–162. This essay was written in several stages between 1973 and 1977. It was first presented publicly and discussed on November 18, 1977, at a conference at the IL on “Pneus in Nature and Technics.”

33 In another version, it is “form, force, path, and mass.” IL 21, 42.

34 IL 24, 55.

35 Out of fifteen selections, “Bic” was chosen because it sounded like the name of Otto’s beloved structures teacher at the TU Berlin, Helmut Bickenbach. Otto, preface to IL 24.
Fig. 2.7
Diagrams illustrating the Bic and Tra principles, c. 1967. ILEK Archive.
“Bic” can be generally understood as the amount of mass, energy, or money that is needed to transfer forces along a path. It can be used to describe structures, where mass is the main concern, but also transportation: the amount of energy (fuel or food) to move a truck or a human being, or the cost of shipping or transporting goods. In equation form, it is written:

\[ Bic = \frac{m}{Fs} \]

where \( m \) = mass, \( F \) = force, and \( s \) = distance.

Otto viewed the efficiency of a structure as similar to a network of paths, where the shortest paths would indicate a more efficient structure – hence the use of distance as a variable. The role of force \( (f) \) and distance \( (d) \) can also be understood through a version of the Bic equation where \( Bic = \frac{m}{Tra} \). “Tra” was yet another variable of Otto’s invention; it determines the ability of a structure to “transmit forces” (it is defined as \( Tra = Fs \), or the product of force and distance). “Tra” was coined by Otto in 1964, and its meaning is described as similar to that of “tran” – transport, transfer, etc. (Otto does not mention a similar word – “transparency,” which may have been more relevant to architects one generation earlier). Unlike a vector used in physics, which is also the product of force and distance, Tra does not take into consideration orientation or

---

36 It is useful to unpack the elements of the Bic equation. Mass \( (m) \), not weight, is used, and is expressed in “grams per Newton-meter.” This was apparently unusual: “Criticism and misunderstanding at the University of Stuttgart were my lot when I worked on lightweight construction, the more so when attempting to measure relative lightweight by Bic in grams per Newton-meter. My colleagues at the College of Civil Engineering have not yet even considered this thought model.” (Otto, preface to IL 24, 9) Otto explains that weight measured by a Newton-meter (which is determined by how far a spring can be stretched by a certain force) was more appropriate to his purposes than a balance scale (which compares two weights) because it was not affected by the influence of gravity. For Otto, the intrinsic quality of a material or structure was more important than how it behaved in a certain context (even under the influence of gravity). Knowing the performance of a structure in spaces without gravity can be attributed in part to his cosmic view, which allowed for the possibilities of architecture on the moon or the measuring of stars and solar systems.
direction.\textsuperscript{37} This aspect makes it similar to Otto’s studies of soap film models, which also had an abstract and context-less space free of orientation and gravity. This path-based approach to structure was influenced directly by Otto’s observations of minimal path systems in soap films as well as threads dipped in water, surface cracking patterns, urban morphologies, and spider webs. Otto’s “network” approach to structures can be understood in the context of research on communications and networks in the 1960s: minimal path systems were studied at the HfG Ulm, for instance, where they were of interest for both their optimized forms and their proximity to communications models.

The Bic was used to calculate many different types of values aside from standard ones like live load and dead load. It was also applied to calculate nonstructural forms of efficiency, specifically ones related to energy. The “traffic bic,” for instance, determines the efficiency of transporting materials according to their weight, path, and fuel costs, and was used not only for trucks but also for bicycles, humans, and even animals, which appear in small drawings in Otto’s diagrams [Fig. 2.8]. “Energy” in every sense was calculated, and could describe the use of biomass in animals and “men who move, spring, or lift something. We can even determine the conductivity of electrical conductors, or the flow of heat and sound, all this thanks to Bic.”\textsuperscript{38}

The concept of the Bic was developed from Otto’s interest in nature. While Otto traces the principles of lightweight construction to his prison camp experiences in 1946, he argues that his ideas reached a critical point through his relationship with biologist

\textsuperscript{37} This is pointed out in Eberhard Möller, “The Lightweight Principle,” in Nerdinger, ed., \textit{Frei Otto: Complete Works}, 36.

\textsuperscript{38} \textit{I.L. 24}, 50.
Fig. 2.8
Detail of Bic-Lambda Chart poster, 1990.
and anthropologist Johann-Gerhard Helmcke [Fig. 2.9]. Otto met Helmcke at the TU Berlin and began collaborating with him in 1961, when they co-taught a seminar on natural construction.\(^{39}\) Helmcke was especially interested in the relationship between biology and engineering, and had co-founded a research group in 1960 on Technology and Biology.\(^{40}\) A seminal member of this group was the aeronautics engineer Heinrich Hertel, who published *Struktur, Form, und Bewegung* (Structure, Form, and Movement) in 1963, a bionic study of the fluid dynamics and structural properties of fish for airplane and ship designs.\(^{41}\) Several other books were influential to the group, including the typological studies in Curt Siegel’s 1960 *Structural Forms of Modern Architecture*, and publications by Konrad Wachsmann (especially his 1959 *The Turning Point of Building*) and Fuller, who later became a friend of both Otto and Helmcke.\(^{42}\)

Later, the Natural Constructions research team at the IL, a collaboration of botanists, paleontologists, zoologists, biophysicists, and behavior scientists, continued the work of

---


\(^{41}\) Heinrich Hertel, *Struktur, Form, und Bewegung* (Mainz: Krausskopf Verlag, 1963).

Fig. 2.9
Helmcke (center) at the IL. 1973. ILEK Archive.
Fig. 2.10
the Berlin group. The scientists included Werner Nachtigall, a zoologist and biologist who was a specialist on insect flight, and Ernst Kullmann, a renowned expert on spiders. It was through these encounters with scientists that Otto began to look at living structures as architectural, concluding that there was a need for a standard unit of measurement to compare a large variety of structural forms and materials. Helmcke too had attempted to measure and represent the structure of diatoms using architectural drawing conventions like sections and renderings, as seen in his “atlas” of diatoms photographed with an electron microscope [Fig. 2.11]. Otto took this one step further by structurally analyzing natural forms, testing materials, and categorizing them according to calculations of their potential performance. The preoccupation with the incalculability of objects that was a theme in his experimental models became a similar problem in the assessment of structures.

It was because of its universality that the Bic made it possible to compare both natural and artificial structures (which might include atoms, molecules, ball bearings, tree trunks, branches, grasses, bones, sails, threads, weavings, nets, beams, steel and wood beams, arched and suspension bridges, air halls, tents, space frames, concrete slabs, and natural stone). Otto believed that the Bic could be applied to all objects: “The

---

43 The work of measuring and calculating Bic values was most intense between 1975 and 1985. The early research on the Bic had been part of a 1969 grant from the DFG (German Research Foundation), which focused on wide-span structures and had helped to fund the work on the 1972 Olympic roofs. In 1984 the IL was awarded a new grant from the DFG for a project entitled “Natürliche Konstruktionen – Leichtbau in Architektur und Natur” (Natural Constructions – Light Building in Architecture and Nature), also known as Sonderforschungsbereich 230 (Special Research Area 230). This vast project involved a large number of outside researchers (including Helmcke) who specialized in the static calculation and measurement of very specific parts of the organic world, whether grasses, birds’ nests, or diatoms.

Fig. 2.11
Bic can be determined at least approximately for any material object without exception (!). One motivation for a universal standard of measurement was to create a continuum between nature and technology: “A wide-ranging compilation of Bic values permits comparative evaluations of the state of development of structures, especially a comparison between objects in biology and technology.”

Otto created several categories to describe the range of objects that could be classified; some are given as examples in the table below [Fig. 2.12].

<table>
<thead>
<tr>
<th>Form world</th>
<th>Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-living nature</td>
<td>Stone, crystals, water pneus</td>
</tr>
<tr>
<td>Living nature</td>
<td>Hair, intestines, skins, stems, branches, straws, shells, bones</td>
</tr>
<tr>
<td>Technology</td>
<td>Threads, sails, chains, struts, beams, vaults, tents, bridges, houses, towers, sports equipment, vehicles, musical instruments, etc.</td>
</tr>
</tbody>
</table>

Within the realm of “living nature” is a special subcategory for various states of life and death: for instance, the structural behavior of a living as opposed to a dead plant or that of an animal that is alive, freshly killed, or dead. One poignant and slightly brutal example can be seen in a pair of photos in the IL archive which show a live chicken, which seems to have been taken by a researcher at a farm, next to a photograph showing a partial chicken skeleton [Fig. 2.13]. Otto similarly describes how, as a boy during the war, he made films of birds in flight, but also picked up the bodies of birds accidentally killed by gunfire and weighed and measured them in the hope of designing

---

46 Ibid.
47 *IL* 21, 64–65.
<table>
<thead>
<tr>
<th>Form World</th>
<th>Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonliving nature</td>
<td>Stones, crystals, water pneus</td>
</tr>
<tr>
<td>Living nature</td>
<td>Hair(^+), intestines, skins, trunks, branches(^+), stalks(^+), shells, bones(^+)</td>
</tr>
<tr>
<td>Technology</td>
<td>Threads(^+), ropes, chains(^+), columns(^+), beams(^+), vaults, tents, bridges, houses, towers, sports equipment, vehicles, musical instruments etc.</td>
</tr>
</tbody>
</table>

\(^+\) Test arrangements are given below for objects designated in this way.

---

Fig. 2.12
Classification table of objects from living and non-living nature.
IL 21 (1979).
Fig. 2.13
Live chicken and chicken skeleton.
ILEK Archive, photo from 1976.
The comparison between living and dead nature seems to be purely based on the question of how the animal is structured internally - a belief that greater economy would be found in a living organism. For Otto, the threshold between life and death was a powerful determination of structural performance:

It is nearly impossible to determine form, material, and material properties on the inside of living objects. Dead objects can be loaded, but objects which have been killed change their mechanical properties within a few seconds or minutes following their death.49

This statement is an extreme form of objectification, in which a living being is considered as a structural object. Like the ephemeral soap bubble, living structures are elusive: they can be measured only in death, but then they change within “seconds.” This morbid paradox is reminiscent of the Victorian practice of photographing the recently deceased, who appear to be in a stage between life and death. Many of the examples of objects tested by the IL occupy this threshold — hair, mollusks, egg shells — which are examples of structures created by “living nature” but are themselves not living. Writing in 1979, Otto believed that superior optimized structures overwhelmingly belong to the category of “living nature”: “from the philosophical viewpoint there can be no optimum structures in non-living nature. . . . Typical optimum structures are found very markedly, exclusively even, in living nature.”50

Even if living nature cannot be measured, it can be observed. As in the case of the soap film models, vision becomes a tool of calculation: “It is possible . . . to observe biological objects with the trained eyes of the ancient architects. To recognize how an object changes its form, to see under which loads failure will begin.” In Otto’s idealist conception of a universal structural principle, the “trained” observation of an object would be enough to render it understandable. For those “lesser” objects that are no longer living, however, measurement and calculation would suffice.

Having considered the process of moving from model to photograph to calculation in the previous chapter, what is the role of the photograph here? Photographic images of these objects played a primary role in the process of comparing different materials. Jürgen Hennicke, a long-time collaborator with Otto, has confirmed that photography was “the central medium” of the work at the IL. Images in the IL archive show eggs, sticks, and bones being tested. The most common view is a cross-section of the object (especially in the case of bones), an image of the object being crushed, or a photograph of the object once it has been subjected to force [Fig. 2.14]. In the case of the latter, objects are neatly lined up according to scale, often with a ruler to document the actual measurement. The photographs, especially images of cut and still bloody bones, suggest a material corollary to the abstraction of numbers seen in the diagrams [Fig. 2.16]. Yet their role is also rhetorical: for instance, in the iconic image of a large bone in a

---

51 “Eine Beobachtung biologischer Objekte mit den geschulten Augen der alten Baumeister ist durchaus möglich. Es ist relativ einfach zu sehen, wie ein Objekt seine Form verändert, bei welchen feststellbaren Belastungen es zu versagen beginnt.” IL 24, 35.
52 Jürgen Hennicke (Instructor, IL, now called ILEK), in discussion with the author, February 2013. By 1970 the IL archive held 25,000 negatives and 8,000 color slides and films. “IL Archiv. Teil 1,” Bericht 06/70, Mitteilungen des Instituts für leichte Flächentragwerke, Universität Stuttgart, Universitätsarchiv TU Stuttgart.
Fig. 2.14
IL experiment with seashell, 1978.
ILEK Archive.
Claus Grünig, “Material Aufwandsuntersuchung an Knochen.” IL Student Project, 1968. ILEK Archive.
Fig. 2.16
IL studies showing cross-sections of bones, late 1960s. ILEK Archive.
Fig. 2.17
Structural experiment using animal bone.
IL, late 1960s. ILEK Archive.
compression test machine, still intact, the bone suggests a column of great strength and monumental character [Fig. 2.17].

Otto’s creation of a universal catalogue of material objects was derived from the same principles as his work with models: a reliance on physical experimentation and the transference of qualities across a wide range of scales. Bic values could not typically be derived from existing material data; thus, literally thousands of experiments had to be conducted at the IL in order to determine the Bic of various and often strange materials. The inclusion of “non-pedigreed materials” (to use a variation of a phrase by Bernard Rudofsky) was meant to be provocative.53

In a 1979 publication showing the experimental determination of “the most important Bics,” various materials are loaded to their breaking point: panes of glass, wooden sticks, straw stalks, metal chains, a chicken bone, horse hair, nylon thread, egg shells, sea shells, and concrete blocks.54 In the conscious effort to include unconventional, natural, and everyday materials, Otto’s criteria was not really the cost of the material but its proximity to nature, and its potentially extraordinary performance. His choice of materials can be viewed in parallel to the “base materialism” that had characterized much of arte povera and post-minimalist art.55 Otto did not elevate the detritus of industrial culture as these movements did, but his use of material suggests a “base” organismism. The natural (and animal) world is idealized on the one hand, but it is also seen instrumentally as the potential source of building material.

---

54 IL 21.
While crystals, stars, and plants were invoked as mystical, symbolic, and decorative themes by the expressionist architects of the early twentieth century, Otto treated them literally, as materials for construction that can be measured, weighed, and classified.

But not all materials could be physically tested, and this is where the “New Landscape” offered by scientific instruments became crucial to overcoming the limits of scale.\(^{56}\) Otto argued that since experiments at the IL can't be conducted on “mountains, towers, or atoms,” they can be applied to “analogous models in other scales.”\(^{57}\) The Bic was inherently scaleless, as it was based on the relative relationship between form and material – thus, a larger object would not have a greater Bic. This scalelessness effectively removed the limits of what could be covered by the equation. But how could this enormous mass of data be organized, not to mention applied? After the “statistical evaluation of thousands of measuring and calculation results,” Otto speculated, “it will at some time be necessary to publish a catalogue of the known Bic values.”\(^{58}\) The IL archives contain countless student research projects and photographs documenting Bic experiments and calculations, so that they would be “ready at hand.” However, surveying these in one system was to take place in the form of a system of graphical notation: the Bic-Lambda chart.

---


\(^{57}\) *IL* 21, 62. Values for objects that were too small or large to test at the IL had to be based on other experiments.

\(^{58}\) Ibid., 54.
The Bic-Lambda chart

The calculation of Bic values was an attempt to translate the transient and sublime qualities of nature into a statistical and numerical form. As Otto so closely associated economy with nature, the experiments seemed to be an effort to derive a pure law of economy from natural objects. These experiments were still, however, limited to individual organisms and objects, and did not yet take into account the larger systems to which these belonged.

The values derived from the Bic equation were organized into graphic representations of great complexity and often perplexing notation. In these charts Otto hoped to create comparative values for forms, a device for the intuitive assessment of structures. Otto cites teaching at the HfG Ulm as among the influences for his systematic approach, or the need to “place a bit of order into this almost infinite range of possibilities.” In other words, the complexity and volume of information produced by the experiments had created the need for an economy of graphic form. As the density of information on minimum values and thresholds increased, the chart came close to a form of excess.

An early version of the diagram was first presented at the German Industrial Fair in West Berlin in 1968. Otto participated in this exhibition together with Helmcke and the architect Rolf Gutbrod. Otto and Helmcke were given an exhibition space in a hall that included findings from similar research institutes in West Germany on topics including

---


60 Deutsche Industrieausstellung, September 27–October 6, 1968, held in the exhibition halls at the radio tower in Berlin. The exhibition motto was “Quality through Research and Development.”
atomic energy and molecular structures. A large amphitheater in the hall, with a pneumatic screen designed by Otto, displayed films and slides depicting the themes of the exhibition booths. The exhibition catalogue shows an iconic image of a diatom, taken from one of Helmcke’s photos, which would later become the symbol used for the IL’s publications.

While it is not certain precisely which materials were included in this exhibition, the Bic diagrams from this period are relatively simple, showing the comparison between mostly familiar building materials. A chart dated to 1971 shows the performance of steel, wood, aluminum, silk, and synthetic fibers loaded according to differing degrees of slenderness [Fig. 2.18]. Otto relied on the Cartesian grid as an organizational device. Here, as elsewhere, the Bic values were mapped against another variable invented by Otto – \( \lambda \) (lambda) – which determines “relative slenderness.” The Bic-lambda diagram was a flexible and expandable structure through which Otto was able to contain all of the data that made up his universal theory of lightness.

As Otto attempted to combine objects (and graphs) of very different scales, new problems of representation began to arise. The 1971 diagram is divided into areas for materials under compression, bending, and tension, as Bic values differ according to

---

61 Qualität durch Forschung und Entwicklung (Berlin: Deutsche Industrieausstellung, 1969).
62 The catalogue text reads: “Otto, with Professor Gutbrod, builder of the German Pavilion . . . demonstrates in wall posters the application of principles from the field of micromorphology that led to stimulation in regard to new ways of stable construction. In the process, the stability and flexibility of different organic and inorganic materials were also illustrated. Professor Helmcke . . . demonstrates living constructions with astonishing support values from the world of diatoms.” Ibid., 20. My translation.
63 The graph is attributed to Gernot Minke, who worked at the IL.
64 \( \lambda \) stands for “relative structural slenderness” and is equal to distance/\( \sqrt{\text{force}} \).
Fig. 2.18
Detail of the bottom left. ILEK Archive.
how an object is loaded. This already begins to create graphical confusion, as do a cloud of small marks close to where the axes meet, which indicate objects with a very low Bic value – presumably cables under tension. The same pattern is seen in subsequent charts, where some of these notational systems became so dense that they were barely legible. This graph presumably was compiled from several others, like figure 2.19, which shows only bending stresses [Fig. 2.19].

The values in the Bic charts were based on experiments conducted at the IL (though Otto claims that some early Bic measurements were already made in Berlin). The introduction of nonstandard materials is seen in a diagram dated to 1967 (and possibly made for the German Industrial Fair), which shows the comparison of several materials under different types of loads (Druck, Zug, Biegung), including atoms, molecules, galaxies, the earth and moon, leather, and bones [Fig. 2.20]. A similar 1971 diagram describes these as the bones of “humans, calves, pigs, geese, and chickens” [Fig. 2.21].

An early text (dated 1971) printed on a slide, presumably for a lecture, gives an explanation of the supposed use for the Bic chart:

Nature and Lightweight Construction: Comparison of Constructions

Until now man has rarely had the opportunity to build lighter than nature does. A comparative number, the Bic, should help here. . . . Practically speaking, the Bic values of all things that can carry forces can be compared, from solid bodies to fluids, gasses, magnets, and celestial bodies. The Bic-comparisons illustrate [veranschaulichen]: tension structures – like sails – are the lightest; compression structures – like columns – heavier; bending structures – like beams – the heaviest.  

---

65 IL 21, 44.
66 IL 24.
67 Slide, IL Archive. My translation.
Fig. 2.19
Bic chart, c. 1967. ILEK Archive.
Fig. 2.20
Bic table showing a variety of objects under different types of loads, c. 1967. ILEK Archive.
Fig. 2.21
Early attempt at a comprehensive representation of different structural systems and their components under different forms of stress. 1971. ILEK Archive.
Otto uses the term “veranschaulichen” to describe the visual process that makes it possible to look at relational comparisons between heterogeneous clusters of information. Visibility and representation were challenged, however, as the notational devices for the charts become increasingly dense and expressive. Otto began to produce charts that included cloud-like shapes to represent a region of results, as well as small drawings showing miniature force diagrams. The obsessive repetition of the same experiment with slightly differing variables created redundancy. The result is clouds of precision, which show general tendencies and fuzzy patterns rather than hard coordinates. This cloudiness is reinforced in the same chart by the use of broad patches of color. The graph is made up of subclusters of materials with specialized Bic functions (such as “magnets” or “transportation”), and uses a notational system in which different materials (hair, grass, atoms) are represented by small icons. The icons are often literal – small cars, bones, bridges, and magnets cover the graph (standard building materials tend to be clustered in the middle, while “fringe” materials appear at the borders). In one early drawing, hundreds of small dots and circles fill the page in clusters, apparently representing repeated experiments, forming “clouds” [Wolken], a word Otto himself uses [Fig. 2.22].

The most ambitious Bic diagram was the poster-size “master” chart that was included in the back of IL 24 (see Fig. 2.4). This chart was an index of several decades of work at the IL, compiling thousands of tests undertaken between 1965 and 1990.68 It contains a density of information that is almost impossible to take in. Because the chart

---

68 One version was made in 1985; the poster dates to 1990.
Early Bic diagram showing colored clouds of data. ILEK Archive.
maps a range of scales that is potentially infinite, researchers at the IL had begun using logarithmic scales for the two axes of the graph (in this case, from $10^{-7}$ to $10^6$) in order to contain the vast range of objects in one space. If mapped into linear, rather than nonlinear space, the graph would have been truly unusable, not unlike Borges’s concept of the one-to-one map of a territory. However, the logarithmic scale unites these seemingly unrelated and vastly distant clumps of information into what appears to be a linear set of relationships. It takes a discontinuous and even cosmic space and renders it continuous and measurable.

In her study of “diagrammatology,” Sybille Krämer looks at the Cartesian grid as a “cultural technique” and “machine of translation” that makes visible, comparable, and transmittable concepts that are otherwise inaccessible and isolated. Krämer sees the Cartesian system as establishing a two-dimensional space of “potential.” More specifically, she points out that the Cartesian system united arithmetic and geometry, which had previously been considered separate realms. It thus serves as an example of Descartes’s notion of a “universal mathesis,” where that which is measurable (magnitudo) and that which is countable (multitudo) are united into a “general quantity.” Otto exploits, and yet subverts, the cultural technique of the Cartesian system. The Bic diagram is an expression of the potential power of a universal mathesis to render nature representable and conquerable. And yet, the diagram is a project of

---

71 Ibid.
futility, characterized by unusual omissions; the most obvious is its lack of legibility. Even if the system of points and notational devices serve as a language or as evidence or a trace of a material act, they no longer convey technical information. If the power of a Cartesian diagram is to unite both algebraic quantity and geometric form, here there is no identifiable form. Where Otto had in his soap film experiments privileged form over quantifiable information, form is undefined here.

While the chart is incredibly precise in some ways, it is also loose and expressive. The expressive qualities of the Bic diagram were developed in conceptual sketches dating to 1982 or 1983, made by Otto either from memory or from an existing graph. In one, a sort of cosmos is drawn, with clouds of marks surrounded by dotted lines showing clear outlines representing data groups, a small drawing of an earth and moon, a mouse, a bird, a bicycle, and fish [Fig. 2.23]. A similar conceptual diagram uses different colors, this time contained in overlapping sausage and bubble-like forms (reminiscent of pneumatic shapes), showing a simplified but wholly inaccurate comparison of values [Fig. 2.25]. Here the graphic quality is not one of accumulated marks but soft, colorful figures.

The density and expressivity of the diagram is reminiscent of other experiments in notational drawing from the time, such as Daniel Libeskind’s 1979 Micromegas or the scores of Karl Heinz Stockhausen and Iannis Xenakis. Libeskind’s drawings, with their references to musical scores, suggest future and past events unfolding in space – a potential (and functionless) architecture that could not be represented using conventional means. Xenakis’s scores similarly show a precise imprecision, depicting
Fig. 2.23
Sketched Bic diagram showing different types of construction. 1982. ILEK Archive.
Fig. 2.24
Compiled Bic diagram, IL, 1985.
ILEK Archive.
Fig. 2.25
Fig. 2.26
“swarms of calculations,” probabilities, and small fragments of aural experiences.\footnote{Iannis Xenakis et al., \textit{Iannis Xenakis: Composer, Architect, Visionary}, Drawing Papers 88 (New York: Drawing Center, 2010), 29.}

While Otto cites Ulm as one of the reasons for organizing information in this way, information design at Ulm was different: it was always optimized to reduce “noise.” Complexity was controlled using carefully designed systems. The Bic chart, like other diagrammatic architectural documents of its time, attempted to represent the possibilities of a new complexity of calculation, a new sublime that was being suggested by the use of computation.

In his experiments Otto moved back and forth between pictorial representations of material structures as captured in photography, and the process of notation, measurement, and calculation. The initial estrangement of matter is followed by an attempt at its mastery through numbers. The Bic chart is a document of the failure of the diagram in this mastery over nature – which proves to have too many variables to account for – and is itself a document that tests the rhetorical limits of this type of notation. In attempting to represent the \textit{minimal} in architectural structures, Otto produced a representational language of \textit{excess} and surplus meaning. The chart shows the irrationality of the process of translating material information into immaterial data through the process of calculation.

Through the Bic system, Otto hoped to create a common, objective criteria by which structures both architectural and nonarchitectural could be judged, and even certain formless or taboo objects and spaces (intestines and animal nests) could be included in the system of classification. Because of this enormous range, the chart can never be
completed because everything could potentially be included. Otto nevertheless lamented that “the main weakness of this diagram is the fact that it is incomplete.”

The chart can be read as one response to the discussions of architecture’s “endgame” during the 1970s: by opening up architecture to the full realm of the natural and physical sciences, Otto was also hoping for a way out. He does this in a different way than the cybernetic and postmodernist architects who turned to formal games of combinatorics.

The paradoxical appearance of excess in trying to represent the minimal is a departure from the questions of scarcity with which Otto’s career began. Economy for Otto seemed to be more of an abstract principle – economy for the sake of economy – than a set of numbers that can be shown in accounting spreadsheets. In fact, Otto admitted that there was no inherent relationship between a lightweight structure and an inexpensive structure: “Lightweight construction should not be equated with economy (Wirtschaftlichkeit).” He clarifies elsewhere:

Structures which, according to the principle of lightweight construction, are capable of transmitting relatively large forces in spite of having little mass, may be considered optimized structures regarding mass expenditure. Those structures that are (both absolutely and relatively speaking) cheap are optimized regarding their production costs; they are considered economical [wirtschaftlich].

The economy of light, optimized structures is thus divorced from notions of economy having to do with costs. Economy found in objects in nature can’t be translated directly

---

73 IL 24, 92. Otto cites gaps in traffic systems, crystals and gasses under hydrostatic compression, and tensile-loaded molecules.
74 “Leichtbau ist nicht mit Wirtschaftlichkeit gleichzusetzen.” IL 21, 58.
75 “Solche Konstruktionen, die nach dem Prinzip Leichtbau bei geringer Masse relativ große Kräfte übertragen können, sind in Bezug auf den Masseaufwand optimierte Konstruktionen. Konstruktionen, die (absolut oder relativ) billig sind, sind in Bezug auf ihre Herstellungskosten optimiert, sie gelten als wirtschaftlich.” Otto, preface, IL 24, 13. Otto’s emphasis.
into structures: “The concept of ‘cheap materials’ does not exist in biology. Almost all biological forms, if one wanted to technically manufacture them with their fine structures, would be unspeakably expensive anyway.”

While economy in nature seems stable and unchanging, Otto argued that economy in terms of value changed according to geography and the different costs of labor and materials: Technical optimization is primarily cost optimization and is valid only in terms of defined geographic and political conditions. This optimization is therefore of short-term validity, but nevertheless determines technological development. It does not help to explain the “Principle of Leichtbau [Light Building]” in nature.

Otto points to the “high labor costs” in industrialized countries like West Germany as having led to the unpopularity of lightweight structures because of their long construction time. He writes, “the situation is reversed in the developing countries where labor is cheap. Lightweight construction provides employment and uses little expensive material.” When Otto wrote these words in 1979, he was involved with a series of projects in the Middle East, including a competition for accommodating pilgrims to Mecca (1974); the unbuilt Government Center in Riyadh, Saudi Arabia (1974–1976); the Sports Hall in Jeddah, Saudi Arabia (designed 1976, constructed 1979–1981); and the Diplomatic Club in Riyadh, Saudi Arabia (designed 1980, constructed 1986) [Fig. 2.27]. The very different economic and political conditions in these regions may have led to these observations. When economy was considered outside of a national framework

Fig. 2.27

and in a global one, it proved to be relative, unstable, and fluctuating. The idea of
scarcity takes on a different meaning in this context.

It was thus a very abstract idea of economy that motivated Otto’s search for
lightweight architecture. This is why Otto did not build in concrete: even if it was
inexpensive in terms of material and labor costs, it was not optimized in terms of its
“lightweight” value or Bic. Thus, the Protestant origins of capitalism as identified by
Weber, in which frugality and profit are eventuality pursued to their own moral ends
and not for a particular purpose, is advanced here to a condition of economy of
materials, a sort of frugality without a real economic base. While the optimization
equation of the Bic can be applied to both structures and their costs, there is no general
equation in which both lightness and cost can be integrated. Building costs, as Otto
demonstrated, were no longer a value that could be relied on without considering a
range of global and local contingencies that would arise in the fluctuations of an
international construction industry. The question of value, Otto seems to say, is no
longer stable – hence the need for a new set of stable criteria, like that of the
"unchanging" world of nature. But nature was also in flux: by the late 1960s, the
systemic behavior of global ecology was already understood, as were the consequences
of nature and technology meeting in catastrophic ways.

Economy/Ecology

Even if in his later writings Otto made a distinction between optimization and
Wirtschaftlichkeit, a shared notion of economy was nevertheless present in his attempt
to find a continuum between nature and technology. This effort was already evident in his dissertation, when he writes about the discovery of the tent form as the earliest example of the suspended roof:

Today, through our reason and rationalist way of thinking, through our artistic and intellectual efforts and achievements, we have, in the midst of an over-technologized world, but with the help of modern technology, once again come closer to the most primeval and simple, which is as old as man.\textsuperscript{79}

Otto describes a process by which reason and rationalism paradoxically lead to the primitive. For Otto the path to the primitive via reason is not a return to barbarism but an idealized alternative in an “over-technologized world.” His goal was to find solutions to architectural problems using “the least technological effort.” This means finding the “natural structure” embedded in a structural problem.\textsuperscript{80} When Otto looks to natural structures for inspiration, it is not in order to copy them but in order to understand their process of arriving at a “solution.” The assumption, of course, is that a natural structure will always choose economy over other concerns:

In terms of a “natural” structural system, we mean the form of a structure in which the forces are transferred to the supports with the least demand of building materials. One can easily imagine that for a certain task that a structure is to fulfill, only one single structural form belongs to it, and that it can solve the task in the easiest and most “natural” way. It is thus remarkable that a singular and exceptional beauty is inherent to such natural structures.\textsuperscript{81}

\textsuperscript{79} “Wir haben uns heute durch unsere Vernunft und rationalistisch denkende Art, durch unser künstlerisches und geistiges Streben und Schaffen, inmitten einer übertechnisierten Welt, aber mit Hilfe der modernen Technik wieder dem Urtümlichsten und Einfachsten genähert, das so alt ist wie der Mensch.” Frei Otto, \textit{Das hängende Dach: Gestalt und Struktur} (Berlin: Bauwelt Verlag, 1954), 9. This was a published version of Otto’s dissertation, which was completed in 1953 at the TU Berlin.

\textsuperscript{80} Ibid.

\textsuperscript{81} “Unter einem ‘natürlichen’ Tragwerk verstehen wir die Form eines Tragwerks, bei dem die Kräfte mit dem geringsten Aufwand an Baustoff auf die Auflager übertragen werden. Man kann sich leicht vorstellen, dass zu einer bestimmten Aufgabe, die ein Tragwerk erfüllen soll, nur eine einzige Tragwerkform gehört, die diese Aufgabe am einfachsten und ‘natürlichsten’ lösen kann. Es ist dabei erstaunlich, dass solchen natürlichen Tragwerken eine eigene und besondere Schönheit innewohnt.” Ibid., 85.
While ecology arguably has no telos, in Otto’s interpretation there is a telos in nature – that of economy (and even beauty). As Otto’s investigations increasingly turned to the natural sciences – in the structural studies of bones and grasses, for instance – a continuity emerged between structural economy and ecological and evolutionary questions of how organisms adapt to their environments. Otto eventually also considered abiotic, inanimate nature as having been constructed according to lightweight principles.\(^{82}\) He viewed planets, stars, crystals, branching systems, and mountains as self-forming optimal structures. This view was partially influenced by the sciences of self-organization:

Physicists are focusing their research on the processes of self-organization of matter. The new concept of the synergetic inspires them. The world does not disintegrate into dead heat, but always forms new orders. . . . This leads to the possibility that with the involvement of biologists, paleontologists, and builders the transition from non-living to living matter will be seen in a new way. . . . Since all living beings have the same constructive system, it is possible for paleontologists and general biologists to observe the formation of living beings not only by species (as it was before) but also according to form and structure. It even opens insight into the domain in which intelligent life begins.\(^{83}\)

Otto argues against entropy and for the generation of order. This ordered continuum between living and non-living matter is an ideal that Otto strove for throughout his work.

\(^{82}\) In a section entitled “Abiotische Selbstbildungsprozesse in Natur und Technik,” IL 24, 175.

In his essay on aesthetics, Otto even suggested a connection between ideal structure, beauty, and evolutionary advantage.\(^8\) While Otto admits that natural objects could not be technologically adopted without some translation, he did see them as “superior” due to the process of optimization that had taken place through evolution:

Even though the phrase “survival of the fittest” is misleading, it has as a consequence a steady negative selection in human technology and culture, bringing about a sophisticated medium; in living nature an evolution towards higher capability is promoted because of the long time evolution takes and because of the “waste.” . . . We are still of the opinion that the objects of living nature are ideally optimized.\(^8\)

In Otto’s concept of evolutionary structures, waste had already been produced in the process of optimization, and should thus not be part of building. These ideas of energy conservation and expenditure – an economy of energy exchange – were also of central importance to several artists of the 1970s, notably Robert Smithson and Joseph Beuys. Unlike Otto, Smithson embraced the entropic nature of energy, the tendency towards loss, waste, and “all-encompassing sameness.”\(^8\) For Smithson, this was reflected architecturally in the “cold glass boxes” of modernism; in the “slurbs, urban sprawl, and the infinite number of housing developments of the postwar boom.”\(^8\) The late-modern architectural landscape that Smithson describes is precisely the sort of “Brutalism” that Otto associated with modern architecture. An embrace of entropy was

\(^8\) Otto, “Das Ästhetische.”
\(^8\) Ibid., 13.
also famously theorized in a radical manner by Georges Bataille, who found not a sublime emptiness but exuberance in the concept of expenditure:

> On the surface of the globe, for living matter in general, energy is always in excess; the question is always posed in terms of extravagance. The choice is limited to how the wealth is to be squandered. . . . [Energy] cannot accumulate limitlessly in the productive forces; eventually, like a river into the sea, it is bound to escape us and be lost to us.\(^88\)

Like Otto, Bataille proposed a universal or general theory of economy that is closely linked to a comprehensive notion of ecology, yet his view of expenditure is directly contrary to Otto’s, which by comparison is closer to rational economy and its laws of calculation.

If a parallel can be drawn to Otto it is perhaps in the work of Joseph Beuys. Beuys, also a pilot during the war, similarly based much of his work on a mythologized war experience, in his case a story of a near-fatal plane crash and his subsequent care by Tartars, who wrapped his wounded body in fat and felt to keep it warm.\(^89\) Beuys’s use of substances that preserve and store energy, like fat, honey, and felt, was based in a preoccupation with energy conservation, with metaphors of healing and “potential.” Even Beuys’s linking of concepts of energy and social interaction suggest a notion of exchange and production that can be understood in an economic sense. Both Beuys and Otto emerged from the experience of the war with similar ideas about the economy of energy as a potential source for a new social beginning. Both display a preoccupation with a materiality tied to the natural and especially the animal world – fat, honey, bones, spider thread, nests, carcasses – which Beuys “rediscovered” as artistic materials


with mystical properties, and Otto saw as possible building materials for architecture. Still, Beuys’s materiality – felt, lead, fat – is one of great heaviness and density, and is used in excess. Energy is conserved and transmitted through matter alone, but not through its form. These materials do not appear in Otto’s Bic chart, as they would likely correspond to an “uneconomic” value. But Otto participates in his own form of expenditure in his preoccupation with the ephemeral; his pneumatic structures, fabric membrane tents, adaptable roofs, and even cable-net pavilions were all constructed with the idea of being expendable. The types of festive “events” for which they were designed, most of them national or industrial exhibitions, suggest a form of excess too, a sort of release valve for the overabundance of capital during the West German Wirtschaftswunder. It is the very lightness of minimal architecture that also makes it superfluous and excessive.

In the structures that Otto referred to as Klimahüllen (climate shells), economy is understood as the preservation and maintenance of an ideal atmosphere. These large-scale projects were based on utopian ideas and visions for cities in unforgiving and almost uninhabitable climates like the desert, the polar caps, and even the moon [Fig. 2.28]. As a result of his preoccupation with climate, Otto is often cited as one of the first “green” architects in Germany.90

Otto’s concern with ecology was already evident in his early writings. In Das hängende Dach, he writes in a section on “Haus, Klima, und Großhüllen”: “The architect mediates between man and Lebensraum, which he achieves through the help of

---

90 He himself described an allegiance with those he called the “proto-green” architects of the 1920s: Wassili Luckhardt, Hans Poelzig, and Erich Mendelsohn. Songel, A Conversation with Frei Otto, 26.
Fig. 2.28
*IL 2: Project Study City in the Arctic, 1971.*
technology. His work is the house. It is as comprehensive as man, and untechnological in its being” [Fig. 2.29].91 Otto viewed the house as an Urklima – a shell for an original climate that human beings must constantly inhabit. He continues: “The house does not absolutely need to be a closed shell like the skin of a balloon, nor completely separated from the local climate, it just needs to transform and improve it.”92 In his thesis, Otto proposed landscape-sized enclosures, such as a cable-net roof over a mountain valley, which would be passively heated by the sun, acting as a “total warmth trap” and water collector.93 He imagined environments like this in Antarctica and even outer space.

The model of economy proposed here cannot be separated from Otto’s idea of “adaptable” (anpassungsfähig) building, with which he became preoccupied during his years of research in West Berlin. This meant, quite literally, the idea of a responsive house that could be adapted to the inhabitant’s needs, but also adaptation in the sense of a building adapting to its environment (here Otto’s collaboration with Yona Friedman and the GEAM was influential). In a 1959 bulletin published by the Entwicklungsstätte für den Leichtbau (the small research institute in West Berlin that Otto founded in 1959, discussed below), Otto presents the notion of adaptable architecture as clearing the way for “a new way of thinking that departs from the static towards a life that is eternally changing” [Fig. 2.30].94 It is interesting to note Otto’s confluence of the term “static” as it is used in engineering and as it applied to the notion of the immutability of

---

91 Otto, Das hängende Dach, 114.
92 Ibid.
93 Ibid., 115.
Fig. 2.29
Fig. 2.30
architecture. Architecture that is adaptable is not only flexible: it also eventually disappears or dematerializes:

It is the task of everybody who builds to create space for man, not for materials. Every construction is corporeal. Every body takes away space and forms a resistance against adaptability. Only the house without building materials – the dematerialized house – can be fully adaptable. I am not able to predict if it will ever be possible to build a house without materials, where we no longer need concrete, steel, wood, synthetics, or even thin skins. Even if we need ever less materials thanks to the development of lightweight construction, we cannot hide the fact that we are not able to achieve immateriality through methods of building. . . . Perhaps the architect of tomorrow is a physicist with a small apparatus that fulfills the tasks of the house, with which one can stop rain from falling in a certain region, and wind from blowing too hard, and one can create the desired artificial climate that keeps out sounds and blocks views. . . . The house without building materials is the house of thoughts alone, and it is as adaptable as it is possible to be.  

Otto is imagining the furthest extreme of lightness, which is the dematerialization of architecture itself. Liberated from matter, architecture reaches the highest stage of optimization. Architecture is instead created by an apparatus that controls the environment, so that shelter is no longer necessary. Rather than see the interior as a controlled environment, the environment itself is adapted to become inhabitable as an interior. In this way, the boundary relationship between inside and outside is manipulated. The final stage of dematerialized architecture is architecture that is made of thoughts alone.

EIN BEITRAG ZUR LÖSUNG DER
STÄDTISCHEN WOHNUNGSFRAGE

VON STADTBAURAT DR.-ING. MARTIN WAGNER


BERLIN / DEUTSCHES VERLAGSHAUS BONG & CO. / LEIPZIG

Fig. 2.31
Also included in the same 1959 bulletin is a reprint of parts of the 1932 book *Das wachsende Haus* by Martin Wagner [Fig. 2.31]. This book would prove to be greatly influential for Otto. According to the bulletin, Wagner had contacted the GEAM group and reminded them of a 1931 competition for an adaptable house, which they had not been familiar with. Wagner’s proposal for a competition was based as much on a notion of economy as it was on promoting prosperity:

One may stone me, but one should not expect me to follow that grey World-Economic-Crises-Poverty-Theory that convinces us of the belief in the coming “seven bad years” of economic downturn and which leaves us no other way than denying ourselves every new progress, every new cultural asset, and every expansion of our Lebensraum. I do not believe that the world and its people have become poor. As long as one pours coffee into the ocean, burns grain in locomotives, blocks people from working, and lets machines rust, we cannot be poor. And thus I will not give up my belief in a pioneering rush forward of our best forces into the frontier of a new economy which forms new life.

In *The Accursed Share*, Bataille had used the same example of coffee being thrown into the sea to describe the destruction of surplus within rational economies. Wagner similarly points to the close relationship between poverty and excess in capitalism. The

---

97 In 1931, during a period of economic crisis in Germany, Wagner had organized a competition for an adaptable house that would be able to grow in response to economic needs. The 1,000 submitted entries included projects by Otto Bartning, Egon Eiermann and Fritz Jaenecke, Walter Gropius, Hugo Häring, Ludwig Hilberseimer, Paul Mebes, Erich Mendelsohn, Leberecht Migge, Hans Poelzig, Hans Scharoun, and Bruno and Max Taut. Twenty of these houses were constructed for the Berlin Building Exhibition of 1932.
growing house is thus on the one hand an answer to material shortages, but also a projection of the unpredictable rise and fall of available economic resources. However, the idea of the growing house is based not only on economic concerns, but also on biological ones; it is assumed that the two would be integrated. As the title suggests, there is a strong metaphor of self-propelled biological growth, which literally includes the biological growth of the family and their need for more space. Wagner describes the “spatial and biological unit” formed by the house and garden in which the garden “actually” grows into the house, or “grows into an edge zone of the house, in which there is no fall or winter but instead an eternal spring and summer.”

Wagner’s competition offers an intriguing example of the overlapping of nature and economy in architecture, an example that seemed particularly influential for Otto. Wagner’s own competition entry especially seemed to be echoed in Otto’s “green” buildings. Wagner proposed a symmetrical core-periphery house with a rectangular plan. The central core of the house is the main living and work space, enclosed by a ring of bedrooms, a kitchen, and a bathroom. This core is in turn enclosed by an angled greenhouse façade, which provides a microclimate for the house itself, protecting it from wind and sound while trapping light and heat. Other competition entries followed a similar model, and some, like that of Leberecht Migge, turned the glass-enclosed buffer space into a winter garden filled with plants.

\[100\] Wagner, *Das wachsende Haus*, 23. He recommends that this edge zone be built as a greenhouse that surrounds the core building, and many of the competition projects are built according to this model. Wagner even suggests how the “core” (Kern) and “expanded” house would be financed, emphasizing the capital needed to build the extension to the house.

\[101\] Wagner, *Das wachsende Haus*, 144.
Otto had begun speculating on the benefits of passive solar heating in the 1950s. In 1955 he published the article “On the Unheated Yet Already Warm House and New Windows,” which begins with the proclamation “Windows are traps for sunbeams!” Otto argues for the possibility of capturing solar heat through a combination of a glazed southern façade and three insulated walls, for the benefit of “healthy living” and “taking advantage of heating energy.” He also writes of “living with the weather in the space’s interior,” suggesting that the membrane might be permeable and ambiguous. In 1956-57, Otto constructed two test model houses to study the benefits of solar heating [Fig. 2.32]. Each model was roughly 150 by 180 cm and 30 cm high. The models show an early preoccupation with physical testing, as well as a very literal understanding of environment. One was glazed only on the southern façade, and the other had an equal amount of glazing, distributed over four sides. The models were placed outdoors for one year in an empty field in the Dahlem neighborhood of West Berlin. Thermographs were placed inside of the models to measure the temperature fluctuations, along with aluminum bottles filled with water to approximate utilities. The results were recorded onto thermographic paper. These models served as representations of the processes of energy economy, and attempted to scientifically prove the theory of energy gain using direct inscription. The thermograph, a device that registers temperature but cannot change it, could be seen as a precursor to Otto’s imagined device that actually changed

103 Ibid. Otto had already (apparently successfully) tested this theory in a 1953-54 house built for his sister in Bremerhaven (the Mrosek Residence), which featured a glazed southern façade. Nerdinger, ed., Frei Otto: Complete Works, 173.
Frei Otto, Test houses in Berlin-Dahlem, 1956-57
the climate, which takes the data generated and turns it into a “command.” Otto’s ideal architecture, then, is somewhere between the building that provides an atmosphere and the device that “knows” what the atmosphere is doing. Because environment, and especially human comfort, could only be described but not measured, the house/thermograph model becomes an ideal hybrid.

With these precedents in mind, one can view Otto’s 1959 self-constructed Entwicklungsstätte für den Leichtbau (Institute for Development of Lightweight Construction) in West Berlin as a built example of an adaptable climate shell [Fig. 2.33]. Unlike many of the open membrane coverings that Otto designed during this time, this building, which was one of the first inhabitable glass houses to be built in Germany, was an expression of Otto’s ideas about climate and enclosure. The structure was constructed in the garden of Otto’s in-laws in the neighborhood of Zehlendorf. It measured five meters by nine meters, and consisted of a simple steel structure of round columns which supported the roof, and an all-glass façade supported by slim steel members. The flat roof was a layered construction of wood, heat insulation, a membrane layer, and gravel. Otto referred to the PVC foil as a “continuous tent strip”; these one-meter-wide sheets were rolled onto the roof and fused together at the seams to form a closed membrane before being covered in sand and gravel. While he

105 “Entwicklungsstätte für den Leichtbau. Frei Otto,” ARCH+ 144/145 (1998): 64–65. In 1950 Otto visited the office of Mies van der Rohe in Chicago, and wrote an article describing the encounter, particularly the details of the Farnsworth House, which was then being developed. Otto was especially concerned about the heating costs associated with the single-pane windows, and the construction of the flat roof. Frei Otto, ”Mies van der Rohe: Bericht einer Amerikafahrt,” Neue Bauwelt 6, no. 36 (1951).
106 The building was torn down in 1969.
107 The membrane covering was described at length in one of the institute’s bulletins, and photos of its installation were depicted. Entwicklungsstätte für den Leichtbau, Mitteilung 6 (Berlin: 1959).
Fig. 2.33
did not see this roof as suitable for “permanent works,” he argued that it could be assembled in only an hour and disassembled in less, making it ideal for temporary structures. In this way, his notion of the minimal surface met his idea of the “climate shell.”

The plan of the studio shows a kind of house-inside-a-house in which the inhabitable interior is surrounded by a climate buffer zone [Fig. 2.34]. In the winter, the interior of the glass house was passively heated (with help from a heater that was placed outside the structure), and sliding translucent and wooden walls surrounding the main work area were closed in order to conserve heat. Heavy curtains in front of the outer glass panes also allowed for temperature adjustments. In the summer, the sliding panels were used to adjust ventilation or shading.

The minimal aesthetic of the modern glass house is met here with the management of energy flows. Otto did not appear to have been specifically driven by material concerns like the conservation of natural resources or lowering heating costs, but seemed to have been motivated by more abstract ideas of a unity between the interior and exterior environment, and the capturing and manipulation of heat generated by the sun. Energy was captured for its own sake. The building, like the IL tent that would be built ten years later in Stuttgart, was a full-scale test model. What is especially striking in this project is the introduction of the large buffer zone. Otto seemed less concerned with the orientation of the glass (as the building was glazed around its periphery) than with the creation of an ambiguous zone, one that takes up about half of the building’s footprint. Otto took Wagner’s idea of growth and made it the determining factor in the
Fig. 2.34
building’s plan. Still, it is unclear whether the space served a specific purpose other than providing the climate for the building. Photographs of the interior clearly indicate that this space was used in flexible ways: one photograph shows two tables set up near the door, with models on them [Fig. 2.35]. Next to the table on the floor sit two crates or suitcases (presumably to transport the models), as if to emphasize the transient nature of the space. Another photograph, taken from the outside, shows furniture and objects inside the space, arranged in yet another way. This unplanned area was clearly tied to the experimental nature of the institute itself.

Otto applied the results of these early experiments to his own residence and studio, built between 1967 and 1969 in Warmbronn, near Stuttgart [Fig. 2.36]. The notion of a house encased in another is repeated here but at a larger scale. Both the main house and studio sit embedded into the earth on one side, with the studio situated below the house on the hill. The main house consists of a series of glass-enclosed boxes partially wrapped by a large greenhouse structure, about ten meters wide and fifteen meters deep. In section, the greenhouse appears to engulf the entire structure, while in elevation it maintains a distinct, even monumental identity. As in the Berlin studio, this space serves as a buffer and microclimate, becoming the “outdoors” for the rest of the house. The greenhouse area is filled with plants (southern species like eucalyptus, fig trees, and cacti, with flowering plants all year long), and a photo from 1971 shows a

---

108 A significant amount of work was done on the project by Rob Krier, Otto’s office manager from 1966 to 1970.
109 See Stabenow, Architekten wohnen; Klotz, “Gespräch mit Frei Otto.” Later sketches, entitled “Wohnhaustyp Warmbronn,” show the greenhouse engulfing the entire structure, with a similar profile.
Fig. 2.35
Fig. 2.36
small pool in which children can play [Figs. 2.37 and 2.38].\textsuperscript{110} The buffer zone also acts as the programmatic center of the house, connecting the communal spaces and tying together the sleeping quarters of the family. The large front façade of the greenhouse, which is angled towards the sun, can be opened during the summer by motor, and an operable awning can be brought down to provide extra shading. During the winter the greenhouse remains unheated until the interior temperature drops to 8 degrees, when a heating system kicks in for the sake of the plants.\textsuperscript{111}

“Adaptability” here is not meant literally in the sense of programmatic flexibility, but is used to describe the response of the house to the environment. In a 1975 IL publication on “Adaptable Architecture,” the house is shown photographed at different intervals throughout the day – though it barely changes – as if to try to capture the processes of thermal exchange taking place in its “automatic” self-regulation [Fig. 2.39].\textsuperscript{112} Otto also used thermographs in this house in order to find “evidence” for his theories of solar gain, which were still new at the time (he referred to his home as Germany’s first Ökohaus).\textsuperscript{113}

At Warmbronn the slim buffer zone that had been the recurring theme in Wagner’s \textit{Wachsende Haus} competition is expanded to become the main aesthetic and technological element of the house. The Warmbronn house initially seems to bear a strong resemblance to Wagner’s greenhouse-enclosed house, except that the greenhouse portion had become inhabitable and filled with plants. The possibility for

\textsuperscript{111} Nerdinger, \textit{Frei Otto: Complete Works}; Stabenow, \textit{Architekten wohnen}.
\textsuperscript{112} University of Stuttgart Institute for Lightweight Structures, \textit{IL 14: Adaptable Architecture}, Information of the Institute for Lightweight Structures (Stuttgart, 1975).
\textsuperscript{113} Stabenow, \textit{Architekten wohnen}.
Fig. 2.37
Fig. 2.38
Fig. 2.39
Frei Otto, House and Studio in Warmbronn, 1967-1969. Photographs show the house at different times of day.
programmatic growth is fully translated into the biological metaphor of natural growth and the maintenance and sustainability of an organism. The house is in many ways a fulfillment of Otto’s early utopian ideas about the Urklima. In 1954 he specified that the “natural-primordial human environment” is especially important for children, who are in a “primordial state” and thus require an Urklima of plants, “between light and shadow.” He characterizes this threshold space as the “world of transitions.” This utopian zone of transitions comes to characterize Otto’s house, and one can infer that it was more than a strictly technological solution to conserving energy, but also was a social project with utopian aspirations.

Otto’s evocations of the primordial are still, however, rooted in a technological modernism: “Not the return to the pastoral or the primitive is meant, but the most spare, smartly thought-out application of the most modern means with which we can create a piece of human nature.” For Otto, the climate shell should be a technical expression: “The house is a machine. It should look like one: a container of beautiful form which floats without weight between trees, over boulders and cliffs, or between the stones of present cities.” “Yet,” he writes, “there is something untechnical about the house: the nest, its most intimate core.” If we use this text to understand the house in Warmbronn, then the “untechnical” nest would be the inner core where the family resides, and the technical and machine-like part the greenhouse areas.

---

115 Ibid., 15.
116 Ibid., 14.
Otto’s house was built in response to utopian ideas about living in nature, and not economic needs. The minimal use of energy was not yet tied to actual heating or cooling costs. There is, however, a notion of the minimum suggested in the aesthetics of the lightweight glass enclosure and the single-pane glazing that rests on the strongly articulated wooden supports underneath. While double-pane glazing would have provided better insulation, the lightness of the glass is instead emphasized. One is reminded again of Otto’s visit to Mies’s office and his observation of the famous single-pane glass used for the Farnsworth house, which increased the transparency but required more heating to compensate. Otto marvels that this tradeoff was possible due to the low heating costs in the United States in 1951, when the house was built.\textsuperscript{117} The minimalist Farnsworth house was thus also an expression of excess in terms of its energy balance. The translation of the Miesian box into the ecological greenhouse similarly betrays the coexistence of minimalism and excess. Wagner had attempted to create wealth and surplus with the concept of growth, as articulated in the glass buffer zone; Otto makes this excessive space economical, and thus integrates utopian ideas of nature and “paradise” with ideas of efficiency.\textsuperscript{118}

In the examples looked at here, Otto’s calculation of a minimal invariably also produces its opposite: excessive expenditure. His Bic chart, an index of thousands of redundant material experiments, resulted in a graphics of increasing proliferation and

\textsuperscript{117} Otto, “Mies van der Rohe: Bericht einer Amerikafahrt.”
\textsuperscript{118} The afterlife of this buffer zone is found in a concurrent project by Rob Krier – the Siemer house in Warmbronn (1968). Similarly built into a slope, this house has a greenhouse space that is reduced to a series of decorative but similarly excessive prisms that are nested in the sloping building.
disorder. In the case of the climate shell, excess is produced as a byproduct of a fear of poverty that began in the 1930s with Wagner’s *Das Wachsende Haus*.

Joseph Vogl has written on the transformations of the cultural meaning of profit from the Aristotelian polis to the modern period. In Aristotle’s state, the acquiring of goods to fulfill basic needs was seen as *natural*, while chrematistics, the pursuit of money or profit for itself (creating money from money), was viewed as *unnatural*. Vogl argues that this perspective changed in early modern Europe when the accumulation of wealth became naturalized, and was associated with images of reproduction and even fertility: “The relational quality of money transformed the Aristotelian, i.e. Scholastic, disjunction of money *or* life into a conjunction of money *and* life, and thus directly tied the proliferation of life to the potency of wealth.”¹¹⁹ As an example of the modern fulfillment of this reproductive capacity of money, Vogl cites Benjamin Franklin’s *Advice to a Young Tradesman* (1748), which is also quoted by Max Weber in *The Protestant Ethic*

*Ethic:*

Remember, that money is of the prolific, generating nature. Money can beget money, and its offspring can beget more, and so on. Five shillings turned is six, turned again it is seven and threepence, and so on, till it becomes a hundred pounds. The more there is of it, the more it produces every turning, so that the profits rise quicker and quicker.¹²⁰

This understanding of the relationship between economy and nature offers a possibility for reading architectural economy in a different way. Otto’s minimalist ethics owes as much to nature as it does to the rationalized prison camp. Architecture, according to the

Protestant ethic, can fall under the sign of asceticism on the one hand, in its lightness and saving of resources, but it is also a source of proliferation and growth. The insulating “fat” that surrounds the building has extended beyond utility, becoming a place for the proliferation of life (both for plants and the humans that inhabit the house). It becomes an artificial nature, adapting to the climate outside in order to maintain an eternal paradisiacal summer on the inside.
II. THRESHOLDS OF CALCULATION

Form-finding models and experiments provided Otto with a way to empirically test his theory of lightweight structures, transforming the economy of the “laws of nature” into architectural form. In Das hängende Dach, Otto had already suggested a relationship between economy, lightness, and self-formation:

Hanging roofs cannot be designed. When every impure tone is avoided, one can help them unfold. They suggest a peculiar beauty that is perhaps closest to the plastic trace of the spider web: an appearance that one cannot draw or explain, that will discreetly elude us.\(^\text{121}\) [Fig. 2.40]

For Otto, an ideal structure unfolds by itself (and in a way that is judged to be beautiful). Not only can these structures not be designed, they can’t be represented. The spider web – a form that preoccupied Otto throughout his career – was the ultimate example of a structure so minimal and light that it is beyond representation or analysis. Otto nevertheless tried to represent such minimal forms, while at the same time insisting on their elusiveness. The contradictory process of measuring and calculating "incalculable" structures became central to his search for a zero degree of economy and lightness in architecture.

Otto’s idealization of the incalculable corresponds to something like Kant’s mathematical sublime. Kant argued that this sublime lay outside of both the senses and the frame of measurement and comparison provided by mathematics. The sublime had

\(^{121}\) “Hängende Dächer lassen sich nicht entwerfen. Wenn man jeden unreinen Ton vermeidet, mag man ihnen helfen können, sich zu entfalten. Sie lassen eine seltsame Schönheit ahnen, die vielleicht dem plastischen Hauch der Spinnwebe am nächsten sein mag: Eine Erscheinung, die man nicht aufzeichnen, die man nicht erklären kann, sie uns unaufdringlich bannen wird.” Otto, Das hängende Dach, 158.
Fig. 2.40
"The web of a grass spider, resembling a circus tent. The grass stems are used like the poles of a circus tent to support a flat trapping web." IL 6, 1973. Photo by Andreas Feininger
an emotional effect that numbers could not produce; its magnitude was absolute – it could only be grasped by the mind.\textsuperscript{122} For Otto, the range of the incalculable included not only minimal forms but also optimized pathway systems, structures that were too small or large to accurately measure (like the bodily interiors of animals and humans), and forms that were considered aesthetically “taboo,” like sexual organs [Fig. 2.41]. Otto avoided calculation in his quest for the elusive object, in an attempt to expand what he considered the limited imagination of modernist architecture.

The incalculable also betrays a conflicted relationship to architectural authorship. Like many of his contemporaries in the 1960s who worked with automation, cybernetics, or intelligent machines, Otto was interested in self-forming structures, indicating a preoccupation with the autopoietic [Fig. 2.42]. In Otto’s case, however, this interest was tied to the behavior of organic, or even inorganic, matter, and not to computation. He idealized self-formed structures as born from the intelligence (and what he assumes was the goodness) of nature, as opposed to the limited capacity and potential brutality of the human imagination. This view of the elusive forms created by chemical, biological, or physical processes was directly related to his suspicion and criticism of postwar modern architecture. A form that was incalculable was also a form that was “good.”

Otto was suspicious of the mathematics of engineering and was ambivalent towards the emerging field of computer-aided design. He considered the calculation of statics

Fig. 2.41
Fig. 2.42
Multiple exposures of a soap film reaching minimal form. IL, 1963.
used by engineers to be “coarse” and based on “inexact assumptions.” He writes that these calculations “will never have the same meaningfulness as the de facto testing of a real object by real forces,” and that “until today there are buildings which cannot be grasped mathematically, meaning that they are – to use the exact term – ‘incalculable’ (unberechenbar).” It is thus not surprising that many models created at Otto’s research institute could not be fully compensated for mathematically:

> With regard to the experiments described in connection with self-forming processes, it is not always possible to adhere to the conditions of an exact mathematical definition; this would run counter to the scope of this work whose objective is to show the immeasurable abundance of this world of forms and put it to use in architectural design.

The insistence on “real objects” and “real forces” meant that physical models played a particularly important role. Otto argued for a method of experience and experimentation rather than finding form through “theoretical planning with drawings and calculations which can today be supported by the extensive use of computers.”

The models and apparati created at the IL embodied a threshold condition between measurable and immeasurable form. They were hybrids of several functions: performance testing, form-finding, measurement device, and means of representation.

Histories of architectural computation typically describe a moment of transition from

---

123 *IL 24*, 33–34.
126 *IL 21*, 63.
physical models and drawings to code, information, and data. But at the IL, where calculating machines played a minor role, the trajectory from material form and its calculated representation was not always so direct. Even if, in the 1960s and ’70s, researchers at the institute arrived at ways of making and calculating architectural form that were arguably proto-digital, these material processes were not easily turned into numerical data. Experiments took place in physical spaces rather than in the immaterial “space” of the screen, where every coordinate position, and thus every form, can be numerically accounted for. Devices, tools, and modes of representation had to be developed to translate between incalculable materiality and calculable information. Unlike early experiments with computation that unfolded within the black box of the computer, here the interaction between material objects and data took place in physical laboratory and workshop spaces.

In Otto’s early publications, experiments with pneumatic structures and suspended roofs were accompanied by substantial calculations to back them up. However, as his models and photographs become more convincing and precise, the numbers disappeared or remained unpublished. With this disappearance, a form of calculation manifested itself nevertheless as models were turned into machines that generate numbers and data. The structures become increasingly expressive of their calculations, not just geometrically, but also in the formal articulation of their internal stresses and loads. The disappearance of the numbers did not mean that the architecture became a black box; instead, it spoke of its calculation through a material language, embedded in models and images.
Models, for Otto, were test sites. They were not architectural models in the conventional sense (scaled representations of form), but structural and material assemblages that generate information. The model gained a certain autonomy as it simulated real conditions such that the distance between model and building became smaller. Otto’s measuring models especially were designed to behave like real buildings; inversely, the buildings behaved as large versions of the model. The calculation of both probability (the measure of expectation that an event will occur) and optimization implied modeling behavior – playing out future scenarios to find desired outcomes and conditions. In designing structures that could not be analyzed by other means, Otto was also modeling, and testing, risk. Each model was a simulated event in which unpredictable, immeasurable, and incalculable behavior was allowed to unfold, but at the same time was controlled within the boundaries of measurement, prediction, and risk tolerances. Because Otto was a pioneer in experimental structures, the question of risk was implicit in his practice. In his early tensile membranes, Otto encountered seams coming undone, parts of structures collapsing, pavilions nearly blowing away in storms, and even a worker falling and being injured.127 His moral stance towards the potential violence of progress was clear: “As I successfully managed during the war to shoot past my target without fail, in order not to kill anybody, I did not see any sense in becoming a

---

murderer as an architect.” Great precision was required in order to avoid “architectural violence.”

**From model to photograph**

Otto worked primarily with soap film models. Soap film forms a structure of almost perfect optimization. With a thickness of only a few molecules and a high and uniform tensile strength, it forms a closed structure, making it ideal for testing pneumatics, tensile roofs, and minimal path systems. Otto believed these forms were close to those formed in nature, and were “meeting the justified and growing demand that technology move away from its abstract, inorganic-mathematical conception, though not its scientific basis, and towards the matters of the organic world.” Soap film structures were, for the most part, still mathematically incalculable at the time Otto began working with them in the 1950s. The creation, measurement, and eventual calculation of these and other minimal forms became an end in itself, first for Otto and then for his large research group at the IL.

Otto came upon soap film after realizing that the fabric tensile structures he was designing were unequally stressed, leading to buckling and flapping [Fig. 2.43]. He began

---

Fig. 2.43
Frei Otto, Tanzbrunnen, Cologne, 1957.
Fig. 2.44
experimenting with soap film at the Institute for Development of Lightweight Construction. An account by Ewald Bubner, a longtime collaborator with Otto, gives an impression of the provisional atmosphere in which these experiments began:

One day I arrived at the studio fairly early. Frei Otto was alone, blowing soap bubbles through a wire loop and chasing them back and forth through the studio to catch them and stick two or three bubbles together at a time. I asked whether he was all right—and was reassured when he answered that he was conducting a scientific experiment.130

Photographs of these experiments would later be published in Zugbeanspruchte Konstruktionen (1962) [Fig. 2.44].131 This book on tensile structures included a large section on pneumatic membranes and showed several early experiments with soap film. Otto was one of the first architects to systematically study and research pneumatic structures. Already evident here is an association between pneumatic structures and plant and animal forms (fruit, air bubbles, blood vessels, and skin are cited).

In this first large publication, Otto makes reference to only one historical source for his experiments: Soap Bubbles, Their Colours and the Forces which Mould Them, by C. V. Boys, first published in 1890 [Fig. 2.45].132 Otto would only later reference Belgian physicist Joseph Plateau, who conducted rigorous experiments with soap films, devising the law of minimal surfaces known as Plateau's Laws.133 Plateau was also the inventor of

131 Otto, Zugbeanspruchte Konstruktionen, vol. 1. According to the publication, initial research with soap film was conducted between 1957 and 1960, with funding provided by Peter Stromeyer of the L. Stromeyer Tent Company (with whom Otto collaborated for many years).
133 Joseph Plateau, Statique expérimentale et théorique des liquides soumis aux seules forces moléculaires (Paris: 1873). Plateau conducted his experiments while completely blind, having lost his eyesight in 1829 during an experiment that involved staring at the sun. He was also the inventor of the phenakistoscope
several instruments for analyzing soap films, and used wire models much like the ones later used by Otto to study minimal surfaces. In contrast to Plateau’s dry and sparsely illustrated volume, Boys’s book was a collection of lectures written for a popular audience of “juveniles.” Illustrated with images showing lanterns projecting light through bubbles, and playful but scientifically questionable experiments, the book points more to the visual effects and mysteries of soap bubbles than to their mathematical properties or economy of materials.134 Boys gives specific instructions for his experiments, many of which Otto repeated. It is in keeping with Otto’s initial unfamiliarity with scientific methodology that he would have borrowed from a set of experiments based more on the formal and visual aspects of soap films than their “hard” scientific properties.

Otto’s early experiments were modest and playful. He notes the frustration of the ephemerality of the bubbles, and the difficulty of photographing them. His photographs show flying bubbles and bubbles floating on surfaces, bubbles by themselves and in clusters, some more sophisticated toroidal shapes, and simple drawings of possible configurations. Other experiments included inflated membranes of various shapes, some printed with grids or constrained by netting; experiments with cushions filled with air, bladders filled with fluids, and a few experiments with sails. The rest of Zugbeanspruchte Konstruktionen is filled with examples of built works, small drawings and photos of models by Otto with crude, collaged proposals for the architectural use of


134 Boys’s book and its description of a couple sailing over the ocean on a sieve dipped in soap film appear in Alfred Jarry’s 1898 Exploits and Opinions of Dr. Faustroll, Pataphysician.
Fig. 2.46 Frei Otto, Zugbeanspruchte Konstruktionen vol.1, 1962.
spheres and membranes [Fig. 2.46].

The second half of the book, by contrast, is dedicated entirely to the demonstration of calculations for membranes, authored not by Otto but by Rudolf Trostel, a building engineer and mathematician. Nowhere is there mention of the “incalculable.” Equations are offered for the geometry of various membranes (spherical, conical, cylindrical, asymmetrical, etc.), and the effects of different loads and deformations. Even “large membrane deformations” involving multiple variables and nonlinear deformations are described as being calculable with “satisfactory accuracy” (though it is noted that “their solution is exceedingly tedious”). Calculation here is shown as secondary to the physical model, but still reliable enough to convince the reader of the feasibility of these structures.

A major shift in Otto’s development of more precise methods can be traced to his relationship with Helmcke. It is without doubt this relationship that solidified Otto’s interest in natural and “self-forming” structures, especially at the micro-scale. Helmcke, who was an expert on the microscopic photography of diatoms, also likely initiated Otto’s interest in scientific images. These images suggested to Otto a universal structural principle that could be applied at any scale:

Helmcke showed me his stereoscopic photographs of diatoms and radiolaria taken with an electron microscope. In these photos I saw shapes which had formed “by themselves” in my experiments with pneumatics, i.e. soap bubbles, soap films,

---

135 Otto, Zugbeanspruchte Konstruktionen, vol. 1, 268. Some doubt is introduced in the calculation of soap films specifically. Trostel writes: “the problem can only be solved approximately by iteration. The examples show, however, that a single iteration provides, in general, satisfactory accuracy.” Where Trostel admits defeat, however, is in the calculation of “Membranes Pretensioned by Cables to a Uniform Sectional Load,” which he describes as “almost unsolvable mathematically” and better addressed using test models. Ibid., 291.
rubber membranes, and net structures. From then on I saw only such forms in all living organisms, not only in diatoms.\textsuperscript{136}

Otto explicitly states that he wishes to avoid elementary forms such as those described by Platonic solids or the Euclidean geometry beloved by many modernist architects, looking instead for unknown, unfamiliar, and incalculable forms that have eluded, or been excluded from, standard architectural representation. Just as Otto used a vast range of scales to broaden the material range of building, he uses scale to expand the repertoire of forms. Here Otto is again deeply influenced by the possibilities of perception with the aid of optical instruments:

By using these aids to enlarge the minute and reduce the large objects, man can transpose an object in the form of a model into that range of object sizes which he can register easily, i.e. sizes between 1cm and 1m (e.g. a map) or 1mm and 100m. The production of comparable models and analogies is one of the most important means of describing an object. . . . The description is used to transmit the information collected during the detection of the object.\textsuperscript{137}

Optical instruments allowed for objects to be scaled up or down so that they can be modeled and included in the realm (and classification) of possible architectural forms.

Objects ranged from the scale of an electron (whose diameter, Otto tells us, is $5.6 \times 10^{15}$)
m) to that of the solar system and universe (“estimated diameter: $2 \times 10^{25}$ m”). These objects are calculable (theoretically) but are neither perceptible to the naked eye, nor directly measurable.

While Otto insisted on using physical models that emulated his organic conception of structures made “without humans,” he also accepted the use of optical instruments as an extension of the senses to apprehend those models. He predicted that the dominance of analytic engineering would wane thanks to these “newly developed, extremely sensitive instruments,” which would usher in a renewed emphasis on observation and experience. Otto believed that humans were inherently incapable of observing forms in an objective way. Thus, the experimental emphasis shifts from the observer to the instrument and model, making the documentation, description, and classification of forms as important as the process of “finding” or producing them. Incalculable forms required a new, “fuzzy” method of observation, one that “on one hand, would be less ‘sharp’ than the exclusively geometric way of seeing that has been used until now, but on the other hand would be more comprehensive.” These are forms in flux, defined by shifting parameters rather than by exact equations. At the IL, direct observation was thus understood as already mediated and enhanced through

---

139 IL 21, 63.
140 According to Otto, this incapacity is due to a number of factors including environment and psychology. See IL 21 and IL 22. Otto writes: “a highly objective description of a form can automatically stimulate a subjective observation by the recipient. Thus, even extreme objectivity in description does not ensure an objective observation.” (“Werden Formen sehr objektiv beschrieben, dann wird aber dennoch automatisch beim Empfänger die subjektive Betrachtung wieder angeregt. Das heißt, selbst extreme Objektivität bei der Beschreibung erzwingt noch keine objective Betrachtung.”) IL 21, 16.
141 “Um diese Variationsbreite der Formen zu erfassen, wurde versucht, eine Betrachtungsweise einzuführen, die gegenüber der bisherigen ausschließlich geometrischen Betrachtungsweise einerseits ‘unschärfer,’ anderseits umfassender ist.” Ibid., 17.
instruments that were borrowed from the sciences to document and measure material forms which were either too small and ephemeral, or too large and complex, to otherwise comprehend.

This idiosyncratic method of scientific observation betrays an irreverent and conflicted relationship to the sciences. Otto frequently referred to himself as a Spinner (madman) and “pseudoscientist” – characterizations symptomatic of the cultural paradigm of the 1960s in which he was working, particularly in West Germany where the critique of Zweckrationalität, or instrumental reason, had reached postwar architectural circles. In the early 1960s, Theodor Adorno and Karl Popper were engaged in the so-called Positivismusstreit, which centered on the question of the unity of scientific methodology, especially the problem of applying the natural sciences to social questions. Otto had absorbed his generation’s criticism of the disastrous outcome of the rational-scientific approach of postwar functionalism, but was at the same time caught up in the Verwissentschaftlichung (scientization) of culture in the 1960s, and made full use of the new technologies and scientific instruments that were available to him at the University of Stuttgart. Otto’s approach to science was irreverent and contradictory, poised between the traditions of avant-garde experimentation and the politics of Big Science.

---

Image, apparatus, number

Otto’s early years of free experimentation with soap film had yielded a collection of attractive photographs and speculative ideas. Yet, these were more a documentation and classification of forms than they were actual data. For the soap film models to be measurable, they had to become more durable, which could only be accomplished by controlling their chemistry and atmospheric conditions. They also had to be placed within a framework in which space was already constructed as measurable, where a total and precise coordination between object, camera, lighting, and background was possible. Here I will argue that the devices developed for this scenario increasingly came to take precedence over the models, becoming more sophisticated and eventually transforming into spatial models themselves.

In 1963 Otto was a referee on a thesis on minimal surfaces by a student at Ulm named Reinhart Butter.144 Butter had heard a lecture given by Otto, and wanted to examine the “materialized laws” of curved surfaces in his thesis. “What is missing,” he writes, “is a systematic of minimal surfaces, a kind of catalog of the principal possibilities.”145 Butter was very precise in his experiments with different types of materials for minimal surfaces, which included glues and soap. He devoted a section of his thesis to the difficulty of photographic soap film, and developed a setup in which models could be photographed against a gridded background [Fig. 2.47]. This approach allowed him to accurately document the form so that it could be used as the basis for a

---

144 Reinhart Butter, “Minimalflächen als Form – Eine Studie” (Diplomarbeit, Ulm School for Design, 1963), HfG-Archiv Ulm. The main referee was Horst Rittel. Otto and Bruce Archer were co-referees.
145 Ibid., 9.
Fig. 2.47
solid shape. It is possible that researchers at the IL were familiar with Butter’s thesis.\textsuperscript{146} His conclusions on the uses for the forms were quite different from theirs, however – he proposed streamlined, easy-to-clean forms for tool handles and other industrial design products.

The precision of Butter’s research was echoed in the first soap-film device at the IL, constructed in 1965 to study minimal path systems, and featured on the cover of the institute’s first publication (\textit{IL 1}) [Figs. 2.48, 2.49].\textsuperscript{147} It consisted of a glass plate with a matrix board of pins suspended over a soap tank.\textsuperscript{148} When the device was dipped in the solution, the soap film would “find” the most efficient path between the pins. The entire device was installed on a concrete slab in order to avoid vibration, and featured a glass cover to protect it from dust and evaporation, which apparently allowed for fragile soap membranes to be kept stable for up to three weeks.\textsuperscript{149} An image shows a camera awkwardly mounted on a tripod to photograph the soap films from above [Fig. 2.50]. This camera was equipped with a water level to ensure that it was perfectly aligned with the horizontal plane of the glass plate.

It is useful to pause here and consider the excessive precision of these “scientific” protocols. In a section of \textit{IL 1} entitled “Measurement Errors,” the steps necessary for the

\textsuperscript{146} Images from experiments by Butter and another Ulm student, Rene Sauter, were included in Otto, \textit{Zugbeanspruchte Konstruktionen}, vol. 1.


\textsuperscript{148} References for this work now also included the work of Joseph Plateau and the German-American mathematician Richard Courant, who in 1940 published his accounts of soap film experiments, many of which were repeated at the IL. A diagram of one of Courant’s experiments led to this first apparatus for soap film structures. See Richard Courant, “Soap Film Experiments with Minimal Surfaces,” \textit{American Mathematical Monthly} 47 (1940): 167–174.

\textsuperscript{149} \textit{IL 1}, 12.
Fig. 2.48
Minimal path device, 1965. Photo ILEK Archive.
Fig. 2.49
Top: *IL1*, 1969.
Fig. 2.50
photographs to reach this high level of accuracy are explained in terms like “exact,” “precise,” and “consistent”: 

1. Exact flush glass plate  
2. Exact vertical thin needles  
3. Shielding the instrument against pollution and the formation of bubbles  
4. Slow lowering of the level of the low-viscous solution  
5. Exact setting of the needles  
6. Consistent photo paper for the interpretation  
7. Exact vertical photographing with the camera  
8. Precise interpretation of the photographs.  

Where chance had in the past served as an aid to design, here it is a distraction that must be eliminated. A series of careful (and repeatable) protocols were carried out not so much for the creation of a model as for the creation of a perfect image of a model.

Images taken using the device show the formation of minimal nets between points, and were published along with simple calculations of the angles of the soap film as it slowly deforms and reaches equilibrium [Fig. 2.51]. High-contrast, graphic photographs were used interchangeably with line drawings and calculations. The impression is that these photographs have the accuracy of a drawing. Thus, model, and then image, becomes data.

Peter Galison identifies a shift in the history of scientific experimentation that is relevant here. He describes two methods of producing information in modern science: photographic images that indexically record phenomena, and non-visual data or what he calls “logic.” According to Galison, image and logic converged during the 1980s with the rise of the electronic image. Otto’s experiments

150 Ibid., 39.  
Fig. 2.51
Photograph, drawing, and measurement of flat soap-film models. *IL* 1, 1969.
were conducted at the cusp of this transition, and often tried to resolve these two types of information. In different ways, the photographs and models produced by Otto are both indexical and generative of data. However, with the increasing dependence on the photographic image in the research — which acts more as a measuring device than as an illustration — there are fewer calculations. According to the research team, “the use of the instrument enables optimization methods . . . without any complicated coding or calculation. This form of analogy permits simple measurement of sufficient exactness.”

What was the purpose of these particular experiments? It was optimization in its purest form, applicable at any scale: “Real systems, such as of supply, traffic, or communication nets can be simulated this way,” as can “operating costs of traffic or supply lines.” One experiment by students shows the device being used to calculate the optimum route between cities in Germany [Fig. 2.52]. The architectural model is no longer that of a building but of the behavior of a system.

As Otto’s team continued to develop a series of devices for soap film structures, the devices became increasingly larger and more complex. Instruments were borrowed from other sciences that could measure the diameter and tension of the soap film. More significantly, these apparati integrated ways of capturing the models photographically,

153 Ibid.
154 Between 1967 and 1968, two students, Walter Reinhardt and Stefan Waldraff, were dedicated to developing a soap film device for three-dimensional forms. Walter Reinhardt and Stefan Waldraff, “Bestimmung der Geometrie eines Minimalflächen-Seifenfilms zwischen Kreisring und Schlaufenförmiger innerer Unterstützung,” IL student research project, 1967-68, IL Archive.
Fig 2.52
IL student research project using minimal net device. Image shows calculation of minimal points between cities in West Germany. 1966. ILEK Archive.
using special lights, plates, and lenses. In the process, the goal was no longer to come up with a variety of forms — in fact, the form remained the same (it was essentially a model of the IL tent). Instead, the focus was on improving the experimental setup and its method of documentation: the photograph.

Soap films not only are difficult to produce but, because of their near immateriality, are especially difficult to photograph in a way that allows for accurate measurement. The method of photography itself had to change. Images could no longer be distorted by the curvature of an amateur 35 mm lens; stereoscopic cameras and methods of flattening were thus used to produce a more measurable image. One of the most important tools was photogrammetry, which uses multiple angles as the basis for obtaining accurate dimensions.\(^{155}\) The technique of photogrammetry from a distance was well developed, but this was not the case for a 10 cm model at close range. In a 1969 study at the IL, engineer Wolfgang Faig invented a short-range stereographic camera to photograph the tiny models.\(^{156}\) Faig also described the difficulties of

\(^{155}\) This technology, used mostly in aerial and architectural photography, was invented in part by a nineteenth-century German architect named Alfred Meydenbauer. Charged with documenting historical Prussian monuments for the sake of preservation, Meydenbauer sought a method of measuring buildings that would improve upon the enormous difficulty and imprecision of doing so by hand. He invented a camera containing a measuring device, and a method of photographing historic monuments so that they can be directly translated to measured scale drawings. Photogrammetry is thus intrinsically linked to the architectural object and, more specifically, to the otherwise ephemeral object that needs to be recorded in order to potentially be recreated. Meydenbauer’s photographs were in fact used to recreate many buildings after World War II. Jörg Albertz, “Albrecht Meydenbauer: Pioneer of Photogrammetric Documentation of the Cultural Heritage,” 18th International Symposium CIPA, Potsdam, Germany, 2001).

\(^{156}\) Two plate cameras were set up and outfitted with calibration marks and “Nürnberg scissors” allowing for the precise placement of the plates. Because of the lens distortion in the photograph, the images had to be measured with a stereo-comparator. The results of this rather complicated analysis were translated into three-dimensional coordinates. Wolfgang Faig “Photogrammetric Determination of the Shape of Thin Soap Membranes,” in University of Stuttgart Institute for Lightweight Structures, *IL 6: Biology and Building 3*, Information of the Institute for Lightweight Structures (Stuttgart: 1973), 74–81. Faig was working under the direction of Prof. Klaus Linkwitz at the IAGB, Institut Für Anwendung der Geodäsie im Bauwesen, at
documenting soap films accurately due to their material qualities. Soap film is so thin—only a few molecules thick, or about the magnitude of a wave of light—that it is practically invisible (calling to mind again the ideal of the spider web). In order for a photogrammetric image to be produced, the object needs to have a series of target points from which measurements can be taken. However, projection onto soap film is difficult because it is both transparent and reflective, and light particles literally move around on the liquid surface [Fig. 2.53]. Faig tried several methods, even filling the membrane with smoke. Eventually he mixed a fluorescent chemical into the soap solution, which he illuminated with an ultraviolet light. This approach proved successful even if the lines created by the grid were so blurry that yet another specialized device—a densitometer—had to be used to read the points.

Other experiments focused on tracing the contours of the model. In one setup, the soap film model was placed on an aluminum ring below a turntable that was able to rotate and thus shift the shape of the model by means of an attached string [Fig. 2.54]. One should note the introduction of this kinetic element—the movement and manipulation of the model in space. From one side of the contraption, a light source was projected onto the model [Fig. 2.56]. The light was located at the considerable distance of 15 meters in order to approximate parallel light waves and reduce distortion. A sheet of photo paper was inserted behind the model. Once exposed to light, it created a photogram [Fig. 2.57]. Photos were taken with rotations of the model in increments of 10 degrees, allowing for a “scan” of the form. This scan can be read as a

Stuttgart University. These studies were based on his dissertation, “Vermessung dünne Seifenlamellen mit Hilfe der Nahbereichsphotogrammetrie” (Munich: Bayrische Akademie der Wissenschaften, 1969).
Fig. 2.53
Fig. 2.54
Fig. 2.55
Fig. 2.56
Fig. 2.57
Walter Reinhardt and S. Waldraff,
Measurement photos of a soap film model showing different angles of rotation of the model, IL, 1967-68. ILEK Archives.
Fig. 2.58
crude version of today’s 3-D scanning, measuring an object in space in order to replicate it.

Subsequent iterations further eliminated imprecision to allow for more accurate measuring. In one iteration, the photo paper was replaced by a frosted plate etched with a millimeter grid. The image of the model was projected onto this screen and photographed with a large-format camera. The entire device, which appears to have been several meters long, was mounted on an optical bench with four convergent lenses in order to create parallel light projections. By now it is clear that another shift had taken place: the apparatus for creating and documenting the model had become larger and far more difficult to produce than the model itself. In a further variation, the structure suspending the model could not only be rotated but also be inverted (to study the possible effects of gravity). The resulting photographs became the basis for plotted contour lines that could produce a “precise” drawing and even a plaster model, again calling to mind 3-D scanning and plotting technologies. As in the early experiments with minimal networks, this process moved from model to photograph to drawing, or transitioned from image to data.

The final and most elaborate apparatus, which is still in use at the IL today, was first developed in 1973 [Figs. 2.59 and 2.60]. The comical-looking machine is a large assemblage (about 7’ tall and 9’ deep) of acrylic basins, rubber and plastic tubes, dials, steel frame supports, a spindle, a light box, and a camera. Aesthetically, it calls to mind the air-, apparatus-, and machine-based fantasies of the avant-garde of the 1960s. In that sense it plays off the utopian idea of a device that harnesses technology to create
Fig. 2.59
Fig. 2.60
Soap film machine, IL.

Minimalflächengerät / Minimal surface apparatus
Vorderansicht / Front View

1 - Parallellichtprojektor / Parallel light projector
2 - Umwälzpumpe/Circulation pump
3 - Kühlaggregat/Cooling unit
4 - Zerspender/Atomizer
5 - Hubspindel/Height adjustable spindle
6 - Seifenhautmodell/Soap film model
7 - Klimakammer/Airconditioned chamber
8 - Kamera/Camera
instant, adaptable, and autonomous architecture. It is at the same time not unlike the self-contained world of the computer, in which model-creation, measurement, calculation, and output are enclosed in one machine.

In this soap film machine, the model is housed in an air-conditioned chamber surrounded by glass and acrylic [Fig. 2.61]. A camera is mounted on an adjustable support in front of the chamber. The support for the soap film model can be fully manipulated using a spindle and fork, which not only adjust the height but also allow the model to be rotated 360 degrees and swiveled 180 degrees. This recalls the disorienting space of the digital model, in which it is no longer the viewer who moves around the model, but the model that is manipulated in space according to its axes.

One can make several observations in looking at the evolution of these devices. The onus of representation is no longer placed on the model, but on the apparatus that documents and measures it. Otto’s ideal of the disappearing spider web is realized: the object is overwhelmed, and eventually disappears, in the structure that measures it and converts it to data. Form-making and “scanning” are integrated in one machine. The question is no longer that of analogue representation but the extraction of numerical data that can be applied across scales.

**The calculated eye**

As these devices became more sophisticated, it was clear that the image had gained prominence, perhaps even over the object. As a result, the experiential and phenomenological aspects of image-making and observation were emphasized. For
Fig. 2.61
Soap film machine, IL.
Fig. 2.62
Images from ILEK Archive showing soap film images and apparatus in use.
instance, a 1973 IL publication included a groovy pair of 3-D glasses for the reader to use in order to view a series of anaglyphic images printed in red and green at the center of the book [Fig. 2.63]. The 3-D images show a hanging chain net model, part of a computer-plotted model of the Olympic roofs, photos of a diatom taken with an electron microscope, the structure of veins in human legs, and a geodesic image of a topographical landscape [Fig. 2.64]. This use of optical illusion is reminiscent of 1960s Op Art and psychedelic film, but also of the teaching of Gestalt-theory optical tricks in the design curriculum of the HfG Ulm. One can also look again at the influence of Helmcke, whose 1953 atlas of microscopic photos of diatoms had also included a pair of stereoscopic glasses, with the explanation that “only in this way is a spatially correct [raumrichtig] impression of the framework of the structural elements possible.” Similarly, the reason for using this technology at the IL was surprisingly tied not to questions of perception but to precision: the IL researchers argue that these images are more “realistic” spatial representations, without distortions, unlike two-dimensional drawings, which they viewed as inadequate to describe new forms that do not follow “simple geometric laws.”

While the measuring photographs had attempted to capture an object in order to

---

157 IL 6.
158 Dieter Blümel, a researcher at the IL, compared the actions of the experimental researcher who aims to see the “whole picture” to the principles of Gestalt psychology. Dieter Blümel, “IL-Archive: Interdisciplinary Information and Documentation,” in University of Stuttgart Institute for Lightweight Structures, IL 8: Nets in Nature and Technics, Information of the Institute for Lightweight Structures (Stuttgart: Institute for Lightweight Structures, 1975), 393.
159 Helmcke, Diatomeenschalen im Elektronenmikroskopischen Bild, 3. In a letter to Otto on March 17, 1973, Helmcke describes traveling around Europe with a stereo-projector, a projection screen, and a box filled with stereoscopic glasses. TU Stuttgart Universitätsarchiv, Bestand 137, No. 2.
Fig. 2.63
Cover of IL 6 (3-D glasses), 1973.
Fig. 2.64
flatten it into data, the anaglyphic images display an effort to maintain the object virtually in three dimensions. This effort was achieved not only by using cameras, but later by taking measurements from models and processing them through a computer and plotting them in red and green ink. In this reconstitution of the object, even the physiology of the human eye was calculated. Research was done on the distance between a human’s eyes, the ability of the brain to perceive depth, and the desired focal distance and angle so as not to create blind spots.\textsuperscript{161}

Otto had placed much emphasis on the importance of image technologies to expand the world of form. Technologies were also used to alter, enhance, and direct human vision—in other words, to insert themselves in the process of perception itself. The “imperfect” eye, which Otto thought to be not entirely capable of objectivity, is helped along so that the brain can produce a more realistic image. In a significant step towards simulation (and computer modeling), the traditional architectural drawing and its outdated technology of perspective were seen as no longer sufficient. These images suggest something closer to a simulated image, and one that, unlike the fragile models, could be stored, reproduced, and transferred in the form of media.

\textit{The incalculable pneu}

Not all form-finding at the IL took place within the carefully controlled space of the measuring apparatus. In the laboratory, photographs of models became increasingly precise, serving more as the basis for measurement than for the discovery of new forms.

\textsuperscript{161} D. Schwenkel, “Three-Dimensional Perspective Representation of Structures Using Automatically Drawn Anaglyphs,” \textit{IL} 6, 85.
In the “field,” however, the quest to collect and document new and incalculable forms led to a very different use of photography. At the intersection between forms found in experiments and those found in nature lay Otto’s theory of the *pneu*.

The *pneu* represented what was perhaps the furthest limit of the immeasurable and incalculable in Otto’s work. “Pneu” refers to pneumatically strained membrane structures, but also to other envelopes (like shells or the inside of bones) that resulted from the hardening of once-moist membranes. Otto viewed the *pneuma* as a universal concept of enclosure found in all nature, especially in the human body. He believed that the *pneu* was tied to the origins of life—“Am Anfang war der Pneu” (“in the beginning was the pneu”)—and was “the essential basis of the world of forms of living nature.”

Otto’s interest in the *pneu* was based in its structural properties, and not related to its function or morphology. Pneus not only represented some of the lightest forms in nature, but were also considered the most optimized. With the *pneu*, Otto claimed to be able to account for every form in nature.

One of the things that made the *pneu* a difficult object of study (and what links it to the soap film experiments and the Bic) is that it is attributed to living, mutable things and is thus difficult to capture. Otto’s interest in these “highly unstable” transient qualities of life (or the utterly ephemeral), and their unique structural properties, can be linked to his early interest in adaptability in terms of the building envelope and its

---

Fig. 2.65
Radiolaria shells in an electronmicrograph, IL 3, 1971.
environmental performance. Unlike the finicky precision of the soap film models, his study of the pneu was looser and less precise, more focused on the observation and classification of structures than on measuring.

Otto discovered the concept of the pneu while working with Helmcke at the TU Berlin during their seminar on nature and engineering. At the time Otto had been working on pneumatic structures but had little familiarity with the natural sciences or biology. Microscopic images of radiolaria – in other words, the perception of structure at a scale invisible to the human eye – brought him this revelation on the pneu [Fig. 2.65]. In his work with Helmcke, Otto’s physical experiments became structurally and conceptually linked to the world of nature. Otto describes the collapse of the distinctions that had been held in his mind between built and natural forms:

I shall never forget what happened to me during that time. My studies of technical pneumatics had introduced me to a world of forms which was entirely new to me. . . . Through Helmcke I became familiar with the forms of all organisms as an astonished observer. Suddenly I saw the animated world with different eyes. In all living things I saw the form of “my” pneumatics, of “my” bubbles, fibers, and nets. At first I could hardly believe it and asked myself whether I was imagining it all. But it became even worse: even those objects of living nature which are not pneumatics such as bones, shells, spines, and timber, exhibited these forms.\(^{163}\)

Observing these larger “patterns,” Otto began to see a reflection of his architecture in the natural world, and it in turn was reflected back to him:

---

Fig. 2.66
Conference on pneus at the IL, 1973.
I felt as if I were observing and participating in the greatest discovery in biology, although there was precious little to discover since one merely had to look closely enough. However: one is only capable of seeing if one is prepared for what is to be seen, and if one knows something comparable, and is thus able to recognize the underlying processes.\footnote{164 Mir war, als sei ich Beobachter und Teilhaber der größten Entdeckung der Biologie, so wenig es eigentlich zu entdecken gab, denn man braucht ja nur hinzusehen. Aber: man sieht eben nur, wenn man darauf vorbereitet ist und Vergleichbares kennt und dadurch Prozeßhaftes erkennen kann.” Ib“.

The pneu, like the Bic, would eventually merge into what Otto saw as a universal order established through criteria that were at times qualitative and at others quantitative.\footnote{165 This corresponds to the systems of ordering that Michel Foucault would characterize as Taxinomia and Mathesis. See Michel Foucault, \textit{The Order of Things: An Archaeology of the Human Sciences} (New York: Vintage Books, 1994).}

But while the Bic was primarily based on mathematical analysis, Otto began organizing found “pneu” forms into a system based on resemblances found mostly in photographs and material experiments.\footnote{166 Ungers’s use of similitudes to categorize urban forms will be discussed in Part III.} With this system he claimed to be able to account for every form in nature. This “great discovery” apparently found few enthusiasts in either engineering or science.\footnote{167 The theory of the pneu was eventually met with skepticism by Helmcke too, as he describes in a 1973 letter to Otto: “Dear Mr. Otto! Yesterday’s phone call from you really brought a glimmer of light into my jungle of thoughts. Afterwards I spent the evening poring over piles of books in order to illustrate the concept of the pneu with good images. — My doubts are now greater than ever. You know that I entered into this topic with great enthusiasm and could cite enough examples off the cuff. The more I pursue this problem, the more drawbacks I see.” (“Lieber Herr Otto! Ihren gestrigen Anruf hatte ich als einen wirklichen Lichtblick in meinem Gedanken-Dschungel betrachtet. Daraufhin habe ich gestern Abend noch Berge von Büchern gewälzt, um das Problem der Pneus mit guten Bildern zu illustrieren. — Meine Verzweiflung ist jetzt größer denn je. Sie wissen, daß ich in dieses Thema mit großer Begeisterung eingestiegen war und aus dem Handgelenk genügend Beispiele anführen konnte. Je mehr ich aber dieses Problem verfolge, um so mehr Pferdefüße sehe ich darin.”) Letter from Helmcke to Otto, February 1, 1973, TU Stuttgart Universitätsarchiv, Bestand 137, No. 2.}

Nevertheless, a conference (the first of many) was organized on the subject in February 1973 [Fig. 2.66]. There, according to Otto, “on Saturday, February 24, 1973, at about 11 a.m. the term ‘pneu’ was coined and its status as origin of all living forms confirmed.”\footnote{IL 9, 194.}
Fig. 2.67
IL 9 (1977); IL 19 (1979); IL 35 (1984).
This project of form-finding in nature was not a side interest but was fully integrated into the IL’s activities, and eventually became a separate, nationally funded research project in 1984. The project logo, which adorned every publication, was an image of a diatom taken by Helmcke. In many IL publications, the experiments with soap film, as well as measuring models and even images of completed buildings, were shown next to photographic images from nature. This was especially evident after the completion of the 1972 Olympics project, when the IL shifted its focus almost completely to the topic of “Biology and Building.” Photographs borrowed from the sciences show a wide range of structures: appropriately enough for a Spinnerzentrum (Spinne = spider), spider webs were a source of great fascination. So were images revealing the structure of hair, a plant fiber, a tendon, or x-rays of the human body [Fig. 2.68]. The photographs show a variety of materials and objects photographed so that they become reduced to structural form. The focus was less on pattern for the sake of abstraction than on the repetition of structural and formal typologies.

To demonstrate the theory of the pneu, Otto’s research team became more playful with form-finding experiments, using threads, fabric, foam, and balloons. Unlike the finicky precision of the soap film models, the study of the pneu was looser and more focused on the observation and classification of forms than on measuring them.

But more significant than the experiments were the photographs taken by the IL team

---


170 On April 14, 1971, Jörg Wagner, a research assistant at the IL, wrote a letter to Max Bense inviting him to moderate a forthcoming colloquium on Biology and Building. Bense was not included in the list of participants, however. TU Stuttgart University Archive, File 137, No. 2.
Fig. 2.68
Fig. 2.69
Pages from photographic studies of “pneumatic” forms taken at a slaughterhouse by IL researchers. Mid-1970s. ILEK Archive.
Fig. 2.70
Pages from photographic studies of “pneumatic” forms taken by IL researchers. Egg yolks. Mid-1970s. ILEK Archive.
members at zoos, slaughterhouses, and indoor markets, or those acquired from science publications [Figs. 2.69, 2.70]. Because the pneu in nature needed no model, so to speak, the photograph became the vehicle through which the natural and the architectural could be placed within the same conceptual system. The great amount of material gathered seemed to have no possible limits, and as a result, the definition of “pneu” seemed just as boundless.\footnote{In 1967 and 1968, two student photo contests were organized at the IL: “Biology and Technology” and “Animal Structures,” both of which were shown as exhibitions.}

Images collected under the title “pneu” were extensive and heterogeneous, and included unusual and “taboo” subjects. There were “found” structures like sails, rubber tubes, upholstery cushions, and fishing nets, but also pig intestines, microscopic images of pollen, corn cobs, frog spawn, vegetables, icicles, cells, car tires, amoebas, a human egg “a few instances before fertilization,” dividing salamander eggs, clouds, algae colonies, sea-horse skin, human skin, a cow’s heart, a Venus flytrap, multiple exposures of a human penis becoming erect, a section through the finger of a human fetus, a pig’s bladder, “the testicles of a 20-year-old man,” an apple next to an image of a girl’s navel, a slug, a human brain and skull, an embryo inside a uterus, and a naked pregnant woman with two children [Figs. 2.71, 2.72].\footnote{Published in \textit{IL} 9, and University of Stuttgart Institute for Lightweight Structures, \textit{IL 19: Growing and Dividing Pneus}, Information of the Institute for Lightweight Structures (Stuttgart: 1979).}

The special interest in the anatomy of human reproduction hints at the idea that the human is somehow privileged in this collection. While the technological objects created by humans still fall far from the structural optimization of a future architecture, the human body by contrast seems to contain potential structures. It is as if the origins of
Fig. 71
Fig. 72
the human body itself – as represented by eggs, sperm, the uterus, the penis, the fetus – offer a kind of new beginning for architecture. The theory of a universal membrane was so expansive that it was able to contain images of seemingly unrelated objects. It is only through the framing devices of the photograph and the juxtaposition of images that the scientists could hope to put together a theory. The objective was to universalize the pneu theory, producing an alternative encyclopedia of possible forms and structures to provoke and question the boundaries of what is permissible within architecture.

Otto’s “paranoid” vision in which he saw pneus everywhere was apparently also transferred to his team. As he describes it:

The more that they penetrated the form-world of the pneus, and the more they learned to identify pneus just from the form, the more pneus they saw in biological objects, and they convinced themselves that they truly had real pneus before them. . . When they then began to catalogue the technical pneus and also the biological pneus, it seemed almost uncanny to them. They kept seeing more pneu-forms in their daily environment, even in objects that are not even pneus: birds’ eggs, apples, insect carcasses, and eventually even in trees and bones. . . The architects of the IL were now seized by something similar to a “hunting fever.”

The word “paranoid” is not used arbitrarily here; it is meant to refer to a larger cultural condition characteristic of the 1960s in which systems, data, and structures (whether those of the natural or political world) appeared to take on a universal, connected, and ubiquitous quality. This tendency towards large, multiplying patterns was also seen in Otto’s taxonomic system of the Bic, and appears in the form of uncanny repetitions in

\[173\] “Je mehr sie dann in die Formenwelt der Pneus eindrangen, je mehr sie lernten, allein an der Form Pneus zu erkennen, umso mehr Pneus sahen sie bei Objekten der Biologie und sie überzeugten sich selbst, dass sie wirklich Pneus vor Augen hatten. . . Als sie dann begannen, die technischen Pneus zu katalogisieren und auch die biologischen Pneus einzuordnen, wurde es bei ihnen beinahe unheimlich. Sie sahen in ihrer täglichen Umwelt immer mehr Pneusformen sogar bei Objekten, die gar keine Pneus sind, bei Vogeleieren, Äpfeln, Insektenleibern und schließlich sogar bei Bäumen und Knochen. . . Die Architekten des IL hatte nun so etwas wie ein Jagdfieber gepackt.” IL 9, 16.
Ungers’s architecture, as discussed in Part III.

The questions of aesthetics raised by the images of the pneus cannot be overlooked, and indeed was not at all suppressed by Otto. In 1976, he wrote: “there has been scarcely any aesthetic observation in architecture for the past five decades. It is only now that we are exploring the problem from a new point of view.”\textsuperscript{174} According to Otto’s theory of \textit{aesthesis} (which he defined as “the ability to perceive the aesthetic”), optimal, lightweight form could be innately perceived. Otto viewed the pneu as a unique subject for which humans “do not yet have the necessary scientific objectivity.”\textsuperscript{175} Photography thus became the preferred method of reframing and collecting forms that the mind resists.

Resistance as evidence of taboo and inhibition plays an important role in Otto’s work. He cites, for instance, the reluctance of the IL researchers to study the pneu-like qualities of the naked human body, as these images were feared to be pornographic.\textsuperscript{176} Otto raises aesthetic questions around beauty and disgust, listing examples of objects that cause inhibition because they have “the quality of a signal”:

A signal of the disgusting and repulsive, such as bloated corpses; a signal of the ugly, such as bowels or folded skin parts; a signal of the aesthetic, such as the idealized human body whose outer form is ultimately determined by the external shape of the complex correlation of filling and the naked skin; a signal of menace, flexing of muscles or phallic impression; or a signal in various fields of sexuality.\textsuperscript{177}
Fig. 2.73
Image of owl as part of photo essay illustrating Frei Otto, "Das Aesthetische" from IL 21 (1979).
According to Otto, animals perceive certain objects in a different way, particularly objects that signal danger or sex (he cites, among other examples, the symmetrical form of an animal about to attack head-on, or a female animal ready to copulate) [Fig. 2.73]. He viewed this special attention as part of a primitive basis for aethesis, which in a more developed stage becomes an ability to read advanced, optimal structures as superior or even sexually arousing. Thus, however improbable, for Otto the question of the taboo object, the object that can’t be represented or measured, is also tied to a theory of an ideal structure – both are transgressive within their relative domains.

Images “from nature and technics” collected under the title of “pneu” are extensive and heterogeneous and do indeed include unusual and “taboo” subjects. Otto thought that conservative moral responses to these cultural taboos were analogous to the resistance to new forms and geometries in architecture. Thus, the incalculable is also that which is taboo, and the Hemmungen (inhibitions) he describes limit both architecture and science. Otto argues that the pneu evokes the anti-rationalist tradition of expressionist architecture: “Strange biological cavern systems have been discovered in stomachs, intestinal tracts, and bones, which are similar to the visions of inhabitable caves of the architects in the 1920s.” His collection of forms calls to mind not only the

dessen äußere Form letztlich durch den komplexen Zusammenhang von Füllung und der nackten Haut gebildet ist), als Signal der Drohung (Vergrößerungen von Muskelpartien, phalasisches Imponieren) oder aber als Signal in verschiedenen Bereichen des Sexuellen.” Ibid.

178 Not surprisingly, this theory was almost unanimously rejected by Otto’s peers – both by the scientists and the architectural and art historians. See discussion of “Das Ästhetische,” in IL 21, 162–187.

organic fantasies of expressionism, but also the language of the *Informe* of Georges Bataille.\(^{180}\) Even in the choice of materials – spiders, carcasses in the abattoir – one finds similarities. Otto used an ordering device to bring together seemingly incongruous objects in a way that challenged their proper order. For Otto, however, the goal is not to disturb an existing order through this formless materialism, but rather to establish an expanded formal order, a system that is able to assimilate all forms and find within them a unifying principle of optimal structure. This attempt can be viewed as yet another form of “risk management,” one that takes account of those formless, taboo objects that anthropologist Mary Douglas describes as evoking fear or apprehension within cultures.\(^{181}\)

As the IL researchers moved further into the terrain of science, especially biology, they allowed themselves greater imprecision. Their contradictory methodology asked for precise measurement, but also required room for subjective experience in order to embrace “unknown forms.” To avoid a recourse to Euclidian geometry used to describe “known” objects, observation was needed that would defamiliarize everyday objects (spider webs, human bodies, etc.) and allow for the recognition of unknown forms. These nevertheless ultimately need to be captured as data: “Today a highly developed measuring technique is available for measuring forms by scanning or photographing them and storing the data. Simple forms require hundreds of datum to permit their

---


adequate description. Complex forms often require millions of datum so that the form can be stored with certainty and recognized reliably by many people.\textsuperscript{182}

As the complexity of a form increased, so did the amount of information needed to capture and reproduce it, suggesting an eventual return to calculation. When constructing large, sophisticated projects, Otto’s institute turned to new instruments that could process this increased quantity of data; new tools were needed that would “permit the comprehension of thousands of data ‘at a glance.’”\textsuperscript{183}

\textit{From incalculability to computation}

While the pneu represented the not-yet-attained and perhaps immeasurable ideal of a universal, optimized structure, Otto’s built projects demanded precise measurement and calculation. Measurement models, designed to produce data objectively, lay at the other end of the spectrum of calculability. These models yielded numerical information about stresses that were difficult to comprehend visually and were nevertheless impossible to calculate mathematically. Forms were arrived at through inductive methods, then tested in models that generated information, which was fed back into the structure. Paradoxically, once an optimal form was found, whether by soap film or other self-forming methods, it lost its mutability, due to the complex and inflexible nature of minimal surfaces. This was especially the case for structures with less consistent loads made of more rigid materials, like the cable-net roofs for the 1972


\textsuperscript{183} Ibid., 16.
Fig. 2.74
Olympics buildings, which required great accuracy. While the overall form is largely stable in these models, change occurs on the micro-level, captured by tiny gauges and stereoscopic cameras. Because the structure is a system, it generates new data with every minute change, a predecessor to today’s parametric design.

Otto had constructed measurement models and form-measuring devices as early as the 1950s [Fig. 2.74], but needed more sophisticated methods when he was commissioned to work on large cable-net projects, beginning with the Montreal 67 Expo pavilion. Unlike the nearly immaterial liquid surface of the soap film, cables and connections on a matrix allowed for the isolation of individual points. These fixed points made it possible to position these forms within the coordinates of Cartesian space, and eventually allowed for Otto’s work to be digitally modeled.184

These types of measurement models sacrificed resemblance to the building in favor of a “picture” of the building in numbers. For a structural model to be measured, it typically has to be “disfigured” with sensors and markings, like “a sick body, to the point of rendering it unrecognizable.”185 But attaching measuring instruments, however precise, to a model also modify and distort the results.186 The model becomes hyper-rationalized as it requires further technological intervention in order for it to correct its own (mis)behavior.

184 As one researcher writes, “In the case of the Munich tent roofs, the digital presentation was simple because the supporting construction is defined by the x,y,z coordinates of the cable junctions.” IL 6, 83.
186 Ibid. It is for this reason that Vaudeville and Kutterer argue that measurement models would eventually have to be supplanted by the “virtual space” of informational calculation.
The metal wire models that were built beginning in the mid-1960s at the IL indeed resembled a technologically sustained body. They were loaded with weights and springs to create strain, and outfitted with stereophotographic cameras and gauges that could register movement to one-tenth of a millimeter. As in the soap film experiments, a physical model was combined with a method of precisely documenting it both photographically and numerically. These models were quite large, and could be adjusted according to the feedback given by the measurements, by changing weights or wire tension. The flexibility (or what would today be called parametric logic) of the models would eventually be built into the construction of the actual buildings: the tension of individual connections in a cable-net structure could be adjusted via clamps, giving a clear material expression of its internal forces.

For the 1967 German Pavilion in Montreal, a cable-net structure with irregular peaks covering 10,000 square meters was designed. At the time it was the largest cable-net structure to ever have been built. Linear calculations of a structure of this type were impossible for “an interchange system that was highly statistically indeterminate internally.”187 The model was thus key to the method of “calculation” [Fig. 2.75]. The use of pre-tensioned wires in the model literally simulated the stresses of the built structure, but at a smaller scale. When the pavilion was erected in Montreal, the system could be adjusted by manually adding or releasing tension via clamps, thus performing optimization (and risk management) on the building itself.

During the time of the Montreal project, mathematics also took on increasing

---

Fig. 2.75
Measurement model and devices for
German Pavilion in Montreal, IL, c. 1966.
importance. With public funds available from the West German government and private funds from the Stromeyer tent company, the engineers with whom Otto worked began to develop mathematical formulas for tent structures. Otto initially embraced these new methods, particularly the geodesic experiments under Klaus Linkwitz at the TU Stuttgart, and later those of John Argyris, who developed computer-based calculations. In 1976, Otto stated that a barrier was broken when “the computer became a help” and “there were persons like the members of the Argyris team, who could play it like virtuosos.”

However, the transition from modeling the incalculable to calculating models with the computer did not happen so smoothly. The turning point was during the design and construction of the Olympic roofs, in which the IL played a great role. The roofs for the 1972 Olympics structures were about ten times larger than the Montreal pavilion, and most significantly, it was built to be permanent, thus requiring a much greater investment. Otto’s involvement was especially intense in the spring of 1968, at which point “there existed no methods yet for the mathematical analysis of cable nets,” and “the experimental methods of model making had to be employed for the determination of the final form and for the investigation of the carrying behavior.”

Working with teams led by Günther Behnisch and Fritz Leonhardt, a tulle design model was first created and accurately measured. Based on the tulle model, several very large measurement models (the largest was 1.9 x 4 meters) were constructed [Fig. 188].

---

188 IL 16, 138. Original in English.
189 IL 8, 275.
190 Soap models, incidentally, were used for only part of the Olympic roofing, and most of the forms of the cable-net structures could not be described as minimal surfaces. This was one of many deviations from Otto’s theory of lightness that occurred during this process. Mick Eekhout, “Frei Otto and the Munich Olympic Games,” Zodiac 21 (1972): 12–73; 27.
Fig. 2.76
A net of wires was soldered together and hung into the model, where it was subjected to various methods of producing and adjusting tension using springs and screws [Fig. 2.77]. What makes these models so impressive is not only their scale but also their machine-like precision. It is not a stretch to refer to these as a form of physical computing. Nothing in the construction of the models was arbitrary, and all of the performance variables were scaled down. For instance, spring wire, dimensioned and cut to scale, was pre-stressed proportionally according to the actual cables [Fig. 2.78].

The measurement of the model took place on several levels. The overall geometry and position of the coordinates in the system were determined by the use of a measuring table [Fig. 2.79]. This large structure, a kind of virtual Cartesian space, was able to trace and measure the geometry of a complex model through the use of a plummet. The data obtained could be read and stored through a computer in the form of punch cards or plain text. These values were saved or transferred to a drawing that was positioned above the model. This method, like the soap film model drawings, results in an indexical “scan.”

A greater level of information was obtained by the use of photography combined with special measurement devices [Figs. 2.80, 2.81]. Measurement here is less a question of dimension than it is one of performance. Individual wires are hung with number tags so that they could be identified in photographs. Every coordinate was a unique instant in which intersecting wires must be in equilibrium. The model was pulled at by means of chains and weights simulating different loads, and devices were developed that could read these minute changes. Thus, whereas in the case of the soap
Fig. 2.77
Fig. 2.78
Fig. 2.79
Measuring table, IL. Screw spindles to move the x, y, and z axes are operated by electric motor. Measurements could be printed directly onto coded punch tape. *IL 10: Grid Shells*, 1974.
Fig. 2.80
IL Instruments for measuring mechanical forces in wire models (from top: contact arm and dial gauge, suspension tongs, measuring tongs, and ring dynanometer).
Fig. 2.81
Measuring devices for wires in measuring model. 1967.
ILEK Archive.
Fig. 2.82
Camera with attachment allowing for isolated, measured photograph of sections of measuring model for Montreal pavilion. 1967. ILEK Archive.
Fig. 2.83
film models, increasingly larger devices engulfed the models, here the development was towards ever-smaller tools that were, in effect, sensors embedded within the model.

While the soap film models had been photographed in their entirety so as to capture a total image of the form, the cable-net model is photographed in close-up sections [Fig. 2.82]. The enormous quantity of data contained in the model, not yet translated into digital information, could be documented only with the camera, and only in parts. Not only single instances, but also multiple layers of information were recorded through time-lapse photographs that showed the model change under strain [Fig. 2.83]. These jittery photographs document a blurred landscape of grids, dials, and numbers. With these images we return to the early modernist desire to capture form in motion, and change through time, using photography. But however similar the effect, the objective was different: to control movement, rather than release its potential energies; to predict the future of architecture mathematically, rather than imagine it.

The calculation of the Olympic roof structures occurred between 1968 and 1972, with the most intense activity at the IL taking place over two years. During this time, an extraordinary number of developmental steps were taken, with multiple experiments, versions, and adjustments as the optimal form was neared. An iterative process of fine-tuning and self-correction took place through a series of protocols that were no longer just linear, but also repetitive. One of the most difficult tasks was the manual tensioning and retensioning of thousands of wires until equilibrium was reached at every point in the structure. This series of protocols clearly resembles the command-

---

191 These many steps of the design process were documented in two diagrams: one produced by the IL in 1975, and one made by a group of students at TU Delft and later published in Zodiac. Ibid.
based process of computing.

In contrast to this careful adjustment over time, a temporality of immediacy was evident in what was called the “multimedia test” [Fig. 2.84]. The great sensitivity of the Olympic stadium model made it vulnerable to imprecision if too many subsequent tests were run. Thus, researchers devised a snapshot of the model in which as much information as possible was collected at once. (The entire test, run according to a checklist, took ninety minutes.)\(^{192}\) The attempt to converge all of the data that could be obtained from a model was brought to a new level in this test. The photograph shows what seems to be more of a test site or performance stage than a model. Hundreds of instruments were attached to the wire mesh model, and the weights that hung from it were all suspended at once as a pneumatically controlled floor below was deflated.

Surrounding it in a manner resembling a television studio is a battery of cameras, from which bundles of wires emerge.\(^{193}\) This setup can be seen as a composite object made up of both the model itself and the devices that measure, adjust, and document it. The two become indistinguishable, together forming an architecture that is as much about form as it is about information. Here the solitary scientific observer looking through a lens (whether that of a camera or a microscope) is displaced; he or she instead becomes a reader and analyzer of data after the event. Information was viewed not with one eye but with many cameras, multiplying the observation experience so that the object could

\(^{192}\) IL 8. The term “multimedia” had only been coined in the early 1960s, and so it seems especially astute that the IL would use the term. “Multimedia” can also be understood as the mediated nature of these images and their distribution as “evidence” of the advanced state of engineering research in West Germany.

\(^{193}\) This setup consisted of eighteen Linhof cameras that took double-exposure photos to show deformations and record stress gauges; miniature cameras documenting protractors to see mesh angle displacements; strain gauges showing vertical displacement; and wire strain gauges showing forces. Ibid.
Fig. 2.84
"Multimedia" test of simultaneous measurements of the Olympics roof model using 6x6 cameras, miniature cameras, and gauges. IL, c. 1968.
be seen from all sides at once. With this assemblage of architecture and devices, the panoptic quest to view “thousands of data at a glance” was achieved.

The simulation of multiple conditions allows the model to potentially slip into an autonomous, more utopian, condition removed from the real. As IL researcher Sigfried Gaß writes:

The . . . main features of all models lead to the epistemologically important realization that models can always only be a reproduction of a reality (no matter what kind) but at the same time are themselves reality and are therefore subject to their own laws. This phenomenon is well known in the field of model construction in architecture: models have their own aesthetic fascination which in some cases may go far beyond their actual function, i.e. to be a model of a planned spatial structure . . . such that an absolutely autonomous architectural model can be created, which may create the illusion of an architecture which is free from all constraints.  

The autonomous object described by Gaß fascinates because it is still ahead of the engineer’s calculations. It participates both as a reproduction of “reality” and as a reality of its own.

Perhaps this was one reason that the data did not seem accurate enough? An enormous amount of information was produced simply by the intricacy of the model and by the detailed manual adjustments provided by the “cheap labor” of the IL

---

194 “Die drei Hauptmerkmale aller Modelle führen zu der erkenntnistheoretisch wichtigen Feststellung, daß Modelle grundsätzlich nur ein Abbild einer wie auch immer gearteten Realität sein können, gleichzeitig aber immer selbst Realität sind und somit eigenen Gesetzmäßigkeiten unterliegen. Im Bereich des Modellbaus in der Architektur ist dieses Phänomen bekannt: Modelle haben einen eigenen ästhetischen Reiz, der in einzelnen Fällen weit über die eigentliche Aufgabe, Modell eines projizierten räumlichen Gefüges zu sein, hinausgehen kann . . . sodaß ein vollkommen autonomes Architekturmodell entstehen kann, das dann die Illusion einer von allen Zwängen befreiten Architektur aufkommen lassen kann.“ IL 25, 1.3. Sigfried Gaß evokes philosopher Herbert Stachowiak’s 1973 “Model Theory.” Stachowiak wrote primarily on cybernetic models, and similarly pointed to their limits and the dangers of attributing too much “reality” to these constructs. According to Stachowiak, all models share three characteristics: (1) They are representations. This could be of natural or artificial things, or even other models. (2) They are reductions. They do not include every attribute of the real. (3) They are pragmatic objects. They are not valid universally but are valid only for a certain time and purpose. Herbert Stachowiak, Allgemeine Modelltheorie (Wien: Springer, 1973).
Fig. 2.85
Top: contour plan made from values taken from measurement model; Bottom: computer-generated drawing produced from mathematical optimization of values. Olympics project, TU Stuttgart IFG, c. 1969.
students. As computer models were increasingly able to calculate complex structures, it became clear that the analogue technologies used in the models were in some ways primitive. The measurement models of the IL generated patterns for cable lengths, which were directly translated to the manufacturing and construction process [Fig. 2.85], and yet the patterns were simply not accurate enough: “a cutting pattern determined in this direct and rather simple way would result in intolerable risks.”

While the pavilion in Montreal had been determined using these methods, the very definition of “precision” seemed to have changed in the interim:

> From geodesy and experimental natural sciences we know . . . that “exact” models and measurements in the very sense of the word “exact” may be imagined mentally, but do not exist in physical reality. Therefore the measured spatial coordinates describe the theoretical exact configuration of the net only with a certain blur.

A certain amount of blur or imprecision had been desirable for investigating the pneu. But in this case it was intolerable. Thus, at the same moment that the measuring models were constructed to replace calculation, they were being replaced by a newer form of calculation. At the TU Stuttgart, the teams of both John Argyris at the Institute for Statics and Dynamics of Aerospace Structures, and Klaus Linkwitz at the Institute for Geodesy separately worked on methods of calculating the structure using computers.

Linkwitz began work on a model in which equilibrium was simultaneously calculated for

---

195 Klaus Linkwitz, “Photogrammetric and Computational Work for the Olympic Roofs, Munich,” *Zodiac* 21 (1972): 77. Incredibly enough, an error of .007 mm in the model could result in a cable being 0.8 mm too long or too short, which when stretched would become 5 cm, which would mean that the tension would be off by 50 percent. Eekhout, “Frei Otto and the Munich Olympic Games,” 45.

196 Linkwitz, “Photogrammetric and Computational Work for the Olympic Roofs, Munich,” 77.

197 Argyris was an aeronautics engineer at the University of Stuttgart. He is known as one of the pioneers of Finite Element analysis (itself based on early theories by Richard Courant). The Finite Element method was developed and applied at a large scale for the first time for the 1972 Olympic roofs.
all points in the net so that loads could be equally distributed. These calculations, some of which required equations with up to 8,000 unknowns, were processed on a CDC 6600 computer (a supercomputer originally used for nuclear physics research).¹⁹⁸

Meanwhile, the engineers Fritz Leonhardt and Hans-Peter Andrä began collaborating with Argyris. The problem faced by the engineers concerned not only the calculation and measurability of the form, but the behavior of each moment in the structure (which could number in the thousands). With the adjustment of the tension, or the position of a single cable in a net system, every other point is influenced. Thus, there is no “typical” moment in the structure. The problem of having such a great amount of information had not yet been faced in the continuous surfaces of membrane structures.¹⁹⁹ Using data obtained from the IL measuring models, Argyris’s team wrote several programs for determining a state of equilibrium between over 10,000 points in the cable-net structure and the fixed anchors at the site. They also ran equations for snow and wind loads, and used plotter outputs to iteratively adjust the design. During the course of their developing this method, the speed of calculation increased from three hours to twenty minutes [Fig. 2.86].²⁰⁰

In the end, the three teams brought different parts of the project to completion using different methods. The transition from relying on Otto’s physical models to calculating the information on computers took place very quickly. By this time, it was

¹⁹⁸ Eekhout, “Frei Otto and the Munich Olympic Games.”
¹⁹⁹ Marios C. Phocas, “John Argyris and His Decisive Contribution in the Development of Light-Weight Structures: Form Follows Force,” 5th International Congress on Computational Mechanics, GRACM 05 (Limassol, 2005).
²⁰⁰ Linkwitz, “Photogrammetric and Computational Work for the Olympic Roofs, Munich.”
Fig. 2.86
also clear that Otto had distanced himself from the process. The large, intricate models built by the IL were brought to the construction site, where the engineers did not know what to do with them. Otto had created a form of architecture so dense with information and potential risk that it could probably have been executed only by using computers. The complexity of the structure and its extremely tight tolerances created a system in which change could only be “processed” and managed by simultaneously solving thousands of nonlinear equations. But this use of computation changed the architecture itself, creating a rigid and inefficient structure that ended up far from Otto’s ideal of lightness.

Otto’s use of models was of great significance for the beginnings of digital architecture, but to subsume it only within this technological history would miss the opportunity to speculate on the potentials of the assemblages of matter, form, information, and image that they suggest. The economist Sanjay G. Reddy writes that “a risk-based conception of the world . . . made of it a fabric that was essentially knowable.” Science promised to make uncertainty knowable through calculation and probability, such that the calculability of risk gave authority and legitimacy to those institutions (including think tanks like the IL) that could claim to produce a “calculable mapping of the future world.” With his concept of the pneu, Otto tried to open up the

---

201 As Jörg Schlaich wrote: “Frei Otto could be [the] team leader. But actually he was and still is against the computer applications. Of course he has developed all these methods himself. He is a man who is not deep in the mathematical field; of course for him all computer calculations are suspect. He wants a model and sees then what happens.” Jörg Schlaich, in Zodiac 21 (1972): 54.

202 The models were destroyed while on the site, through negligence. IL 14, 17.


204 Ibid.
possibility of the incalculable and unknowable. But with the criteria of optimization determining the selection of these forms, forms were already integrated into a system of measurement. This was the threshold of calculation. Could a space for what Reddy calls “radical uncertainty” be created at the IL? As the case of the Olympics project shows, uncertainty was intolerable, and a clear calculation and management of the complexity of the risks eventually had to be carried out by other means, namely by pure calculation.

Perhaps Otto’s insistence on physical model testing was a reaction to what has been described as a culture of dematerialization that began in the 1960s. At the occasion of his 1985 exhibition, *Les Immateriaux*, Jean-François Lyotard described this new relationship between matter and information:

Research and development in the techno-sciences, technology and the arts . . . give the impression that reality, whatever it may be, becomes increasingly intangible, that it is never immediately mastered. . . . Materials themselves never cease to become more complex. . . . It is as if a filter has been dropped between things and us, a screen of numbers. A color, a sound, a material, a pain, or a star return to us as very precise identification cards. These coders-decoders teach us about realities that are otherwise unknowable. In the end the good and beautiful matter itself reaches us analyzed and reconstituted into complex formulas. Reality is made of indiscernible elements organized by structural rules (matrices) in inhuman scales of space and time.²⁰⁵

Fig. 2.87
Fig 2.88
Snail, photographed by IL researchers. Date unknown (1970s). ILEK Archive.
Otto’s experimental models predate this text by at least two decades, but one can already observe his engagement with the problem of “the good old matter” as it is coded and decoded, reduced to numbers and then rematerialized. His response to dematerialization was to grasp for matter. [Figs. 2.87, 2.88]

Considering his politics of lightness, one could go so far as to ascribe a moral imperative to Otto’s insistence on physical evidence. Calculation, especially with the more sophisticated tools of computation, may displace the arrogance of authorship, but its programmed rationality also displaces accountability and blame. Otto later criticized the Olympic roofs project as “the symbol of German ability, modesty, and humanity . . . it was to drive out the evil spirit and replace it with an illusion.”206 The Olympic models were built in a state of obliviousness during the unrest of the student movement, “amid the verdure in heavenly isolation, and thus laid the basis for a monumental building which justly was the most disputed of the past decade, and which finally four years later was the symbol of a gay hospitality for a few days, and then was remembered by the world as a symbol of terror and murder.”207 Lightness had not been able to deter such violent acts.

While it was Otto’s project to move beyond the confines of calculation, his melancholic limitation was to constantly return to it in the form of structures that became immaterial and transformed into numbers. The idealization of the incalculable

206 “Ein Symbol deutscher Tüchtigkeit, Bescheidenheit und Menschlichkeit...es sollte den Ungeist verdrängen und durch eine Illusion ersetzen.” IL 14, 114.
and ephemeral was also, it turned out, an idealization of complex and possibly risky forces that had to be simulated and measured. Because nature was not a metaphor for Otto, but a direct source of material and structural behavior, it was subjected to the very rationalist modes of interpretation that he objected to. The ethical architecture of the minimal – light and unbound envelopes, adaptable forms, living nature – became symbols of a new rationality.
Part III
Prediction, Repetition, Ratio
In a letter dated April 5, 1962, Frei Otto wrote Oswald Mathias Ungers from the Institute for Development of Lightweight Construction in West Berlin:

Dear Ungers,

Even if you will not agree with my point of view in many ways, I do not want to miss the opportunity to tell you that I value your work very much, and have much understanding for your defiant advocacy, even if it perhaps aims in different directions – but perhaps precisely for that reason!

Cordially yours,
Frei Otto

Otto’s carefully phrased admission of their differences refers to their divergent views in post-war architectural discourse. The letter was sent shortly before a moment of transition for both architects: Otto would soon leave West Berlin to head the Institute for Lightweight Structures in Stuttgart, and Ungers would leave Cologne to begin his professorship at the TU Berlin in 1963. Otto sent the letter with a copy of Wort und Wahrheit (Word and truth), a monthly Austrian publication on religion and culture founded after World War II by Otto Mauer and Karl Strobl, who were anti-fascist Catholic priests. An essay by Otto, “Bauen für Morgen” (Building for tomorrow), appeared in the issue he mailed. In this essay Otto made his case for adaptable and ephemeral architecture, and criticized the “thoughtless” and “aimless” architecture

---

1 “Lieber Ungers, Wenn Sie in Vielen meinen Standpunkt nicht folgen werden, so möchte Ich aber nicht versäumen Ihnen zu sagen, das ich ihre Arbeiten sehr schätze und viel Verständnis für ihr kämpferisches Eintreten habe, auch wenn es vielleicht in anderen Richtungen zielt – aber vielleicht gerade deswegen! Herzlichst Ihr, Frei Otto, 5.4.62.” Handwritten letter, April 5, 1962, Ungers Archiv für Architekturwissenschaft. All translations are mine unless noted otherwise.

2 Their paths may have crossed again: in October of 1964, Frei Otto returned to the TU Berlin to give a lecture entitled “Bauten mit geringen Aufwand” (Buildings with little effort). The lecture was given on October 16, as part of the Berliner Bauwochen. An exhibition of Frei Otto’s work was also held at the TU Berlin, opening on October 8, 1964. TU Berlin Universitätsarchiv, Archive 206-90.
Lieber Ungers,

Wenn die im Vordergrunde meiner Sichtpunkte nicht folgen werden, so müßte ich sehr wohl verzögert bleiben. Ich aber hoffe, daß wir in Ihrer Arbeit sehr schätzen und viel Verständnis für Ihren künstlerischen Eindruck haben, auch wenn es vielleicht in andere Richtungen fällt - oder vielleicht gerade deswegen! 

Gegrüßt auch Ihn

Frei Otto

5.4.62
Fig 3.2
of reconstruction. He mentions Ungers among others that he supported as representative of a new architecture of individual expression and fantasy.³

Otto also argues that scientific reason was inadequate for addressing the question of biological wholeness:

One believes that the exact sciences can deliver it [biological wholeness] ready to be picked up in each case, without recognizing that knowledge of the influence of modern technology on the organic world is barely available, because far too few architects are aware of their productive role as the intermediary between the mathematical-abstract and the living world.⁴

Ungers would likely have agreed with this criticism of the “mathematical-abstract,” but not the recourse to nature.⁵ Whereas Otto looked to nature for a set of rules and laws with which to organize architectural form, Ungers looked to history. The rational turn in Ungers’s case was a convergence of two tendencies: one was a historicist approach modeled after that of figures like Karl Friedrich Schinkel and Jean-Nicolas-Louis Durand, used in search of a new set of rules for creating architectural form. Ungers’s intense study of historical architectural treatises, which extended to physically collecting these rare documents, was evidence of his ambivalence towards the technological demands of the present. At the same time, especially during a period in the 1960s, Ungers was swept up in the exuberant embrace of mass production and scientization, resulting in a

³ Other architects mentioned were Eero Saarinen, Louis Kahn, Paul Rudolph, Werner Ruhnau, and Günter Günschel, with whom he collaborated on the 1957 Interbau exhibition. Frei Otto, “Bauen für Morgen,” Wort und Wahrheit 17, no. 3 (March 1962): 209–220; 211.

⁴ “Man glaube vertrauensselig, daß man das Wissen dazu habe. Man glaubt, daß es die exakten Wissenschaft jeweils abholbereit liefern könnten, und erkennt nicht, daß das Wissen über die Einflüsse der modernen Technik auf die organische Welt noch kaum vorhanden ist, weil sich viel zu wenige Architekten ihrer produktiven Mittlerrolle zwischen der mathematisch-abstrakten und der lebendigen Welt bewußt sind.” Ibid., 210.

different sort of rationalism. In both Otto’s and Ungers’s work, a rational approach is used to define form as driven by autonomous forces that are largely detached from social and political processes. However, the ethical and moral concerns that dominated discussions of architecture in the 1950s, and continued to be important for Otto, were absent in Ungers’s work, or appeared only as an afterthought. This uncoupling of rational architectural methods from a progressive social agenda marked yet another facet of rationalism as it will be studied here, and would be particularly significant around 1968.

The differences between Otto and Ungers can be gleaned even from Ungers’s notes in the margin of Otto’s essay. Ungers underlined several passages and included some small comments. For instance, when Otto writes, “One must finally recognize that buildings with unchangeable, rigid structures can never be organically related to the body of a human being,” Ungers notes that this is “biological materialism” (biologischer Materialismus).\textsuperscript{6} Ungers never expressed an interest in nature, the biological, or the material – he was purely interested in Geist (the intellect) and form.

Their views on history also differed. Otto took an interest in the long span of natural and evolutionary histories that exceeded human and architectural time. This biological viewpoint meant that architects similarly had to consider an expanded historical perspective, even in the traumatic aftermath of war: “The architect never stands in front of nothing, even when he finds a desert or rubble.”\textsuperscript{7} Following this concept, Otto


\textsuperscript{7} “Niemals steht der Architekt vor dem Nichts, selbst wenn er Wüste oder Trümmer vorfindet.” Ibid., 217.
proposed adaptable buildings “that never become old, because they can independently renew themselves.” Ungers underlines this and asks: “and ruins, are they not adaptable.” Ungers is perhaps expressing a certain cynicism towards Otto’s technological idealism, but he also indicates his developing interest in an architecture that works directly from architectural (not natural) history, and what would be his excavation of the “ruins” of architectural theory.

Ungers drafted a response letter to Otto on expired pages torn out from a calendar [Fig. 3.3]. In these notes, he emphasized his agreement with many of Otto’s thoughts, particularly Otto’s claim for the importance of new architectural ideas and concepts. He also defends a “submission” to an “intellectual will of form,” defining the art of building (Baukunst) as based on the expression of the creator of architecture (Schöpfer) through form. This Ungers views in opposition to “material tools” (stoffliche Hilfsmittel), or the “expert use of materials” (fachgerechten Anwendung von Materialien).

The language used here by Ungers is remarkably similar to that of his manifesto “Zu einer neuen Architektur,” co-written with Reinhard Gieselmann in 1960, which was a declaration of their “doubts about calculability” (Zweifel an der Berechenbarkeit) and their “belief in intuition” (Glauben an die Intuition) [Fig. 3.4]. The manifesto defends

---

8 “Die niemals alt werden, weil sie sich fast selbstständig erneuern können.” Ibid., 216.
10 A letter was sent, though no copy of the final version is in the archive. Otto replied to Ungers, thanking him for the letter. Undated letter from Frei Otto, also found within the copy of Wort und Wahrheit. Ungers Archiv für Architekturwissenschaft.
11 Unpaginated handwritten notes found inside the issue of Wort und Wahrheit. Ungers Archiv für Architekturwissenschaft.
12 The manifesto was published as part of a letter to the editor in Der Monat 15, no. 174 (March, 1963): 96. In his introduction to the manifesto, Gieselmann lists their intellectual sources as Max Planck, Wilhelm Worringer, Henri Bergson, Jean Gebser, and Lewis Mumford. The manifesto was later published in Ulrich
Fig. 3.3
creativity, vitality, mystery, and the freedom of the architect as crucial to a democratic society, in opposition to a technological, functional, and mathematical architecture of a “materialistic social order” (materialistischen Gesellschaftsordnung). In keeping with the postwar culture of the protection of the homeless human subject, architecture is described as a kind of healing shroud: “Architecture is envelopment and recovery and thus a fulfillment and deepening of the individual.” This concept hints at an idea that Unger’s would revisit later: that of incorporation, or the enclosure of a series of objects inside one another.

Nevertheless, the positions of Unger’s and Otto were perhaps the closest at this moment than they ever would be. Unger’s had recently completed the construction of his own house at Belvederestraße 60 and was working on an exhibition and book about the expressionist architecture of the Glass Chain. He was not yet associated with the highly rational and even technocratic approach to architecture that he would later adopt. Max Bill, when writing a letter of recommendation for Unger in support of his position at the TU Berlin, even wrote: “[The students] will, however, have to be taught

13 Ibid.
14 “Architektur ist Einhüllung und Bergung und damit eine Erfüllung und Vertiefung des Individuums.” Ibid.
15 Unger was responsible for significant exhibitions and a publication on the letters of the Glass Chain (one of the first, if not the first, publication of this material). This project began with an encounter with Hermann Finsterlin in 1962. Unger organized an exhibition at the Galerie Diogenes (September 1–16, 1962) together with Ulrich Conrads, and an exhibition at the Museum Leverkusen, which opened in July 1963, together with Udo Kultermann. These exhibitions included works from Unger’s own collection of expressionist drawings. Max Taut, O. M. Unger, Udo Kultermann, and Bruno Taut, Die Gläserne Kette: visionäre Architekturen aus dem Kreis um Bruno Taut, 1919–1920: Ausstellung im Museum Leverkusen, Schloss Morsbroich, und in der Akademie der Künste, Berlin (Berlin: Akademie der Künste, 1963). See also Jasper Cépl, Oswald Mathias Unger: Eine Intellektuelle Biographie (Köln: Walther König, 2007), 113–119. Cépl’s 647-page biography, written with Unger’s cooperation, is currently the only source for much of Unger’s personal archival materials, as well as thorough insight into his intellectual and personal history, as revealed through interviews with the author.
elsewhere when it comes to that which is systematic and purely concerned with reason” [Fig. 3.5].

Ungers’s own “rational turn” began with his study of historical treatises of architectural history and theory, and his development of systems for ordering form. This approach significantly changed with the influence of scientization on architecture in the 1960s, and the particularly strong presence it had at the TU Berlin among Ungers’s students. The result was a kind of super-rationality, in which historical formalist systems like seriality, typology, and proportion encountered the 1960s technologies of mass production, prefabrication, simulation, and cybernetics. “Rational architecture” here thus describes an ongoing engagement with seriality, mass production, and calculation, but at the same, a return to purely formal uses of geometry (without the “goodness” Bill associated with it). Architecture became formally self-referential, oscillating between excess and minimization, growth and shrinkage, future projection and history.

Ungers became increasingly dogmatic in his defense of Ratio and Vernunft (reason) against architecture that was determined by fantasy or the arbitrary. And yet, his rationalism was always marked by aporia that provide a glimpse into the irrationality of postmodern and late capitalist societies. This glimpse appears in Ungers’s slippage between real, calculated, and simulated worlds in the late 1960s, his uncanny use of

---


17 He distanced himself from his early interest in expressionism: “Expressionism in architecture leads to a dead end, because it is a type of pseudo-religion, because it is a negation of rationality.” “Der Expressionismus in der Architektur führt in eine Sackgasse, weil er eine Art Pseudo-Religion ist, weil er eine Negation der Rationalität ist.” “Oswald Mathias Ungers im Gespräch mit Nikolaus Kuhnert,” Arch+ 85 (June 1986): 32–39; 32.
18-3-63

herrn prof. k. dübbers
lehrstuhl für entwerfen und gebäudelehre
technische universität berlin-charlottenburg
hardenbergstrasse 35
berlin

sehr geehrter herr dübbers,

ihrer anfrage vom 15-3-63, über herrn oswald mathias ungers eine
beurteilung abzugeben, komme ich gern nach.

ich kenne herrn ungers persönlich und kenne eine anzahl seiner bauten
in wirklichkeit.

ich bin der überzeugung, dass sich herr ungers für die in aussicht
genommene lehrtätigkeit aus zwei gründen speziell eignet:
1) weil er eine freie raumkonzeption vertritt, die er im gegenatz
etwa zu scharoun oder schwagenscheidt auch weitgehend ästhetisch
auswertet. 2) weil er der detailbearbeitung besonderen wert beimiast.

wenn ich auch persönlich mit seiner architektonischen konzeption nicht
übereinstimme, so bin ich doch überzeugt, dass er als hochschullehrer
sich gut auswirken würde, schon dadurch, dass er jedem schematischen
vorgehen gegenüber skeptisch ist und auch die studenten in diesem sinn
erziehen würde, das systematische und rein vernunftmassige vorgehen
müsten sie dann allerdings anderswoher gelehrt bekommen.

mit freundlichen grüssen

max bill
strategies of repetition and mise en abyme in the 1970s, and his almost cabalistic focus on the figure of the square in the 1980s and ‘90s. The early metaphor of architecture as a shroud of enclosure was perhaps apt, as Ungers, like many of his postmodern contemporaries, created closed, self-referential systems that in many ways all operated as simulations (with an emphasis on the idea of similitude and sameness suggested by this term). This is true both formally – in the use of closed systems that contain difference and variety – and also socially and politically. The extreme defense of the artistic freedom of the individual gradually became a defense of architectural autonomy, one that left little room for material and functional concerns. Even his “engaged” urban proposals of the late 1960s were based on abstract formal systems in which the social and economic “real” appears only in the form of numbers. Ungers’s enchantment with technocratic approaches would lead to a crisis around the use of scientific reason that led to intense political confrontations during the student movement.

In Dürer’s allegory *Melencolia I*, the futility of measurement is seen in the tools that lie strewn at the angel’s feet. Otto’s incalculable ideal of lightness led to a melancholic stasis as his attempts to capture the ephemeral forms found in nature reduced them to numbers. A different form of melancholy is represented by the magic square favored by Ungers: the postmodernist games of formal exhaustion found in the architecture of the 1970s and ‘80s. This late rationalism, I will argue, is highly irrational. No longer associated with a political project or even with functionalist concerns, it transforms into a self-referential system with surrealist results: mirroring, repetition, mise en abyme.
I. CALCULATING THE CITY: PREDICTION AND SIMULATION IN BERLIN, 1968

Jeder Wissenschaftler ist ein idealist. (Every scientist is an idealist.)
—Welt am Draht (1973), directed by R. W. Fassbinder

What does it mean to predict architecture? Calculation is a powerful but also potentially mythical tool for predicting the future. It lies at the heart of foretelling and trying to manage risk in both natural and artificial events: storms, the behavior of stock markets, patterns of consumption, and other systems that can be statistically and numerically documented. The promise of calculation is that it can shape the future. But in order to predict, one must be able to measure past behavior by translating the world of things into numbers. Considered in the context of architecture, prediction implies the act of measuring what is already there, but also projecting towards the future.

The modern city, which generates enormous quantities of statistical data, has been one of the central objects for architectural prediction and risk management. Urban prognostication, while seemingly rooted in the statistically real, quickly takes on a fictive element when future scenarios are imagined, simulated, and desired. Prediction, in the context of the city, departs from organic models of “natural” growth, as it attempts to artificially steer urban and human systems that, perhaps by definition, cannot be controlled. Urban design has almost without exception been a project aimed at planning
for, or imagining, growth. The graph that invisibly underlies most urban visions is a line angled steadily upward as it moves towards the future.

A similar graph [Fig. 3.6] was the basis for Berlin 1995: Planungsmodelle für eine Fünfmillionenstadt im Übergang zu dem Siebziger Jahren, a 244-page book self-published by Uengers and his assistants Tilman Heyde and Michael Wegener at the Technical University of Berlin in 1969 [Fig. 3.7]. This was one of twenty-seven experimental publications in the series Veröffentlichungen zur Architektur (Publications on architecture), which documented the research of Uengers’s seminars on the city, and were printed between 1965 and 1971 on a Rotaprint purchased by Uengers for his department at the TU Berlin. The premise of Berlin 1995 was that the city would continue to grow until it reached five million residents by the year 1995; 1970 was declared the new Stunde Null (year zero) for Berlin, at a midpoint twenty-five years after 1945, and twenty-five years before 1995.

In a series of related projects around 1968 by Uengers, his collaborators, and students, the primary concern was the calculation, prediction, and simulation of urban conditions in Berlin. These projects reflect a variety of forces in West Germany in the late 1960s: conflicting attitudes towards utopian architecture, a new belief in the

---


Entwicklungsmöglichkeiten

Einwohner (Mll.)

1900 1950 2000

Zeit (Jahr n. Chr.)

Berlin
Moskau
Paris
London
Tokio

Fünfmillionenstadt

Fig. 3.6
Fig. 3.7
possibilities of technology, and the emergence of radical leftist politics among the student population. Some of the greatest contradictions at the time were found among the students themselves, who in their political activities criticized the technocratic tendencies within architecture and politics in West Germany, while at the same time they appropriated scientific and sociological instruments for their own projects. The contradictions were symptomatic of the unstable and changing ideas surrounding rationalism and its tools by the end of the 1960s. This conflict was also generational: already in the contrast between the pessimistic preface to Berlin 1995 by Unger and the idealistic introduction by the students, one can detect differing views on the role of planning in the face of growth. It was not only the young architects in Berlin who were positioned between the critical Marxism of the student movement and the idealism of technocratic architecture; Unger also radically shifted his attitudes towards the question of rationalism and politics during the 1960s and ’70s.

When Berlin 1995 was published, Unger had recently left the politically tense environment at the TU Berlin to take a position at Cornell University, and it was there that he wrote the preface. Unger had already been influenced by the urban problems he encountered in the United States when he described the potential systemic crisis facing Berlin:

The big cities are the scenes of permanent crises. Constant population growth on the one hand, inadequate services on the other, lead to the gradual collapse of the metropolis. The crisis is a crisis of peak load. The inability of systems to function when overloaded . . . paralyzes the metropolis.20

Ungers goes on to use New York City as an example of a city in crisis, citing the overloaded phone and electrical networks, inadequate snow and garbage removal, and strikes which brought the city’s productivity to a standstill in the late 1960s. The language he uses to describe this confluence of human and natural factors is typical of the fears of “risk culture”:

New York is a model for the future of other large cities and a typical example of what happens when the factors of humans, nature, and technology go out of control. . . . Considering the situation of these facts, can the question of the future of the metropolis still be discussed, or are they not evidence that the metropolis no longer has a future and is simply no longer possible? . . . Maintaining both nature and culture is no longer possible. The decision of which environment will offer the more desirable living conditions can only be seen as a compromise.  

Ungers is essentially declaring the end of the future of the metropolis. He admits that Berlin has not yet reached this moment of difficult compromise, but it is clear that he views New York’s condition as the possible future of every city.  

---


22 In the 1970s Ungers began to transition from a belief in urban growth to planning for the city’s demise. The fear of imminent growth was challenged by economist Colin Clark in his book The Myth of Over-population (Melbourne: Advocate Press, 1973), which was translated from the English by Ungers’s wife Liselotte (Der Mythos von der Überbevölkerung [Köln: Adamas Verlag, 1975]). Liselotte Ungers was an economist with a degree in business, and she collaborated with her husband on several publications in the early 1970s, on subjects that included utopian communities in the United States. See Liselotte and O. M. Ungers, Kommunen in der Neuen Welt, 1741–1971 (Köln: Kiepenheuer & Witsch, 1972).
Ungers’s students and assistants, by contrast, described new technological systems and the future of the city with exuberance. They saw the question of Berlin’s future as an opportunity to test out an urban system in the context of a “simulation”:

The seminar that will be reported on here is the attempt at a planning simulation. . . . Every theoretical engagement with planning has the character of a simulation insofar as planning decisions are not directly implemented in reality. . . . By “simulation,” we thus mean the playing out of a planning process in a representable expenditure of time. Thereby even complicated processes like the planning of a large city, which in reality takes decades . . . can be represented as if in time-lapse and can be viewed in broad strokes.23

One can see how this idea of simulation differs from Ungers’s evocation of “real” events taking place in New York – strikes, natural catastrophes, blackouts. For Tilman Heyde and Michael Wegener, instead, there is not one reality but multiple, simulated realities that can be played out in a game optimistically based on imagined future scenarios.

Simulation is a special category of prediction. While prediction is aimed towards the future with the hope of accuracy and truth, simulation, which is based on questions of semblance, plays with both temporal categories and the question of what is, or can be, true. Simulation is not only a departure from the real; it is a “fast-forward” of events that would otherwise play themselves out in real time. This results in what Elena Esposito describes as “time binding,” where time (both the past and the future) is structured and secured within a system that turns the uncertainty of the future into a

---

resource (Esposito uses finance as an example). According to Esposito, this mapping of the future “liberates” us from the confines of the present. Such a construction of a temporal system will be examined here in the context of architecture and urban form. It will be understood, in one sense, as an attempt to lessen or eliminate uncertainty and risk, but also as a form of utopian projection into unknown architectures.

Simulation, as it was used in 1969, was still associated with the use of the concept in computer science and mathematics, and not yet the influential (and critical) theory of simulation that was proposed by Jean Baudrillard in the late 1970s. The authors of Berlin 1995 describe their project as a Planungssimulation (planning simulation), a term that was apparently new in West Germany at the time. Wegener cited the work of systems scientist Jay W. Forrester as one of the most influential sources for this concept [Fig. 3.8]. Forrester worked on defense projects at MIT, designing servomechanisms

---

26 “I think that we invented the word ‘Planungssimulation’ at that time – today it evokes 3,240 entries in Google.” Wegener cites various examples from operations and systems research as influential, including the work of Ludwig von Bertalanffy, Norbert Wiener, and Talcott Parsons. Michael Wegener, email to the author on August 9, 2013. It is relevant to contextualize the question of simulation within the social and political atmosphere of the late 1960s. During World War II and in the decade after, technologies of prediction were used for operations that included defensive and offensive bombing strategies, managing military budgets and resources, Communist “containment,” and playing out scenarios for thermonuclear warfare. In postwar think tanks, notably the Rand Corporation in the United States, these technologies were applied to “civilian” problems including those of cities and populations. Rand especially became the origin for a series of thinkers (like Herman Kahn), and eventually institutions, devoted to futurology or future studies. For instance, in 1965 the Commission on the Year 2000, led by Daniel Bell, was formed in response to “fractious problems” such as “Negro rights, poverty pollution, urban sprawl.” One of the works that emerged from the Commission was a book by Herman Kahn and Anthony Wiener, The Year 2000: A Framework for Speculation on the Next Thirty-Three Years (New York: Macmillan, 1967). Similarly, Daniel Bell published The Coming of Post-Industrial Society: A Venture in Social Forecasting (New York: Basic Books, 1973). See Wendell Bell, Foundations of Future Studies: Human Science for a New Era: History, Purpose, Knowledge (New Brunswick, NJ: Transaction Publishers, 2003), especially 39.
27 “Although [Jay Forrester’s] Urban Dynamics and Simulation appeared only in 1969, when our project was nearing completion, the students I worked with were familiar with these new ideas and shared my
Fig. 3.8

Figure 1-1  Life cycle of an urban area—250 years of internal development, maturity, and stagnation.
for gun mounts and radar and eventually participating in the development of the U.S.

military SAGE (Semi-Automatic Ground Environment) system. In 1956 he joined the MIT Sloan School of Management, where he developed the field of system dynamics to simulate and predict social and economic behavior. He published several books using the system dynamics methods that were influential to Wegener and his colleagues, including *Industrial Dynamics* (1961), *Urban Dynamics* (1969), and *World Dynamics* (1971). The model used in the last publication would become the basis for the predictions made by the Club of Rome in *Limits to Growth* (1972).

While American systems research influenced the TU Berlin students and instructors, there was also a future studies movement based in West Germany that should be taken

---

28 Forrester describes the easy transition from military to civilian work: “People ask why I left engineering to go into management. There were several reasons. By 1956, I felt the pioneering days in digital computers were over. That might seem surprising after the major technical advances of the last thirty years. . . . Another reason for moving to management was that I was already in management. We had been running a several billion-dollar operation in which we had complete control of everything. We wrote the contracts between the prime contractors and the Air Force. We designed the computers with full control over what went into production. We had been managing an enterprise that involved the Air Defense Command, the Air Material Command, the Air Research and Development Command, Western Electric, A.T. &T., and I.B.M. So, it was not really a change to go into management.” Jay W. Forrester, “The Beginning of System Dynamics,” banquet talk at the international meeting of the System Dynamics Society, Stuttgart, Germany, July 13, 1989, 4. Unpublished.


30 Forrester also influenced system dynamics in Germany. In 1968 Gert von Kortzfleisch was introduced to system dynamics by Forrester during a stay at MIT. Both Kortzfleisch and several of his students were part of the *Club of Rome* publication. Forrester, “The Beginning of System Dynamics.”
One of the central figures was the journalist Robert Jungk who published a series of books with Hans Josef Mundt under the title *Modelle für eine neue Welt*, beginning in 1964. Another prominent figure was Ossip Flechtheim, who is credited with having coined the term “futurology.” Several future studies think tanks were established in West Germany, including the independent Zentrum Berlin für Zukunftsforschung (ZBZ), co-founded by TU Berlin sociologist Helmut Klages in 1968, which included the participation of Jungk and Flechtheim. Futurology in West Germany was divided into two camps and political directions: on the one hand was the “socialist, emancipatory, and utopian-inspired futures research based on social fantasy” associated with Jungks, Flechtheim, and Georg Picht; on the other was the “cybernetics-inspired futures research that operated close to the market and could rather be considered ‘neoconservative.’” The uses and abuses of futurology thus became part of the political discussions of the late 1960s and early 1970s. A 1967 review of Picht’s 1967 book *Prognose, Utopie, Planung* succinctly describes how utopia and predictive reasoning were made compatible for the Left:

> For Picht, utopia is not a dream image of an unreal world, but the design of images of the conditions that can be brought about through goal-oriented acts. Thus utopia is in no way in contradiction to prognosis, but instead chooses from the prognostically determined range of possibilities, from which a combination emerges as the optimum according to the respective standpoint. “The intention of planning is not the choice or the design of utopia, but the working out of directives for the realization of utopia. Its method is thus analytical.”

---


The methods of futures research seemed to promise a perfect synthesis between simulating and planning the future, to the point that such a utopia seemed realizable.

By the time Baudrillard published *Simulacra and Simulation* in 1981, however, this seeming indistinction between prognosis and planning was already a lost space for utopian possibility. Baudrillard identifies three distinct orders of simulacra that led towards this point: the first was the pre-industrial imaginary that projected a utopia that was radically different from the real; the second was the order of science fiction, which is not an alternative but an addition and multiplication of the possibilities of industrial production; the third and final was the “simulacra of simulation, founded on information, the model, the cybernetic game—total operationality, hyperreality, aim of total control.”34 This last category could be used to describe the information-based planning and design experiments of the 1960s – systems that aspire to becoming interchangeable with the real.35

In West Germany, the dark possibilities of simulation were portrayed in Rainer Werner Fassbinder’s 1973 science-fiction television film *Welt am Draht* (World on a wire) [Fig. 3.9].36 The timing of Fassbinder’s film was clearly linked to the political situation in West Germany in the 1970s, where both government and industry were using information technologies for security and profit. One of the most controversial

---

34 Baudrillard, *Simulacra and Simulation*, 121.
35 Baudrillard had, of course, also directed his criticism at architecture, most famously at the Centre Georges Pompidou – that delayed product of the technological utopianism of the 1960s – an architecture that he described as capable of “mass simulation.” Ibid., 61.
Fig. 3.9
Still from *Welt am Draht* (dir. Werner Rainer Fassbinder, 1973).
projects was the *Rasterfahndung* (raster dragnet) method, initially developed to find Red Army Faction members, which was used to search vast information databases on German citizens for potential criminal activity. *Welt am Draht* describes a simulated world unwittingly inhabited by 10,000 people, created by a computer at the fictional Institut für Kybernetik und Zukunftsforschung (Institute for Cybernetics and Future Research). There the “Simulacron” experiment, created with public funds for the “betterment of human society,” was secretly also being used for private purposes to accurately predict the future of the aluminum industry. The same system used to control the future of investments was thus also used to track and simulate human lives, closing the divide between social-utopian and market-driven uses of simulation.

The experiments in urban simulation of the 1960s struggled with the issue of utopia, and whether it was a category commensurable with the technologies of simulation. Two important questions are whether the claim to be a “simulation” – i.e., not enacted in the real – allowed these projects to be free from instrumentalization, or whether the deterministic mechanisms that enabled these games already precluded this possibility of freedom.

**Berlin 1995**

Simulation does not refer only to questions of semblance – it also describes the management and scripting of time. *Berlin 1995* was as project of science fiction, based on a narrative in which multiple possibilities were presented at every step. It suggests that history itself is an open-ended process with missed chances and alternative
trajectories that can be retraced through feedback. The narrative of *Berlin 1995* begins by looping back to Berlin in 1945, the so-called “zero hour.” It is within this moment in Berlin’s history that the authors propose a new beginning. They start with a coordinate grid that reunifies and organizes the divided city. The city center lost in 1945 would now return as a point of orientation. This grid is repeated at every scale, from the city to the block. Street names, and their historical signification, would no longer be needed – an address would now be made up of coordinates. Life would occur in a data grid, and the grid would determine everything: transportation, buildings, utilities. As a landscape instead of an island, the city could expand in all directions.

This narrative describes the endpoint of a series of rules laid out for a game of urban design. *Berlin 1995* begins by considering several hypotheses for the possible future of the city, which are essentially divided between the choice of abandoning the city to become a ghost town, or developing it to become a metropolis.  

The authors choose the narrative of growth, envisioning Berlin as a unified urban region of five million residents. 

This optimistic hypothesis was based on a positive understanding of growth as having the power to generate a new political reality for Berlin that would challenge the borders of the Cold War. The chosen hypothesis was also based on the projected economic development of West Germany imagined by the authors:

---

37 In one proposal, which they call “Big Lift,” West Berlin is evacuated and sold to East Berlin. The population would then be moved to a newly built city (“Neu-Berlin”) near Hannover. Yet another hypothesis (and one which in some ways became true) was that the two halves of the city would become twins, doubles of one another (“Doppelstadt”), with two National Galleries, two Zoologischer Gärten, etc.

38 Berlin had around two million residents in 1969. In order to illustrate the scale (and possible economic future) of the new Berlin, the authors compare it to a map of the Ruhr region.
Fig. 3.10
View of the Kulturforum, Berlin, 1969.

Fig 3.11
Ernst Reuter Platz, Berlin, 1966. The TU Berlin Architecture Department building is at the top right.
Fig. 3.12
With an annual increase of four percent, the gross domestic product of the Federal Republic of Germany will increase five-fold in the next twenty-five years. In this period a sum of one billion marks will be apportioned to infrastructural investments. Of this about half will be used for solutions for traffic problems. During this time the population will only grow by about twelve percent. This juxtaposition gives a sense of the scale of excess through which the environment of humans will change in highly industrialized countries.  

The passage describes a city (and nation) of excessive infrastructure. This vision contrasts directly with Ungers’s model of the city as a space of systemic breakdown and overpopulation. Indeed, the model that would be proposed in Berlin 1995 is one of delirious technological and infrastructural redundancy.

An influential precedent for this emphasis on infrastructure was Fritz Haller’s 1968 “Totale Stadt” [Fig. 3.13], which is reproduced in Berlin 1995. Haller – known for his design of the USM furniture system and his collaboration with Konrad Wachsmann – published several books in which he outlined his plans for an ideal city. The authors include an example from Totale Stadt – Ein Modell (1968) in which a city for six million is shown placed over the grid of Berlin. Haller shows an urban space defined by graphic

---

40 The authors also show other precedents, including Ludwig Hilberseimer’s 1933 “Dezentralisierte Großstadt” and the 1946 “Kollektivplan” organized by the Planungskollektiv (led by Hans Scharoun). This last proposal divided the city into bands of functional zones spanning from East to West, and transformed the radial infrastructural grid of the city into a rectilinear one. The authors see this plan as a missed opportunity for Berlin to become an undivided, global city. There were other influences: Wegener mentions the importance of the Metabolists, particularly Kenzo Tange, whose 1960 Tokyo Bay project is shown in the book but without reference. Interview with the author, April 10, 2013. A surprising omission is Alison and Peter Smithson’s entry for the 1957-8 Haupstadt Berlin competition, which featured a multi-level, large-scale infrastructure covering the destroyed city.
Fig. 3.13
systems that can be multiplied to accommodate various scales. In these drawings, which display extreme restraint, most of the page is white, covered by fine lines that resemble circuitry diagrams. Like Ungers, Haller participated in the crisis theory of cities, writing of “paralyzed centers” and the need to “protect new communities from economic and social catastrophes.” In response, his minimal drawings show an orderly city designed along traditionally functionalist guidelines of separating programmatic areas. In this functionalist approach it differs from the distributed field of programs proposed in Berlin 1995. Where it was perhaps most influential was in the universal coordinate system that was used, which in Haller’s city serves as the basis for a symmetrically formed plan of circuitry for different modes of transportation.

*Berlin 1995* followed on the heels of the other publications in the series *Veröffentlichungen zur Architektur* in which one repeatedly sees the rational analysis of Berlin according to its infrastructure, and the proposal of large-scale interventions suggestive of megastructures. One example is a book by Volker Sayn, entitled *Contribution to the Planetization of the Earth* (published in May 1968) [Fig. 3.14].

---


43 Ibid., 8.

44 For Haller, the coordinate system is not the literal diagram for the city but a way of aligning and organizing it. As in Berlin 1995, different addresses in the city can be identified by their coordinate (for example “+11.13–03.02”), as he indicates in his drawings.

45 The full title was considerably longer. Volker Sayn, *Vorschlag einer Bebauung im Modifizierten Gradnetzsystem (Hier Hassloch-System Genannt) für einen Bewohnbaren Himmelskörper, Dargestellt am Beispiel der Erde, als Beitrag zu deren “Planetisierung”* (Proposal for a development in a modified coordinate system (named Hassloch-System here) for an inhabitable celestial body, shown using the
Sayn’s book, “dedicated to the UN and OMU,” proposed a built urban structure organized along the coordinate systems of the earth, which was to cover the entire planet. Like *Berlin 1995*, the project points to the limitations of concentrated urban centers, and proposes the even distribution of populations along a continuous grid. This grid would organize not only cities but the entire planet into one zone without borders and without centers or peripheries. Sayn uses the earth’s geographic coordinate system as a model for how the distribution of cities would work, creating grids at multiple scales. The earth is shown as a globe, as opposed to a flat map, suggesting a continuous planet without a center.

A perspective drawing showing a built structure along two axes is strongly reminiscent of (though nowhere near as evocative as) Superstudio’s 1969 “The Continuous Monument: An Architectural Model for Total Urbanization” [Fig. 3.15]. We are told that 18,000 people would reside in each linear kilometer of this system. To give a sense of what this might look like, a map of West Germany is shown completely covered by the grid (distorted slightly to accommodate topography), which is reminiscent of Constant Nieuwenhuys’s 1963 drawing for New Babylon as it covers the Ruhrgebiet, yet without the utopian associations of play and freedom [Fig. 3.16].

---

46 Sayn also suggests an alternative proposal that would not require a grid at all, or even architecture: he foresees a future in which the earth is covered by points representing autonomous individuals with apparati. Humans no longer need shelter or solid or liquid nutrition; communication is achieved through instruments that locate man three-dimensionally on the globe. This is again reminiscent of the work of Superstudio, but also Otto’s early ideas about lightweight architecture.
Fig. 3.15
Fig. 3.16
The project is more dystopian than utopian, and is characterized by a cynicism similarly found in the work of Superstudio and Archizoom. Sayn addresses the reader directly with the following provocation:

Do you find this development system inhuman?
Think of this:
The “freedom” that rules today is the freedom of those who develop and fence off the lakeshores and southern exposures, and erect signs that say “trespassing and bathing forbidden,” who “buy” themselves third-class epigones of Le Corbusier, Mies, and Scharoun.
An advantage of this system . . . is this:
Architects, already expendable, are robbed of their excuses! They must decide: engineer, businessman, lawyer, designer?

Here the political aspirations that lie behind the project become clear: the total occupation of the earth by a grid suggests a different form of freedom, one that is represented by the image of an even distribution of resources and power over the surface of the planet. Freedom is no longer idealized as it was in the work of Constant or Yona Friedman, but is now associated with liberalization: the privatization of the land and the stylistic whims of imitation architects. The grid thus not only redistributes populations and resources, it abolishes the role of the architect, who must now choose a different profession within the new order.

Like Haller and Sayn, the authors of Berlin 1995 begin with a coordinate system that conceptually supports the careful control of a simulated future [Fig. 3.17]. The

47 “Finden sie das Bebauungssystem ‘unmenschlich’? Bedenken sie:
Die heute Herrschende ‘Freiheit’ ist die Freiheit deren, die die Seeufer und Südhänge verbauen, einzäumen und Schilder aufstellen, ‘Betreten und Baden Verboten,’ die sich drittklassige Epigonen L-C.s, Mies’s und Scharouns ‘kaufen.’
Ein Vorzug dieses Systems . . . ist der:
Die Architekten, längst entbehrlich, wären ihrer Ausrede beraubt! Sie müssten sich entscheiden: Bauingenieur, Kaufmann, Jurist, Designer?” Ibid., 16.
Fig. 3.17
coordinates are superimposed over Berlin, with the center (0,0) at the Brandenburg Gate, and the grid is numbered as it extends along the two axes from this center without concern for topography. This first grid establishes a framework for subsequent ones at smaller scales. It was believed that such a meta-grid would provide residents with the greatest degree of freedom in how they moved around the city. The urban fabric based on this grid would be one of incredible density, which would supposedly increase “communication” and the range of choices for residents [Figs. 3.18a, 3.18b]. They do not propose to eradicate the existing urban fabric; in fact, at the smaller scale, the grid is shown as capable of a series of local deformations in order to accommodate existing areas. As the authors write: “This grid should not be fully abstract, like a measurement grid for instance, but should relate to the built reality.” The grid acts as the intermediary between an abstract concept and the city, becoming a three-dimensional space of possibility that covers the entire urban area [Figs. 3.19a, 3.19b]. This infrastructure creates the framework – or one could say the mainframe – for a maximum of simulated futures. The authors refer to the grid as a “megastructure,” but explain:

`The term “Megastructure” as it is used in this work is not meant to indicate, as is the usual case, a universal super-development, which is suitable for everything and can

---

48 The area covered measures 72 by 60 kilometers, or five times the size of the urban region of Berlin. It is divided into four quadrants (NO, NW, SW, SO), and each square in the grid measures 3 x 3 km.
49 Here the authors echo a notion of freedom found in similar utopian projects, but without the same aspirations for liberation or ideas of self-construction. While they considered several types of grid patterns, they ultimately chose the orthogonal grid for its ability to expand in every direction and its scalability, whereby a small part resembles the larger and vice versa. This flexibility would allow for the growth of the city and the replacement or development of isolated areas. In this structure, grids are repeated at ever-smaller scales.
Fig. 3.18a
Model F ("Flächenstadt"), *Berlin* 1995.
Fig. 3.19a
Model F ("Flächenstadt"), Berlin 1995.
“do” everything. Instead, it should circumscribe a new type of three-dimensional land-use planning.  

Rather than design a large building or space-frame, the authors propose to establish an “abstract allocation schema, which . . . forms the frame for the detailed planning of an individual situation.”  

Drawings show a matrix of horizontal communication laid out over the city with points for vertical circulation and small dots in the center of each square representing utilities [Fig. 3.20].

One of the most compelling qualities of the proposed plan is that it does not designate specific urban programs:

It would be easiest if all places in the city region could be seen as having more or less equal value. That would theoretically lead to an even and equal distribution of all of the elements that make up the city. . . . It means the most radical departure from the separation of functions as outlined in the Athens Charter, but also all ideas of neighborhoods, cells, or other non-technical categories of organizing the city.

This statement of “equality” is radical in nature when considering the extreme divisions that had characterized Cold War Berlin. The authors argue that the complexity of functions in a future urban society, as well as the technological changes such a society would bring, would not necessitate the “hygienic” separation of functions that had been

---

51 "Der in dieser Arbeit verwendete Begriff ‘Megastruktur’ soll dabei nicht wie üblich eine universale Superbebauung kennzeichnen, die für alles geeignet ist und alles ‘kann,’ sondern soll diese neue Art einer dreidimensionalen Bauleitplanung umschreiben. Gegenstand dieser Bauleitplanung ist der Umwandlungsprozeß der bestehenden Bebauung in die neue Struktur." Ibid., 90.

52 Ibid., 91. Within the urban coordinate system of 3 km squares, a further division was proposed of four “basic units” of 720 meters, which is further broken down into a 30-meter grid.

53 The authors argue that the density of points requires more connectivity: thus, for pedestrians there are elevators, people movers, and escalators; for people traveling longer distances, there is a minicar system which runs on electromagnetic tracks and is controlled by a computer.

Fig. 3.20
proposed by the Athens Charter. Their vision corresponds to an imagined post-industrial future where neither immaterial labor nor transportation produces any material by-products. The future city, they argue, would have no need for zoning use diagrams.

The Cartesian coordinate system is the preferred graphical expression of mathematical prediction, with the ability to match performance (the y-axis) with time (the x-axis). In the previous section, we saw how Frei Otto used this system to align incommensurable objects within a system of universal mathesis. Here, the grid similarly becomes a universal space in which the divided city with its heterogeneous objects, geometries, and quantities, can be unified within one coherent system. The coordinate system, as Sybille Krämer argues, is a space of potential. Still, it is difficult not to imagine this diagrammatic overlay of the city as an echo of similar abstractions, such as the representational flattening of urban territory into a series of coordinates under the gaze of aerial bombing campaigns. Recalibrating Berlin symbolically establishes a new “year zero.”

One of the problems associated with the urban grid is its redundancy. This is especially evident when confronted with the extraordinary drawings in Berlin 1995 showing dense, overlapping gridded transportation systems that form a network without any obvious hierarchy (see Figs. 3.18a, 3.18b). Redundancy is used to calculate maximum certainty and return, but it also runs counter to optimization. These images...

---

56 This criticism comes from Michael Wegener himself. Interview with the author.
57 Frei Otto’s lightweight architecture depended on optimization. In his experiments used to determine this architectural minimum, however, he similarly created redundancy and density.
serve as a representation of a state of overdeveloped infrastructure and technological support that exceed human need, as mentioned by the authors in their prediction for the West German economy. One can only imagine the anxiety that must have existed about the underdevelopment of West Berlin in the 1960s in order for such density to have been proposed.

With the framework for an urban simulation having been established, the authors of Berlin 1995 test two possible future scenarios. They write:

[The results of the planning simulation] do not have the form of a single, final plan. . . . It seemed much more sensible to work out at least two fundamental alternatives in parallel. . . . It is easier to compare competing alternatives rather than steering straight towards an “optimum.”

Here the role of simulation – the playing out of competing scenarios – is made clear. Prediction does not point to a single, optimized future but to the possibility of multiple potential futures (even if the alternatives presented take place within a limited playing field). But the supposed open-endedness of the simulation is countered by the rigidity of the layered, gridded system that determines the path of prediction. Like the Cartesian grid that both illustrates and shapes future performance, the urban grid is more than a passive framework in which events simply “happen”; it is a system of codes, rules, and limitations that ultimately determine growth in a highly controlled manner.

Two simulation models were tested: the Bandstadt (Ribbon City) and Flächenstadt (Planar City) (see Figs. 3.18a, 3.18b, 3.19a, 3.19b). Both proposals have a similar representational strategy in which the urban plan, with its dense and seemingly chaotic network of communications, is shown overlaid with an orthogonal megastructural plan in relief. The scale of this structure is initially difficult to imagine. An image of it shown on the cover of the book appears similar to a large game board laid over Berlin, functioning as a “connector” between East and West (see Fig. 3.7).

In the Bandstadt, a grid composed of basic megastructural “units” was placed over the center of Berlin, with empty spaces left for the Tiergarten and Friedrichshain parks. The location chosen was Berlin’s former center, which was already relatively dense, and where “in the case of uncontrolled development, megastructure-like zones of density would most likely develop at different spots, independent of one another.” As examples of this density, the authors point to West Berlin’s Europa Center (1963–1965), an 80,000 square-meter multi-use center designed under the direction of Egon Eiermann. They also mention the recent development of their own university, the TU Berlin, where in the early 1960s several major projects transformed the campus to promote the image of a technologically advanced place for research (see Fig. 3.11). The

---

59 The linear city is a model that has haunted the avant-garde, with its most famous manifestations appearing during the 1930s with Milyutin’s Sotsgorod (1930), and plans for Magnitogorsk by Ernst May, Ivan Leonidov, and others. Leonidov’s gridded plan for Magnitogorsk, with its checkerboard pattern, in particular resembles the plan proposed in Berlin 1995. These linear cities had been designed with the industrial city in mind, separating residential, industrial, and transportation areas. While Berlin 1995 borrows the linear model and morphology, its goal in designing a post-industrial city is to combine as many programs as possible, to create density, growth, and connectivity.

60 The authors suggest that the linear version could extend beyond the city and even be connected to other similar urban zones in the region, repeating the grid pattern at another scale.

61 Berlin 1995, 129.
changes already taking place in West Berlin fueled the fantasy of a continuous megastructural system.

In contrast to this centralized model, the Flächenstadt gives equal weight to all parts of Berlin. This plan, with strips 10 to 12 kilometers long, ties together different urban nodes of the city, while the areas left over between the strips become green recreational zones. These infrastructural grids are of an even greater density (and redundancy) than in the linear plan. Organized as a hierarchy of scales of communication, the networks are shown evenly dispersed in a drawing of intense graphical thickness. The argument seems to be that Berlin would be so hyper-connected that it would no longer need a center. Commenting on the redundancy of the network, the authors write:

As considerations of capacity lay outside of the scope of what could be achieved in this seminar, it is possible that the high-speed train and street networks represented in the plans seem over-dimensioned for the tasks assigned to them. Because of the quality of simulation of this work, this does not, however, have an effect on the result.\(^{62}\)

Simulation, we are reminded here, does not necessarily mean adapting to optimal or even functional results. The objective was to create a field of Verdichtungszonen (densification zones) through the proliferation of nodes. The use of the concept of simulation refers to a provisional state and not to a resemblance to the real. Over-dimensioning is the opposite of optimization – the goal is to provide for all moments at

\(^{62}\) “Da Kapazitätsüberlegungen außerhalb des in diesem Seminar Erreichbaren lagen, mag es wohl sein, dass die in den Plänen dargestellten Schnellbahn- und Straßenetze für die ihnen zugeordnete Aufgabe überdimensioniert erscheinen. Das tut jedoch infolge des Simulationscharakters der Arbeit dem Ergebnis keinen Abbruch.” Ibid., 143.
once as opposed to an ideal state, to fill the entire urban (and graphic) field with the *image* of density and growth, even at the expense of legibility.

Vilém Flusser has suggested a close connection between density and simulation. According to Flusser, the “alternative worlds” emerging from computers and realized through calculation “are nothing but computed point elements, because they are hazy constructs floating in nothingness.”63 This results in what he considers a modern paradox – that in the translation from the continuous world into the world of numbers, the seamless nature of the *res extensa* (in Descartes’s terms) is lost.64 The resemblance to reality is thus measured by the degree of resolution, or “the density of distribution.”65 Filling in the gaps with information, and creating density both graphically and urbanistically, becomes conflated with the real. The simulation becomes more real in this form of projection, which moves away from the objectivity of the numerical and towards an imagined future.

A dialectic is thus formed between the authoritative Cartesian coordinate system in which every place in the city is represented by a point that corresponds to a number, and the method of filling between the points (or “stuffing the intervals between the numbers,” as Flusser calls it), which is an exercise in an extensive reality that cannot be easily changed or undone.66 The simulation thus goes too far, straying from its requirement to be flexible. How far can a simulation be carried out before there is no longer the possibility of return? At what point does the projected future become

64 Ibid.
65 “Dichte der Streuung.” Ibid.
66 “Stopfen der Intervalle zwischen den Zahlen.” Ibid.
confused with the real? For the authors of *Berlin 1995*, the possibility of switching
between the simulated and the real is always left open, so that the project can appear
rational and objective on the one hand, yet can also claim that it is “only a simulation”
on the other. While the idea of simulation is derived from scientific thinking, it is also a
way of stepping back from objectivity, creating space for the possibility of a utopian
project. In this way, *Berlin 1995* distinguished itself from the positivism of much
sociologically based urban planning of the 1960s.

But can it truly be called a simulation? This project was created at the cusp of the
transition from architectural simulation as static representation, to simulation as a time-
based process.\(^{67}\) It was no longer enough to recreate the world in space; through
calculation the world would also be predicted as it changes through time. But the
authors were not technologically able to show the process playing itself out in time, nor
do they propose something like a programmatic code. At best, *Berlin 1995* aspires to
what technological simulation might one day provide – not only the simulation of
reality, but also information about the best possible way to proceed in the future.

*Berlin 1995* ends with thirteen student proposals for architectural projects.\(^{68}\) In this
section, the layering and density seen in the drawings for the city and its infrastructural
systems are translated into a fantastical architecture. Precise axonometric views show
architectural components that jump towards and away from us in the picture plane [Fig.

---

\(^{67}\) Computer simulation is a “leap from a timeless to a time-contingent technology. It is this temporal
original.

\(^{68}\) Niklaus Kuhnert, who would later be the editor of *ARCH+*, participated in the seminar.
Fig. 3.21
Student project, Berlin 1995
(Hildebrand Machleidt, Bahnhof Zoo).
3.21]. These geometries recall Piranesian spaces, as well as the optical illusions seen in much art of the 1960s, in Op-Art or in the works of the Zero group. One struggles to locate a familiar architecture within this disorienting pattern. Occasionally there is a moment of recognition: dizzying views of rows of tower-slabs with gridded façades, ramps, conduits, and interchanges, ventilation and circulation shafts, glass-covered arcades, roads, spherical trees, trusses, courtyards. But at times the language becomes entirely abstract, showing lines and grids, layers of massed volumes and intricate patterns [Fig. 3.22]. It is an architecture of stacking, circulation, densification. While there are a series of programs that are represented (transportation hubs are especially popular), there is very little difference in architectural form – in other words, programmatic functions are not architecturally specified. Each student provides only a small view into this simulation of Berlin – a pixel, one could say – while its architecture extends beyond the frame, suggesting that it potentially covers the entire city.⁶⁹

Reyner Banham wrote about *Berlin 1995* in his 1976 book *Megastructure: Urban Futures of the Recent Past*, commenting that “the conception of megastructure entertained by the seminar was perhaps the most abstract, intellectual and academic of any period.”⁷⁰ He describes it as “an elaborate intellectual, mathematical and graphical apparatus” in which “one sees a cool and elaborate draughtsmanship pattern-making, as obtrusively neutral as ‘minimal’ art, as obsessive as a computer print-out, as two-

---

⁶⁹ In their dense and layered aesthetic, these drawings also prevision the graphic virtuosity that would characterize the paper architecture of the 1970s.

Fig. 3.22
Student project, *Berlin 1995*
(Dieter Wiencoop, Hauptbahnhof).
dimensionally dense in appearance as some scores by Stockhausen.”71 The “apparatus” that Banham refers to is the language of drawing, which remains consistent across the students’ projects.72 The apparatus is also the grid structure that underlies the project at its multiple scales. The neutrality of the grid seems to contain and make possible the excess and even chaos that is presented to us in these urban vignettes. Banham describes the drawings as “peering helicopterwise into the microworlds of the new Berlin.”73 But these micro-worlds are only small when compared to the massive systems within which they are organized. The intricacy and technological precision of the drawings allow them to contain an unusually great amount of information. They appear to us not unlike the surface of a microchip, a small world in itself, yet in truth a crucial part of a much larger system of relationships linking space and information. Friedrich Kittler has made the comparison between the city and a microchip (“Entire cities made of silicon, silicon oxide, and gold wire have since arisen”), arguing that in both, information circulates through “the play between commands, addresses, and data.”74 In this suggestive image of the city as a vast medium by which to generate and transmit information, the city appears not only as a simulation, but also as a model of the electronic media that enable the processing of futures. It is not enough, in other words, to suggest that the city is one of several outputs generated by some imagined computer program, but the city itself should resemble, mimetically, the otherwise invisible inner workings of that process.

71 Ibid.
72 This consistency in drawing style can also be seen in other books produced by Ungers’s seminars.
73 Banham, Megastructure), 159.
In one drawing by a student named Catherine Hoja, Eiermann’s Kaiser-Wilhelm-Gedächtniskirche (1959–1963) is shown dwarfed by stacks of mixed-used slabs and coiled ramps for mini-cars [Figs. 3.23, 3.24, 3.25]. In a section drawing, West Berlin’s Europa Center, with its iconic Mercedes symbol, appears in the background. The image of this project in particular encapsulates three important moments for postwar Berlin: Eiermann’s church is emblematic of the pathos of postwar reconstruction, with the jagged spire serving as a reminder of the destruction of the city, and Eiermann’s solemn intervention suggesting the absent building. The Europa Center, by contrast, expresses a metropolitan desire for bigness, and the misguided hope that Berlin might again attain the status of a world city, even after being divided by the wall. The drawing’s machinic overlay, with its futuristic ramps and slabs, all but erases the city’s nostalgic past. Much of the effect of these drawings lies in the fact that while they are “simulations,” they are also highly detailed. The jarring reminder of scale, context, and history that the Gedächtniskirche provides – the “real” for Baudrillard – only deepens the uncanny sense that these architectures do not belong to a human or historical context. They are designed not for human programs or needs but for the self-proliferating rules of the city – in other words, the rules of a simulated game.

Berlin 1968

The critical aspirations and contradictions of Berlin 1995 can perhaps be better understood when viewed in light of the political environment at the TU Berlin in the late 1960s. Several of the protagonists who authored Berlin 1995 and imagined its hyper-
Fig. 3.23
Student project, Berlin 1995
(Catherine Hoja, Bahnhof Zoo).
Fig. 3.24
Student project, Berlin 1995
(Catherine Hoja, Bahnhof Zoo).
Fig. 3.25
Gedächtniskirche and Europa Center, West Berlin, 1960s.
technological development of the city were also publishing pamphlets challenging the rationalism of real estate development and urban planning. This disjunction can be understood as symptomatic of the shifting political values attached to scientific methodologies within the student movement at that time.\textsuperscript{75} Recalling the political events of this period chronologically allows one to appreciate the momentum that built up in only a few short years. On June 2, 1967, the university student Benno Ohnesorg was killed by police during a demonstration against the Shah of Iran’s visit to West Berlin [Fig. 3.26]. His death had a catalyzing effect on the students in Berlin, who were already becoming politically engaged. Students from the architecture department at the TU Berlin had attended this demonstration, including several in Ungers’s seminars.\textsuperscript{76} Ungers, who was then the dean of the Faculty for Architecture, commented on the events in Anrisse, a TU Berlin student magazine:

> With concern one determines that more and more political taboos are emerging, and that gradually a freezing of political activity is spreading, and the self-sufficiency of political instances, from whatever side, is a dearly needed corrective, and essential for the existence of democratic social order. Especially when the majority of public institutions are failing as critical partners, which seems to above all be the case in our immediate surroundings, it is not a pretension, but a duty, for the students to protest.\textsuperscript{77} [Fig. 3.27]


\textsuperscript{76} See Lernen von O. M. Ungers and Cepl, “Oswald Mathias Ungers und seine Schule.”

Fig. 3.26
Ursache oder Indiz sich anbahnender Umwälzungen?

ANRISSE-Gespräch mit dem Dekan der Fakultät für Architektur, Prof. O. M. Ungers

ANRISSE: Eine provokative These besagt, die starke Solidarisierung besonders seitens der TU-Studentenschaft mit den Trägern und Teilnehmern der Demonstration vom 2. Juni sei unter anderem darauf zurückzuführen, daß infolge der günstigen politischen Gegebenheiten viele TU-Studenten ihr Informationsbedürfnis befriedigen wollten, und dabei in die Rolle der Polizei offensichtlich gesuchte Konfrontation geraten seien — was stimmt daran?


Die in der Demonstration gezeigte politische Haltung wandte sich einerseits gegen einen Herrscher, der sein Volk mit diktatorischen Methoden regiert, wie in durchaus substantiierten, von den Studenten verfaßten Berichten nachgewiesen wurde, und anderseits gegen die in diesem Fall gewiß übertriebene Form eines Staatsbesuchs. Beides mußte zu Protesten herausfordern. Wie ich mich selbst überzeugen konnte, hat die Polizei durch bewuβte Provokation, wie beispielsweise das Einfahren der sogenannten jubelpersönliche vor die Oper — die später auch als Schläger auf die Studenten losgelassen wurden — die Konfrontation gesucht. Man hatte den Eindruck, hier sollte in einer Denkzettelaktion eines abschreckenden Exempels statuiert werden.


Ungers’s cautious endorsement of the students was connected to his belief in the necessity for constant reform within the TU Berlin. Thus, his call for political change could not be separated from the call for technological change:

A technical university must be much more variable than one in the humanities in terms of the structure of the topics and facilities. Its existence is dependent on the ability to adapt to the latest state of knowledge in science. That demands a dynamic, constantly changing system.  

For Ungers, this scientific system would be achieved by applying scientific methodologies to the study of urbanism, and using printed media to distribute the outcome of this research. The impressive amount of published material printed under Ungers’s guidance is testament to his belief in the importance of media.

However, when Ungers purchased a Rotaprint machine for the department for printing the results of his research, the printer had a secondary effect – the students made use of “his” machine for the printing and distribution of political Flugblätter (fliers) [Fig. 3.28]. This common source is one of the many parallel links that existed between the books published by Ungers’s seminars and the publications of the student movement at the TU Berlin. By 1969, when Ungers had left for Cornell, his private opinion of the politicization of the students and the university had become embittered:

---

78 “Eine Technische Hochschule muß viel mehr als eine geisteswissenschaftliche in der Struktur der Lehrgebiete und Einrichtungen variabel sein. Sie ist in ihrer Existenz abhängig von der Anpassungsfähigkeit an den neuesten Erkenntnisstand der Wissenschaft. Das bedingt ein dynamisches, ständig sich wandelndes System.” Ibid., 120.

79 “I am thinking in particular of scientific-based methods and the means of publicity.” Ibid.


81 One of the first significant actions taken by the students was the interruption of a 1967 conference on architectural theory at the TU Berlin, which was organized by Ungers. Speakers at the conference included Reyner Banham, Sigfried Giedion, Kenneth Frampton, and Julius Posener. The politicized students,

Die Studenten betrachteten die Räume dieses Lehrstuhls als ihre Räume, die Einrichtungen dieses Lehrstuhls als ihre Einrichtungen. Sie erwarteten, daß ihnen für die Durchführung ihrer Seminare weitere Sachmittel und auch Personal zur Verfügung gestellt werden.

Weitere Informationen folgen

---

VEREINIGTE VEREINIGTE VEREINIGTE VEREINIGTE VEREINIGTE
REFORMSEMINARE DER "UNTERSTUFE", PLANERSEMINARE, CO OP,
FACHSCHAFT ARCHITEKTUR
12. 12. 68

LEHRSTUHL ÜBERNOMMEN-LEHRSTUHL ÜBERNOMMEN-LEHRSTUHL ÜBERNOMMEN

---

Fig. 3.28
Political flier created by “Co-op” of architecture students using the Rotaprint machine. Here they announce the occupation of the office of the dean of the architecture school. December 12, 1968. TU Berlin Universitätsarchiv.
Who should tolerate this idiocy? . . . The vision of the future of the leading revolutionaries is – *God knows* – somewhat dilettantish. But the fathers teach that action is everything. That is how the department will fall to pieces. – All power to the councils – Whoever takes power will show himself. The *profs* are deprived of power, defeated, dispossessed, stripped of rights. The university belongs to the forces of production.82

The students at the School of Architecture had become increasingly radical since 1967 [Fig. 3.29]. Seminar and storage rooms were occupied and repurposed as headquarters for leftist groups, and the private offices of faculty members were broken into and vandalized. Students brought activists from outside of the school to conduct classes, and spontaneous “tribunals” were held in which professors were “put on trial” as to their viewpoints on architecture and politics.83 Some of the more radical students and assistants of Unger participated in the so-called Kritische Universität, a student-organized series of seminars at the Freie Universität in Berlin (in collaboration with students from the TU Berlin), envisioned as an alternative to “the ossified forms and contents of academic teaching.”84 Michael Wegener’s photograph appears in a collage on the cover of the Winter 1967/68 pamphlet, as does Peter Neitzke’s, who had also focused on action, were uninterested in discussions about form. A banner was unfurled during the conference with the words "Alle Häuser sind schön, hört auf zu bauen." (All buildings are beautiful. Stop building.). See Hartmut Frank, “Alle Häuser sind schön, hört auf zu bauen,” *Stadtbauwelt* 74, no. 80 (1983): 340–345. A conference publication was also produced: *Architekturtheorie. Internationaler Kongress in der Technischen Universität Berlin, 11.–15. Dezember 1967* (Berlin: 1967), Ungers Archiv für Architekturwissenschaft.


83 A chronicle of some of these events is listed in a letter dated July 2, 1970, sent by the faculty members of the School of Architecture to the Senator for Science and Art Prof. Dr. W. Stein in Berlin. The subject of the letter is “Documentation of the unacceptable circumstances at the Faculty III.” TU Berlin University Archive, 206–221.

Fig. 3.29
been a student of Ungers [Fig. 3.30]. The students in the organization not only sought reform in their respective universities, but also aspired to “dismantle oligarchical domination,” “realize democratic freedom,” and prevent the “second failure of democracy and the dehumanization of society in Germany.”³⁵ The students hoped to rethink the university as a place for politically oriented research, and in particular to “understand the psychological, social, economic, and political situation of West Berlin after June 2nd.”³⁶ Of particular significance for the students enrolled at the Technical University was an Adornian critique of the instrumentalization of knowledge “for inhuman and destructive uses.”³⁷

The Kritische Universität seminar on architecture, called “Architektur und Gesellschaft,” focused on the role of the architect in society and the tendencies of the discipline towards technocracy in the form of Berufsnormen (professional standards) on the one hand, and a “panicked faith in technology” on the other.³⁸ According to the pamphlet, practical and political consciousness could be introduced to the discipline through collaboration with economists and sociologists, in order to steer architecture away from the functionalism of technocrats towards a better “social praxis.”³⁹ While critique of the instrumental and technocratic uses of science was central to the student movement, the social sciences were embraced and politicized by both the architecture students and parts of the West German student movement.

---
³⁵ Ibid., 3–5.
³⁶ Ibid.
³⁷ Ibid., 13.
³⁸ Ibid., 64.
Fig. 3.30
Kritische Universität pamphlet, 1967/68. Private archive of Michael Wegener.
At the beginning of the fall semester of 1968, architecture students from the TU Berlin formed a group called “Aktion 507” (named after a seminar room at the school), which included participants in the Kritische Universität [Fig. 3.31]. A participant, Ingrid Krau describes the discussions of this group as having been born out of a desire for a new moral and ethical direction for architecture, a desire that arose from a perceived contradiction between West Germany’s official public morality, as established in the postwar period, and the private experience of events like the shooting of Ohnesorg.  

Aktion 507 organized an exhibition called *Diagnose Zum Bauen in West-Berlin.* Students held the exhibition in the raw concrete structure of Scharoun’s 1966–1969 building for the architecture school, which made it a direct comment on what they saw as an obsolete and apolitical culture of artistic architectural design [Figs. 3.32, 3.33]. The construction fence around the building was covered with the slogan “DIE NEUE SCHWERE GRÜNDERZEIT BERLINS WIRD SICH ALS EINE AUS DER NOT GEBORENE TUGEND VOR DER GESCHICHTE SEHEN LASSEN KÖNNEN” (THE NEW DIFFICULT

---

91 The exhibition was a response to the “Berliner Bauwochen” (Berlin Building Weeks) and was hosted by the Bausenat of the city. The Berliner Bauwochen took place every two years beginning in 1960. Events in 1968 included the opening of Mies’s Neue Nationalgalerie, and ceremonies for the inauguration of housing units and new subway and highway lines. Ironically, the Senat funded the *Diagnose* exhibition. “Städte-Bau. West Berlin. Slums Verschoben,” *Der Spiegel* (September 9, 1968): 134–138.
92 “Last week, in a half-finished lecture-room building of the Technical University, they glued large photographs to particleboard, constructed the wooden scaffolding for graphical representations, and installed the speaker systems from which the sound scenery for the protest exhibition *Diagnose* would drone. The spoken accusations of inhabitants of a satellite-city, recorded on tape, and the slide projections on raw concrete, are to impress upon the visitors the stone deserts of the new settlements in the peripheries of Berlin. The triste concrete façades of the ‘Märkisches Viertel,’ for instance . . . the paradigm for anti-social housing construction.” Ibid., 134. See also Hans Stimmann, “Wohnegebirge für die neue Gesellschaft, Megastrukturen und Eskapismus: Was bleibt von der Architektur der 68er?” *Die Welt*, March 28, 2008.
Fig. 3.31
GRÜNDERZEIT OF BERLIN WILL BE SEEN BY HISTORY AS A VIRTUE BORN OUT OF NECESSITY) [Fig. 3.34].

To accompany the exhibit a comprehensive booklet of over 100 pages was published in which the students presented a manifesto, along with a series of texts and statistics.

The cover of the booklet shows four interlocking arms, labeled Senat, Architekten, Spekulanten, Baugesellschaften (building department, architects, speculators, construction companies), which were laid across images of residential high-rises in the Märkisches Viertel in West Berlin [Fig. 3.35]. The texts took special aim at the politics of urban development in West Berlin, but also criticized the profession of architecture in general. The booklet begins with the manifesto:

West Berlin lives by the slogan, by faded quotes and embarrassing little sayings. The ruling parties have let the city sink under against their declared goals, to become a gigantic object for income return. . . . They are fully occupied with the profit-making intentions of their capital investors and with their own self-preservation. . . . But West Berlin has a chance if it understands itself as a social and thus an urban planning and architecture model. The condition for this is a public sphere that has control from the bottom up, comprehensive enlightenment through unswayable information media, and a readiness to surrender taboos and conventions.

93 Gründerzeit (period of foundation) usually refers to the late nineteenth-century period of industrial growth in Germany, which was characterized by opulent historicist architecture.
Fig. 3.32
Fig. 3.33
Fig. 3.34
Fig. 3.35
*Diagnose* exhibition poster and book cover showing buildings from the Märkisches Viertel in the background. 1968. Ungers Archiv für Architekturwissenschaft.
Zahlen über die Man nachdenken sollte

Wir fordern öffentlich kontrollierte Vergabe!

Diagnose zum bauen in westberlin
Ausstellungs-und Diskussionsstelle für Urteile über das bauen in westberlin

Fig. 3.36
Ungers Archiv für Architekturwissenschaft.
Fig. 3.38
The manifesto was signed by sixty-nine students, including Michael Wegener, Nikolaus Kuhnert, Jürgen Sawade, Josef Kleihues, and Jan Rave. The writing of the students in the *Diagnose* booklet, conceptually influenced by the Frankfurt School, calls for the criticism of functionalism coupled with the hope for new forms of urban life that allow for an “unalienated” relationship to the city [Figs. 3.36, 3.37]. The students also levied criticism against the selling of West Berlin to real estate investors [Fig. 3.38]. At the same time, the students were calling for new forms of *Aufklärung* (enlightenment), which indicates an idea of social awareness but also a new rational and objective view of political circumstances.

Modeling their theory on the geography of Cold War Berlin, the students identified a series of ideological and spatial lines drawn not only between East and West but also between theory and praxis. Here, as in *Berlin 1995*, there was a rejection of the

---

Reduktion der Bauverwaltung auf Koordinierung/Aufsicht/Abrechnung
Offenlegung aller Kriterien in der Vergabepolitik der Öffentlichen Hand
Abbau der Entwurfsabteilungen bei den Baugesellschaften
Planungs alternatives durch unabhängige interdisziplinäre Arbeitsgruppen
Abschaffen des Berufsbeamten
Gesellschaftliche Verfügung über Grund und Boden
Orientierung der sog. Berlinhilfe an realen Bedürfnissen und Chancen. ”
(“Establishment of an enlightened and critical public sphere
Participation of all affected in every type of planning and decision-making
Economic, social, and architectural models (1:1)
Scientific and socially oriented need +/- program determination
Reduction of the building administration to coordination/supervision/accounting
Disclosure of all criteria in the allocation politics of public funds
Dismantling of the design departments of construction corporations
Planning alternatives through independent interdisciplinary working groups
Abolition of professional bureaucracy
Social access to land and territory
Orientiation of the so-called Berlinhilfe to real needs and opportunities.”)
*Diagnose zum Bauen in West-Berlin.* “Berlinhilfe” was the name of a law according to which developers in West Berlin could benefit from tax breaks.

96 Krau also cites Alexander Mitscherlich’s work as having popularized a connection between the psyche and the material environment. Krau, “Die Zeit der Diagnose,” 342.
separation of urban functions, which was thought to lead to social ghettos and the enforcement of social norms through the segregation of space, or the “solidification” of urban contradictions. But when it came to overcoming those urban divisions, the solution proposed was not a technological one of dense connectivity. Urban alienation would be overcome “not through information put in from the outside and the static knowledge that it is based on, but through the process of experience”.\footnote{In order to substantiate their anti-rationalist claim, they quote social psychologist Klaus Horn’s \textit{Architektur als Ideologie}: “It should not be that ‘Architecture . . . should try to bring into language, into form, the instrumentally rational moment, so that therein difference is symbolically expressed as “substantial rationality.”’” (“Nicht darf ‘Architektur . . . das zweckrationale Moment so zur Sprache, in Form zu bringen versuchen, daß darin die Differenz zur ‘substantiellen Rationalität’ symbolisch zum Ausdruck kommt.””) Klaus Horn, \textit{Architektur als Ideologie} (Frankfurt am Main: Suhrkamp, 1968). Cited in \textit{Diagnose zum Bauen in West-Berlin}.}

This experience can only attach itself punctually, in partial public spheres . . . and to recognized contradictions. They are, in the specific historical situation in Berlin: . . . (R)eserves like Märkisches Viertel, Britz-Buckow-Rudow, Europa-Center, Kemperplatz, etc. Contradiction between the student body that is emancipating itself and the conformist employees and bureaucrats (and thus the conflict between theory and praxis).\footnote{“Diese Erfahrung kann nur in Teilöffentlichkeiten punktuell an . . . vorhandenen und erkennenden Widersprüchen ansetzen. Solche sind in der spezifischen, historischen Situation Berlins: Existenz der genannten Reservate, wie Märkisches Viertel, Britz-Buckow-Rudow, Europa-center, Kemperplatz, usw. Widerspruch zwischen der sich emanzipierenden Studentenschaft und den angepaßten Tätigen und Bürokraten (und damit der Konflikt zwischen Theorie und Praxis).” \textit{Diagnose zum Bauen in West-Berlin}. Britz-Buckow-Rudow was the name originally given to what is now known as Gropiusstadt. Kemperplatz is the location of Scharoun’s Philharmonie and Mies’s Neue Nationalgalerie.}

In this passage, the students sketch out a fragmented map of Berlin characterized by social contradictions. In a sort of inverse of Guy Debord’s 1957 \textit{Psychogeographic Map of Paris}, the students describe a continuous landscape of “reserves” created by the further division of the already-divided city into zones by developers. “Experience” is posited as a form of knowledge that would counter the alienated rationalism of the large-scale interventions in Berlin.
Diagnose took special aim at the Märkisches Viertel, a 17,000-unit housing complex in West Berlin built between 1964 and 1974 [Fig. 3.39]. Krau describes the group as having formed a sort of “tribunal” in judgment of the project. Twenty-two architects had participated in the Märkisches Viertel project, including Ungers, who built towers there from 1962 to 1967 [Figs. 3.40, 3.41]. This exhibition was thus also self-critical, as several students of Ungers – including Jürgen Sawade, Wegener, and Ulrich Fleming – had worked on the Märkisches Viertel as assistants. During the exhibition, audio recordings were played of student interviews with residents of the neighborhood, who spoke of it in deeply negative terms. The exhibition and the booklet showed abstracted photographs of rows of buildings and gritty everyday scenes of life, accompanied by quotes by Frankfurt School sociologists Friedrich Pollock and Claus Offe. If Berlin 1995 was a simulation, this was a project about “the real,” as the exhibition’s raw concrete walls and documentary materials attested. The critique was clear: architectural rationalism had led to disastrous consequences. The students pointed to these urban contradictions as evidence of systemic risk, but argued that it is precisely this state of risk that creates the potential for revolutionary change. Making these contradictions manifest would reveal the inadequacy of institutions, and lead to new social forms.

In the 1970s, the housing complex became a cause for the Left, including Ulrike Meinhof (who was still a journalist at the time) and other future RAF members, who were involved in the organization Arbeitskreis Mieten und Wohnen Märkisches Viertel. Meinhof was arrested while occupying an empty factory in the area in May 1970. Ulrike Meinhof, “Vorläufiges Strategie – Papier Märkisches Viertel,” in Johannes Beck et al., eds., “Jetzt reden wir”: Betroffene des Märkischen Viertels. Wohnste sozial, haste die Qual (Hamburg: Rohwolt, 1975).

The use of the tribunal as a model of moral and ethical judgment will be discussed in the conclusion.

“City planning, which has as its goal the liberation of people and not the perpetuation of relations of power and the norms that support them, must be oriented towards a critical theory that reflects the contradictions in society in their current appearance.” (“Städtebau, der die Befreiung des Menschen zum Ziele hat und nicht die Verewigung von Machtverhältnissen und der sie stützenden Normen, muß an einer
Fig. 3.39
Fig. 3.40
Fig. 3.41
Oswald Mathias Ungers,
Thus, the way to enact change was not by trying to eliminate systemic crises or social divisions, but by intensifying the revolutionary energies that these have produced.

When it came to the question of rationalism and science, however, a contradiction remained, and it was a similar to that found at Ulm. Even if the students criticized capitalist rationality following the theories of the Frankfurt School, they nevertheless embraced a rationalist architecture. As Krau puts it, “We were Aufklärer [those who raise awareness], who believed in the power or technological and scientific progress.” “We were rationalists.”

“We also thought in technocratic terms to a large extent, and reduced the inhabitant to their objectifiable, plannable, and addable needs.” The problem with the Märkisches Viertel, then, was not that it was a product of too much rationality, but that it resulted from too little: it had been designed according to arbitrary formal and aesthetic criteria without consideration for “objective” social needs.

Optimal planning

In 1968, another kind of simulation was also underway. Ungers, together with the business economist Horst Albach, was asked by the Bausenat in Berlin to collaborate on
an optimization study of the city’s housing projects. As part of an effort to create a more objective approach to designing and building public housing, architects and economists would work together to translate spatial values into numerical ones, which would be processed through a series of equations. One of the case studies looked at by the researchers was the Märkisches Viertel, where Unger had been responsible for building more than 1,400 units. Unger described his contribution as an attempt to advance the Zeilenbau housing models of the 1920s towards a more urbanistic concept of a small city. According to Unger, his design scheme had begun with buildings that were two to six stories tall, but the developers pressured him to push their height to twelve and even twenty-four stories. He later spoke of this change as a grave error, and the result of the naïve belief in the early 1960s that “quantity could bring about quality.”

According to Unger, the critical public reaction to the Märkisches Viertel was one of the reasons that he stopped building for fifteen years:

At the end of the 1960s the Märkisches Viertel had become, for the public, a stigma for what is evil and bad, and I had to expose myself to the worst accusations. You design a facility with the best knowledge and intentions [Wissen und Gewissen], and seek to solve a problem with great engagement, namely that of mass housing, and then one day you open Stern and a sequence of photos spread over two pages jumps out at you, in which there is a row of garbage cans in the foreground, with children sitting in them, and the background is made up of your buildings. To experience that day and overcome that shock, you need a constitution that is almost inhuman. . . . That, of course, was an enormous psychological stress for me. . . . Believe me, I needed fifteen years for that, and did not build for fifteen years. . . .

---

104 Albach taught economics at the Rheinischen Friedrich-Wilhelms-University Bonn, and served on the advisory council for the German Ministry of Economics, as well as the boards of several West German corporations.
106 Ibid., 183.
Fig. 3.42
That indeed had to do with the Märkisches Viertel. I did not touch another project, because the shock was so endlessly deep.\footnote{Zunächst einmal war es vor allem die Überwindung eines Schocks, der dadurch entstanden ist, dass das Märkische Viertel am Ende der 60er Jahre in der Öffentlichkeit zum Stigma für das Böse, zum Stigma für das Schlachte geworden war und ich mich schlimmsten Anschuldigungen aussetzen musste. Sie haben also eine Anlage entworfen mit bestem Wissen und Gewissen und haben mit großem Engagement ein Problem, nämlich das des Massenwohnungsbauens, zu lösen gesucht, und Sie schlagen eines Tages den Stern auf und eine Bildsequenz über zwei Seiten springt ihnen entgegen, in dem eine Reihe von Mülltonnen im Vordergrund sind, in denen Kinder sitzen und den Hintergrund bilden ihre Gebäude. Diesen Tag zu erleben und diesen Schock zu überstehen, dazu brauchen Sie ein Standvermögen, das ist beinahe unmenschlich. . . . Das hat mich natürlich auch seelisch enorm strapaziert. . . . Glauben Sie mir, ich habe 15 Jahre dafür gebraucht und deshalb auch 15 Jahre nichts mehr gebaut. Das hat tatsächlich mit dem Märkischen Viertel zu tun. Ich habe keinen Bau mehr angefasst, weil dieser Schock so unendlich tief saß.” Ibid., 183–184. While Ungers clearly recognized the limitations of the Märkisches Viertel, he nevertheless described its criticism as having stemmed from a “pseudo-revolutionary” politics for which it became a scapegoat. Ibid., 190.} [Fig. 3.42]

It is thus within the context of this complicated ethical relationship between \textit{Wissen} and \textit{Gewissen} (“knowledge and intention,” or even “knowledge and conscience”) that we can look at the 1968-69 study of optimization for housing. Here the relationship between rationality and morality manifests itself in yet another way. How can optimization and the turn from form to numbers be understood in light of the politics that confronted Ungers during those turbulent years? In what ways was the naïveté of the early 1960s, which led to the over-dimensioning of the project, replaced by a different form of misplaced faith: belief in the power of calculation to predict the future and avoid risk? In this project, architectural information was combined with economic calculation in order to mathematically determine an “optimal” housing form – from a purely financial perspective.

Ungers hired his assistants Wegener and Heyde from the TU Berlin to work on the study. An early version of the project was presented in 1968 at a joint conference between the TU Berlin and MIT. Participants in “The Computer in the University”
conference included Max Bense, Max Bill, cybernetic artist and author Herbert W. Franke, American computer scientist J. C. R. Licklider, and German computer inventor Konrad Zuse. Albach and Ungers presented their work at a panel called “Manipulation of Complex Systems by the Use of the Computer,” which also featured Aaron Fleisher and Nicholas Negroponte. Ungers and Albach summarized their project as follows:

The task was to devise models of optimization of large housing developments and to test the models against data of several large housing developments carried out over the last ten years. The model consists in minimizing total housing costs per capita as well as total housing costs per square foot subject to a multitude of technical as well as legal constraints. . . . The model gives an optimal solution with respect to the number of floors and building type (hexagonal, quadratic, slab, and tower), depth of building and optimal parking system. The model is then incorporated in a larger model on the optimal device of large city areas for new housing development.

Although Ungers would later claim that the study was arguing against building high-rise housing, he describes how the TU Berlin students nevertheless reacted to the project with rage:

There were 2,000 students in the Audimax of the TU, and in front of the doors they were distributing fliers in which I was compared to Hitler and Nietzsche, and characterized as having euthanized society’s corpse. That was a vicious controversy, which affected me more at the time than it did Albach. We were not even on the podium yet when the hissing and shouting began.
Fig. 3.43

Fig. 3.44
Comparison of grid systems.
This scientific and economic reevaluation of West Berlin’s housing was published in 1969 in the book *Optimale Wohngebietsplanung* [Fig. 3.43].\footnote{Horst Albach and O. M. Ungers, *Optimale Wohngebietsplanung. Band I: Analyse, Optimierung und Vergleich der Kosten städtischer Wohngebiete* (Wiesbaden: Betriebswirtschaftlicher Verlag Gabler, 1969). A second volume of the book was planned but never published outside of the university: O. M. Ungers and Horst Albach, *Optimale Wohngebietsplanung. Band II: Der Wohnwert Städtischer Wohngebiete. Faktorenanalyse zur Bestimmung einer Wohnwertfunktion* (Bonn: Universität Bonn, Betriebswirtschaftliche Abteilung, 1968). Private archive of Michael Wegener.} In the preface Albach and Ungers write:

> Questions of public transport, urban renewal, investment in education, hospital building, and infrastructure are increasingly being scientifically researched. In answering these questions, economic criteria play an ever more meaningful role. The justification of the large sums that bind decisions about public investments . . . is an urgent concern for modern planning processes.\footnote{“Fragen des öffentlichen Verkehrs, der Stadtsanierung, der Bildungsinvestitionen, des Krankenhauswesens und der Infrastrukturinvestitionen werden in immer stärkeren Maße wissenschaftlich untersucht. Bei der Beantwortung dieser Fragen spielen wirtschaftliche Kriterien eine immer bedeutendere Rolle. Die Rechtfertigung der großen Summen, die Entscheidung über öffentliche Investitionen binden, durch den mit diesen Investitionen geschaffenem Nutzen ist ein Anliegen moderner Planungsverfahren.” Albach and Ungers, preface to *Optimale Wohngebietsplanung. Band I*. The preface is unpaginated.}

This reevaluation of housing in West Berlin does not take into consideration the recent criticism of these projects, but instead uses scientific methods for justifying and “optimizing” public expenditure. While this study was published several years before the so-called *Legitimationskrise* of the 1970s – the loss of faith in public institutions – it betrays a similar anxiety about the role of the state in providing services and institutions. The application of economic tools developed for the private sector, in a simulated cost optimization of public expenditure, hints at the increasing privatization of urban development in West Germany in the 1980s.

An entirely different form of calculation is promoted here than the one seen in *Berlin 1995* and other student work. While the students preclude the possibility of an
optimum, preferring to play within the parameters of multiple simulations, Ungers and Albach instead work with a variety of variables in order to find a single optimal “solution.” This solution is based almost entirely on the needs of financing, not the needs of residents. To express this mathematically, they translate a variety of variables into quantifiable information, even while they admit that these depend on subjective values:

The quantification of such magnitudes of influence is still very difficult to achieve. That is why a limitation to the gathering and optimization of primarily quantitative factors is at first appropriate. . . . At least with the optimization of quantitative factors it is possible for evidence of the motivations in planning a residential area to be established based on a rationally graspable foundation of measurement.114

The effort here is one of finding a foundation for design that is as “neutral” as possible, which requires looking for something that is measurable and can be translated into numbers. The problem of measurability that Otto confronted in relationship to form appears here in a social context.

The first chapter of the book begins, not surprisingly, with an equation.115 What follows is a series of algebraic manipulations in which a number of variables are introduced: building area, code constraints, number of residents, number of floors, building depth, costs for real estate, parking, and streets. In order to process these variables within a range of values, and more importantly, to calculate them, the researchers used an IBM 7090, located at the University of Bonn. The end result of these

115 DK = GK/BG: The average cost of building = The total cost of building/reference value. Ibid., 19.
Fig. 3.45
manipulations was an equation used to calculate an ideal set of variables for the minimum housing cost per resident.

This equation was then applied to four urban patterns for housing forms (block, row, square, and hexagon). [Fig. 3.44] The book shows an image of the flowchart used to generate a list of tables and graphs for every pattern according to different building heights. While each pattern is considered in isolation, the outcome of this attempt at formal variation is, oddly enough, always a grid. The authors arrive at an optimum shape (the hexagon) and building height (six stories) [Fig. 3.45]. Evidence for this result is provided in a graph laconically entitled “Absolutes Optimum der Optimalkombination beim Bebauungssystem” (Absolute optimum of the optimum combination in the building system) [Fig. 3.46]. Having established an ideal urban form in a calculated space, Albach and Unger use the same methods to reassess existing housing projects in West Berlin, including the Märkisches Viertel, according to a simulated “rebuilding.” Going through several hundred iterations using the data obtained from the neighborhood, they determine that an optimized version of the project would have cost up to 25 percent less. Social criticism of the project is never addressed.

These equations, and the computer that processed them, could be used to calculate a complex number of variables, but this process did not yet have the flexibility of later parametric computer modeling programs that would allow for multiple solutions. The results allow for several options for building height and depth, but these are

---

116 Similar patterns showing comparative plan formations had also appeared in Berlin 1995 and in Gutachten Ruhwald, Veröffentlichungen zur Architektur 9 (Berlin: 1967).

117 This is not to suggest that the “flexibility” of parametric systems should be idealized, as they are accompanied by their own ideological and technical constraints.
Fig. 3.46
Horst Albach and Oswald Mathias Ungers, Optimale Wohngebietsplanung, Band 1 (Wiesbaden: Betriebswirtschaftlicher Verlag Dr. Th. Gabler, 1969).
nevertheless part of a unified, quantifiable structure that “overlays a residential area as a homogeneously structured housing net” – a kind of megastructure. The book shows all of the raw parametric data generated by the calculations, but in the end the project was still a search for a single optimum combination of values. The authors warn that such absolute optimization would reduce the average space allowed per resident to 15.14 square meters – which clearly shows that not every significant factor, especially this most important one – could be accounted for. This use of calculation to work towards an optimum was not the realization of a new social reality, but an act of cost-reduction.

In the unpublished second volume to Optimale Wohngebietsplanung, Albach and Unger tried to address the problem encountered in the first study by focusing on questions of “values”:

This study begins with the hypothesis that the “users” are themselves capable of giving information about their ideas of housing values. At the same time, one must nevertheless be aware that the formulation of goals, preferences, and criteria, on which a choice is based, is especially difficult for most people. Their consciousness is not so far developed that they have fully rationalized these subjective decision-making processes. The criteria that they name here must thus be understood as incomplete expressions of influential factors that stand in the background.

118 Albach and Unger, Optimale Wohngebietsplanung. Band I, 23.
119 Aside from being six stories tall and hexagonal, the units should have 93 residents and would cost 17,376 DM per resident to build. Ibid., 201.
Here they delve deeper into the territory of social “immeasurables” by trying to rationalize the consciousness of human subjects. Albach and Ungers propose using a statistical method called “factor analysis” to measure the seemingly unconscious desires of the future residents and to bring to light the hidden factors that influence housing quality. Twenty-nine qualities, including location, housing type, gardens, garages, and central heating are taken into consideration and calculated. As these new values are introduced, Albach and Ungers attempt to mathematically formulate an ideal housing form that factors in both the minimization of costs and the maximization of values (even if optimization itself, according to the authors, can only be a process of minimization). This study, in attempting to translate subjective values into quantifiable ones, is based in an even deeper faith in the powers of calculation when compared to the first one. In projecting and rationalizing desire itself, the hope is to remove uncertainty, to create a systemic stability in which the spending of the state and the unpredictable needs of the residents are in balance.

Prediction thus plays a double role. For the students with utopian aspirations, the conditions for a different future still had to be created. Rather than seeing Berlin 1995 as a literal expression of the desire for a technocratic future, we can view it as a way to make manifest the contemporaneous contradictions within Berlin and West German society – the divisions of Berlin not only into east and west but also into “ghettos” of social control and consumption. The equalizing function of the grid symbolically eradicates these differences by connecting all points in the city. Spatial and social isolation are reduced through hyper-density; the overlapping and proliferating systems
are so unmanageable that they may evade total social control. At the same time, the
city is a simulation; the problem therein lies not with the question of what is real – in a
utopian setting, that is no longer of concern – but with the question of who is in control.
As in Welt am Draht, one has to assume that there are always managers and
technocrats behind the layers of simulation. Perhaps the political aspiration of Berlin
1995, then, was that the future could be controlled at all, that the tools used by
technocrats could be taken over by the students to imagine their own destiny. The
technology of simulation, perfected during the Cold War in order to imagine, predict,
and control virtual future conflicts, would be used to erase the geographies it created,
to provide a space for new social and architectural possibilities.

By contrast, Optimale Wohngebietsplanung was less the anticipation for the future
than an attempt at correcting and managing past mistakes. In reprocessing the
Märkisches Viertel through the machine of calculation, Albach and Unger perhaps
hoped for a different outcome. By letting the neutrality of numbers speak for
themselves, pure reason could be translated into form. But it is, of course, precisely this
abstract and instrumental use of science that the students warn of. And while the grids
of Berlin 1995 lead away from optimization towards a maximization of systems that
makes a hilarious mockery of rational planning, the uses of calculation in Optimale
Wohngebietsplanung end in a single graph, a tempered curve that promises the
absolute minimum expense for developers.

Simulation is not simply imagining a future or alternative world; it is equally
grounded in both the science of prediction and the art of the imaginary. For Baudrillard,
the “problem” with the last order of simulacra—that associated with the cybernetic game—was that there is no longer the necessary distance between the real and the game of simulation that allows for the imaginary:

The models no longer constitute either transcendence or projection, they no longer constitute the imaginary in relation to the real, they are themselves an anticipation of the real, and thus leave no room for any sort of fictional anticipation – they are immanent. . . . The field opened is that of simulation in the cybernetic sense, that is, of the manipulation of these models at every level . . . but then nothing distinguishes this operation from the operation itself and the gestation of the real: there is no more fiction.121

A vertical order of multiple worlds, real or unreal, was suggested in the mis en abyme of the grids of Berlin 1995. But the students did not, in fact, simulate anything; they simply invented a city that looked as if it had been created by a computer program. Thanks to historical hindsight, this fantasy of a simulated cybernetic game seems fictional, because the technology that would have enabled such a detailed architectural simulation did not yet exist. But as Baudrillard suggests, this science fiction was perhaps too close to the technocratic “real” in which potential futures are reduced rather than multiplied.

121 Baudrillard, Simulacra and Simulation, 122. Emphasis in the original.
II. RATIO AND REPETITION

In the 1970 essay “Theatrum Philosophicum,” Michel Foucault described the effect of the repetition of mass-produced objects in Andy Warhol’s paintings as follows:

“Here or there, it’s always the same thing; what difference if the colors vary, if they’re darker or lighter. It's all so senseless . . .” But, in concentrating on this boundless monotony, we find the sudden illumination of multiplicity itself – with nothing at its center, at its highest point, or beyond it – a flickering of light that travels even faster than the eyes and successively lights up the moving labels and the captive snapshots that refer to each other to eternity, without ever saying anything: suddenly, arising from the background of the old inertia of equivalences, the zebra stripe of the event tears through the darkness, and the eternal phantasm informs that soup can, that singular and depthless face.\footnote{Michel Foucault, “Theatrum Philosophicum,” in Aesthetics, Method, and Epistemology, ed. James D. Faubion, trans. Robert Hurley et al. (New York: The New Press, 1998), 362. Deleuze similarly describes difference as “light, aerial, and affirmative.” Gilles Deleuze, Difference and Repetition (New York: Columbia University Press, 1995), 54.}

In this essay, which was also a review of Gilles Deleuze’s Difference and Repetition and The Logic of Sense, Foucault points to the potential of repetition to produce a particular kind of multiplicity, one that arises out of monotony and exhaustion to provide the sudden “illumination” of the event. In Foucault’s extraordinary reading of Warhol’s paintings (and Deleuze’s philosophy), he describes a form of difference that both transcends and tears through modernity’s will to repetition. This difference is based neither on the false difference of the commodity (the array of flavors of the same soup can), nor the negation of dialectics [Fig. 3.47].

Deleuze had formulated a philosophy of the “power peculiar to repetition” in response to what he described as the dominant (Hegelian) model of identity and
Fig. 3.47
Ernst May, *Siedlung Westhausen*, Frankfurt, 1929-31
Peter Roehr, *Untitled*, 1965
contradiction, which he saw as reduced to the choice between $A=A$ or $A\neq A$. Deleuze argued that identity and its contradiction were no longer possible in a modern world of simulacra.\textsuperscript{123} Yet it is precisely the forms of repetition found in modernity that make difference possible: “Modern life is such that, confronted with the most mechanical, the most stereotypical repetitions, inside and outside ourselves, we endlessly extract from them little differences, variations and modifications. . . . The task of life is to make these repetitions coexist in a space in which difference is distributed.”\textsuperscript{124} Deleuze proposes a concept of repetition “in which physical, mechanical or bare repetitions . . . would find their raison d’être in the more profound structures of a hidden repetition in which a ‘differential’ is disguised and displaced.”\textsuperscript{125} Difference is not immediately apparent; it can be so small that it is not perceptible, as Deleuze suggests through the example of infinitesimal calculus.

Modern aesthetics of repetition were a reflection of social forms of repetition, such as those found in mass production, labor, and the mechanical and digital reproduction of media. Repetition is the product of an industrial rationality according to which repeated movements and repeated products result in an economy of labor and materials. As Warhol’s soup cans suggest, this form of repetition also allows for variation, but this is a controlled notion of difference that does not run counter to the rationality of industrial repetition, but is in fact part of its logic. Similarly, in mathematics there are combinations and permutations of numbers that can introduce many possible

\textsuperscript{123} Deleuze, preface to \textit{Difference and Repetition}, xi.
\textsuperscript{124} Ibid.
\textsuperscript{125} Ibid., xx.
sequences, but these possibilities always take place within a limited and closed set of variables.

Repetition was also part of Adorno and Horkheimer’s concept of enlightenment, in which the mythical and magical explanations for repetition are replaced by an immanent order in which everything is connected to everything else such that difference is no longer possible:

The more the illusion of magic vanishes, the more implacable repetition, in the guise of regularity, imprisons human beings in the cycle now objectified in the laws of nature, to which they believe they owe their security as free subjects. The principle of immanence, the explanation of every event as repetition, which enlightenment upholds against mythical imagination, is that of myth itself. The arid wisdom which acknowledges nothing new under the sun, because all the pieces in the meaningless game have been played out, all the great thoughts have been thought . . . this barren wisdom merely reproduces the fantastic doctrine it rejects: the sanction of fate which, through retribution, incessantly reinstates what always was. Whatever might be different is made the same.¹²⁶

Repetition also marked modernity in less obvious ways, as in the trans-historical and trans-cultural patterns of structural anthropology, or psychoanalytic concepts like mirroring and the repetition compulsion. These theories can nevertheless be described as products of societies that use repetition as systems of ordering. In the work of Unger, repetition appears in the different guises described here – as a principle of economy and mass-production on the one hand, but also in patterns and figures that reappear in history and in space, with uncanny and irrational results.

Repetition was an inherent quality of rational architecture, from Durand’s grids of plan variations, to the rows and façades in the 1920s housing projects in Frankfurt, to

the monotony of the *Plattenbau* constructions of the 1960s. Serial repetition in particular played a large part in modern architecture, from typological systems in the eighteenth century to the mass production and prefabrication of building components in the nineteenth and twentieth centuries. The postmodern use of repetition continued in this rationalist tradition, but should also be considered in light of several changes in architecture in the late 1960s and early 1970s. One of these changes was the influence of cybernetics and computation on design, which introduced new types of repetition: pattern formation and recognition, iteration, recursion, feedback, and simulation, to name only a few. Automated systems, including those developed for architectural drafting, were closely associated with the repetitive processes or movements that they replaced and accelerated.

It is clear that postmodern repetition has different effects, but what were they? The passage by Foucault suggests that even within the coarse calculations of industrial production, and the monotonous commodities that are the result, there is a calculus that can be found at a finer level. Differential calculus, used to find the rate of change at very precise points in curved lines, operates at the micro-scale, taking what seems continuous and breaking it down into smaller points. Deleuze’s work, published in the political environment of 1968, described a deeply optimistic and radical way of thinking through the repetitive habits of late industrial societies. Could there be an architectural corollary to this aesthetic and philosophical “power of repetition”? Might difference lie at the level of the micro-scale, as explored by Otto in his graphs of the range of structural forms, or in the fractal-like density of the drawings for *Berlin 1995*? Simulation
operates on the basis of resemblance, of micro-differences that separate the model from the real or original.

But repetition, as I have argued in the introduction to this dissertation, can also lead to an impasse, to exhaustion. The combinatorics of postmodern architecture suggest this – the perpetual search for variation within a finite set of possibilities. Repetition appeared in various forms in Ungers’s work, and was often the basis of the rational systems he used to organize his architecture. One of the most important of these, especially during the late 1960s, was architectural mass production. Ungers’s interest in mass production coincided with his academic and “technocratic” studies for housing and urban development, in which an abstract idea of an urban “mass” determined numerical and formal experiments. I will argue that even as Ungers’s faith in mass production waned during the 1970s, repetition nevertheless lingered as a purely formal strategy of organizing patterns and typologies, using rational devices like the grid. Repetition, seemingly detached from economic and social concerns, became an abstract and hermetic game of resemblances, doubles, and analogies. Does architecture then remain confined to the rational boundaries of repetition, in which the sameness of reproduction, and the seeming difference of variation (in the form of endless typological deviation, for example), are subsumed under one system?

A parallel can be drawn between this use of repetition and serial practices in art in the 1960s and ’70s [Figs. 3.48, 3.49].

127 While Ungers never explicitly wrote on serialism

127 I am not considering repetition and serialism in music in this chapter. However, discussions of serialism in the 1950s and early 1960s in Germany, particularly at the Darmstadt School, are highly relevant, especially considering Adorno’s writings on this topic.
Fig. 3.48
Sol LeWitt, *Serial Project A 1 5 9*, 1966. enamel on steel, 20-1/2” x 82-1/4” x 31-7/8” (52.1 cm x 208.9 cm x 81 cm).
This piece is in the collection of O. M. Unger.
Fig. 3.49
Mel Bochner, *36 Photographs and 12 Diagrams*, 1966. Thirty-six gelatin silver prints and twelve pen-and-ink drawings mounted on board, 73" x 55".
in art, he had personal ties (and in some cases, close friendships) to several artists who worked in a serial manner, including Gerhard Merz, Sol LeWitt, Bernd and Hilla Becher, and Gerhard Richter.\textsuperscript{128} Ungers was also a serious art collector, with works by these artists as well as many who used themes of repetition to varying degrees.\textsuperscript{129} In his 1967 text “The Serial Attitude,” Mel Bochner defined the qualities of “serially ordered works” as follows:

1. The derivation of the terms or interior divisions of the work is by means of a numerical or otherwise systematically predetermined process (permutation, progression, rotation, reversal).
2. The order takes precedence over the execution.
3. The completed work is fundamentally parsimonious and systematically self-exhausting.\textsuperscript{130}

Repetition and seriality in the art of the 1960s brought together formalist structures of early modernism (exemplified most clearly by the grid) and the visual culture of mass production and reproduction.\textsuperscript{131} Rosalind Krauss argues that the exhaustion of possibilities through repetition eroded the culture of the original artwork, and

\begin{itemize}
\item \textsuperscript{128} Sophia Ungers, interview with author, April 9, 2013, Cologne. In an email from Jörg Pampe to the author, dated November 21, 2013, he states that Ungers was a friend of the Bechers.
\item \textsuperscript{129} Ungers’s collection included works by Robert Morris, Richard Hamilton, Günther Förg, Bruce Naumann, Max Bill, Richard Long, Dan Flavin, Donald Judd, Marcel Broodthaers, Blinky Palermo, Josef Albers, Larry Bell, Rosemarie Trockel, Reinhard Mucha, Robert Mangold, and Carl André. Most of what remains of Unger’s collection was acquired in the 1990s, but several works were acquired as early as the 1960s. The artists listed here represent only a portion of his collection, which included Art Informe and expressionist drawings (most of which were sold to build his house), and architectural drawings, paintings, and models from the seventeenth through the twentieth century. Unger tended to collect pieces that reflected themes in his own work (especially the motif of the square); thus there is also repetition in the collection as a whole, which was characterized by a high degree of self-referentiality. Unger’s drive to collect extended not only to art but also to books: his library in Cologne still contains an extraordinary number of rare books on architecture, some of which date to the Renaissance. Interview with Sophia Ungers.
\item \textsuperscript{131} Rosalind Krauss, “Grids,” \textit{October} 9 (Summer 1979): 50–64.
\end{itemize}
undermined the expansionary logic of capitalist mass production.\textsuperscript{132} But seriality, at least according to Bochner, implies not endless repetition but a closed, “parsimonious” system of possibilities. In the work of Unger, one finds both kinds of repetition. There are sets of objects that have a definite limit, such as typological variations, which suggest the exhaustion of possibilities. But there are also open-ended systems in which there is no possibility of closure, and where repetition threatens to continue indefinitely. Rational and irrational systems of ordering become so tightly wound into one another that the most arid, calculated projects appear delirious, and forays into surrealist or structuralist experimentation only seem to reinforce the suspicion that these are built upon a desire for a rational foundation.

***

The rational systems underlying Unger’s work, which were the basis for his use of repetition, were developed during a period when he was distancing himself from his early “expressionist” phase, but was still hostile to the idea of mass production. In his 1963 \textit{Berufungsvortrag} (candidate lecture) at the TU Berlin on the “Prinzipien der Raumgestaltung” (Principles of spatial design), Unger transitions from defending the freedom of the “unfolding of the creative spirit” of the architect, to inventing rational systems for producing form.\textsuperscript{133} During his years of practice in Cologne, Unger had defended the autonomy of architectural form against social, functional, and economic demands. At the TU Berlin, his talk begins in a similar vein when he speaks of the

\textsuperscript{132} Ibid.
\textsuperscript{133} Unger was invited to give the talk on February 11, 1963. Oswald Mathias Unger, “Berufungsvortrag,” \textit{ARCH+ 65} (January 1982): 41–48. The talk was republished in \textit{ARCH+ 181/182}. The editor of \textit{ARCH+}, Nikolaus Kuhnert, was a student of Unger. See Unger and Gieselmann, “Zu Einer Neuen Architektur.”
“anachronism” of the architect in the face of new economic, sociological, and technological problems. He complains that through the “objectification” of building elements and the “development of standards,” “architecture becomes more and more a process of serial production, and the building an item in a catalog that can be stacked, registered, and kept ready to ship at any time.” Here Ungers still views the concept of the serial with suspicion. The domination of architecture and building by “experts” using rational calculation results in the architect becoming superfluous, he argues:

Everything is expressed in endless mathematical formula that take on an astronomical proportion, and become increasingly incomprehensible to the architect. He can no longer participate in a conversation, because his expertise is not sufficient. The engineers carry on the conversation amongst themselves in a sort of coded secret language.

Architects literally lose their ability to speak: “The only layman in the forum of specialists is the architect, who can barely draw an audience, and whose language becomes increasingly mute. Until one day he is no longer heard at all.”

Ungers responds by creating a new “language” of systems that are proper to architecture. His previous response to economic and functional architecture had been to look to the “fantasy” and “mystery” of expressionism. Now, however, he proposes a rational system for architectural Gestaltung (design), calling for architectural “rules,” the

---

136 “Der einzige Laie in dem Gremium der Fachleute ist der Architekt, der sich kaum noch Gehör verschaffen kann und dessen Sprache immer mehr verstummt. Bis er eines Tages überhaupt nicht mehr gehört wird.” Ibid.
Fig. 3.50
“reduction of structural shapes to their basic forms,” and “objective structures” that are free from functional demands and “independent of historical epochs or their respective cultural character.”

Ungers uses examples of “primitive” architecture (a tent, an assemblage of masses at Stonehenge, an igloo) in order to derive “general rules for forming space.” These forms translated into the categories of Linie, Fläche, and Kubus (line, plane, and cube). To physically illustrate this new system, Ungers created a small wooden Baukasten (kit-of-parts) [Fig. 3.50]. While this “toy” initially suggests a notion of play or chance, it was instead the basis of a rational system of order. This wooden model could be taken apart to show three variations on a cube (a preview of his later fascination with the square): an open structure, a volume formed by planes, and a solid. These variations were the basis for a series of further manipulations as the cubes are stacked in various configurations. Showing models that bring to mind Sol LeWitt’s sculptural variations, Ungers follows a serial, rule-based approach in assembling the three original variations on the cube.

Ungers pairs these spatial models with photographs of architecture, prefiguring his later concepts of architectural “images,” “analogies,” and “metaphors,” which were terms that he used interchangeably. In the 1970s Ungers compared urban plans and photographs of ordinary objects, or urban plans of historically and geographically

137 “Reduzierung der baulichen Gebilde auf ihre Grundformen”; “unabhängig von geschichtlichen Epochen oder dem jeweiligen kulturellen Charakter.” Ibid., 41, 42.
138 Ibid., 42
139 Jasper Cepl suggests that the cube model was inspired by the toys and kit-of-parts designed by Hermann Finsterlin in the 1920s. In December 1962, Ungers mailed Finsterlin an invertible cube designed by the anthroposophist and artist Paul Schatz. Cepl, Oswald Mathias Ungers, 121–122.
disparate cities, arguing that these introduced an imaginary element into architecture. The imaginary was thought to stem from the comparison of two elements that are not alike, a process that he calls “analogy” or “metaphor.” In the Berufungsvortrag however, there seems to be more interest in establishing a rational foundation for architectural form than introducing imaginary elements. Images of architecture were culled from a variety of historical and geographical contexts, and used didactically as an argument for general categories of form that repeat over time. Working backwards, not from the image of architecture to the model but from the model to the image, Ungers shows a myriad of architectural examples in what he calls a “cinematographic” sequence.\(^{140}\) For example, he compares a “linear” combination of open cubes to the floor plan of the Cologne cathedral, Ludwig Hilberseimer’s proposal for the Chicago Tribune tower, and a “group of pile dwellings from the South Seas.”\(^{141}\) [Fig. 3.51]. A similar combination of solid cubes is compared to images of a street in a Peruvian Indian village, Aldo van Eyck’s orphanage, and Columbia Presbyterian Hospital in New York. The examples are not organized according to any preexisting principle (history, geography, typology) other than the abstract categories of Ungers’s own invention.

Even if Ungers begins with what seems like yet another account of the primitive origins of architecture, it quickly becomes clear that these examples relate to one another without hierarchy or chronology. Repetition thus undermines the role of historical origin in favor of formal similitude. Ungers’s models serve only to illustrate the abstract principles that – according to his own vision – underlie the possibilities of

\(^{140}\) Ungers, “Berufungsvortrag,” 43.
\(^{141}\) Ibid.
Fig. 3.51
architecture. While Unger describes his method as “objective,” he is vague about whether it is “scientific.” His intention seems to be to provide a communicable language of expertise for architects that is an alternative to the “secret” mathematical dialogue of the engineers.

In the second part of the lecture, Unger made a strong argument for the independence of form and function, a position that would essentially remain unchanged through his career.\(^{142}\) He ends the talk with his previous themes of the “creative will of the individual,” and its “independent spiritual existence.”\(^{143}\) There are thus two competing forces at play here: on the one hand, the idea of the singularity of the building as an expression of the vision of the architect; on the other, a first attempt to establish a theory of repetition. Forms repeat themselves throughout history, no matter what the creative will of the architect wants to express. They repeat themselves globally, in modern and pre-modern cultures; they also repeat themselves at different scales – from a birdcage to a city. With his inclusion of examples of “architecture without architects,” Unger opens up the question of the anonymous production of architecture.\(^{144}\) There is no point of origin – whether geographically or historically; there is only a system of rules, and a seemingly open-ended chain of possible combinations and associations.

\(^{142}\) He defends his position by comparing four formally different examples of the same program (a theater building): Alvar Aalto’s opera house in Essen (designed 1959), Mies van der Rohe’s Nationaltheater in Mannheim (1952-53), Hans Scharoun’s Staatstheater in Kassel (1952), and Le Corbusier’s Palace of the Assembly in Chandigarh (1955).


\(^{144}\) Bernard Rudofsky, *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture* (New York: Museum of Modern Art, 1965). Ungers may have been exposed to the vernacular through his participation in Team Ten meetings.
Mass production

While Ungers had clearly stated his opposition to serial production and architecture based on technological and economic determinations, his views shift quite radically by the late 1960s. This transformation can be attributed to his new focus on mass housing. Ungers worked on several housing projects and competitions while he was based in Cologne (“Neue Stadt” in 1962 and Grünzug Süd, 1962–1965), but his most direct confrontation with the question of scale occurred when he worked on the Märkisches Viertel in West Berlin. Ungers’s interest in urban planning and the “greater number” was also related to his membership in Team Ten: Ungers invited several members to West Berlin to give lectures, and hosted a meeting in September 1965. He began to develop his first urban planning theories, which initially came in response to an apocalyptic vision of urban sprawl: “Endless steppes of housing will spread across Europe in a short amount of time, and the landscape will be attacked by an unparalleled building plague and will be destroyed.”

During this time, Ungers developed what he called the Großform or “large form.” While his 1964 lecture had suggested that the problem of scale would be addressed additively – through the multiplication or stacking of units – Ungers later put forth the

---

147 The term Großform was used by Otto Ernst Schweizer, Ungers’s teacher when he was a student in Karlsruhe. Otto Ernst Schweizer, Die Architektonische Großform. Gebautes und Gedachtes (Karlsruhe: G. Braun, 1957). See Cepl, Oswald Mathias Unger, 204.
idea that the *Großform* could be both an assemblage of discrete units *and* a single, cohesive form. In a 1966 talk entitled “Gesichtspunkte der Planung beim Wohnungsba,” Ungers defends the *Großform* as addressing “the greater context” and part-to-whole relationships.\(^{148}\) There is a clear shift in scale away from the *Einzelwerk* (stand-alone work):

Building from day to day, at the scale of small steps, can no longer solve developing demands in the future. With the change in quantity there is a change in scale, and with the change in scale there is necessarily also a change in the means and the elements. The claim persists: particularistic thinking in design is over. It is both a senseless waste and an anachronism to continue to focus on the single architectural work.\(^{149}\)

While Ungers does not specifically address the theme of repetition here, he has laid the groundwork for a kind of practice that is no longer about the single, autonomous object, but about the multiple. In doing so, he opens the architectural object to being integrated into systems other than purely formal ones, namely technical, economic, and organizational ones. It is this combination of the idea of the multiple with the view towards new forms of reproduction that make room for a rational approach to building.

The relationship between mass housing and mass production is more clearly outlined in the self-published 1966 booklet *Großformen im Wohnungsbau* [Fig. 3.52].\(^{150}\)

Ungers once again tries to find a compromise between the accumulation of units at a

---

\(^{148}\) Ungers, “Gesichtspunkte der Planung beim Wohnungsba.”


Fig. 3.52
mass scale and the expression of large-scale “images.” The booklet, which was based on a lecture that Ungers had given in Moscow, begins with a quantitative assessment of the question of housing in West Germany.\footnote{Ungers gave a series of lectures in the USSR in the fall of 1966 in cities including Moscow, Odessa, Kiev, and Leningrad as part of an exchange between professors of the Bauakademie Moscow and the TU Berlin. During these lectures, Ungers spoke of architectural prefabrication and the architecture of the 1920s. Cepl, 	extit{Oswald Mathias Ungers}, 547. It is difficult to guess the political intentions of Ungers’s talk, but in the light of the Cold War, one can’t help but wonder about the implications of his emphasis on West German productivity and the success of its economic recovery.} To illustrate his point, Ungers argues that the volume of housing that had been built in West Germany between 1950 and 1966 (8 million units) would translate into a twenty-story building covering the entirety of the country’s highway network. This massive, megastructural vision is a diagrammatic representation of the reproduction of units at a larger scale. While he holds onto the image of the large form, Ungers also suggests that mass production is the necessary method of arriving there.

The cover of the booklet shows an abstract pattern that resembles some sort of aggregate. On closer inspection, this turns out to be an image of a crowd, turned on its side – an amorphous and disorganized “mass.” Ungers writes of the formless growth of cities (“excessive agglomeration and infinite growth are the two poles between which the pendulum swings”) and proposes “centralization of the built volume, rationalization of building methods, and densification” to counteract the tendency towards “proliferation,” “agglomeration,” “formlessness,” and “amorphousness.”\footnote{Ungers, 	extit{Großformen im Wohnungsbaul.}}

To illustrate this rational approach, Ungers shows a composite of four images of a Volkswagen (VW) Beetle, rotated along one axis. The image, which emphasizes the
uniformity and economy of the car, was likely taken from a recent VW ad.\(^{153}\) The object is repeated with the neutrality of a technical drawing in a manner suggesting serial variation. Below this mass-produced object, Ungers writes:

A car, the Volkswagen, costs 5,000 DM. An apartment for 4 people, 100sqm in size, costs 100,000 DM. That makes 20 VW = 1 WE or 5 monthly salaries for one car and 8 annual salaries for an apartment.\(^{154}\) The costs of an apartment are unfavorable when compared to the costs of a car. The car is a mass-produced item, manufactured with the technical means and procedures of serial production. The apartment, which by now is a mass product, is bound to tradition in its manufacturing process.\(^{155}\)

Ungers is calculating. He uses calculation to establish a set of economic equivalences between the automobile, a housing unit, and household income. In making this argument for mass-produced housing, Ungers chose the VW Beetle, one of the most visible symbols of West Germany’s postwar economic recovery. Yet, in 1966-67, West Germany experienced its first postwar recession, which marked the beginning of the end of the “Economic Miracle,” suggesting that Ungers’s project was less a reflection of real conditions than it was an idealized representation of productivity.

After 1966, serial production, together with a quantitative approach to architecture and urban design, became the central concern in competitions, studios, and publications by Ungers and his students at the TU Berlin. These included a study of Joseph Paxton’s Crystal Palace (\textit{Paxton: Kristallpalast}, 1967), a proposal for the Ruhwald area of Berlin (published fully in \textit{Gutachten Ruhwald}, 1967), and a series on the “industrialization of construction” (\textit{Wohnungssysteme in Stahl}, 1968; \textit{Wohnungssysteme in Großtafeln}, 1968;
Fig. 3.53
Fig. 3.54
VzA 9: Gutachten Ruhwald (1967). Montage of prefabricated elements; model; Cyklogram; plan for on-site factory and cost spreadsheet.
and *Wohnungssysteme in Raumzellen*, 1969). The focus visibly shifted towards a highly rational approach using the assemblage of repetitive elements across multiple scales [Fig. 3.53].

The 1967 proposal for the Ruhwald competition (Ruhwald is an area in Berlin-Charlottenburg) was organized as a layered composition of linear elements recalling both a *Siedlung* from the 1920s and the sort of megastructural projects that were in vogue in the 1960s [Fig. 3.54]. Long spines, from which housing slabs protrude like ribs, were interspersed by stretches of roads and green areas indicated by a gridded pattern of circles representing trees. The project encompassed housing for youths and seniors, with supportive programs including schools and light industrial areas. In this project, everything is determined and described in a rational, scientific manner, from the infrastructural connections, to the use of shading diagrams, to the choice of pattern grids, to the plan showing the location of the construction crane tracks. Several pages of the publication were devoted only to technical data, such as a page of graphs displaying a range of planning and parking variables that suggest all possibilities had been exhausted before choosing an optimum condition [Fig. 3.55]. Here the coded language of the specialists, which Unger had warned against just a few years earlier, was being appropriated by the architect.

---

Fig. 3.55

One of the most impressive spreads shows what they call a “Cyklogram” charting the construction process of housing units that were to be completed block-by-block, as mapped against time. The graph shows a reassuringly stable and steep incline. On the opposing page we are shown a plan of the on-site factory that will store and prepare the parts, and just below, a detailed estimate of the total costs of production. The complexity of this “evidence” stands in contrast to the abstract simplicity of the architecture itself. The design is driven by the plan, which is shown multiple times, each with different layers of information about the site or use. Only one elevation view is included, which consists of a grid composed of prefabricated panels that conform to the units inside. An isometric drawing shows a closely cropped detail of one of the blocks, in which the eleven different types of panels used in the construction are individually identified, and are even shown in the process of being assembled by crane.\footnote{Ungers had used a similar method of representation in his drawings for the Märkisches Viertel (1962–1967), though these drawings were likely to have been made once Ungers was at the TU Berlin.}

The drawing style also dramatically changes in these projects. Technical-looking isometric and axonometric drawings begin to appear in Ungers’s work, which can be attributed to his interest in the historical avant-garde (and especially at this time, Russian constructivism), but also to a resurgence of this method among architects in the late 1960s.\footnote{Yve-Alain Bois, “Metamorphosen der Axonometrie” / “Metamorphosis of Axonometry,” in Daidalos 1 (September 1981): 40–58.} The use of this type of drawing suggests several things. It introduces an objective quality (a certain technical validity), while removing both the trace of the human hand and the constructed perspective of the human eye. It is, in other words, a more rational form of drawing. At the same time, the axonometric drawing was...
disorienting: it was a tool of the avant-gardes not only for its accuracy but also, as Yve-Alain Bois argues, for its “perceptive ambiguity” and “polymorphous,” “abstract” qualities.  

Ruhwald was a decisive step away from the play with large urban forms of the Grünzug Süd project in Cologne, and the rhythmic arrangement of volumes in the Märkisches Viertel. It was a fully abstract project, in the sense that it was based on formal and technical systems, but also because it was abstracted from the urban context. Ungers reflected on the pedagogical urban planning projects of this period in a 1982 interview:

Many things were hypertrophied; every idea hypertrophies when it is thought through to its end . . . it can be understood as a purely hypothetical exercise, a purely conceptual process, a speculative matter. . . . One could not have practically done something like that. I see the danger of these things very clearly, but I said that it has to be possible to expand an idea to the point of absurdity, in order to implement it from that point to gain new perceptions.

It would not be accurate to call these proposals utopian, but one could say that they are evidence of a deliberate suspension of reality, a way of fantasizing with technology.

The same isometric drawing of the Ruhwald “kit-of-parts” would be featured on the cover of a 1967 issue of Bau that was guest-edited by Ungers [Fig. 3.56].

---

159 Ibid., 56–57. English in original.
161 Bau 22, no. 6 (1967). The editorial board consisted of Hans Hollein, Oswald Oberhuber, and Gustav Peichl. In the subsequent issue, where the theme was “Alles ist Architektur,” the editorial note mentions that several readers had complained that the Unger’s issue was “too dry” and did not contain enough illustrations. See Bau 23, nos. 1/2 (1968).
Fig. 3.56
*Bau*, 22, No. 6 (1967).
focused exclusively on Ungers’s Berlin projects, and can be seen as evidence of international interest – in this case, that of “radical” Austrian architects – in Ungers’s work. Here Ungers begins by repeating earlier concerns with the question of the “mass”:

The constant growth of the population and the concentration in urban areas leads to the problem of finding the best possible housing for a mass of people. . . . A generally neutral building structure corresponds to the needs of residents for anonymity, and leaves open the possibility for self-activation. Neutrality is value-free and makes room for chance development and temporary changeability.¹⁶²

These calls for anonymity and neutrality are a decisive turn away from Ungers’s earlier polemic on the freedom of the architect as an artist. His association between neutrality as a concept in design and the idea of it as “value-free” also resembles the rhetoric about rational design established at Ulm.

This issue of Bau also published Ungers’s pessimistic farewell address to the 1967 graduating class of architects at the TU Berlin, which provides further insight into his changed perspective in relationship to the role of the architect as author.¹⁶³ Ungers’s speech came shortly after the June 2 shooting of Benno Ohnesorg, in what was already a charged political atmosphere. This text is relevant both for its controversial assertion of the limited agency of the architect as author, and for its suggestions about mass society and mass production:


¹⁶³ Oswald Mathias Ungers, “Verabschiedung der Diplomanten 1967,” Bau 22, no. 6 (1967): 144–145. Cepl also points to the criticism of the Märkisches Viertel as a personal blow to Ungers that might explain the pessimism of this talk.
Where will it lead if the architect only wants to see himself realized in a house, in a neighborhood, or in a city? . . . In recent years especially, there has been an outbreak of a cult of personality among architects, which has led to the most grotesque stylistic blunders. . . . The architect once described as the only true designer, blessed with the property of talent, no longer exists.\(^{164}\)

He continues by arguing that a different Leitbild (example) is needed for a society that is a mass society, and one that has mass problems. He goes on to call for an emphasis on “praxis” and “the problems of real needs.”\(^{165}\) At the same time, Ungers warns the students of the impotence of the architect in the face of developers:

You will only find construction companies who dictate their wishes and demands . . . as they are fundamentally hostile to architects. You will also no longer win competitions, because the process increasingly goes awry, and if you are lucky enough to win. . . then you will have to build the way the authorities demand, because an Apparat is sitting there who knows better and wants to be occupied. You will want to design and build houses; industry will do it faster and cheaper.\(^{166}\)

Ungers, it seems, is trying to define a rational architecture that is strongly opposed to the arbitrary will of the individual architect, yet is also resistant to the machinery of bureaucratic rationalization. By turning to mass production and a statistical approach to building, he seems to want to create his own “machine” in opposition to the domination of the construction industry.


\(^{165}\) Ibid., 145.

\(^{166}\) “Sie finden nur noch Baugesellschaften, die Ihnen ihre Wünsche und Forderungen diktieren . . . denn sie sind im Grunde architektenfeindlich. Sie werden auch keine Wettbewerbe mehr gewinnen, denn das Verfahren stellt sich immer mehr als ein Irrweg heraus, und wenn Sie das Glück haben, zu gewinnen . . . dann werden Sie so bauen, wie die Behörde es verlangt, denn dort sitzt ein Apparat, der weiß es besser und will beschäftigt sein. Sie werden Häuser entwerfen und bauen wollen; die Industrie macht es schneller und billiger.” Ibid., 145.
This experiment is fully carried out in the three publications in the
Wohnungssysteme (Housing Systems) series, which were based on seminars taught by
Ungers at the TU Berlin between 1967 and 1969. The seminars were taught under the
guidance of Ungers, who was at Cornell for a year at the time, and were carried out by
his teaching assistants Joachim Schlandt and Jürgen Sawade.\textsuperscript{167} The cover of
Wohnungssysteme in Stahl shows an abstracted image taken from the steel
construction of Otto Haesler’s Rothenberg-Siedlung in Kassel (1929–1931), an early
example of rationalizing building methods for affordable housing (see Fig. 3.53).\textsuperscript{168} In
the preface, Sawade echoes Ungers’s focus on mass housing; he also makes clear that
the focus on standardization was not an argument for uniformity but a call for individual
adaptation. Using pseudo-sociological terms like unverändbare Abhängigkeitszwänge
(inflexible dependency compulsions) and Identitätsstrukturen (identity structures),
Sawade argues:

A neutral building structure leaves the inhabitant the necessary space for self-
affirmation (identification). It is largely unburdened by anticipatory decisions and
enables chance developments and temporary changes. Instead of a maximum
definition of what is built, there should be a minimal determination, which allows for
a maximum of personal decisions for the individual inhabitant.\textsuperscript{169}

He continues:

\textsuperscript{167} A total of forty-nine students participated in the three seminars.
\textsuperscript{168} There was considerable interest in the history of mass housing. Joachim Schlandt also authored a VzA
book on the Superblocks in Vienna. Die Wiener Superblocks, Veröffentlichungen zur Architektur 23,
\textsuperscript{169} “Dagegen läßt eine neutrale Baustruktur dem Bewohner den notwendigen Raum zur Selbstbestätigung
(Identifikation). Sie ist weitgehend unbelastet von antizipatorischen Entscheidungen und ermöglicht
zufällige Entwicklungen und temporäre Veränderungen. Statt einer maximalen Definition des Gebäutes
sollte eine minimale Festlegung erfolgen, die dem einzelnen Bewohner ein Maximum an persönlicher
Entscheidung zugesteht.” Jürgen Sawade, preface to Wohnungssysteme in Stahl, 6.
The sociological changes in society, the family, and the individual demand the development and production of adaptable housing systems. Industrialized (unitized) outfitting systems in primary structures enable the user to have a maximum of personal development. The identification with the objectified, serially produced apartment is possible through subjectively changeable outfitting systems.\textsuperscript{170}

Though shrouded in sociological jargon, Sawade is repeating a theme that was common in the 1960s – the difficulty of achieving individual expression and variation within the repetition created by mass production. Sawade addresses this problem by proposing a fixed “primary” structure and variable “secondary” elements. His use of scientific language lends an air of validity to these claims.

The three volumes offer an astonishing amount of technical information about the building systems under study, from material and structural data, to building codes for housing (including details about proper kitchen arrangement and shower fixtures), elevator volume requirements, technical diagrams of elevators, beam and slab force diagrams, information on construction cranes and their range of motion and loading capacity, and the chemical analysis of steel, concrete, and plastic [Figs. 3.57, 3.58, 3.59]. This level of technical information is a display of fluency in the aforementioned “coded” language of the technocrats. The only thing missing is evidence of the \textit{economy} of mass production – there are, in fact, almost no arguments explaining \textit{why} housing built in this serial manner is more beneficial. The argument for mass production in this series was not tied to real functional or economic concerns. Considering Ungers’s formal interest in the question of repetition and variation, one begins to suspect that these experiments

Fig. 3.57
Fig. 3.58
Für die Auslegerlängen von 120 bzw. 50 und 40% sind spez. Auslegerspitzen erforderlich.
are formal and aesthetic exercises as much as they are an expression of the technological zeitgeist.

Ungers’s past and future concern with repetition can be seen in the student drawings and diagrams that fill these three volumes. Each volume takes a systematic approach to form, in which all possible combinations are considered and exhausted. Typological charts show apartment types (Simplex, Semi-Duplex, Semi-Triplex, Semi-Tetraplex, Duplex), possible combinations of prefabricated housing units, or potential beam configurations [Fig. 3.60]. The same serial process of variation across repeated elements is used in the representation of the projects. It is clear that the students were given very specific constraints in both the requirements of the projects and how they were drawn. In Wohnungssysteme in Großtafeln, for example, each project shows a linear building of the same dimensions, drawn in an axonometric view that is open on one end so as to illustrate the construction system, and cropped on the other, suggesting that the building could be endlessly reproduced [Fig. 3.61]. 171 This same building is reproduced again and again by different students, each time with variation in the façade, the design of the panels, or the placement of elevator cores. The facing page shows statistical data about the outcome of every iteration, so that the systems can be compared both visually and quantitatively [Fig. 3.62]. The students are thus enacting the very concept of repetition that is at the core of the project by working with a “primary” formal and representational structure, and introducing their own “subjective,” “expressive,” or “spontaneous” variations.

171 The same strategy is used in Wohnungssysteme in Stahl, and a less rigorous version organizes Wohnungssysteme in Raumzellen.
Fig. 3.60

Constrution diagram. Spatial cell typologies.
Fig. 3.61
Student projects.
Repetition is emphasized at various scales, from the recurrence of the same image, to the carefully drawn and highly detailed renderings of the modular façades, to the reproduction of the books themselves (these were not “original” drawings made for display, but images made to be easily reproduced). The production of “catalogue-like knowledge” about building systems was designed to be cumulative, and applied not only to housing but to entire cities.\textsuperscript{172}

What was the purpose of this level of redundancy and repetition? Schlandt describes the “countless combination forms of the different spatial units” as having successfully produced “divergent values” within the system. However, he also writes that “because of the complexity of such systems, it has up to now not been possible to develop an algorithm for the synthetic development of larger units.”\textsuperscript{173} By evoking the algorithm, Schlandt suggests that the question of calculability is at stake. All of the repetition needed to produce complexity could eventually be processed with the help of an algorithm. The hope is that repetition will produce a level of complexity that allows for the reintroduction of difference.

Repetition as a formal and systematic device was also used as the basis for typological studies, as in the 1969 VzA book \textit{Berliner Brandwände} [Fig. 3.62].\textsuperscript{174} This was the last of the publications made by Ungers’ students at the TU Berlin, and is evidence of a shift away from the rationality of repetition as a purely industrial manufacturing process of making copies, to repetition as found in the environment, through visual

\footnotesize
\textsuperscript{172} \textit{Wohnungssysteme in Gro\ss\tafeln}, 1.
\textsuperscript{173} Ibid., 2.
\textsuperscript{174} \textit{Berliner Brandwände}, Veröffentlichungen zur Architektur 27. Lehrstuhl für Entwerfen VI (Berlin: TU Berlin, 1969). The authors were Artur Laskus, Ulrike Pampe, and Jürgen Sawade.
Berliner Brandwände

Fig. 3.62
Fig. 3.63
resemblance. This in some ways also signified a return to Unger’s early interest in
patterns that repeat over historical periods. A series of thirty-seven photographs show
the textured façades of Berlin’s firewalls, presumably left exposed by bombing during
the war [Fig. 3.63]. The book was the result of a collaboration between Ulrike Pampe,
Jürgen Sawade, and the artist Artur Laskus. The serial use of architectural photography
shows a strong resemblance to contemporaneous projects like Ed Ruscha’s books of
photographs of Los Angeles, Bernd and Hilla Becher’s photographs of industrial
architecture, and conceptual pieces like Hans Haacke’s 1971 *Shapolsky et al. Manhattan
Real Estate Holdings, A Real Time Social System, as of May 1, 1971* [Fig. 3.64]. According
to Jörg Pampe, the Bechers had visited Unger’s seminars at the TU Berlin.\footnote{Ulrike Pampe, interview with the author in Berlin, February 13, 2013, and subsequent emails. According to Pampe, Unger was a friend of the Bechers, but the book was made when Unger was already at Cornell and thus Pampe doubts the influence of the Bechers. Email to author, November 13, 2013.} The photos
appear at the bottom of the page, while at the top the building in question is shown to
scale in a section of West Berlin’s city plan (most of the photos were taken in the
neighborhood of Charlottenburg). Like the Bechers, the authors of the book
photographed the buildings in a flat, “objective” manner, using a Linhof camera.\footnote{Pampe, email.} The
rough façades of the brick walls appear flattened, and upon closer inspection, one sees
that the background of the photos had been removed, creating a uniform, white sky
against which the forms of the buildings stand out with greater contrast.

The images were printed and reproduced in a high-contrast manner that emphasizes
the unfinished texture of the brick walls. Pampe remembers that this was an attempt to

\[175\] Ulrike Pampe, interview with the author in Berlin, February 13, 2013, and subsequent emails. According to Pampe, Unger was a friend of the Bechers, but the book was made when Unger was already at Cornell and thus Pampe doubts the influence of the Bechers. Email to author, November 13, 2013.
\[176\] Pampe, email.
Fig. 3.64
draw attention to the “haptic” quality of the façades.\textsuperscript{177} This emphasis is especially visible on the front and back covers of the book, which show an abstract graphic pattern resembling a degraded Xerox that has been derived from one of the photographs. The image emphasizes the material nature of the processes of mechanical reproduction that created both the photographs and the book.

The decision to document the utilitarian surface of the firewall as opposed to the façades of the nineteenth-century buildings was a deliberate statement. The firewall, an architectural element that is usually invisible to the city, becomes a new type of façade – one defined by its monolithic appearance and blankness.\textsuperscript{178} While the firewall was a functional “system” in the original building, in its behavior as a façade it is silent about any functions on the interior. The use of repetition in the book emphasizes the sense that this is a continuous façade that moves through the city. In that sense it is difficult not to associate it with the Berlin Wall itself – as a boundary that cuts through the city.\textsuperscript{179}

The project is not only about documenting an urban artifact that was produced through an act of erasure; it is also a study of nineteenth-century housing forms. Following the series of photographs is a short examination of the origin of the firewall as a tool of real estate speculation, and the differing housing typologies that resulted from the parceling of land. The firewall is thus revealed to be a technology that was part of a

\textsuperscript{177} Pampe, interview with author.
\textsuperscript{178} Some of the façades show traces of buildings that were once there.
\textsuperscript{179} The documentation of these walls acts as a device that reveals the systematic nature of Berlin’s destruction, and its transformation into a city of walls and boundaries. It also brings to mind Gordon Matta-Clark’s architectural cutting projects, which began in 1972-73. Matta-Clark did a performance piece at the Berlin Wall in 1976 (\textit{The Wall}, 1976).
larger system that organized the city and determined housing forms. This focus on urban systems puts the book in line with the other studies in the publication series that focus on the question of mass housing. As the twenty-seventh and last book in the Veröffentlichungen zur Architektur series, and in contrast to *Berlin 1995, Berliner Brandwände* has a somber feel to it. In its “silent” documentation of the found urban object, and the void that created it, the book seems to be looking ahead to the preservation movement of the 1970s, and the end of a blind faith in mass housing.

**Incorporation**

As Ungers’s interest in the possibilities of mass production waned during the course of the 1970s, another form of repetition became more prominent in his work. His focus was no longer on the mass-produced object but on the question of architectural morphology – how change takes place across variations on the same form or type. Tension between the repetition and variation of the same can be seen in Ungers’s work as early as the 1963 *Berufungsvortrag*. A more advanced concept of morphological change was developed for a 1964 competition for student housing in Enschede (the Netherlands). Ungers, along with his assistants Jürgen Sawade and Jonas Geist, established a system of variations on the circle, the square, and the triangle – which he would later call “an incomplete morphological code.”

![Image](image-url)

180 Oswald Mathias Ungers, *Architettura come tema/Architecture as Theme* (Miland: Electa/New York: Rizzoli, 1982), 22. English from original. According to Cepl, Ungers later claimed that these exercises were inspired by Durand, but Sawade and Geist both deny this. Cepl has suggested that a more likely influence was Johannes Itten’s Vorkurs at the Bauhaus, and Amédée Ozenfant’s *Leben und Gestaltung* (1931). See Cepl, *Oswald Mathias Ungers*, 163–64.
Fid. 3.65
O. M. Ungers, study drawing for the TH Twente, Entscheide competition for student housing, 1964.
permutations of these forms as they are manipulated and combined into new entities [Fig. 3.65]. Ungers described this “encyclopedia for forms of space and solids” as being impossible to complete because “the variety got beyond control.” Here Ungers indicates that there is a threshold where variation no longer is desirable, where the seeming inexhaustibility of a system produces new forms of exhaustion and disorder.

Even as Ungers became increasingly critical of architectural mass production in the 1970s and ’80s, seriality and repetition remained central themes in his work. As Ungers distanced himself from the technocratic visions of mass-produced housing, his earlier interest in morphological variation returned to his practice. In the mid-1970s Ungers co-authored a series of related studies in which encyclopedic collections, whether of archetypes or of variations on a single urban or architectural form, played a prominent role. These studies were designed around systems in which variation and difference are produced, yet are still contained in a rational structure. One example of such a system is Ungers’s concept of incorporation, or the principle of the “doll-in-the-doll.” The idea of incorporation – of an object nested inside another one, ad infinitum –

181 Ungers, Architettura come tema/Architecture as Theme, 23.
182 In a 1985 article, Ungers attacked “fantasy-less technocrats” who perpetuated mediocrity through rules and regulations based on figures and charts. He specifically attacked prefabricated construction when he says that “since the invention of the method of Plattenbau, one can no longer speak of building, only assembling.” Oswald Mathias Ungers, “Steinarchitektur,” Baumeister 82, no. 11 (November 1985): 17–20; 18. Mass-produced pieces were used in Ungers’s buildings but were not aestheticized as such: “When . . . one speaks of the problem of multiplication, and specifically the fabrication of industrially made parts for building, then it is surely not the case that one would dismiss them in principle, but it is a question of how one can achieve an aestheticization with these elements.” Ungers makes this comment in a discussion following his essay “Das Recht der Architektur auf eine Autonome Sprache,” in Heinrich Klotz, ed., Kunst und Gesellschaft. Grenzen der Kunst, (Frankfurt a. M.: Umwelt und Medizin Verlagsgesellschaft, 1981), 94.
183 Examples include O. M. Ungers et al., The Urban Block and Gotham City: Metaphors and Metamorphosis (Ithaca, NY: Cornell University, College of Architecture, 1978); O. M. Ungers et al., The Urban Villa: A Multi Family Dwelling Type (Cologne: Studioverlag für Architektur L. Ungers, 1977); and O. M. Ungers et al., The Urban Garden: Student Projects for the Südliche Friedrichstadt Berlin (Cologne: Studioverlag für Architektur L. Ungers, 1979).
was closely related to Unger’s interest in morphological transformation, or the linear sequence of changes to a form. Incorporation, in the way it is used by Unger, similarly suggests a series of transformations, but the spatial device of the row or grid is replaced by the use of nesting.

The idea of incorporation, specifically the idea of the mise en abyme, was a familiar theme of postmodernism. Lucien Dällenbach wrote in Le récit spéculaire: essai sur la mise en abyme (1977) that the term “mise en abyme” had recently “insinuated itself into everyday vocabulary.” Dällenbach traces the origin of the concept to an 1893 passage by André Gide in which he compares his own writing to the image of a heraldic shield “containing, in its centre, a miniature replica of itself,” and uses it to refer to “an aspect enclosed within a work that shows a similarity with the work that contains it.”

Unger began using the terms “house in the house,” “city in the city,” and “doll-in-the-doll” with increasing frequency in the late 1970s, and designed several projects according to this principle, especially the Hotel Berlin (1977), “The City in the City—Berlin: A Green Archipelago” (1977), Solarhaus in Landstuhl (1979), and the Deutsches Architektur Museum (1979–1984). In 1981, Unger published a treatment of this concept, explaining:

Its fascination lies in the observation that it contains an element of continuity whose end cannot be conceived. An object that continues to turn up inside another object

---

185 Ibid., 8.
Fig. 3.66
describes a sequence which could theoretically carry on indefinitely, a continual process that is no longer intelligible in logical terms.186

Already it is clear that, for Ungers, this “unintelligible” and “illogical” sequence differs from the rational repetition associated with mass production, even if one could question just how rational his earlier projects really were. To illustrate this “surreal” association, Ungers turns to René Magritte, illustrating his text with a reproduction of Magritte’s 1927 painting L’Importance des Merveilles [Fig. 3.66]. The painting not only shows the Russian doll effect, it also emphasizes the very corporeal aspect of incorporation by showing a grotesque and partially severed figure that no longer conforms to human proportion or function. In the same essay, Ungers includes other illustrations of the concept: a mise en abyme depicted in a picture of a boy holding a mirror, and the plan for the town of Victoria by J. S. Buckingham. These are described as “a frame within a frame” and a “block within a block.” This repetition is more literal, suggesting the infinite copy of the same at ever-smaller scales. Another image, Dürer’s “Ideal project for a fortified city,” shows a redundancy of enclosure that suggests a defensive attitude.

In this model of incorporation, there is no clear origin for the repetition. Repetition from the edge to the center can also, as Ungers argues, be inversed, suggesting infinite expansion and growth (“From a theoretical viewpoint the city could go on growing indefinitely, so that the concept of the doll within the doll can be seen in this case too, but turned on its head”187). Ungers points to a series of superimposed plans of the

---

187 Ibid., 15.
Fig. 3.67
Severinskirche in Cologne, which expanded over centuries, as evidence of repetition as a process of potentially infinite growth. At the same time, this model describes something different from the “structuralist” approach of Unger’s early model, in which the same forms appear throughout history. Here repetition is not the return to the same, but is a process of transformation and change that takes place through history. Unger is clearly looking to repetition precisely for its ability to produce difference, in “a process that, thanks to its numerous possibilities, stimulates fantasy and expands the world of representation.”

This concept is very literally illustrated in the project for the Hotel Berlin, which Unger designed for a competition in the same year (1977) as the The City in the City—Berlin: A Green Archipelago. Unger described the Hotel Berlin as a “House as City,” arguing that it contained “all of the elements of a city.” The hotel indeed has the appearance of a medieval city (like that of Dürer), and Unger encourages this comparison through illustrations [Fig. 3.67]. He also compares it to Schinkel’s Altes Museum (1823–1830), pointing to the Pantheon-like room in the middle of this building as an appropriated archetypal form nested within another space. Located on Berlin’s Lützowplatz, the hotel is surrounded by a nine-story perimeter “city wall,” made of stone, with an arcade at the bottom. This wall makes it clear that this is a concept of the city separate from the actual city – it is, in other words, a replica in miniature. Rendered

188 Ibid.
Entwürfe für eine klimagerechte und energiesparende Architektur

in the highly detailed and claustrophobic axonometric style of the work by Ungers’s students in the 1960s, the drawing shows a series of spaces nested in one another – the rectangular city wall made of stone, four towers which are to be covered in aluminum, a circular rotunda clad in majolica tile, and at the center, a small glass house with a peaked roof. The variety in materials and typological forms was a deliberate attempt to underscore the concept of difference and variation across these nested spaces, which are unified by the ubiquity of gridded surfaces. In spite of their differences, the overall effect is nevertheless that of a mise en abyme, in which one world contains another ad infinitum, all the way to the core, where the small archetypal house stands.

A similar concept was applied in a very different way in the 1979 “Solarhaus” competition entry [Fig. 3.68].¹⁹¹ This unusual project is Ungers’s only “environmental” design, and one of the few in which he shows interest in mechanical and ecological concerns. This project echoes the themes of energy conservation and consumption that concerned Otto, and there are many parallels with Otto’s design for his own home in Warmbronn.¹⁹² Ungers similarly writes of a “thermal buffer zone” that creates a micro-climate in the house and the use of a series of enclosures to passively heat and cool the interior. These glass-enclosed systems are described as improving the “value of living and experience” as well as the Energiebilanz (energy account balance). In the competition proposal, there are three different typologies: a dense matrix of inhabitable greenhouses, freestanding houses, and a linear settlement built around masonry arches.

¹⁹¹ O. M. Ungers, Entwürfe für eine klimagerechte und energiesparende Architektur (Köln: Studioverlag für Architektur L. Ungers, 1980), unpaginated.
¹⁹² Ungers even shows an image of Otto’s house in the competition booklet.
Ungers likens the greenhouses to the Crystal Palace, but also to the corporate postmodern architecture of Philip Johnson and John Burgee’s 1975 Pennzoil Place in Houston. The alternating rows of stone houses, glass houses, greenhouses, and “light” houses (the term used to describe undefined open spaces for public use) are drawn in a dense cut-away axonometric, suggesting a linear, rational process of production and assembly. In the variations on the detached house, the theme of incorporation is made clear as volumes made of different materials (stone, glass, wood, greenery) contain one another.

The drawings of the houses in various seasonal states are highly technical (with details of various mechanical systems), but they also depict a wildness of natural growth, which is similarly rendered with extreme precision. The rationally ordered system of the structure seems to contrast with this uninhibited nature, yet this is, in truth, part of the climatic system. Natural growth is thus already part of an artificial system of industrial reproduction (this is also suggested by the rows of perfectly spherical bushes).¹⁹³

Even if Ungers (characteristically) avoids idealizing the natural, he does propose an idealized narrative of architectural origins. He writes of the use of “spatial wrapping” in architecture over the centuries: “one of the earliest examples is provided by the ancient temple, roughly speaking the most elaborate form of the archaic hut. In the innermost

¹⁹³ Ungers describes the “natural life” depicted in these drawings as a “satyric scene,” a reference to Sebastiano Serlio’s prescriptive writing on the reproduction of natural landscapes as stage sets for theater. Ungers, “The Doll within the Doll,” 17.
nucleus of the temple are to be found the cell and sanctuary.”

Ungers emphasizes this comparison with ancient architecture with an illustration showing a schematic representation of a Roman house.

With the introduction of this historical idea, incorporation is treated as an eternal, archetypal concept in architecture; it also becomes a way of modeling historical change over time, a temporal progression in the movement across “layers.” Ungers often points to the inspiration for this idea in Schinkel’s design for Schloss Glinelieke (1826), where a path through the landscape takes the visitor over a series of bridges that allegorically replicate architectural history, moving from a primitive wood bridge over a rustic brook, to a masonry structure, to a modern cast iron bridge over an engineered canal. These bridges are accompanied by a series of tectonic “remnants” – tree stumps, broken columns, and fragments of building façades. Ungers spoke of this project, and its influence on his work, as the variation of a particular theme or typology through space and time, as opposed to optimization in the name of progress.

This example demonstrates the dominance of the synchronous over the diachronous; historical styles are presented as a non-linear “variation.”

Ungers’s Deutsches Architekturmuseum in Frankfurt [Fig. 3.69] suggests a similar non-linear progression through architectural history. Topologically, the museum can be read as a constant upheaval of relationships between interior and exterior. Moving through the space, one is always in the paradoxical position of being both inside and

---

194 Ibid., 15.
196 Ibid., 286–287.
Fig. 3.69
Fig. 3.70
outside, of having to negotiate multiple levels of containment. Preliminary sketches show an iconic house-form nested like a seed within the hollowed-out space of the villa; the villa is embedded in a solid, gridded volume of glass [Fig. 3.70]. In the built version, the villa is surrounded by a rusticated stone “city wall” closed on all sides except for the front, where it forms a loggia. This wall turns the museum and its gardens into a sort of city-in-the-city. The space between the stone wall and the villa is spanned by a gridded glass roof structure forming a series of arcade-like canopies.

Ungers’s museum sets up a procession through shells representing various architectural styles and histories. The passage is also one through a series of materials (masonry, concrete, glass) and porosities. These are successive stages in a continuous and seemingly infinite interiorization. The turn-of-the-century villa with its Doric columns has a neoclassical façade, but Ungers partially obscures it with the masonry wall that separates it from the city. This treatment of the façade is a deliberate desecration of the modernist ideal of transparency, both materially and functionally. With each layer, façade and content are separated, severing the connection between form and function.

After a visitor passes through these walls, an interior space opens up in which an entirely separate “house” has been pulled up through the center of the building, standing on four supports like a baldachin. Only the supports and walls of the “house” are visible at each floor, so it is not until one reaches the top of the museum that one

---

197 Symbolically, the baldachin forms a canopy over highly sacred or powerful objects – examples are St. Peter’s tomb in Rome or a throne at a court. Yet, without an object or body as a symbolic center of power, the house within the house essentially contains a void.
sees the iconic house intact, complete with pitched roof and windows. Its scale is that of the simplest traditional rural home; the house looks like one that a child would draw—the *Hexenhaus* of German fairy tales. In this building, Otto’s layered architecture of buffer zones comes to mind again, except that the core here is not an idealized natural paradise, but a regression to a cultural image of the home reminiscent of the *Heimatschutzstil* of Heinrich Tessenow and other architects at the beginning of the twentieth century. Where previous efforts at reducing architecture to core elements had focused on the formal properties of buildings in a rational manner, in the Deutsches Architekturmuseum the archetype is a symbolic one. During this period, Unger made references to Jungian archetypes several times, so his ideas about psychological and cultural mythology would have informed his work at this time.¹⁹⁸

The little house is rendered using the pure white walls of modern architecture, yet its functionless pitched roof and staged naïveté are an affront to modernism. It is a resurrection of the deepest and most primal image of architecture—not “primitive” in the sense of Laugier’s hut, which was based on its proximity to nature, but primal in terms of its iconic and symbolic force. It is the built form of the simplest *mental* image of a house. The house in the house—the museum’s core concept—was no doubt influenced by the postmodernist appropriation of generic signs, and the importation of “low” language into high architecture. But its historic and cultural references can’t be overlooked either.

Incorporation, like Dürer’s image of a medieval city surrounded by walls, was also a defensive architecture and thus a provocation of postwar West German architectural ideals of openness and transparency. A political and historical interpretation of the symbol of the house and the idea of this defensive incorporation can be read in Oskar Negt and Alexander Kluge’s 1981 Geschichte und Eigensinn (History and Obstinacy). Negt and Kluge revisit the methodology of Dialectic of Enlightenment, using mythology to illustrate both foundational myths and revolutionary potentials in modern West German society. In this context, the image of the house appears several times. In the opening spread for Part II of Geschichte und Eigensinn (“Deutschland Als Produktionsöffentlichkeit”) two photographs are shown with the caption “Bau des Hauses, 1950” [Fig. 3.71]. One image shows two elderly farmers looking out at a small village of newly constructed homes with traditional pitched roofs. The other shows a rural couple laying bricks for a new house. The metaphor of the house was used by Negt and Kluge to describe German culture under fascism, collectively housed “as if under one roof.” Here and elsewhere, Negt and Kluge portray postwar physical and moral reconstruction as having been built upon the same foundations that existed before the war, “the plagiarism of the old made out of new buildings.” The synthesis and reintegration of the old and the new, they argue, was a missed chance for historical and dialectical upheaval.

200 Ibid., 634.
201 “Das Plagiat des alten aus Neubauten.” Ibid, 635.
202 Ibid., 710.
Fig. 3.71
But the house is also a basic image of enclosure, representing the limits of the self. Negt and Kluge draw upon Norbert Elias’s notion of *homo clausus*, according to which the human body is a metaphorical house that is used to negotiate what is allowed in and what is not – a threshold of experience and knowledge, but also of defense. Negt and Kluge argue that this image of security has remained at the core of social relationships and historical processes. The sedentary house becomes a specifically Continental (even German) problematic of enlightenment that they view as more relevant than the mobile Odyssean model of the ship. Its central question is one of judgment – what to let in and what to keep out? How to determine who or what may pass from the outside to the inside?

Negt and Kluge use the popular fairy tale *Der Wolf und die Sieben Geißlein* to illustrate this idea. In the tale, a wolf continuously seeks to gain access to a house and to the little lambs inside by disguising himself as their mother. The wolf tries several disguises and tricks, and a series of negotiations take place at the door as the lambs decide whether or not to let the wolf inside. The problem in German cultural mythology, according to Negt and Kluge, is not one of resisting the siren’s song, but of determining friend from enemy.

There is no real way to determine what is a wolf and what is a sheep; thus, the myth of enclosure is also the myth of *Unterscheidungsvermögen*, or the ability to distinguish and discriminate. As Negt and Kluge point out, at the end of the story the little sheep survive not because of an ability to tell friend from foe, but because of a further series of negotiations.

---

203 Ibid., 754.
of enclosures: the smallest sheep hides in the body of a grandfather clock in the house (a sort of house within the house), and is able to tell the mother to rescue the other sheep from the wolf’s belly. The mother takes out the sheep while the wolf is sleeping and fills his belly with stones. Not only are the sheep somehow kept safe in the enclosure of the stomach (they are not fully “digested” and incorporated by the wolf), they are rescued because the wolf is not able to judge what has been let into the inside of his own body. There is no moral to the story or indication that the little sheep have finally learned to differentiate between friend and foe as a result of the experience.²⁰⁴

Viewed in this light, the excess of defensive enclosures in Ungers’s museum encourages the idea of a historical and stylistic regression. While the redundancy of enclosures is a playful criticism of an “enlightened” modern architecture of transparency and openness, it is also a deeply cynical position on the possibility of architecture playing a public or social role through some sort of Vernunft. Negt and Kluge viewed this retreat as the condition of postwar reconstruction. They use the image of the snail to describe the withdrawal from the public sphere as a response to catastrophe. The aerial bombing of cities in Germany, they argue, was the destruction of these protective shells, creating a moment of vulnerability and openness that, however traumatic, also held revolutionary potential.²⁰⁵ However, with the architecture of reconstruction, these

²⁰⁴ Ibid., 760.
²⁰⁵ Ibid., 719–721.
“snail shells” were built up again, this time out of concrete and not brick, upon a new “historical foundation” that cannot be destroyed.\textsuperscript{206}

The archetypal house at the core of the Deutsches Architketurmuseum suggests an idea of origin. Yet, as an approach to history, the mise en abyme is an irrational and even uncanny temporal model.\textsuperscript{207} If the building is a statement on architectural history, then the question of origin is unclear, as another incorporation or miniaturization is always possible. The same could be said of the building’s enclosures, which are potentially always expanding. Ungers describes the museum as “both the possibility and limits of architecture.”\textsuperscript{208}

Lyotard evoked the idea of incorporation in 1979 when he wrote of Mandelbrot’s recently developed theory of fractals – models of infinite self-similarity – as an example of indeterminacy in postmodern science.\textsuperscript{209} The idea that the universe is made up of structures that infinitely repeat themselves across scales suggested an entirely new understanding of the nature of space, and questioned whether it could be mastered or measured. This expanded scale was not unlike Otto’s cosmic model of structures, which similarly approached an irrational limit as the theory tried to account for more and more objects. Here the mise en abyme is evidence of a continuous system across scales; less a

\textsuperscript{206}Ibid., 635. Adorno and Horkheimer had written of the snail as an image of potential intelligence which withdraws into stupidity when it is threatened. Like a snail, the tender intellect encounters danger and recedes into its shell, where like an unused muscle it eventually becomes weak and lazy. Adorno and Horkheimer, \textit{Dialectic of Enlightenment}, 213–214. In \textit{From the Diary of a Snail} (1972), Günter Grass describes not a snail so much as a slug, or a “homeless” and “naked” snail.

\textsuperscript{207}Through its evocation of the homely the little house already suggests the uncanny – the \textit{Unheimlichkeit} of the homely. For a discussion of this idea, see Anthony Vidler, \textit{The Architectural Uncanny: Essays in the Modern Unhomely} (Cambridge, MA: MIT Press, 1992).

\textsuperscript{208}Ungers, \textit{Architettura come tema/Architecture as Theme}, 63.

series of confining spaces than the desire for infinite expansion as a form of freedom or escape.

Ungers does not take this scientific approach, but he does dabble in the cosmic: in his essay “The Janus Face of Architecture,” he compares the plan for the Hotel Berlin with an image of “The Seven Planets according to C. G. Jung: Man and His Symbols.” The expansion into the universal (and the allusion to architecture being able to contain the universe) is evoked, even if it is limited by the rigid and perfect geometry of the solar system that corresponds to Jung’s archetypes.

This scientific-cosmic view is given metaphysical tones when Ungers claims that the Deutsches Architekturmuseum is “a demonstration of spatial infinity.” Ungers spoke of his competition entry for the Wallraf-Richartz Museum (1975) in a similar vein:

When one thus thinks in morphology, that a closed place perhaps leads to a place that begins to dissolve itself, to a place that is now only drawn in edges, and finally to a place that leads into the infinite. ... the stairs lead into an infinite space, which continues into a quasi-nothing. [Fig. 3.72]

---

210 The image was originally taken from Copernicus’s De Revolutionibus. Ungers also includes an image of the seven spheres of the underworld from Dante’s Divine Comedy. O. M. Ungers, “The Janus Face of Architecture,” Architectural Design 56, no. 6 (June 1986): 9–11. This is a translation of “Das Janusgesicht der Architektur,” in O. M. Ungers, Sieben Variationen des Raumes über die Sieben Leuchter der Baukunst von John Ruskin (Stuttgart: Hatje, 1985).

211 Ungers, Architettura come tema/Architecture as Theme, 63. Kenneth Frampton eagerly embraces this idea when he writes that in the Deutsches Architekturmuseum “one is returned to the apotropaic, if not to say the alchemical attributes of the aboriginal house, to the mystical definition of God as ‘a sphere whose center is everywhere and whose circumference is nowhere,’ and to the primeval temple where presence is embodied in the absence apparent at the center.” Kenneth Frampton, preface to O. M. Ungers, Works in Progress: 1976-1980 (New York: IAUS/Rizzoli, 1981), 4.

Fig. 3.72
Ungers is describing his concept of morphology, or change across a series, in terms of spatial opening and closure. But the process is also one of gradual erasure of the architecture, from an enclosed space, to one of only edges, to “quasi-nothingness.” Seen in a less mystical light, this process can be understood as repetition to the point of the exhaustion or annihilation of the architectural object. Yet, rather than staging morphology as a confrontation with the repetitive nature of the commodity, or as a position on rational building, Ungers evades the question of the effects of repetition with metaphysical transcendence.

**Metaphor, morphology, mirroring**

One of Ungers’s most didactic studies of the relationship between repetition and morphology was his contribution to the 1976 Cooper-Hewitt exhibition *Man Transforms*, curated by Hans Hollein. Ungers’s installation, entitled “The City as Metaphor,” featured long rows of square panels that were vertically arranged in triads [Fig. 3.73]. In each grouping, the top panel shows an urban plan, the middle a black-and-white photograph that is visually related to the plan, and the bottom a word, printed in four languages (English, Arabic, Russian, and Chinese), that serves as a metaphorical description of the images [Fig. 3.74].

---


Fig. 3.73
Fig. 3.74
Fig. 3.75
Fig. 3.76
For example, an image of Hilberseimer’s “New City” (1944) is shown juxtaposed with an image of a row of marching soldiers, whose swinging arms resemble the ladder-like streets in the plan.\(^{215}\) The word that completes the triad is “Uniformity” [Fig. 3.75]. A 1670 plan for an ideal city by Georg Rimpler is paired with a curled-up hedgehog surrounded by its quills (“Protection”). A 1928 satellite town by Robert Unwin is paired with a white fluffy cat nursing four kittens (“Dependency”), and an 1809 plan of St. Gallen with an illustration of a fetus in a womb (“Enclosure”) [Fig. 3.76].\(^{216}\) In another example, the same images later used in “The Doll within the Doll” essay – the 1848 plan for the model town of Victoria by J. S. Buckingham, and the boy holding a mirror in which his own image appears endlessly repeated (see Fig. 3.66) – are chosen to describe the word “Reduction”.

According to Ungers, these panels correspond to three “levels of reality”: the urban plan is “the factual reality – the object”; the photographic image is “the perceptual reality – the analogy”; the text is “the conceptual reality – the idea.”\(^{217}\) Ungers is establishing a system that breaks signification into a series of components, not unlike the semiotics described by Ferdinand de Saussure and Charles Sanders Peirce.\(^{218}\) However, the shifts in translation between the plan, photograph, and text are too great for this system to be only about the structure of signification. Furthermore, the

\(^{215}\) In the book Hilberseimer’s city is incorrectly dated as 1930.

\(^{216}\) Interestingly, the image of the maternal womb is used in an entirely different way by Otto, who saw it as an example of the structural principle of the Pneu.


\(^{218}\) Similarly, the tripartite organization of the different forms of signification suggests a conceptual process similar to Joseph Kosuth’s 1965 One and Three Chairs.
experience of the installation was just as much determined by the horizontal relationships across the different groups. While in the book format the photographs and plans read as diptychs, in the exhibition the photographs are hung at eye-height, and are equally spaced, so that they relate as much to one another as they do to the urban plans.

Ungers had hoped to produce an encyclopedia of “urban ideas,” and amassed several boxes filled with index cards on which various urban plans were depicted.\textsuperscript{219} These would supposedly aid in designing new cities from a tabula rasa, while still giving them “identity and recognizability.” In the installation, the urban plans were identified by place, date, and author, while the photographs remained anonymous.\textsuperscript{220} Having abandoned architectural mass production, Ungers now turned to the mass-produced image. These images were also produced for mass consumption, and represent a broad yet shallow spectrum of the layman’s knowledge about the natural and technological worlds.

Ungers built upon a long tradition in architecture of didactic and formal uses of photographs to establish new associations between architecture, nature, and technology. Around half of the photographs in the installation show images taken from nature, including magnified and cropped images of plants or animals that emphasize

---

\textsuperscript{219} Cepl, \textit{Oswald Mathias Ungers}, 334. A collection of plans for urban block typologies had also been assembled for the Cornell 1976 summer session project \textit{The Urban Block and Gotham City: Metaphors and Metamorphosis}. Here the concept of the urban metaphor was combined with a series of urban proposals for Manhattan. In many ways the grid that organizes the plates of the Cooper Hewitt exhibition can also be understood as a reflection of what is described as the “relentless pattern” of the grid of Manhattan.

\textsuperscript{220} The photographs were apparently taken from popular photography books like the Time-Life series \textit{Life Science Library} and \textit{Life Nature Library}, and Andreas Feininger’s \textit{Das Anlitz der Natur} (1957). Cepl, \textit{Oswald Mathias Ungers}, 577. Frei Otto also frequently used images by Feininger, particularly his photographs of spiders.
Fig. 3.77
their abstract patterns, as was typical of *Neue Sachlichkeit*-style photography. This style is part of a longer tradition in postwar modernism in which scientific and found images were used to establish connections between realms and scales of knowledge, and with different aims.²²¹ Around the same number of images depict technological objects, from wagon wheels to satellite dishes and microprocessors. There are also a few whimsical images, like one of a woman in hair curlers (which is compared to a 1928 satellite town by Raymond Unwin), or a glazed donut (which is paired with a 1469 etching of Aachen by Wenzel Hollar) [Fig. 3.77]. These do not serve, as in Otto’s case, as scientific evidence for universal physical structures in nature; Unger uses nature only for its proclivity to generate abstract and similar patterns. The content of the images is never mentioned in any of the texts, and the presentation of both the plans and the photographs is entirely devoid of any historical narrative, whether one of technological progress or of natural evolution.

There are several ways in which this project can be understood. The "structuralist" influence of the exhibition concept can’t be overlooked. As the inaugural exhibition for a national design museum, *MAN transFORMS* took a strong position against “Good Form” exhibitions of the postwar period that put new commodities on display, and instead focused on the artifacts that Hollein and George Nelson (the exhibition and catalogue

---
²²¹ Examples include Team 10’s universal ideas of the human as expressed in images of “organic” structures and pre-modern forms of social organization (for instance, in the 1953 *Parallel of Life and Art* exhibition at the London Institute of Contemporary Art). György Kepes’s 1951 exhibition *The New Landscape* similarly used juxtapositions of images from nature and technology with art and culture to express the new capacity of (technologically enhanced) vision to organize and potentially design space at every scale. For more on the relationship between micro- and macro-scales in architectural history, see Spyros Papapetros, “MICRO/MACRO: Architecture, Cosmology, and the Real World,” *Perspecta* 42 (2010): 108–125.
designer) viewed as related to man's universal basic needs (like loaves of bread or hammers), but also focused on cultural, religious, and mythical practices. As Nelson writes:

The most powerful and passionate intellectual thrust today is a search for unifying concepts, for a metaphysical base that will again provide a meaning for existence in a society that has all but lost it. We are discovering, rather late in the day, that neither science nor technology is capable of doing this.222

This approach meant turning against the “belief that value can only be expressed in numbers” and that engineering could be used to solve problems, in favor of “non-rational, subconscious, primeval, religious elements,” a “return to sources”, and a “series of metaphors.”223

While it was based on these seemingly irrational concepts, this project was one of Ungers’s most ambitious attempts at establishing a rational basis for urban architecture outside of the epistemological framework of technology or science. In the introductory text to the book *Morphologie/City Metaphors*, Ungers writes:

In every human being there is a strong metaphysical desire to create a reality structured through images in which objects become meaningful through vision and which does not, as Max Planck believed, exist because it is measureable. . . . Only in more recent history this process of thinking has been undervalued because of the predominance of quantitative and materialistic criteria.224

Against the dominance of “empirical” thought based on “facts that can be measured and justified,” Ungers argues for what he summarizes as “Gestalt theory,” based “not on reality as it is but the search for an all-around idea, for a general content, a coherent

---

222 George Nelson, introduction to *MAN transFORMS*, 5.
223 Ibid., 7.
thought, or an overall concept that ties everything together.”

The emergence of this concept relies entirely on the faculty of vision. Photographs and text become a way of translating the “factual reality” of the architectural plan to an image and a concept, eluding the specific and technical nature of the plan. Ungers is building an argument against the positivism that had characterized his work, and that of his students, in the late 1960s and early ’70s. He is still using a rational system of ordering, but one based on a different set of criteria for knowledge.

Ungers appears to combines several different strategies in this assemblage of architectural forms. One could read this project as an example of “pseudomorphism” (as identified by Erwin Panofsky), according to which distant phenomena are brought into a conspiracy of meaning based on formal resemblance. Claude Lévi-Strauss, for instance, “abused” this concept in his comparisons of primitive art from disparate parts of the world. But Ungers is not making an art historical argument of influence or cultural kinship between different images and models, even if structuralist ideas were of interest to him. He seems to be arguing instead for a "comprehensive vision" with which to organize the world. To return to Foucault, a system of order can be created just from a “sharp” eye that recognizes resemblances, and a grid that organizes them.

But the eye Ungers used here is similar to that described by Otto’s researchers as “less

---

225 Ibid., 7.
227 Ibid.
228 Cepl argues that Ungers was influenced by Colin Rowe’s interest in Levi-Strauss’s The Savage Mind. Cepl, Oswald Mathias Ungers, 335.
229 Ungers, Morphologie/City Metaphors, 8.
sharp.” It is a mode of finding similitudes in the world, such as those of “convenience, emulation, analogy, and sympathy” that Foucault attributed to the Renaissance, when the things that resembled one another were “infinite in number” and “the universe was folded in upon itself.” Unger’s knowledge of Renaissance treatises, in which cities were frequently compared to the human body, may have played a part here. His use of analogies that from a modern perspective seem sometimes humorous or arbitrary refers to what Foucault classified as the pre-Classical world of semblances. These are objects which could not be compared through measurement.

Uungs explicitly suggests that his method of analogous relationships offers an alternative to “those sciences that claim a monopoly of understanding”:

What all that means – thinking and designing in images, metaphors, models, analogies, symbols and allegories – is nothing more than a transition from a purely pragmatic approach to a more creative mode of thinking. It means a process of thinking in qualitative values rather than quantitative data, a process that is based on synthesis rather than analysis. . . . It is meant to be a transition in the process of thinking from a metrical space to the visionary space of coherent systems, from the concepts of homology to the concepts of morphology. . . . this approach is not meant to act as a substitute for the quantitative sciences which break down forms, as we know them, into functions to make them controllable, but it is meant to counteract the increasing influence of those sciences that claim a monopoly of understanding.

Here Unges establishes a set of oppositions: the pragmatic, quantitative, analytical, metrical, and homologous versus the creative, qualitative, synthetical, visionary, coherent, and morphological. He develops these dichotomies based on a number of influences. One is his belief in the primacy of visual and optic information as opposed to the haptic (this is reinforced by the large image of the eye on the cover of the book).

---

231 Ibid., 19–20.
232 Ibid., 14.
Making reference to the philosopher Hermann Friedmann (1873–1957), Ungers argued that the haptic is “non-productive”: “it measures, is geometrical, and acts in congruity.” Sight, by contrast, is “productive”: “it interpolates, is integral, and acts in similarities.”

This is also an argument against scientific tools; he claims, “if we look at physical phenomena in a morphological sense, like Gestalten in their metamorphosis, we can manage to develop our knowledge without machines or apparatus.”

What can’t be measured also can’t be calculated. But it is not the sublime of the incalculable that Ungers is after so much as an alternative method of comparing and ordering forms. He writes:

The city-images as they are shown in this anthology are not analyzed according to function and other measureable criteria – a method which is usually applied – but they are interpreted on a conceptual level demonstrating ideas, images, metaphors and analogies. The interpretations are conceived in a morphological sense, wide open to subjective speculation and transformation.

When Ungers refers to “images, metaphors, models, analogies, symbols and allegories,” he uses these terms almost interchangeably, as if indiscriminately using all of these modes at once might increase the potential for finding similarities in the dissimilar. While they all suggest relationships of substitution or representation, Ungers gives only a partial account of their different meanings, and never offers a coherent statement on what unites them, other than that they “are part of a morphological concept which is understood as a study of formations and transformations whether of

\[\text{233 Ibid., 7.}\]
\[\text{234 Ibid., 9.}\]
\[\text{235 Ibid., 14.}\]
thought, facts, objects, or conditions as they present themselves to sentient experiences.”

Some of these concepts may have come from Hans Hollein, who initially gave the exhibition the working title “Metaphors and Metamorphoses.” In a statement on the exhibition concept Hollein writes of the visitor “relating the elements of the show to his experiences, memories, and wishes, to situational modes common to man-kind.” Making reference to Lévi-Strauss, he continues: “structures can be employed and deducted and . . . the mythical has a logic of its own. Design understood as an art in that sense, clearly also falls into the mythical category. This accounts for the introduction of metaphors.” In a review of the exhibition in Artforum, Unger’s installation is described as “visual structuralism.” If this is the case, then metaphor is not simply an act of poetic substitution made according to the imagination of the individual, but part of a universal system of the logic of myth. A very different form of repetition is enacted here in the notion of symbols (or, in this case, urban forms) that repeat across different histories and cultures.

The concept of morphology, which also determines the German title for Unger’s project (Morphologie), is especially relevant. Unger claims that this project is rooted in “the philosophical treatises of morphological idealism” produced during the “age of

---

236 Ibid.
237 Cepl, Oswald Mathias Unger, 332.
240 In the MAN transFORMS catalogue, Unger also includes a long quotation on cities from Roland Barthes’s 1970 L’Empire des Signes, which he does not comment on.
humanism.” The term “morphology,” which is attributed to Goethe, describes the comparison of forms in search of an underlying unity in the natural world.

Morphological idealism focuses on forms independent of their function or evolutionary origin. The relationship between forms is established visually, and by analogy, leading to the concept of an archetype (in Goethe’s case, the Urpflanze). While the concept of homology seeks to establish a direct evolutionary lineage between species based on the repetition of a part (a bone, for example) within a larger system, morphology is holistic, and focused on the repetition of forms across the natural world, regardless of origin or function. Morphology seems to have appealed to Ungers because it is free of the scientific associations of development and progress, specialization and optimization.

Ungers returns here to themes introduced in his 1963 Berufungsvortrag – the establishment of formal repetitions across different architectural periods, functions, and styles. Ungers focuses on the overall form, and not the endless variations of forms that can be achieved with the combination of mass-produced parts.

These ideas – a structuralist notion of universality, a morphological concept of ideal forms – suggest a “soft” scientific approach. Against the repetition of capitalist mass production, Ungers proposes a universal formal repetition that crosses the spheres of nature and technology. But there is another aspect to the project, which indicates that

---

242 The influence of Goethe is reinforced in a quotation that serves as the book’s epigraph, taken from one of his letters from Italy: “On the 18th of August in the year 1787 Goethe wrote from Italy to Knebel: ‘After what I have seen of plants and fishes by Naples, in Sicily, I would, were I ten years younger, be possessed to travel to India, not to discover anything new but rather to see the discovered in my own way.” Quoted in Ungers, Morphologie/City Metaphors, 5.
the grouping of drawings, photographs, and texts is more than just a collection of universal urban archetypes. Rather than simply repeating and reinforcing one another, the three forms of representation allow for displacements and shifts in meaning. This idea is suggested by Ungers’s interest in the work of Magritte during this period, and his overt references to Magritte in the *MAN transFORMS* exhibition.\(^244\) Ungers described *The City as Metaphor* as follows:

The exhibition room is designed as a tube with a square cross-section and mirrored front walls. It represents a continuous street. The effect of the endless space is reinforced by a completely symmetrical arrangement of the spatial elements. The city images and metaphors are mounted on panels on the two longitudinal walls. The walls, floor, and ceiling are white. Black wooden figures, six inches thick and taken from a Magritte painting, float in the room – as part of another spatial reality that stands in dialectical contradiction to the linear geometry of the main room. The character of the room is by and large that of a 1:1 cardboard model. The dominance of the geometry, the absence of colors, the floating figures, and the infiniteness should generate a metaphysical ambience.\(^245\)

\(^244\) Ungers was fascinated by Magritte in the 1970s. The figure of the bowler hat appeared in the renderings for his 1975 competition entry for the Wallraf-Richartz Museum, and he uses it again in the back of *Architettura come tema/Architecture as Theme*, where he collages a photograph of himself into the outline of the bowler hat figure. Ungers’s interest in surrealism likely came through Koolhaas, though it was very much in the air in architectural culture in the mid-1970s. Cepl speculates that Ungers may also have been influenced by Léon Krier and Stanley Tigerman. Cepl, *Oswald Mathias Ungers*, 322. The surrealist aesthetic was present throughout the *MAN transFORMS* exhibition, and not only in Ungers’s installation. Magritte-like clouds covered wallpaper in Arata Isozaki’s installation of an “Angel Cage,” and a Freudian couch was part of the “Situations of Man” installation.

Ungers’s introduction of the human figure inevitably introduces the question of scale. While all of the Magritte figures except one are cropped to give the appearance of “floating” and passing through the walls and floors, they are nevertheless at human scale, creating a datum from which to read the scale-less patterns. This is a reminder of the “man” that was the subject of the exhibition *MAN transFORMS*. Ungers’s use of incorporation had been partially based on the model of the body as a volume and threshold between interior and exterior. In the *The City as Metaphor* installation, however, the human body is presented as flat, a repeatable and measurable unit.

Repetition is used by Ungers as a device for ordering a system; but it is also used to undo a system. Even without the heavy-handed reference to Magritte, the surrealist practice of doubling would have been clear from the construction of the space, the use of mirrors, the reflection of the fluorescent lights in painted strips on the floor (which also resemble a street), and the status of the room as a “cardboard model” (suggesting that it is merely a copy of a “real” space). Unlike the strategy of incorporation, which indicates transformation with every layer of interiorization, repetition here is a purely visual, and deceptive, process.

In the exhibition catalogue, Ungers’s text is illustrated with Magritte's *La Trahison des Images (Ceci n’est pas une pipe)* (1929) [Fig. 3.78]. Ungers does not comment on the painting but hints at its meaning: “Reality is what our imagination perceives it to be. In a general sense, an image describes a set of facts in such a way that the same visual
Fig. 3.78
perception is connected with the condition as with the image itself."²⁴⁶ The image, in other words, can be just as important as the “set of facts.” Magritte’s painting brings us back again to Foucault, and his famous reading of it in his own text entitled *Ceci n’est pas une pipe*.²⁴⁷ Foucault saw the incongruity between the image and the text as an overthrow of basic principles of representational realism. These challenged the authority of the text and image in themselves, but also the relationship between them (which is blurred because the pipe acts as a text, and the text as an image of a pipe).

Ungers seems to have two different messages: one tells us that there are universal, stable metaphors for urban forms that can be deduced from their plans. An image of something substitutes for the plan, and a word substitutes for the image; this tripartite urban metaphor can be collected and catalogued in a morphological manner.

The other message (delivered via Magritte) tells us that where there are no stable texts or images, analogies and metaphors are arbitrary, and substitution introduces not difference, but even more of the same. This is strongly suggested in Foucault’s reading of Magritte. He writes of “similitudes” that “multiply of themselves . . . born from their own vapor and [rising] endlessly into an ether where they refer to nothing more than themselves.” Foucault concludes that “a day will come when, by means of similitude relayed indefinitely along the length of a series, the image itself, along with the name it

bears, will lose its identity. Campbell, Campbell, Campbell, Campbell.\textsuperscript{248} In this postmodern form of similitude, the possibility of different identities crossing into one another, which Foucault associated with pre-Enlightenment similitudes, is replaced by a return to sameness. Magritte becomes the predecessor to Warhol’s soup cans. But in this form of similitude difference does not break through the repetition of the same, suggesting that the assemblage of analogies and metaphors might not guarantee difference. But this similitude also indicates that difference may be found precisely in the most self-identical and mundane forms of repetition.

\textsuperscript{248} Michel Foucault, \textit{This is not a Pipe}, trans. James Harkness (Berkeley: University of California Press, 1983), 54.
III. THE SQUARE: WITH AND AGAINST RATIO

“I am not the guru of the square, as it has been written.”

–O. M. Ungers

While the theme of incorporation suggests the repetition of spaces inside one another, often with “surrealist” results, Ungers’s increasingly ubiquitous use of the square and the grid after the 1970s evokes a different sort of repetition. His obsessive use of the square, and the square grid, served as both an organizing principle and an ornamental pattern for his architecture. Ungers began turning to historical rules for form in the 1980s—Durand, Albert, Palladio, Vitruvius, and others—signifying a deeper preoccupation with history, and a turn away from the technological rationalism he had experimented with in the 1960s. Where he had once used statistical tables and algorithms to organize the forces of mass production into optimized building systems, he now introduced a pre-industrial form of Ratio, based on the language of classical geometry. However, the outcome of this reliance on the single module of the square was often less one of Palladian stability than it was a more delirious form of repetition.

In some ways, the aesthetic of mass production at multiple scales seen in the Berlin work of the 1960s seems to return; but here there is no longer a question of production but simply one of reproduction – of the square as signifier, an image of rational order without any apparent function. A conflict between two forms of rationality arises: the single square as a humanist symbol of proportion and geometry tied to the human
figure, and the grid as a system of repetition and organization between discrete elements, seen in the design of postwar façades and cities or in systems of organizing knowledge and information. It is also not by chance that Ungers’s intense interest in the square evolves at the same time as architectural computation and the tools of digital reproduction.

The square grid had already made several appearances in Ungers’s work in the 1960s: as a conceptual model in his 1963 *Berufungsvortrag*; as a framework for mass-produced, flexible façades; and as a way of organizing the city to maximize its field of possibilities. When Ungers returns to building in the 1980s after almost two decades of only conceptual and research-based projects, the square and the square grid became the most visible “signature” of his work. In a single project, it might appear in the plan, in a façade, in interior surfaces, and even in pieces of furniture, hardware, and floor tiling. Its repetition also occurs across projects, lending a self-replicating quality to his work.

The grid was typically used as a generic wrapper that covered both façades and roofs, while isolated or repeated squares were used to compose larger volumes. These strategies can already be seen in the 1965 competition for the Museen Preußischer Kulturbesitz, in a 1973 urban planning competition for the Landwehrkanal-Tiergarten district in Berlin, and in the 1975 competition for Roosevelt Island [Fig. 3.79]. In the last, the Manhattan grid was transcribed at a smaller scale, creating a generic volume for buildings made up of stacked cubes in a variety of possible configurations. In the 1975 Wallraf-Richartz Museum competition, the grid enclosed long rows of arcade-like
Fig. 3.79
galleries and organized the “open” spaces of a series of rectangular courtyards, where even the trees are cut into cubes that hover over the gridded surfaces below.

Rosalind Krauss describes the grid as emblematic of modernism in two ways. Spatially, the grid “states the autonomy of the realm of art. Flattened, geometricized, ordered, it is antinatural, antimimetic, antireal. It is what art looks like when it turns its back on nature.” Temporally, Krauss views the ubiquity of the grid in the twentieth century as an announcement of the presentness of modernity, and its proclamation of liberation from history.

Indeed, for Ungers, the increased appearance of the square and the grid coincide with his development of an explicit theory of architectural autonomy. Autonomy is proposed by Ungers in response to the “overestimation” of ecological, sociological, and technological factors in building by functionalists and technocrats. He writes: “the total failure of modern architecture in transmitting the cultural models of our times into formal symbols is proof of the lack of spiritual values and contents.” Ungers distinguishes his notion of autonomy from Kant’s separation of the pure and applied arts, turning instead to the Vitruvian definition of architecture as “firmitas, utilitas, venustas” – which he interprets as “construction, space, and form.” Of these, form is of particular importance:

---

252 Ibid., 320.
The formal language of architecture is not—as is commonly assumed—a function of a number of different empirical conditions, but expresses the aesthetic value of architecture as an intrinsic value. It has its own Ratio and only thus is the concept of rational architecture to be understood.253

In German, the word Ratio can refer to a mathematical proportion, but it also means “reason,” and that is how Ungers uses it here. However, this interest in Ratio also coincided with Ungers’s turn to formal geometry. Mathematical terms (function, value, and ratio) are suggestive of a logical basis for architecture. This geometry, it should be pointed out, is a classical and primarily two-dimensional one, and should be distinguished from the experiments in non-Euclidean modern geometry (like topology) of Bill and Ulm. Here and elsewhere, Ungers also makes it clear that what he means by “rational” should not be confused with the Zweckrational. In other words, Ratio (reason) does not refer to any purpose, but is the expression of mathematical laws internal to architecture: “architectural space, in contrast to nature and cosmic space, must be defined. This requires a rational concept, an idea, or an expression of the intellect.”254

Yet, when it comes to Krauss’s assertion of the “modernity” of the grid, Ungers’s approach is decidedly ambiguous. His grid and square are not those of modernism, and certainly not those of his teacher Egon Eiermann. Ungers instead takes this modernist trope and retroactively bases it in the longer history of the humanist tradition. Looking for a rational basis for architecture, Ungers turns to the works of Dürer, Vitruvius,

253 Ibid., 321. The German version reads: “Die formale Sprache der Architektur ist nicht, wie allgemein angenommen wird, eine Funktion von empirischen wie auch immer gearteten Bedingungen, sonder sie drückt den ästhetischen Wert der Architektur als Eigenwert aus. Sie hat ihre eigene Ratio und nur so ist der Begriff der rationalen Architektur zu verstehen.” Ungers, “Das Recht der Architektur auf eine Autonome Sprache” (1981), 75. Ungers uses the term Eigenwert (intrinsic value), which also has a mathematical meaning; it is translated into English as “eigenvalue.”

Alberti, Palladio, Durand, Boullée, and Schinkel. He also makes frequent references to what he calls the “scientific” architectural theory of the nineteenth century: Semper, Riegl, Worringer, Sörgel, and Lipps. According to Ungers, modernism broke from this established tradition of systematically studying form, and he proposes to continue where it had left off.²⁵⁵

A further confusion arises in Ungers’s indiscriminate use of the square and the square grid. The potential for a grid to extend and organize heterogeneous urban space almost indefinitely was a recurring theme in his work of the 1960s, as seen in Berlin 1995, and was an expression of Ungers’s optimism about mass production and reproduction. However, in this later period, the grid shrinks to the scale of the square; the grid still appears, but Ungers now views it as a collection of squares. If for Otto the Cartesian grid was a technique with which to contain incommensurable objects at every scale, here it is a device with which to perpetuate sameness. Where by the 1960s the grid had also been associated with the scale of production made possible by calculation and technology, in Ungers’s work in the 1970s there is a return to the scale of the human body and a belief in the near divinity of the powers of geometry. Ungers’s turn against the grid can be seen in his 1979 article “Architecture of the Collective Memory,” in which he argues for a city that is designed like Hadrian’s Villa at Tivoli (125–134 A.D.): a city of contradictions and inconsistencies made up of a collection of memories, archetypes, and fragments of histories.²⁵⁶ In contrast, he presents Hippodamus’s plan

²⁵⁵ “The supremacy of space and form was destroyed by constructive thought and the principles of utility and functional logic.” Ibid.

for Miletus (479–466 B.C.), one of the first cities planned entirely according to a square grid, which fills the land mass of the irregular peninsula. This city is “clear, direct and precise, measurable, geometrical.”257 While Hadrian’s reality was determined by his imagination, Hippodamus’s was determined by what can be measured.

Ungers believed that the square and the cube stood in for a number of values that have accumulated throughout the history of architecture: “geometric transparency, elementary principles, universality, proportional balance, spatial clarity, conceptual austerity, asceticism, purity of form, consistency of formative means, originality, simplicity, harmony, infinity, and permanence.”258 At the same time, Ungers (who was often self-contradictory) described his project as a continuation of certain elements of modern architecture:

Nothing would be a worse offence or label than if I were counted among the postmodernists, as I don’t think that is what I am. My entire architectural vocabulary is built upon the modern: it is built upon functionalism. It leads functionalism and modernism farther as an art form into a certain extreme exaggeration.259

Ungers also aligned himself with the use of the square in modern art, though he seems unconcerned with the fact that this usage had represented a break with the humanist tradition. Responding to an interviewer’s criticism that the square was

---

257 Ibid.
essentially generic, and the same whether it was in “Frankfurt, Karlsruhe, or New York,” he replied:

Nobody would come up with the idea of reproaching Albers, for example, for painting squares for his entire life. And he still exemplified the entire theory of painting with the squares. . . . Nobody took offense that Malevich worked with squares as a formal means of expression, and that he condensed Suprematist painting into a square. . . . I don’t need more than a simple base element in order to show all of the phenomena of space and architecture that I want to present.  

In another interview he makes reference to Malevich again, comparing his own work to Malevich’s “square” paintings:

The black cube is an extreme, beyond which it is impossible to speak of architecture. It is like Malevich’s black square, which reduced painting to the essential. . . . It doesn’t involve emotional interpretation, and that is why I love it. . . . When I am the one who decides, I want rational elements at hand.  

In 1986 Ungers showed several works in an exhibition entitled Quadratische Häuser (Square houses). The exhibition catalogue, oddly enough, did not include any texts by Ungers, but instead a reprint of portions of Bruno Munari’s 1965 Discovery of the Square – a playful and visual “universal” history of the square from prehistory through Malevich and Le Corbusier [Fig. 3.80]. The catalogue featured Cesariano's Vitruvian man on the front, inscribed inside a square, inside a circle, inside another square, with a gridded

---


262 O. M. Ungers, Quadratische Häuser, Galerie Denise René Hans Meyer, Düsseldorf, 1986.

263 O. M. Ungers, Quadratische Häuser (Stuttgart: Hatje, 1986). The Munari material was taken from Discovery of the Square (New York: George Wittenborn, 1965). An untitled text by art historian Paul Naredi-Rainer is also included, taken from his book Architektur und Harmonie. Maß, Zahl, und Proportion in der abendländischen Baukunst (Köln: DuMont-Dokumente, 1982). Ungers frequently used the combination “Maß, Zahl, Proportion” in his texts in the 1990s.
Fig. 3.80
Pages from O. M. Ungers, *Quadratische Häuser*, 1986, showing buildings by Mies van der Rohe and Karl Friedrich Schinkel.
background (see Fig. 0.7).\textsuperscript{264} The back cover shows a close-up of the image of the magic square that appears in the background of Dürer’s \textit{Melencolia I}.\textsuperscript{265} The melancholic angel and its sad acts of geometric measurement are omitted from the image, indicating that a return to (geometric) order might again be considered as a response to architectural stasis.

Where Ungers had once been concerned with the question of the \textit{Masse} – mass production and mass populations – his focus now was on \textit{Maß} (dimension). In an essay entitled “\textit{Maß, Zahl, Proportion},” he describes his theory of the relationship between reason, geometry, and form:

\begin{quote}
Architecture . . . is predominantly determined by \textit{Ratio} and is thus also a science that expresses itself in relationships of proportion and is based on the orders of measurement and modular systems. That is why geometry is the foundation of all architectural rules. Form does not emerge through chance, but is the result of enlightened reason, which can also be equated with the result of applied relations of proportion. Thus, architecture is the ordering of heterogeneous conditions through the means of \textit{Ratio}. In this process, matter is subordinate to form. Arguments concerning appropriate materials or functionality are thus irrelevant.\textsuperscript{266}
\end{quote}

\textsuperscript{264} The drawing is attributed to Cesare Cesariano. The Vitruvian Man was also used as a logo of the Institute for Architecture and Urban Studies in its early years, encouraged no doubt by Colin Rowe and, by extension, Rudolf Wittkower. See Reyner Banham, “Vitruvius over Manhattan,” \textit{New Society} 10, no. 271 (December 1967): 827–828. See also Suzanne Frank, \textit{IAUS: The Institute for Architecture and Urban Studies: An Insider’s Memoir} (Bloomington, IN: AuthorHouse, 2011).

\textsuperscript{265} The image is attributed to a \textit{Life Science Library} book on mathematics. When Ungers “discovered” the square, he began to reframe past projects to fit this new theory. Ten projects by Ungers are shown in the \textit{Quadratische Häuser} catalogue, both built and unbuilt, including those that had previously illustrated the theme of “incorporation” (Hotel Berlin, Solarhaus, DAM). These are followed by ten historic buildings that take up the theme of the square, by architects including Palladio, Mies, Schinkel, and Ledoux.

Fig. 3.81
Library at the home of O. M. Ungers, Cologne, 1990s.
Ungers directly appropriated these ideas from Renaissance and neoclassical readings of Vitruvius (his collection of rare architectural books was often the source of these strangely anachronistic positions) [Fig. 3.81]. He focuses on geometry in particular as the formal language with which to resurrect humanist ideas of “enlightened reason” (Vernunft): “Translated into today’s architectural language, this indicates the art of omission and reduction. The basic geometric forms, like the circle, square, ellipse, cone and cube, provide the formal repertoire for the metamorphosis of natural reality into mental Sinnbilder (symbols).” This shift towards a more limited repertoire of geometric forms indicates a shift away from the forms that proliferated from the pseudomorphism of “The City as Metaphor.” It is also an almost opposite approach to that of Otto, who sought to escape from the repertoire of Platonic solids by finding new and incalculable forms.

In interviews and essays, Ungers also quoted writers like Valéry, Wittgenstein, and Beckett, bringing together modernist ideas of abstraction and reduction with classical theories on geometry and order. Ungers viewed his use of historical ideas as a step towards a new abstraction:

What we can still contribute to the problem of measurement, number, and proportion and the use of modules is to show them in their purity and to a degree of abstraction as they have not been used before. That means stripping them of all of their stylistic burdens or implications, to reduce a building to its core, to work as if polishing a precious stone, where with the highest degree of abstraction only the proportion, the dimension, and the number remain.268

268 “Was wir zum Problem von Maß, Zahl und Proportion und der Anwendung von Modulen noch beitragen können, ist, sie in ihrer Reinheit und in einem Abstraktionsgrade zu zeigen, wie sie bisher nicht angewandt worden sind. Das heißt, sie von all ihren stilistischen Belastungen oder Implikationen zu
Form thus not only stems from numbers, but can be reduced to numbers – if it is simplified enough, it eventually reveals its numerical substrate. Here Ungers almost approaches Bill’s philosophy of sculptural forms that can be expressed in numerical equations.

Ungers formulated this approach during a period when many of his projects were once again being built and publicly discussed. The austerity and monumentality of his work, and the solipsistic ideas on which they were based, made him a frequent target of criticism. This criticism partially had to do with the direction in which architectural culture was moving. Ungers’s call for anthropocentrism, stable geometries, and enlightened reason came during a period when architectural culture was investigating deconstruction, poststructuralist and feminist ideas of the human body, and, perhaps more significantly, new concepts of space and geometry that were made possible through digital modeling.

Looking at Ungers’s work in the 1980s and after, we can clearly see a disjunction between his appeals to classical humanism and modernist abstraction, and the result when these theories are translated into architecture. The almost Adornian hope to create an autonomous architecture through formal austerity and disregard for function resulted instead in a hyper-rational formalism that was in keeping with the rationality of corporate postmodernism. Reason (Vernunft) becomes the signifier of a new austerity.

Fig. 3.82
O.M. Ungers, Hochhaus Mediapark, Cologne, 1987
O.M. Ungers, Kampanile Kulturforum, Berlin 1983
From the 1994 exhibition “O.M. Ungers: Architekt” at the Hamburger Kunsthalle
Fig. 3.83
From the 1994 exhibition *O. M. Ungers: Architekt* at the Hamburger Kunsthalle.
that is apparently meant to counter some perceived irrationality (Ungers does not articulate what this might be).

Examples of austerity can be seen in a 1994 exhibition of Ungers’s work at the Hamburger Kunsthalle, an institution for which Ungers had also designed a new building.\(^{269}\) In the catalogue, a drawing of the building’s façade (dated to 1986) is shown next to Palladio’s Villa La Rotonda, both with proportion studies drawn over them.\(^{270}\) However, the rest of the buildings in the catalogue are towers of various kinds, shown as white plaster models or simple drawings and perspectives [Figs. 3.82, 3.83]. Each building (dating from 1983 to 1993) is a variation of the same monolith with a surface covered by square grids of varying dimensions. The forms range from an exaggerated Miesian tower for the Kulturforum in Berlin (1983), to an open cube of four L-shaped towers (1990), to an entirely gridded \textit{Torhaus} (gatehouse) building (1991) that straddles a highway, calling to mind a superstructure design from the 1960s. A 1987 proposal for a squat tower for a media park in Cologne consists of a rotated monolith with a slanted top, surrounded by a latticed cube with square grids at two scales. Shown in elevation, its two volumes have the flatness of an abstract painting.

While the buildings represented were projects or competition proposals with different contexts, they appear as repetitious, generic models for late modern corporate architecture. Ungers tries to fold them into his elaborate theory of Western humanism by pretentiously referring to them as “campanile” and “castrum,” but this historicization denies the fact that they were entirely contemporary products of an exhaustion of


architectural form. They are radical models of a new scale of abstraction beyond that of International Modernism or the façades of Adolf Loos or Ludwig Hilberseimer. This exaggerated and unsentimental abstraction can be read differently – as a critique of the formal excesses of postmodern architecture. They are generic typologies, buildings without qualities, without claims to function, transparency, or ideology.\textsuperscript{271} They simply signify “building,” without aspirations to postmodern ideas of context or communication. The same catalogue shows two human figures – Dürer’s 1528 \textit{Maßstabsfigur} and (again) Cesariano’s 1521 \textit{Vitruvian Man}. However, these claims to the proportions of the human body seem out of place when all that remains in the architecture are the gridded devices that measure the body. Ungers’s buildings are ideal formal representations that conform to their internal logic, not to the scale of the human body or even that of the city.

A critique of this gap between Ungers’s humanist claims and their formal expression was also made by Ulm co-founder Otl Aicher in his 1991 response to a series of proposals made for post-reunification Berlin, which included a design for a Marx-Engels memorial by Ungers [Fig. 3.84].\textsuperscript{272} Ungers proposed a simple, graphic structure of four Wolkenbügel-like towers surrounding a square plaza, forming an open volume lined with gridded office windows.\textsuperscript{273} Aicher attacks Ungers’s “Platonic idealism” and his

\begin{flushright}
\textsuperscript{271} Ungers would later build a house for himself in Cologne that was called the “Haus Ohne Eigenschaften” (House without Qualities) (1994-95).
\textsuperscript{273} Ungers would later recycle this form for a “Castrum” for Neuss (1990).
\end{flushright}
Fig. 3.84

Fig. 3.85
repetitive use of the square: “The form comes before the object, the soul before the body, the house before its use. That is the philosophy of Oswald Mathias Ungers, as long as the form always leads back to the square."274 For Aicher, the idealism of the form and its exaggerated scale made it alarmingly evocative of rationalist bureaucracy:

Perhaps it is not at all inconsistent that here Ungers the idealist wants to build a memorial for materialist do-gooders, whose mistake it was to enforce reason with violence and bureaucracy from above. Somebody like Ungers also makes architecture “from above.” In both cases there is a principle of pure reason, of *Ratio* per se, which is withdrawn from the depths of the everyday and the human. . . . In that sense a pure structure that is not seen for its purpose, but from above, is the adequate form for a Marx-Engels memorial. Then, however, the most sensible use would be if it only served as facilities for bureaucracy.275

For Aicher, whose critique stems from a post-fascist humanist position rather than a rediscovered historicist humanism, the large-scale, monolithic structure could only signal the return to a totalitarian form of reason. Unlike other projects from this period that sought to reclaim a lost humanism, Ungers uses a highly abstract and formal language that – appropriately for a Marx-Engels memorial – evokes avant-garde architectures of the 1920s. It is precisely because Ungers’s theory of the square has depoliticized this form that he is able to use architecture to question the status of twentieth-century utopian forms and their transformation into generic buildings in the postwar decades. In doing so, he brings up the question of what role an ideal rational

---

architecture plays in the “post-historical” and “post-ideological” space of Berlin immediately after the fall of the wall.

In his search for an autonomous formal architecture free of purpose, Ungers appropriated the revolutionary forms of early modernism, but he also returned to conservative ideals of an imagined origin of Western architectural culture. While many elements of modernism, like Bauhaus pedagogy, for example, had also called for a return to elementary geometries, this return would be done in order to establish a new beginning, and a new abstraction, that would break from the past. In the case of the work of Ungers, abstraction meant a return to history. It can also be seen as a flight from postmodern culture, particularly the rise of digital technology and multiculturalism, which threatened Ungers’s universalist claims of Western culture. This austere combination of avant-garde abstraction, humanist classicism, and corporate modernism made Ungers, as Heinrich Klotz had already written in 1979, “the most controversial personality in contemporary German architecture.”

Other controversies arose when this architecture of pure Ratio was used for functional and social purposes. Frampton once noted that the “sublime” quality of Ungers’s “meticulously drawn” projects “proved to be strangely elusive in his realized work.” This was certainly the case in a 1985–1989 housing project for Kreuzberg, which was part of the Internationale Bauausstellung in Berlin [Fig. 3.85]. This square-shaped building, with squares repeating at every scale in the plans and façades, was one


Fig. 3.86

Fig. 3.87
of Ungers’s first and fully conceptualized and realized applications of the use of the square at every scale. Designed around an abstract geometric principle as opposed to functional and social demands, the building proved unsuitable for the complex and varied needs of the low-income immigrants who resided there.278 Once again, Ungers’s use of formalist principles for a housing project in Berlin resulted in a social disaster.

Ungers’s obsessive use of the square and appropriation of classical themes became especially controversial in his residence for the German Ambassador in Washington, D.C. (1987–1994) [Fig. 3.86].279 Here the repetition of the square at every scale can truly be thought of in terms of a Gesamtkunstwerk. In a 1994 review, Frampton wrote:

This is Ungers in the apotheosis of his quadrat mode to such an extent as to make Josef Hoffman look like an amateur, for almost everything in the building is determined in terms of major and minor squares. The square ladies’ living room is a case in point for its central square carpet is surrounded by two bands of marble squares, amounting to seventy-six squares in all. The two pairs of double-doors giving access to the room are each three squares wide while the four light columns in the four corners of the carpeted area are, needless to say, square in plan.280

While Frampton initially compared the building to Peter Behren’s ostentatious 1912 German embassy in St. Petersburg, he concludes that it is instead closer to the “metaphysical modernity” of Ad Reinhardt or Sol LeWitt.281 The “hermetic” nature of the architecture led Frampton to read the building as a project with an “Adornian” aesthetic, even if this would have been completely at odds with the Gesamtkunstwerk.

---

279 Ungers also was a finalist in the first round of the competition, which was held in 1982. The original proposal was similar to that for the DAM, calling for the extension of an existing villa through the use of a “house-in-a-house.” Bauwelt 85, no. 40/41 (1994): 2240.
280 Frampton, “Ungers: In the Name of the Father,” 21.
281 Ibid., 22.
In the non-architectural press, however, Ungers’s building was not appreciated in this way, particularly after the German ambassador, Imo Stabreit, publicly complained about its “ice-cold atmosphere.” The monumentality of the building and its allusions to classicism also drew comparisons to Nazi architecture from several journalists. The Gesamtkunstwerk of the building and its interiors was interpreted as an “obsessive will to order”; the Wagnerian theme suggested by the installation of a series of panels on the theme of “Parsifal” by the artist Markus Lüppertz did not help matters. Calling the building a “Teutonic block,” journalist Klaus Harpprecht denounced Ungers’s “architecture of arrogance” as a “monumental declaration of power.” Several journalists compared the building unfavorably to Eiermann’s 1958–1964 West German Embassy in Washington [Fig. 3.87]. Eiermann’s mid-century technocratic façade and unobtrusive presence in the landscape expressed the enlightened, democratic image that was carefully cultivated by West Germany’s postwar democracy. Ungers’s building for a recently reunited Germany raised, for many, the “ghost of fascism,” or as Frampton puts it, “the values of a totally different, emergent epoch [which] seems to evoke in the name of a reunited Germany the dream of a lost imperial past.”

Was this the danger of an architecture that follows its own Ratio, or the result of different political understandings of an acceptable form of rationalism? Ungers no doubt followed his own methodology with great fidelity, applying the rule of the square in every carefully considered detail. The proportional laws of humanism likely informed

---

284 Frampton, “Ungers: In the Name of the Father,” 22.
every formal decision, and contextual references were carefully made to Washington’s neoclassical architecture, even including the use of Vermont stone. Yet, in this late work, Ungers’s preoccupation with elementary geometry and his compulsion to repeat that geometry across every scale became a private, cabalistic exercise unsuitable to the building’s public role. At the same time austere and pompous, it seemed to be governed by an altogether different understanding of reason, one that seemed to veer towards the irrational in a way that was directly at odds with the enlightened scientific reason of West Germany’s postwar period.

Ungers’s tendency towards a “rationalist Gesamtkunstwerk” is seen across most of his built projects after the 1970s, particularly ones in which he was given full control over the interior spaces. This total design was also realized, for instance, in the Deutsches Architekturmuseum, with its specially designed square furniture, or the 1990 Bayerische Hypotheken und Wechselbank in Düsseldorf, where Ungers collaborated with Sol LeWitt to create an interior determined entirely by both men’s obsession with the square [Fig. 3.88]. But while LeWitt deliberately challenged the boundaries between control and excess in his work, Ungers insisted that these multiplying and repeating spaces were evidence of a mastery of reason over built form. Ungers associated the repeating module with a notion of purity, a regular and homogeneous order that would obliterate not only the outward appearance of the function and Zweck of a building, but also differences between its functional parts (column, cornice, etc.) and even its materiality.285 For Ungers, this kind of minimalism can also translate into an economic

---

285 Cepl, Oswald Mathias Ungers, 491.
Fig. 3.88
Detail showing Sol LeWitt installation, O. M. Ungers, Bayerische Hypotheken und Wechselbank, Düsseldorf, 1990.
austerity that would be achieved through “reduction to the essential, clarity of the spaces and masses, avoiding extravagance, omitting anything excessive.” This austerity suggests that Ungers was participating in the ongoing concern with economy in the postwar period.

But what if the total nature of these spaces is seen less as an expression of restraint than as a decadence of repetition made possible by industrial, and even digital, culture? Ungers’s eventual retreat into the rule of the square seems incomprehensible at times, but it was in many ways a response to changes to the nature of calculation in architecture, specifically the advent of the digital. One could go so far as to call it a “fear of calculation.” In 1986 a conversation was published between Ungers and one of his former students from Berlin, Peter Neitzke, on the question of computer-aided design. Ungers expressed great reservations about the use of the computer for design, especially for the decision-making process: “One cannot leave that up to a device that can make if/then or yes/no decisions and nothing else. The process is too complex to leave to a machine.” He continues:

Architects are endorsing a realm where the alienation from the object of one’s own work continues to the point where this work can finally be taken over by somebody who just manipulates a program. One has to imagine what it means when I am “designing” with programs, with the “retrieval” of certain data instead of concrete material.

---

287 Neitzke was one of the most radical students in 1968. “Das kann man nicht einem Maschinenprozeß überlassen! Oswald Mathias Ungers im Gespräch mit Peter Neitzke,” in Walter Ehlers et al., eds., CAD: Architektur Automatisch?, Bauwelt Fundamente 76 (Braunschweig: Vieweg, 1986), 247–254.
288 “Das kann man nicht einem Gerät überlassen, das Wenn-/Dann- oder Ja-/Nein- Entscheidungen treffen kann und sonst nichts. Der Prozeß ist zu complex, um ihn einer Maschine zu überlassen.” Ibid., 249.
289 “Die Architekten begeben sich auf ein Gebiet, auf dem die Entfremdung von Gegenstand der eigenen Tätigkeit immer weitergeht, bis diese Tätigkeit schließlich durch jemanden übernommen werden kann,
For Ungers, the machine would always revert to what is known, as opposed to “daring the adventure of the birth of the new.”\(^{290}\) The digital then leads to a bad repetition. In this interview, Ungers was not returning to his youthful theories of individual expression; he firmly believed in rule-based systems, but no longer believed in the digital ones that he had pursued in the 1960s.\(^{291}\)

Ungers, who once experimented with early forms of simulation, was now also concerned about losing three-dimensional space and materiality.\(^{292}\) Responding to Neitzke’s concern about the decline of physical models and the use of perspective and axonometrics in drawing, Ungers laments that CAD is causing architecture to become graphic and two-dimensional: “It would thus be no wonder if the contemporary architecture that already appears flat now would become even flatter with the spread of the use of CAD: mere façade, as two-dimensional as drawing.”\(^{293}\) Ungers was likely responding to the dominance of the façade in postmodern architecture, yet the use of the grid in his own work, and the simple volumes on which it was applied, also had the

---

\(^{290}\) “Wenn man das der Maschine überlassen würde, würde man sich immer nur auf bereits Vorhandenes stützen, man würde nie das Abenteuer der Geburt des Neuen wagen.” Ibid., 249.

\(^{291}\) “Without these rules I would question everything, every detail would confront me with some sort of deficiency. I want to work according to strict rules, and I want to keep up these rules until the last details of the house, all the way to the seams.” “Ohne diese Regeln würde ich alles in Frage stellen, jedes Detail würde mich mit irgendwelchen Unzulänglichkeiten konfrontieren. Ich will nach strengen Regeln arbeiten, und ich will diese Regeln bis in die letzte Einzelheit des Hauses durchhalten, bis in die Fugen.” Ungers, interview by Weiss, “Zwischen Ordnung und Konflikt,” 7.

\(^{292}\) This is also reflected in “Steinarchitektur,” his essay on brick and stone architecture. In a 1993 interview, Ungers even positioned himself against mass production: “I don’t believe in industrial production, but in craftsmanship.” Ungers, interview by Pasca, “La radicalità della geometria / Radical Geometry,” 20.

\(^{293}\) “Es wäre darum eigentlich kein Wunder, wenn die schon gegenwärtig flach wirkende Architektur mit der Verbreitung von CAD noch flacher würde, bloße Fassade, zweidimensional wie die Zeichnung.” In “Das kann man nicht einem Maschinenprozeß überlassen!,” 251.
effect of creating precisely the flatness that he attributes to the computer. With the possibility of designing and creating spaces virtually having become achievable through technology, Ungers positions himself against simulation:

Space and material now only exist in the presentation, in the simulation; the distance of the designer from the material has already been so successful that one . . . no longer really knows it, one no longer touches it. . . . I consider that a total desensualization [Entsinnlichung], as one must after all sense from the material how something will be in reality. If the existential contact with architecture will be replaced by an automatic, manipulated contact with architecture, then at the end what remains is perhaps only a shell, an empty construction that is no longer tangible or alive, even for the “architect,” which also for others is somehow artificial and unreal, comparable to a car: a cold, impersonal object. But architecture is generated because it can be experienced; space, an extension of skin, of one’s own existence, in other words.

When he speaks of space as an extension of the physical and corporeal presence of the architect, Ungers could be describing the layered plan of one of his “Russian doll” buildings. He also seems to be returning to the notion of architecture as the envelopment of the individual that he first wrote of in the early 1960s. This refutation of the simulated world and its mass-produced objects (like the car, which Ungers had so admired in the 1960s) is a turn away from the dangers that repetition can bring – the

\[\text{\textsuperscript{294}}\text{It is Neitzke who first brings up this word in the conversation with Ungers. This term was used by Arnold Gehlen, who spoke of the “Entsinnlichung der Welt” as a result of industrialization. See Gehlen, \textit{Die Seele im technischen Zeitalter. Sozialpsychologische Probleme in den industriellen Gesellschaft} (Hamburg: Rowohlt, 1957).}\]

problem of the copy and the simulacrum, and the tendency toward dematerialization, as described by Baudrillard and Lyotard by this time.

This mistrust of the digital was also in many ways connected to Ungers’s call for a return to the ideals of Western humanism in the wake of the technological euphoria of the digital. In several texts published in the 1990s, including one in an issue of Rassegna on the “European Archipelago,” Ungers described an apocalyptic vision of cultural dematerialization:

It is undeniable that we have already begun to disappear. Objective, corporeal reality crumbles into smaller and smaller pieces. Human beings dissolve into particles and genes. Our mind breaks up into bits of information. Our decisions disintegrate and everything around us turns into dust. Culture becomes a heap of ruins, language a mass of phonemes.

After everything has been calculated, broken down into raster images we now drift like windblown grains of sand that form ever-changing, ghost-like dunes, rags of former conceptual abstract thinking which is lost forever. Everything is gradually reduced to a zero-dimension of a mechanical, freely exchangeable world view.296

Those familiar with the work of Vilém Flusser will immediately recognize that the writing here is not the voice of Ungers. The words that Ungers paraphrases here – without attribution – are in fact those of Flusser, taken from his writing on nomadism.297

---

297 Flusser wrote: “There can be no doubt that we are leaving our enclosures and moving out into the dust. The objective, physical world is disintegrating into dust, into particles. Life within is also disintegrating into dust, into genes. Our thinking is disintegrating into dust, into bits of information. Our decisions, into dust, into decidemes. . . . And everything about it is getting dusty, such as culture turning into a dust pile of culturemes; language, into a dust pile of phonemes. And we rove ghostlike about the windswept, shifting dunes in the Saharan landscape, like scraps of a previous but now definitely lost rational, conceptual, and scientific understanding. In this sense we are undoubtedly becoming nomadic. But something in this description is not quite right, because after we have laid waste to everything through calculation (granulation, pulverization), we can make it blossom again thanks to computation (assemblage, networking). We can concretize something out of the abstract dust particles (abstract because nondimensional).” Vilém Flusser, “Nomads,” in The Freedom of the Migrant: Objections to Nationalism, trans. Kenneth Kronenberg (Chicago: University of Illinois Press, 2003), 51. (This is the version cited subsequently.) “Nomadism” appeared had earlier in Horst Gerhard Haberl, ed., Auf, und,
Ungers’s intention with this text is very different, however. Flusser saw both possibility and destruction in the new fluidity of postmodern experience; there is no more “rational, conceptual thinking” because of “calculatory analysis,” but at the same time “the relational network, a *mathesis universalis*, is becoming visible behind this desert. That is where experience lies. We are becoming nomads.”

Ungers, by contrast, appropriates this text for an essay he published just a few years after the official establishment of the European Union, in which he comments on the “crisis” of European identity. In a different sort of repetition, the postwar theme of homelessness re-emerges in Ungers’s arguments against cultural nomadism and in defense of what he viewed as the sedentary history of the humanist urban culture of Western Europe.

This was also a statement against the sort of lightness, the ephemeral architecture of tents, that Otto and others of the postwar generation had imagined as a response to the problematic culture of *Heimat*.

At the same time, Ungers argues for a return to a universal “identity” of architecture itself, which he views as autonomous from regional or cultural contexts. This identity, which guards against arbitrariness, is derived from simple, basic modules (taken from the canon of Western architecture, not surprisingly) – the Parthenon, the Pantheon, and

davon: Eine Nomadologie der Neunziger (Droschl: Erstaugs, 1990). Jasper Cepl also points out the similarity between the texts, and confirms that Ungers read Flusser and used his ideas several times. Cepl, *Oswald Mathias Ungers*, 496. The lack of attribution for this and other citations of Flusser removes the context in which they were used, with the effect of turning these evocative descriptions into apocalyptic warnings.

298 Flusser, “Nomads,” 50.
Fig. 3.89
the Pyramids.\footnote{Ungers, “Architecture as Autonomy,” 52.} Ungers claims that even the avant-garde, with its celebration of individual expression, has “destroyed the very identity of architecture”:\footnote{Ibid., 53.}

The essence of architecture . . . is understood as a structural concept governed by geometric rules and systems. This concept is irrevocable and independent, and based on the regularity of measurement, numbers and proportions. It exists beyond time and place as a language with its own formal, aesthetic logic.\footnote{Ibid., 58.}

Ungers viewed architectural form as having the power of a Tower of Babel – as the basis of a common language, an object with the power to unite a civilization and prevent its diaspora [Fig. 3.89].\footnote{Ibid., 52.} He writes: “I believe that civilization’s anxieties are actually the loss of identity of European architecture.”\footnote{Ibid., 55.} The crisis of European identity, for Ungers, can only be solved by looking to the origins of Occidental culture, which he believed to be relevant for “the whole of humanity.”\footnote{Ibid., 55.}

It is difficult to say with certainty whether this late text was a political reframing of Ungers’s fascination with the square and with classical modules and systems of rules, or whether this Eurocentrism was always present. But it seems clear that these theories were developed as a reaction against postmodern conditions of multiplicity and difference, of calculation and virtualization. Just as Max Bill’s turn to mathematics and basic geometry was an “ethical” reaction to the chaos left in the aftermath of the war,\footnote{Ibid., 55.}
Fig. 3.90
Top: Frankfurt Fair today, with Helmut Jahn tower in background.
Perspective rendering of Messe Torhaus, Ungers Archiv für Architekturwissenschaft.
Ungers turns to what he sees as the origins of Western rational thought to counter the apparent irrationalities of contemporary global culture.

The limits of this form of reason can be seen in a kind of Tower of Babel that Ungers built in Frankfurt in 1984: a high-rise for the grounds of the Frankfurt Trade Fair [Fig. 3.90]. Frankfurt’s location as a trade center dates to the twentieth century; but by the 1980s, the combination of its large international airport, finance sector, and trade fair center made the relatively small city one of the most globalized urban centers in Europe. Ungers’ projects for the trade fair, which include the tower, an exhibition hall, and a glass-covered “galleria,” were by far the largest and most commercial buildings of his career.

The form of the tower itself was derived from Ungers’ theory of analogical and thematic thinking. Ungers argued that the building was a gate or portal to the city and the fairgrounds, citing its resemblance to Frankfurt’s medieval city gates. The building is not sited at the entrance to the trade grounds, however, but rather in the middle, where it sits on top of rail lines, serving as a transfer point between the two halves of the site. Before the construction of Helmut Jahn’s 1991 Messeeturm skyscraper (which would become the tallest building in Europe until 1997), Ungers’ “gate” was the tallest and most visible building on the site. Nevertheless, at 117 meters, the tower hardly competed with Frankfurt’s other skyscrapers, nor was it built in the idiom of the tall, glass corporate tower.

The tower is made up of two parts – a thin glass slab inserted inside of a masonry base that indeed has a gate-like form. Both volumes sit on a wedge-shaped plinth that
follows the site’s footprint. An early perspective drawing shows a void at the opening of the gate, though in the final building this was filled by the glass slab. However, the void that was originally suggested reappears within the glass structure, as I will explain below.

Before focusing on the question of the square, which once again appears throughout this project at multiple scales, a few things should be said about the use of an image or theme here. Unger had turned to images after a period of intense investment in quantifiable and calculable systems for creating architecture; the archetypal image served as a counterpoint to the scientific worldview of the measurable and quantifiable. The Messe Torhaus (1980–1984) brings together the theme of incorporation (the house within the house) that was seen in his projects during the 1970s, as well as the appropriation of a historical archetype. However, when Unger presented this project at the infamous 1982 conference at the University of Virginia that was captured in The Charlottesville Tapes, it was met with almost total derision.306 The use of a historical archetype at a scale this large led Léon Krier, for instance, to refer to the project as “hard kitsch.”307 Jaquelin Robertson likened the project to a “cigar-cutter” or “guillotine.”308 The proliferation of similitudes that had previously allowed Unger to playfully engage different urban metaphors was now out of his control, leading unintended images to be associated with his architecture. One of the difficulties that Unger ran into was that he insisted the “image” of the gate belongs to an archetypal

307 Ibid., 73.
308 Ibid., 67.
collection of urban elements like the “agora” or “villa,” which he saw as being of universal significance in the Western tradition. At the same time, he made claims for the specificity of these images in the context of Frankfurt.\textsuperscript{309} Krier responded that the use of terms like “agora” or “gate” “have a connotation of such cultural profundity that I shiver when I hear them,” and that the project was “empty” and about “big business and nothing else.”\textsuperscript{310} Philip Johnson added: “this project could be in Kansas City.”\textsuperscript{311} In the end, the buildings succumb to the generic nature of global postmodernism.

Ungers clung to an idea of archetypal architectural and urban forms as resisting the rationalized world of technology and capitalism. But what he failed to see, and what his peers pointed out, was that this use of images – the sign – had already been entirely incorporated into the rationale of late capitalism.\textsuperscript{312} This “surrealist” and historicist insertion of familiar urban forms only served to render more visible an economy (whether of tourism, finance, or trade) based not only on hard numbers but also on soft signs.

This historicism can be seen in particular in an early proposal for a masterplan of the fairgrounds (which did not yet include the tower), showing a postmodern fantasy of nineteenth-century industrial architecture.\textsuperscript{313} A view onto the “Agora” from the “Roman

\textsuperscript{309} Ungers even claims that the masonry is context-specific as he used the same red sandstone that is used in several buildings in Frankfurt. Ibid., 69.
\textsuperscript{310} Ibid., 73.
\textsuperscript{311} Ibid., 67.
\textsuperscript{312} See Andre Bideau, Architektur und Symbolisches Kapital. Bilderzählungen und Identitätsproduktion bei Oswald Mathias Ungers, Bauwelt Fundamente 147 (Basel: Birkhäuser, 2011).
\textsuperscript{313} These drawings were published in Peter Davey, “Ungers Transforms: Exhibition Complex Design for Frankfurt,” in The Architectural Review (March 1981), 140–145. Ungers worked on the urban plan for the complex with Albert Speer Jr in 1979-1980. Other architects asked to contribute to the invitation-only competition were Robert Venturi, Albert Speer Jr., Hentrich+Petschnigg, and Glaser+Partners.
Fig. 3.91
Fig. 3.92
Theater” is framed by steel trussed arches, and shows a paved courtyard leading to low-slung trees and fountains [Fig. 3.91]. The vegetation, which has a dense, creeping quality, frames a steel tower topped by a satellite dish, recalling a Russian constructivist radio tower. The rest of the site is filled with parking structures and large industrial halls, connected by glass-covered arcades. One rendering shows details of the large “galleria” that Ungers would end up building, filled with palm trees and abstract sculptures [Fig. 3.92]. Throughout the plan, Ungers draws rows of highly abstract spherical and conical trees, which mirror the modular repetition of the halls and arcades.

The detailed axonometric drawings and dense industrial structures initially recall Ungers’s technocratic urban fantasies of the 1960s. But then details like the stepped “Italian Garden,” which is used to mask a parking complex, suggest that in this project Ungers’s early fascination with the formal qualities of mass production would collide with his interest in historical urban typologies. A color perspective with a blue, Mediterranean sky and cypress trees shows that this rational architecture is meant to evoke a cheerful humanist culture, one far removed from the leaden skies and massive warehouses that usually greet visitors to the Frankfurt Fair [Fig. 3.93]. Returning to Ungers’s increasing interest at this time in the “origins” of Western architecture, this project can be seen as a way to reclaim the generic, mass-produced qualities of global industrial architecture as somehow continuous with a humanist European tradition.

The fair is, of course, above all a space of large-scale logistics – from the goods and people that pass through it to the mass-produced building parts required to construct it – and these buildings would have to have been designed with the greatest attention to
Fig. 3.93
the most economic use of space. Behind Ungers’s façades, this form of rationalization is inevitably present. The square then acts as a kind of talisman in an effort to temper the rationalization suggested by the fair by imposing the *Ratio* of geometry. Once again, this is the question of *Maß* vs. *Masse*.

Ungers’s masterplan and its repeating square grids were never realized, but they reappear in the façade of the tower. One sees this to some extent in the building’s proportions: the “glass house” is divided into two large squares at the front façade, one slightly larger than the other; and the bottom plinth, at least as it was drawn, can be equally divided into two squares [Fig. 3.94]. But the truly radical use of the square happens at the next scale: in the red stone panels that make up the façades, the punched square windows, the glass curtainwall, and the surface of the elevated walkways penetrating the building. Use of the square becomes even more delirious in the interior, as it appears in floor tiles, illuminated ceiling panels, ventilation covers, lanterns, wall coverings, interior window mullions, paneled doors, and a square-shaped marble fountain in the cafeteria [Figs. 3.95, 3.96]. There is little trace of the ideal square or magical grid that Ungers upholds in his writing as a system of order and harmony based in classical ideals. This square is one of relentless repetition, applied to the building in panels and pieces.\textsuperscript{314} Rather than organize space according to its “ratio,” the square takes on a purely ornamental role, a sign that is repeated ad absurdum. Whether

\textsuperscript{314} The core of the tower itself was constructed using a continuous slipform system – it was not made from prefabricated parts. Interestingly, the building has a hidden “functional” component: it acts as a chimney for the heating plant used for the fair grounds.
Fig. 3.94
Fig. 3.95
Fig. 3.96
organized into a grid on the building’s surfaces, or appearing at different scales with fractal persistence, the square signifies repetition.

Ungers also constructed the adjacent hall and galleria, both of which were similarly defined by the square. The hall is covered with a pattern of square tiles and windows, and cubical planters with spherical trees adorn the roof.\(^3\) The galleria is similarly clad on the interior, and its arched roof of members framing square glass panels, is finished in white steel [Fig. 3.97]. According to Ungers, the proportions of the hall were derived from the circle and the square, and were thus comparable to the section of the Pantheon.\(^3\) He also looked to the central arched spaces of the Crystal Palace and the arcades of the nineteenth century, however, evoking their fantasies of a continuous, global capitalist space. But he suppresses the optimization of the structure in favor of the ratio of geometric form. The galleria, dominated by heavy white steel members and a series of large supporting arches that are placed in the interior of the space, has little in common with those lighter engineering feats of the industrial age which were meant to blur distinctions between interior and exterior spaces.\(^3\) Once again, in trying to avoid the outward symbols of technological rationalization associated with the postwar period – lightweight structures like those of Otto, or prefabrication – Ungers turns to geometric Ratio. The space nevertheless loses its “identity” in the seamless continuity of the grid that covers and unifies all of these structures. The attempt to forge a sense of

\(^3\) Ungers claimed the façade was his most successful, and that it “reminded him of the Palazzo Pitti in Florence.” Ungers, “Die Kunst des Bauens,” 52.

\(^3\) Ibid., 51.

\(^3\) The components of the building were custom-made rather than using a prefabricated space-frame system. Ungers said that this decision stemmed from wanting the hall to be “more permanent,” and having the space be “legible” so that it “doesn’t just disappear in some sort of technological screwed-together and assembled constructions.” Ibid., 51–52.
Fig. 3.97
identity by appropriating archetypal forms within a vast industrial complex would turn out to enforce, rather than resist, its inclusion in the language of corporate postmodernism. When Ungers was later accused of repeating a familiar canon in this insistence on the square, he responded:

The forms determined through measure and number do not become an end in themselves, even if I am accused again and again of having the square always appear again. . . . For the superficial observer, the modules may look the same. When one looks at them generally, they will always be undifferentiated. But when one looks more closely, one will recognize the subtlety of the proportions.\(^{318}\)

The repetition of the square in the trade fairground projects is not simply an illustration of the tension between the logic of the image and the numerical logic of industrial repetition. It also illustrates the enacting of repetition to the point where it can no longer be defended as rational. Some critics, like Charles Jencks, associated this repetition with a sublime aesthetic quality: “like Aldo Rossi, Ungers repeats a pylon incessantly and hypnotically. In this building type, perhaps the sublime monotony is most appropriate, and it was, of course, a virtue in the nineteenth century.”\(^{319}\)

Perhaps “sublime” is not the right term, but a clue that these grids indicate something beyond the logic of rational production can be found in the core of the tower: in the center of the “glass house” where there is a mirrored, narrow atrium that rises nine stories with catwalks above [Fig. 3.98]. Here the “hard kitsch” of the tower


Fig. 3.98
achieves the level of awe. This space – described as a “secret cave,” a “place of illusion and vertigo”\(^{320}\) – is reminiscent of the rising empty core of the Deutsches Architekturmuseum, but its seemingly bottomless depths also recall the density of Berlin 1995. Here, however, there is an intensification of the repetition effect, a veritable mise en abyme created by the mirrored glass and claustrophobic space in which it is reflected. The opacity created by this interior façade is an affront to the ideology of transparency of postwar glass curtainwalls; its illegibility resists any potentially generic use. In this highly disorienting space, grids proliferate and multiply, and distinctions between vertical and horizontal, inside and outside, near and far, become confused. At this nexus, the geometry of the square breaks down. As they are distorted, the grids swell and buckle, creating unstable forms [Fig. 3.99].\(^{321}\)

If the building was to act as an organizing force, a Tower of Babel against the cultural entropy of globalization, here Ungers demonstrates the futility of “good form.” The human subject, who is also reflected in these mirrors, disintegrates and becomes detached from the system of proportions that is presumably based on its body [Fig. 3.100]. When they are turned into images – in this case, reflections – the uniform products of mass production similarly disintegrate and become detached from their function. Ungers’s participation in postmodernism is perhaps revealed less in his historicist decoration of banal industrial structures than in this spatial experiment. Here


\(^{321}\) The experience calls to mind Fredric Jameson’s famous description of the lobby of the Bonaventure Hotel in Los Angeles: “We do not yet possess the perceptual equipment to match this new hyperspace, as I will call it, in part because our perceptual habits were formed in that older kind of space I have called the space of high modernism.” Frederic Jameson, *Postmodernism, Or, The Cultural Logic of Late Capitalism* (Durham: Duke University Press, 1991), 38–39.
Fig. 3.99
Fig. 3.100
the exhaustive endgame of formal repetition – the endless parade of squares within squares within squares – finds its conclusion. In this case, the core of the building, almost like a nuclear core, intensifies this process until it implodes.
Epilogue: Frankfurt
Fig. 4.1
Bad form

On September 7, 1986, an sixty-six-ton granite version of Max Bill’s sculpture Continuity arrived at the Frankfurt river port and was transferred to a site in front of the recently completed Deutsche Bank headquarters [FIG 4.1]. The mirrored twin towers were the newest, and tallest, addition to the Frankfurt skyline, and their appearance coincided with the bank’s recent transformation into a global financial player. The towers were nondescript and heavily mirrored; they had been built on speculation by the Frankfurt firm ABB Architekten, possibly for a hotel, which partially explains their generic quality. Among locals, the buildings became known as “Soll und Haben” – Debit and Credit – as if they were the visual manifestation of the double-entry bookkeeping system that for Weber was the origin of capitalism. The crystalline shape of the base of the building also evoked eighteenth-century military fortifications, which was perhaps not a coincidence, considering the radical political atmosphere in Frankfurt at the time, characterized by the leftist terrorism of the Red Army Faction and demonstrations against real estate speculation.

Perhaps it was the bank’s recent expansion into the uncharted and unstable territory of global finance capitalism that inspired the choice of Bill’s monolith. In the 1960s and ’70s, Bill’s sculptures were a popular choice for the public collections of several European banks and insurance companies. In this context, Bill’s “good form” suggested both the continuity of the progressive ideals of the modern project and the

---

promise of stability, austerity, and moral integrity. But here the sculpture’s form was overshadowed. Even the monumental scale of Continuity – standing at a height of 4.5 meters – could not compete with the gleaming Deutsche Bank towers, an example of “bad form” if there ever was one. The dynamism and flow suggested by the sculpture was contained and stable, a feeling reinforced by the weighty material. The towers, by contrast, seemed flimsy, their excessively mirrored surfaces producing a disorganized continuity – a bad repetition – in their faceted reflections of each other and the city around them.

The placement of Bill’s sculpture in front of the towers marked the end of the belief that the Ratio of geometry could resist the formless rationality of capitalism. Frankfurt, which had been the scene of utopian rationalist architecture in the 1920s under Ernst May, as well as of a vehement critique of rationalism by the postwar Frankfurt School, would, had become the locus for the transformation of rationalism, calculation, and ethics into new and unprecedented contortions. The disintegration of the ethical project of rationalism coincided with the demise of the Frankfurt School. Theodor Adorno died of a heart attack on August 6, 1969, while hiking in Switzerland with his wife, Gretel. Adorno had been trying to recover from the growing psychological pressure that he had

---

2 Deutsche Bank apparently became aware of the outdated symbolism of Bill’s sculpture, and replaced it with a new signifier: sustainability. Bill’s sculpture was recently removed from the site and sits in a small adjacent park. The towers re-opened four years ago after extensive and costly renovations to turn the building into “one of the most eco-friendly high-rise buildings in the world.” Thomas Schäfer, Hesse’s Minister of Finance, commented: “Transparency and sustainability are expected in the financial sector just as they are in matters of financial policy.” Deutsche Bank press release, February 24, 2011, https://www.db.com/newsroom_news/archive/medien/re-opening-ceremony-of-the-deutsche-bank-towers-en-11648.htm. Last accessed October 2, 2016.
experienced in the face of the increasingly radicalized and hostile student movement in Frankfurt. He and several of his colleagues, including Jürgen Habermas, Alexander Mitscherlich, and Claus Offe, had initially supported the student movement during the increasingly undemocratic atmosphere in West Germany. Events contributing to this atmosphere included the arrest of the editors of Der Spiegel under accusations of high treason in 1962; the Grand Coalition of 1966, which united the country’s two largest opposing parties under a single government; the establishment of Emergency Laws in 1968, which made the government’s state of exception constitutional; and the Berufsverbot (Occupational ban) or Radikalenerlass (Anti-Radical decree) of 1972, which blocked anyone considered to have radical political views from working as civil servants or teachers. This reinstatement of Weimar and Nazi-era legislation was deeply alarming to the members of the Frankfurt School. In response, Adorno organized “Democracy in a State of Emergency,” a three-hour event broadcast on local television, featuring leading members of the Left.³

However, a deep rift had formed between the theoretical positions of Adorno and Habermas and the students’ hostile and disruptive action-oriented protest. According to Adorno, the rift was due in part to the “unreasonable” nature of youth protest: “I have nothing in common with the students’ narrow-minded direct action strategies which are already degenerating into an abominable irrationalism.”⁴ Adorno, who was working at the time on what would become Aesthetic Theory, viewed the autonomy of the artwork, and not recourse to the irrational, as a viable form of resistance against the domination

⁴ Quoted in ibid., 461.
of rationality. For Habermas, the student movement held the potential for establishing a new politicized public sphere, but the turn to action and violence in place of dialogue raised the specter of what he called “Leftist Fascism.”

Adorno in particular endured a great deal of psychological harassment from his students, culminating in a group of women baring their breasts and approaching him while mockingly performing an erotic dance during one of his seminars. The Institute for Social Research was occupied by students, prompting Adorno to call the police to have them removed. Just as the futility of the ethics behind Bill’s sculpture became clear when it was placed in front of a mirrored bank building, the Frankfurt School’s earnest dialectical approach to the problem of rationalism and violence suddenly seemed to belong to a different era.

While the student movement also targeted symbols of rationalist authority – the military, bureaucracy, technocracy – it did so through a libidinous and sometimes violent rejection of reason. This tendency would become clear in the actions of the heirs to the student movement: the Red Army Faction (RAF) and its splinter groups. In April 1968, the group bombed two department stores in Frankfurt on the Zeil shopping street; one bomb was left in a faux-Biedermeier wardrobe, leaving behind a spectacle of burned interior furnishing [FIG 4.2]. This act was carried out in protest of the West German government’s support of US actions in Vietnam, and was meant to demonstrate

---

5 Rolf Wiggershaus, Die Frankfurter Schule (Reinbek: Rohwolt, 2010), 130.
6 Müller-Doohm, Adorno: A Biography, 475.
7 After Adorno’s death, many of his protégés left Frankfurt. Habermas also left in 1971, and Horkheimer died in 1973. Soon after, the SDS (Sozialistischer Deutscher Studentenbund), and much of the student movement, were dissolved.
Fig. 4.2
Department store bombing by Red Army Faction, Frankfurt, April 1968.
the link between consumer capitalism and foreign imperialism. In an article entitled “Setting Fire to Department Stores,” Ulrike Meinhof offers her version of design criticism as she muses on the poor design and planned obsolescence of consumer goods. She argues that the act of destroying these objects was not itself revolutionary, as consumer society was already based on disposable objects. But she defends the progressive potential of what she calls a “desperate act,” as it makes evident that the rule of law is primarily there to protect property, not the people who produce commodities. Where the Ulm School’s reaction to the overproduction of consumer goods had been to economize and rationalize through form, in this violent act form was replaced by performance, through the destruction of objects.

The RAF described these acts as those of the “urban guerilla,” a term they borrowed from Latin American revolutionaries. Frankfurt became the chosen metropolis for these acts as it provided a sympathetic political milieu of young leftists, a large number of anonymous postwar high-rises to serve as safe houses, and a density of targets. In 1972, three bombs went off in the headquarters of the US Army in Frankfurt in the Westend, housed in a building designed by Hans Poelzig for IG Farben in 1928–1931. With this act, both Nazi scientific-industrial violence and American imperialism in Vietnam were targeted at once. In 1977, Jürgen Ponto, then the head of the Dresdener Bank, was murdered at his home in a suburb of Frankfurt. In 1989, Alfred Herrhausen,

---

10 Ibid.
12 Today the building is occupied by the Johann Wolfgang Goethe University.
the chairman of Deutsche Bank, was killed by a roadside bomb while on his way to work in an armored Mercedes.

These acts suggest that Bill’s monolith can also be viewed as a defensive object. The milieu in West Germany had changed after 1968, and it seemed that the power of calculation could no longer ensure the reasonable and rational society it had promised in the postwar decades. With the new movement of computation into more aspects of daily life, perhaps most notably the financial transactions taking place in Frankfurt, calculation was no longer a stable source of rational decision-making. It is no wonder that the “innocent” geometry of Bill’s sculpture would symbolically serve as an anchor – a brick to the balloon – even if its sixty-six tons were an affront to Otto’s dictum of “lightness against brutality.” It was an object that could not be destroyed or easily reproduced, a symbol of West Germany’s ongoing stability and power. Its presence in front of the Deutsche Bank towers suggested that the ongoing dialectic between the rational and irrational had become irrelevant.

Architecture in Autumn

The social and ethical project of modern architecture had already experienced a crisis of legitimacy by the time the Deutsche Bank towers were built.\(^\text{13}\) The presence of

\(^{13}\) Jürgen Habermas begins *Legitimation Crisis* with a brief and insightful genealogy of crisis. Habermas points to the medical origins of crisis, describing it as an experience “that cannot be separated from the viewpoint of the one who is experiencing it. . . . An objective force that deprives a subject of some part of his normal subjectivity. To conceive of a process as a crisis effects a liberation of the subject caught up in it.” The most relevant issue here is the limited viewpoint of subjects experiencing a historical “crisis” and whether there is an awareness of its larger systemic causes. Jürgen Habermas, *Legitimation Crisis*, trans. Thomas McCarthy (Boston: Beacon Press, 1975), 1–7; 1. The German edition is Jürgen Habermas, *Legitimationsprobleme im Spätkapitalismus* (Frankfurt am Main: Suhrkamp, 1973).
conservative and provincial elements in the discourse of architecture lingered long after the end of the war, with painful consequences for the formation of a post-war avant-garde. Additional defeats included the closing of the Ulm School for Design in 1968, a backlash against the proliferation of generic and oppressive modern architecture of reconstruction, and the influence of conservative postmodernists by the 1980s. The city, as the physical manifestation of layers of history, destruction, and reconstruction, became one of the stages on which the demise of modern architecture was played out.

In the 1970s, an ideological and aesthetic struggle took place regarding the question of Sanierung (the extraordinary corporeal term for building renovation). Cities literally became battlegrounds over historical preservation, housing rights for squatters, “the right to the city,” housing shortages, protests against modernization and development, and what to do with the remains of Nazi architecture.

While postwar modernist architecture had been perceived as being in crisis at least since the late 1960s, by 1977 it was officially pronounced dead or deserving the gallows.

A Spiegel article, entitled “Architects: Box-makers in a Hairshirt” (“Architekten: Kistenmacher im Büßerhemd”), begins as follows:

Never before in history was the lifework of a generation of builders so unanimously vilified as the failed performance of German architects during reconstruction. The year 1977 became the year of reckoning – but also of self-criticism. Invariably, architects placed the blame on the plight of the state and of society. Now, in the valley of the downturn, they confess their guilt and vow that they will better themselves. Those in the know remain skeptical.15

---

15 “Nie zuvor in der Geschichte wurde das Lebenswerk einer Baumeister-Generation so einmütig geschmäht wie die Fehlleistung der Deutschen Architekten beim Wiederaufbau. Das Jahr 1977 wurde zum
The same issue of *Der Spiegel* covered the series of violent events that took place in West Germany in late 1977, known as the German Autumn.\(^{16}\) The most dramatic of these were the kidnapping of the industrialist Hanns-Martin Schleyer by the Red Army Faction, the hijacking of the Landshut Lufthansa airliner by terrorists, and the violent deaths and public funerals of Schleyer and the main members of the RAF. A wide field of shock waves – aesthetic, historical, and political – emanated from the repressive atmosphere of the state under the threat of terrorism, and affected all spheres of life.\(^ {17}\)

Just as the retreat of the state into a militant and absolute position spoke of the failure of West Germany’s democracy, West German architects were seen as having failed to fulfill the potentials of reconstruction to create modern, democratic cities. [Fig. 4.3] Suddenly architects, too, found themselves positioned behind a sort of rampart.

The *Spiegel* article continues:

Modern architecture is dead. “Concrete” has become an emotional word: the synonym for everything bad in this world. People are fleeing the new cities, their eager turn towards the old became a withering judgment on the lifework of a generation of architects.\(^ {18}\)
Architekt

Spekulant
Der Spekulant kauft auf, vertreibt Mieter, zerstört Häuser und Stadtteile. Er baut gewinnbringend, nicht nutzbringend. Er nutzt die Ziellösigkeit von Politik und Verwaltung für sein Ziel: Profit. Er ist ein gefährlicher Stadtzerstörer. Muß das so bleiben?

Finanzier
Der Finanzier will durch Bauen nur Geld machen. Architektur ist für ihn nur Ware. Er hat nicht gelernt, daß das Ziel nicht sein größter Gewinn, sondern richtige Wohnformen für alle, die menschengerechte Stadt heißt. Muß das so bleiben?

Bauherr
Der Bauherr als Einzelperson kommt kaum noch vor. Stattdessen entziehen sich Gremien – mit zeitlich begrenzter Verantwortung – der Aufgabe, als Bauherr Partner des Architekten zu sein. Der Ersatzbauherr, der Baubetreuer, „organisiert“ als nicht direkt an der Aufgabe interessierter Planung und Baudurchführung, bis von Qualität der Planung keine Rede mehr sein kann. Muß das so bleiben?

Fig. 4.3
Gunter Rambow, posters for the Federal Chamber of German Architects (BAK), 1971.
As the article mentions, the population of West German cities shrunk in the 1970s and people recoiled from the new urban districts. The government’s focus on new construction was to the detriment of historic buildings, many of which became derelict and were in danger of being demolished. The work of “a generation of architects” was declared dead.

Modern architecture was seen to have failed society, betraying its promises of progressive and emancipatory living and work spaces. But its failure was also aesthetic. The rejection of modernism resulted in a retreat into the past, a nostalgic unearthing of the recently buried architectural styles of the eighteenth and nineteenth centuries. The destruction wrought by the bombings in European cities has often been described as being comparatively less devastating than the greater damage caused by modernization. To postmodernists, modernization was yet another act of war, which had left a pile of fragments from which to salvage a future city.

The question of architecture’s demise was the subject of the April 1978 issue of ARCH+, which took as its main theme “The ‘Death of Architecture’ and the Response of Architects” (“Der ‘Tod der Architektur’ und die Antwort der Architekten”). In the introduction, editors Nikolaus Kuhnert (a former student of Ungers) and Marc Fester write:

Architecture seems to have lost its objective, and the international architectural avant-garde has been reassigned to a task once frowned upon: the design of monuments, “artificial constructions of collective memory suspended from life.

---

19 “Just as in the first years after the war scrap-metal thieves stole copper and brass from ruins and construction sites, today nostalgic plunderers are raiding districts under restoration looking for old plaster and iron ornamentation.” (Ähnlich wie in den ersten Nachkriegsjahren Buntmetalliebe aus Ruinen und von Baustellen Kupfer und Messing klauten, gehen heute in Sanierungsgebieten nostalgische Plünderer auf Raubzug – auf der suche nach altem Zierat aus Stuck und Eisen.”) Ibid.
praxis.” They must also, of course, artificially (re)construct the collective memories *themselves*. The self-dissolution of bourgeois culture in the progressive advancement of capitalism constantly erases its own traces; collective memory retains the experience of hegemony and this must therefore be denied along with its existence. 20

Architecture had, by the 1970s, become a discipline without purpose. With the loss of legitimacy of the scientific approach, architectural rationalism, like that of Ungers, became a tool of pure formalism used in the service of designing monuments. As a result, architecture became an autonomous art of formal rule-playing. While rationalist postmodern interventions attempted to bring some sort of order into the chaos of the city, they were also without social content. The idea of architecture’s “collective memory,” which Ungers had been promoting during that time, is revealed to be a fabricated memory, with the effect of obscuring or beautifying the unlivable conditions of fractured capitalist space. Or, alternatively, it covered over the effects of instrumental rationality on the built environment.

*From calculation to speculation*

The Deutsche Bank towers were only the latest in a number of high-rises that had been built in Frankfurt since the 1960s. 21 Frankfurt had long been a financial center (its stock exchange dates to the seventeenth century), but in the late 1960s, an increasing number

---


21 Eleven buildings over 100 meters tall were built by 1984. Phillip Sturm et al., *Hochhausstadt Frankfurt.*
Fig. 4.4
“Fingerplan” for the Westend, 1967-68. Institut für Stadtgeschichte, Frankfurt.
of banks and insurance companies arrived to establish headquarters and trading centers. This architecture represented a more aggressive demonstration of West Germany’s postwar wealth, without efforts to compensate via formal austerity or transparency. Frankfurt’s towers were the result of both planning initiatives on the part of the city and speculation on the ground. The controlled, simulated games of urban optimization that had been the stuff of cybernetics fantasies of the 1960s were replaced by a liberalization of the urban plan.

One of the most controversial proposals was the so-called Fingerplan of 1967-68, which called for finger-like expansion along several axes of the city, including the small residential streets of Jugendstil houses in the Westend [FIG 4.4]. The city’s planning department did not officially rezone the Westend, fearing public resistance. Instead, it internally marked a few areas ("fingers") where exemptions to development would be granted, but only for buildings on large lots.22 The outcome was that speculators bought up groups of houses next to one another, with financing provided by the banks [FIG 4.5].23

This new atmosphere in Frankfurt and other West German cities was the result of several pieces of legislation. One was a 1960 law calling for the end of the policy of the Wohnungzwangswirtschaft (state-controlled housing economy), which had been established to regulate the market for postwar housing due to its severely short supply. This was the first time since 1918 that such risky real estate speculation was even

23 “Without the banks, the speculators would not have even been able to buy a garden shed.” Alexander Hoffmann, “Das Abenteuer Frankfurt,” Frankfurter Rundschau, November 5, 1977.
possible in Germany.\textsuperscript{24} In 1967, a law established in 1932 that regulated interest rates for banks became ineffective, departing from a long-standing conservatism in granting mortgages in Germany.\textsuperscript{25} The local effect of such laws was visible in the Westend, where property values rose by 350 percent between 1962 and 1970 and mortgage amounts increased by 500 percent.\textsuperscript{26} During the short and intense period of buying properties in the Westend, a total of 1 billion DM in credit was granted to speculators, an amount equal to around $1.8 billion today.\textsuperscript{27}

This new form of calculation represented a form of excess that was a departure from the sort of number-crunching that had defined the postwar ethics of economy, austerity, and optimization. The very notion of an ethical project of calculation had lost legitimacy. This was perhaps most obvious in the controversial role that Jewish reparations and anti-Semitism came to play in the battle for the Westend. Frankfurt’s high-rises were from the beginning tied to the history of its former Jewish community. The city’s first International Style high-rise, the Zürich-Haus (1958–1960) on Bockenheimer Landstrasse at the Opernplatz, was built by an insurance company on the site of the large Rothschild Park, which had been the property of the Jewish Frankfurt banking family in the nineteenth century. As part of a reparations agreement, an exemption was made for the family to develop a tower on part of the site, in exchange for maintaining the Rothschild Park as a public space.\textsuperscript{28} In this process, an act of \textit{Schuld} (guilt) was combined with an act of \textit{Schuld} (debt): a conflation of ethics and credit.

\textsuperscript{24} Führer, \textit{Die Stadt das Geld und der Markt}, 6.
\textsuperscript{25} Ibid.
\textsuperscript{26} Ibid., 110.
\textsuperscript{27} Hoffmann, “Das Abenteuer Frankfurt.”
\textsuperscript{28} Phillip Sturm et al., \textit{Hochhausstadt Frankfurt}, 170.
An association was formed in the public mind between high-rise development and Jews who had returned to Frankfurt after the war. This association took on an openly anti-Semitic tone in the 1970s when the leftist protest groups of the Häuserkampf began to blend their accusations against real estate speculators with the language of anti-Semitism.\(^{29}\) Ignatz Bubis, a prominent developer who was responsible for some of the projects in the Westend, became one of the most visible targets of the groups. Bubis was at the center of a notorious battle over a block of four houses at the corner of Bockenheimer Landstrasse and Schumannstrasse, which happened to be located on the same block as the Institute for Social Research. The claims to property rights of many Westend homeowners were based on their acquisition of properties when the area’s Jewish community living there was dispossessed of them after 1937.\(^{30}\) Many of the elderly postwar occupants of the neighborhood had profited from this forced exodus, and sold their properties to the new speculators at great profit. Some sold properties to real estate holding companies that became landlords to what quickly became derelict houses.

By the late 1960s, students and immigrant families “temporarily” lived in many houses in the Westend that had been sold for development or purposefully neglected.

\(^{29}\) When I visited the city archives of Frankfurt to consult the files of the Aktionsgemeinschaft Westend, the largest protest organization involved with the anti-development movement, I discovered that a large number of files had been removed from the public archive due to their anti-Semitic content. I was told that these could only be viewed with special permission of the organization.

\(^{30}\) Michael Schmitt, “Der Aufstand der Gegenwart” – Ereignistheoretische Analyse der Kontroversen um Rainer-Werner Fassbinders Skandalstück “Der Müll, die Stadt und der Tod” (Magisterarbeit, Friedrich-Alexander-Universität Erlangen-Nürnberg: Institut für Theater- und Medienwissenschaft, 2010), 45. For instance, Siesmayerstraße 6, which was occupied by protesters for over ten years beginning in 1971, was owned by a Jewish banker in the 1930s before it was taken over by an SS major, and was later used to house the homeless immediately after the war. Häuserkampf I: Wir wollen alles – der Beginn einer Bewegung, Bibliotek des Widerstands, vol. 21 (Hamburg: Laika Verlag, 2012), 55.
Fig. 4.5
Speculation properties in the Westend, 1972.
Institut für Stadtgeschichte, Frankfurt.
Einladung zur kostenlosen Stadtumfahrt

TAGE DER OFFENEN TÜR
1974

BANKFURT AM MAIN

Sie sehen:
- Einige der 5.000 leerstehenden Wohnungen (neu und alte)
- Einige der vielen überfälligen Gastarbeiterhäuser
- Notunterkünfte in Frankfurt (a)
- Vorläufige Mieten von 100-200 DM: durchschnittliche Höhe zu schätzen.

Sie haben auch eine Wohnung mit Küche und Bad für DM 120,- pro Monat.

Die Arbeitnehmer und die Stadt werden diese Situation in Frankfurt (a) nicht übersehen!

Deutsche Autobahnen erwerben aus unserem Informationsservice.

Das Auto an einem der offenen Türen abstellen.

(Anm.: Jeder Besucher bekommt eine Schrauben- sitzung in Frankfurt (a) gegen 11 Uhr.)

Zeit der Fahrt: 45 Minuten

Die Mitarbeiter werben für die Stadt und deren Informationsservice.

Wenn Sie sich nach dieser Stunde noch nicht getrauen, zu kommen, dann auch viele offene Türen zu schließen.

---

Fig. 4.6
Poster advertising a “tour” of derelict housing in Frankfurt, 1974. Institut für Stadtgeschichte, Frankfurt.
Fig. 4.7
The neighborhood thus became the center of confrontations between speculators and politicized students [FIG 4.6]. The houses on Bockenheimer Landstrasse and Schumannstrasse were occupied by students in 1971.\(^\text{31}\) Activist Daniel Cohn-Bendit, who lived in the Westend, called for further occupations of houses, and was involved in the creation of a *Häuserrat* (housing council) that in 1972 held a “Tribunal against Speculators and Profiteers” in the Frankfurt University cafeteria.\(^\text{32}\) On August 23, 1973, the Westend high-rise known as the Selmi Hochhaus, after the Persian developer Ali Selmi, caught fire. The crowds in the streets below cheered [FIG 4.7].

Bubis owned the occupied properties on Bockenheimer Landstraße, and planned to build a tower on the site.\(^\text{33}\) On the night of February 21, 1974, the houses were invaded in a military-style raid by the police, using water cannons, floodlights, and demolition equipment [FIGS 4.8 and 4.9]. All of the residents were arrested, and the houses were destroyed by the next afternoon. The police used chains to secure the ruins, as if they were afraid that “the piles of rubble could be brought back to life.”\(^\text{34}\) The proposed tower was never built, and for over a decade the site remained a “lunar landscape.”\(^\text{35}\)

Development in the Westend continued throughout the 1970s even though residents were against it and an official land-use plan had been drawn up that no longer allowed

\(^{31}\) Joschka Fischer is said to have occupied one of these houses at the time. *Häuserkampf I*, 48.

\(^{32}\) Manfred Kittel, *Marsch durch die Institutionen?: Politik und Kultur in Frankfurt nach 1968*, Quellen und Darstellungen zur Zeitgeschichte, vol. 86 (Munich: De Gruyter Oldenbourg, 2011), 51. The Auschwitz trials had been held in Frankfurt from 1963 to 1965. The choice of staging a mock juridical process seems relevant in this context, perhaps as part of an effort to formalize moral accountability.

\(^{33}\) According to Bubis, it was the city planning office that encouraged him to acquire even more of the surrounding houses, and to extend the tower from sixteen stories to twenty-eight. “Wir haben eine Leiche im Keller. Ignatz Bubis und Daniel Cohn-Bendit über Juden in Frankfurt und den Fassbinder-Streit,” Der Spiegel no. 46 (November 11, 1985): 24–32.

\(^{34}\) *Häuserkampf I*, 51.

\(^{35}\) Ibid., 54. In the end, and in part because of these difficulties, Bubis built only one high-rise in Frankfurt. “Wir haben eine Leiche im Keller.”
Fig. 4.8
“Bubis is the Greatest” grafitti near the Bockenheimer Landstraße squat, 1974.
Fig. 4.9
Eviction of squatters at the corner of Bockenheimer Landstraße and Schumannstraße, Frankfurt, February 1974.
it. The city allowed development to continue because it did not want to pay for claims resulting from the losses to developers.  

Dark stars

The set of circumstances that defined Frankfurt in the 1970s – real estate development and speculation, the power of banks, political violence and protest, leftist movements – were the subject of several depictions of the city. The old theme of uninhabitability returned in Gerhard Zwerenz’s 1973 Die Erde ist Unbwohnbar wie der Mond (The Earth is as uninhabitable as the moon), a violent and dystopian novel set in Frankfurt (described as “a formless, tumescent city of changing value”). The novel is centered on a Jewish real estate developer – clearly based on Bubis – whose portrayal by Zwerenz drew accusations of anti-Semitism. The controversy over the work exploded with Fassbinder’s 1975 adaptation of the novel into the play Der Müll, die Stadt, und der Tod (Garbage, the city, and death). Fassbinder depicts a series of paranoid and sadomasochistic relationships between different elements of Frankfurt’s upper- and underclass, including a Jewish real estate speculator (The Rich Jew), a competing anti-Semitic developer (Hans von Gluck), a prostitute (Roma B.), and a transvestite who is a former Nazi (Müller).

Whether Fassbinder could be accused of “leftist fascism” in his use of anti-Semitic

36 Sturm et al., Hochhausstadt Frankfurt, 167.
38 A film version was also made: Schatten der Engel (1976). The play could not be staged in Frankfurt due to heavy protests from the Jewish community.
stereotypes was the subject of numerous debates, which are too complex to cover here.

What is clear is that his work reflects the dissolution of clear ethical boundaries as they had been established during the era of reconstruction, revealing repressed and virulent energies among all parts of West German society. Frankfurt was the stage set where these dark forces were unleashed. In a melancholic monologue delivered to the prostitute (Roma B.), the Jewish speculator describes the forces of Schuld – both in terms of capital and guilt – that drive his actions:

I buy old houses in this city, tear them down, build new ones, and sell those at a profit. The city protects me, it has to. Besides, I’m a Jew. . . . Should my soul answer for the decisions of others, that I only carry out with the profit I need, in order to afford what I need? What do I need? Need, Need – strange, when you say a word often enough, it loses its meaning, which is only random anyway. The city needs the unscrupulous businessman who allows it to change.

The suggestion that speculation takes place without meaning, without need or purpose, indicates that it is self-perpetuating. Hans von Gluck, his competitor, gives a parallel but anti-Semitic monologue in which he plays on the various meanings of Schuld (blame, guilt, and debt): “He sucks us dry, the Jew. Drinks our blood, and puts us in the wrong because he is a Jew and we carry the blame. . . . And the Jew is to blame because he

---

39 According to Thomas Elsaesser, “The acts of violence during the 1970s, complexly motivated, but challenging the very moral basis of the West German reconstruction effort, seemed to have further hardened the resistance of the parental generation to cease disavowing or to admit to remorse.” Thomas Elsaesser, Fassbinder’s Germany: History, Identity, Subject (Amsterdam: Amsterdam University Press, 1996), 177.

makes us guilty, because he is there.”

Michael Schmitt has argued that Fassbinder’s critique was primarily aimed at the banks and developers; because Jews were considered “untouchable,” they were instrumentalized as speculators so that developers could carry out quasi-legal construction. Perhaps even more to the point, Fassbinder’s provocation is that perhaps there never were clear ethical boundaries to define accountability, judgment and guilt, reason and unreason. Fassbinder shows that under capitalism this false righteousness collapses, and that the other (in this case, the Jew) is once again made into the scapegoat.

This set of circumstances in Frankfurt was also depicted by Alexander Kluge in the 1974 film In Gefahr und größter Not bringt der Mittelweg den Tod (In danger and dire distress, the middle of the road leads to death). After leaving Ulm and the film department that he had co-founded there in 1968, Kluge returned to Frankfurt, where he had spent his student years, and documented the state of the city with a precise and critical eye. Frankfurt appears as a city dominated by policemen and the managerial class, with an increasingly tense atmosphere. There are images that again suggest the theme of an uninhabitable planet: news footage of a flood in West Germany with the commentator calling for a “Noah’s ark,” flooded streets and houses, a shot of the moon.

43 In 1977, Fassbinder was also planning a film interpretation of Gustav Freitag’s 1855 novel Soll und Haben (Debit and Credit), which was meant to show the origins of anti-Semitism in the German bourgeoisie of the nineteenth century. Elsaesser, Fassbinder’s Germany.
44 In Gefahr und größter Not bringt der Mittelweg den Tod (In danger and dire distress, the middle of the road leads to death), dir. Alexander Kluge and Edgar Reitz, 1974.
We see repeated shots of high-rises emerging over the old city, a soccer game with nervous policemen patrolling the stands, airplanes from the nearby airport against the skyline, and protesting students. The imminent confrontation between the police and the occupiers is foreshadowed in long scenes depicting the kitschy formality of a policeman’s banquet, with policemen parading and singing songs and chorus girls marching in unison, contrasted with scenes of the squatters in the Westend barricading their building.

The last portion of the film is dedicated to documentary footage of the squatters at the Bockenheimer Landstrasse being forcefully evicted and arrested and the buildings being demolished in the early hours of the morning. The film focuses on two fictional outsider protagonists – a pickpocket (Inge Maier) and an East German spy (Rita Müller-Eisert). Kluge’s protagonists, incredibly enough, are part of these documentary scenes. Inge Maier is seen running with her suitcase past the police in their riot gear and stays in the barricaded house at one point. Rita Müller-Eisert runs back to her apartment and packs up her books on Marx. Kluge managed to integrate his fictional characters into a real political and historical event, lending the historically “real” an allegorical quality.

One of the most enigmatic and significant moments in the film suggests that these events were still dictated by a larger logic of calculation. Rita is shown sneaking into a convention for astrophysicists where the discussion is devoted to the subject of dark stars. Dark stars are objects with an enormous amount of gravitational force; they are invisible because they do not allow light to escape. This is an apt metaphor to describe a remote organizational force (of capital, or power) controlling the city. As Rita takes
Fig. 4.10
Stills from In Gefahr und größter Not bringt der Mittelweg den Tod (In danger and dire distress the middle of the road leads to death), dir. Alexander Kluge and Edgar Reitz, 1974.
notes, one of the scientists begins to write an equation on a blackboard [FIG 4.10]. With
the voiceover of the scientist explaining the complex mathematics, Kluge cuts to scenes
of nighttime aerial bombing as viewed from the perspective of an airplane, implying an
underlying, abstract violence; thus, he links the will to calculate distant phenomena
taking place in the universe with the will to power expressed in the calculation of aerial
bombing. From this pairing, Kluge cuts to found footage of an interview with “young
entrepreneurs,” which is conducted in a nearly incomprehensible language of
management-ese. When asked what qualities an entrepreneur must have for success,
one of them responds: “Diligent, clean, honest, open.” The connection between
calculation and ethics is clear: calculated bombing, like capitalist entrepreneurship, can
be justified if it is done with honesty and openness.

***

The “irrational” events and configurations of power in Frankfurt after 1968 were the
result of a different sort of calculation, one that suggested that limits could no longer be
(and perhaps never were) set on forces of rationalization. In this dissertation, we have
seen how in the architecture of the 1960s and ’70s, calculation was a device for
simulations and models, as well as for formal and structural games. In the urban
development of Frankfurt, however, the calculation of risk was a real economic game
played at the scale of the city. The city was a reflection of the globalization, speed, and
instability of international financial speculation. The computerization of stock markets,
including the Frankfurt Stock Exchange, intensified the speed of transactions and the
likelihood for volatility.
Fig. 4.11
Model used for study of the influence of high-rises on city climate, Frankfurt, 1975. Institut für Stadtgeschichte, Frankfurt.
Fig. 4.12
Frankfurt smog study, June 1975. Institut für Stadtgeschichte, Frankfurt.
Frankfurt may have been the city in West Germany that came closest to the fantasies of a dense, global city projected by Unger’s students in the 1960s. But in place of a controlled and simulated city on a grid, or a plan that could be produced by algorithm, it became a city governed by the powers of the incalculable sublime of markets. After the political turmoil surrounding development and speculation in the early 1970s, city planners took more cautious measures in order to mitigate new risks. In 1975, a test model of the banking quarter in Frankfurt was built and placed inside a wind tunnel in order to study its microclimatic effects [FIG 4.11].\footnote{The Arbeitsgemeinschaft Umweltschutz Frankfurt Magistrat studied the influence of high-rises on wind and climate by using both a model in a wind tunnel and a computer to calculate and plot the results. “Die City steht im Windkanal. Test einer Arbeitsgruppe,” Frankfurter Rundschau no. 70, March 24, 1975.} A computer was used to calculate smog accumulations [FIG 4.12]. The calculation and simulation of these environmental conditions provided a means of sublimating the effects of the social and political upheavals that were taking place. In 1983, under the new conservative CDU government, towers were planned for Frankfurt again, according to a masterplan by Albert Speer Jr. In this context, Unger proposed not only the Messe Torhaus, but also a postmodern planning concept for CityWest based on his idea of the city-in-the-city. This proposal was a last attempt at a rationally planned European city in miniature, in resistance to the forces of globalization.

In Frankfurt, calculation was used in the service of excess, without purpose or limits. The results were reflected in the excess of riots, derelict properties, real estate bubbles, bombed shopping centers, towers burnt or unbuilt, reflecting façades, and postmodern ornament. Excess had threatened the optimization and economy of form in the work of
Otto. It was also manifest in the redundancy and repetition seen in the work of Unger.

Perhaps excess had always lain at the heart of rationality, and is what contributed to its appeal. In 1968, Habermas warned of the “glassy” background ideology of the fetish of science as being “more irresistible and farther-reaching than ideologies of the old type.”46 As the period of scientization in West Germany waned, this ideological aspect became clearer. I would disagree, however, with Habermas’s characterization of technocratic consciousness as “the repression of ‘ethics’ as such as a category of life.”47 I would posit that the ideology of the rational turn was so potent precisely because it was legitimized on ethical grounds. Ethics, even of the false kind, were key to the ideological power of the fetish of science.

The events in Frankfurt were also a sign of the splintering and blurring of rationalities. It became more difficult to distinguish between forms of reason and rationality in the context of real estate and finance, the Frankfurt School philosophy of reason and rational discourse, and the irrational nature of finance markets and the behavior of students, protestors, and speculators. The architectural examples discussed in this dissertation reveal a similar dissolution of differences and boundaries. Rationality had long ceased to be used to banish myth or dominate nature. Perhaps in fulfillment of Habermas’s warning, rationality was also no longer driven by ethical imperative. It had become a new type of self-driven rationalism, without the intervention of reason or human decision.

47 Ibid., 112.