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**BIOTECHNIQUES:
REMARKS ON THE
INTENSITY OF
CONDITIONING**

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PERFORMANCE DESIGN (AGAIN)

In 1967 *Progressive Architecture* magazine published a special issue on “performance design,” explaining it as a set of practices that had emerged from general systems theory, operations research and cybernetics thirty years earlier, at the end of the World War II.¹ The editors described its practitioners as “systems analysts, systems engineers, operations researchers” and argued that it was a more “scientific method of analyzing functional requirements,” which involved “psychological and aesthetic needs” as well as physical measures of performance. The interest in performance clearly draws on the long history of determinism and functionalism in architecture, understood in large part through the mechanical and organic analogies of the late nineteenth and early twentieth centuries. It is perhaps fitting at the outset to recall that Le Corbusier’s famous description of a house as “machine for living” was his adaptation of the phrase that he and Ozenfant had earlier used to describe painting, a *machine à émouvoir* — a machine for moving emotions. All the objectivity of functional methods depends on the assessment of subjective needs, of quantified and temporarily stabilized desires.

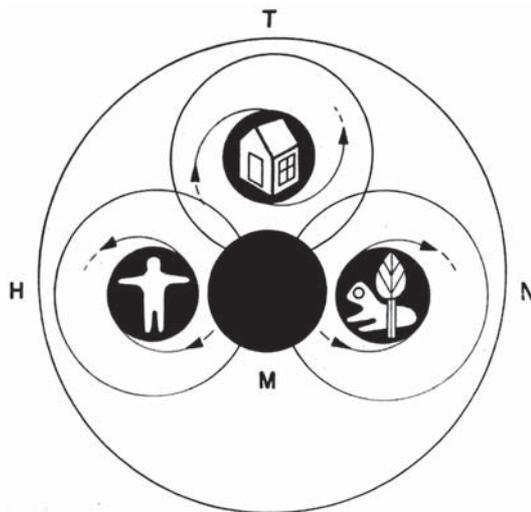
To enter the discussion of performance design (again), this chapter examines the environmental performance of contemporary buildings. In the last half-century, buildings have become bigger in a new and bulked-up sense; they enclose ever larger volumes, which have been engineered for ever greater comfort and productivity. This bulking-up of modern construction has been made possible by its systems of conditioning — air conditioning, artificial illumination,

plumbing, electric power, telecommunications, and now networked information flow — which allow them to assume radically new scales and configurations.

To describe the mechanisms underlying the intensification of conditioning, I have adopted Frederick Kiesler’s provocative term “biotechniques,” with all its implications of equivalence between biology and technology. In the current context, biotechniques might best be described as the biological analysis of technological systems. They represent the collapse of the mechanical and organic analogies in architecture within the powerful concept of complex system dynamics. The intensification of conditioning operates equally on buildings and their inhabitants, literally conditioning them to want and then “need” the new services, and steadily escalating the levels of comfort and convenience they expect. That process has its thresholds of intensity, beyond which results can be both unexpected and difficult to reverse.

BIOTECHNIQUES

The term “biotechniques” was coined by the architect Frederick Kiesler in 1939 to indicate the equivalence between biology and technology.² He was affiliated with Buckminster Fuller’s Structural Studies Associations at the time and he used the term to distinguish his thinking from the more direct imitation of biological forms or processes, which today we call biomimicry, and was being called biotechnics by Patrick Geddes, Louis Mumford and Karel Honzik in Kiesler’s time.³ As he observed in an acerbic footnote, “[the Crystal Palace] was built by Paxton in 1851 in imitation of the African water lily’s foliate, with its longitudinal and transverse girders. This was an essentially romantic attempt to fashion a man-built structure by literal application of nature’s design principles.”⁴ Instead, Kiesler based his term on a concept he called “correalism”, by which he meant “the dynamics of continual interaction between man and his natural and technological environments.”⁵ I do not mean to claim Kiesler as the originator of these ideas — they were being explored in many fields — but he saw earlier than others how radical their implications were for architecture. Those implications derived from three basic propositions: first, that technology was based on steadily evolving human needs; second, that despite their origin in human needs, technological systems develop according to their own “laws of heredity;” and third, that the final criteria of technological design is not technical performance, but human health (figure 4.1).



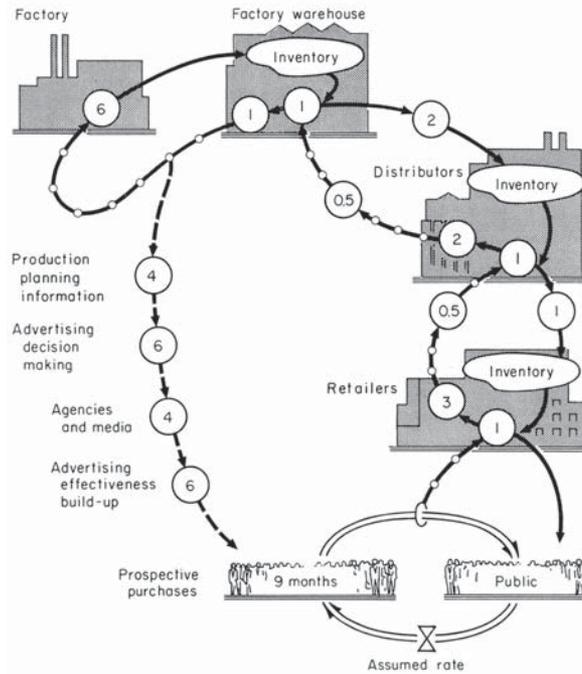
4.1
“Man = Heredity + Environment. This diagram expresses the continual interaction of both the total environment on man and the continual interaction of its constituent parts on one another.” From Kiesler, “On Correalism and Biotechnique.”⁶

In my adapted usage, biotechniques are any method by which buildings are examined as participants in dynamic, “living” systems, whether of the biosphere or of financial, technical or social systems. They may or may not produce results that look biological, and they were initially deployed metaphorically to explain or understand how buildings or artifacts changed or adapted through time. Such biological analogies became more substantial with the introduction of devices and systems that literally flowed or operated — plumbing, electricity, heating, ventilation and lighting — especially with the introduction of feedback techniques, like

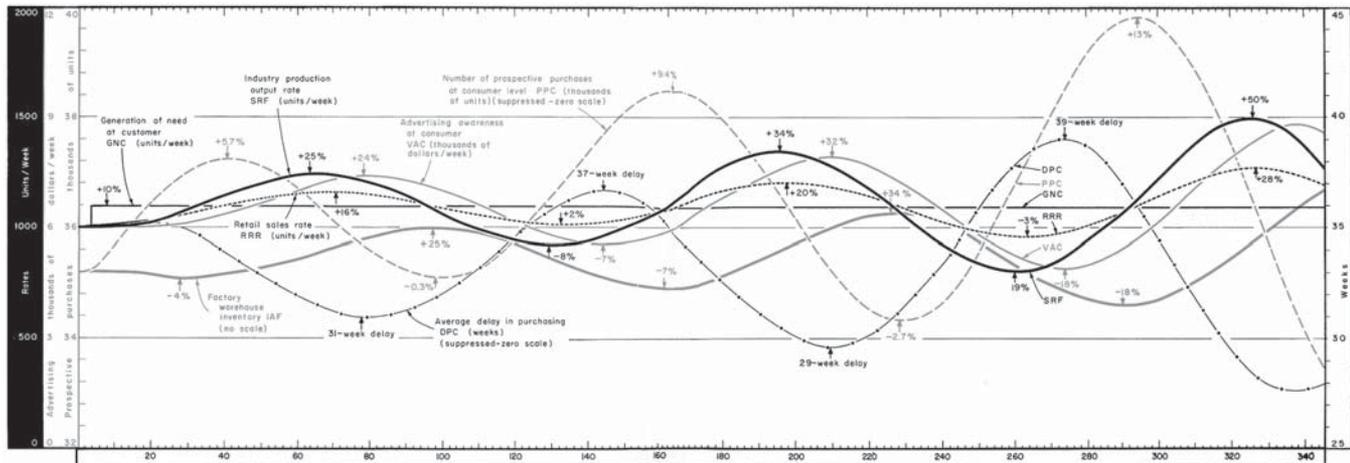
thermostats, CO₂ sensors and daylight monitors, that enabled building systems to adapt and respond independently. As these elements were fixed in products, codes, standards and procedures, the building of flows and its feedback devices became the legal norm, while new techniques emerged to understand and regulate the dynamic aspects of design.

Such biotechniques became ever more important in the decades after World War II, as cybernetics and general systems theory were applied to organisms and artificial systems alike, rapidly collapsing the difference between mechanical and organic analogies, and making both increasingly operative. This is a critical point. At the moment that living organisms (or ecologies) are understood as kinds of feedback systems, then the difference between mechanical and organic systems virtually disappears. And almost from the beginning of systems research, natural and artificial systems were analyzed together.⁷ The career of Jay Forrester, who developed the World III model used in *The Limits to Growth*,⁸ exemplifies this process. After early work on air defense systems, he focused his efforts on *Industrial Dynamics*,⁹ evaluating the dynamic problems inherent in industrial production, sales and advertising, such as seasonal cycles, countercyclical policies, price stability, sensitivity and unexpected responses to all manner of events, actions and decisions. Through a chance meeting with an ex-mayor of Boston, he applied the same techniques to *Urban Dynamics*,¹⁰ and then after a conversation with the Club of Rome applied them to *World Dynamics*,¹¹ exploring the interaction between population, industrialization and pollution. This kind of world and climate modeling was central to the developing awareness of global environmental effects, making the construction and authorization of such models vital (figures 4.2 and 4.3).

4.2
Simulation model of
“production-
distribution system,”
from Forrester,
*Industrial
Dynamics*.¹²



4.3
Amplified oscillatory
response of sales and
factory inventory to
the introduction of a
feedback mechanism
in advertising, from
Forrester, *Industrial
Dynamics*.¹³



There have been many criticisms of these simple models, mostly that Forrester's results exceeded the precision of any data that were available. In defense, he argued that the "interaction between system components can be more important than the components themselves" and that the "computer model embodies a theory of system structure."¹⁴ In *World Dynamics*, his primary interest was global population and the early models captured were the dynamic, non-linear effects of multiple feedback conditions; the effect of pollution, food production and resource shortages on population and then of population on food, pollution and resources. But like the contemporary simulations of artificial life, what these simulations lacked were any of the surprising and innovative developments that seem to characterize actual events, or even the internal "laws of heredity" of technological systems. They could not simulate the unpredictable effects that occur at certain intensities of population, such as occurred in the political transition from city-state to national political organization or in the technological transition from wood to coal, oil and gas.

The power of such models lies in their demonstration of effects that are complex, non-intuitive or disproportionate to our actions. For example, many kinds of traffic jams occur once a certain number of people decide to drive, once a certain threshold volume

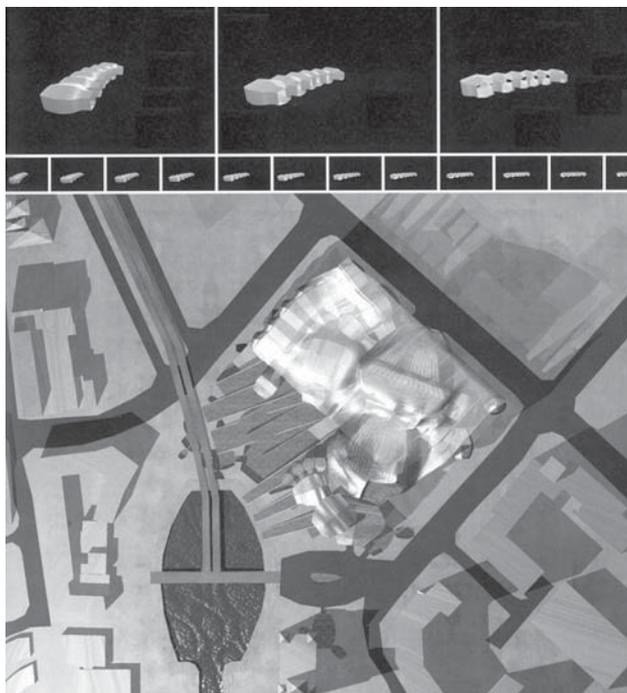
of cars is on the highway. The creeping or stop-and-start traffic that results is not caused by any one person's speed or decision to drive, but occurs like the change of phase as a freely flowing liquid congeals into a solid at a certain temperature (and pressure). One of the greatest challenges for environmentalists is to demonstrate the connection between seemingly minor individual actions — driving to the supermarket, turning on an air conditioner — and these kinds of threshold effects. And if the model is more important than the data, the question for any dynamic simulation is what flows and connections to model? As Forrester's early work suggested, the critical sources of environmental problems are ultimately social, cultural and political, deriving from ideas about health, wealth and pleasure.

BIOTECHNIQUES: MORPHOGENETIC PRACTICES

For over a century, architects have sought "organic" techniques for generating building form, deriving them from structural diagrams, from charts of function, and now from flows of data made manifest with digital animation software. The interest in these new techniques is not difficult to assess. In a 1996 article entitled "Blobs (or Why Tectonics is Square and Topology is Groovy)," Greg Lynn argued that "the mobile, multiple, and mutable body, while not a new concept, presents a paradigm of perpetual novelty that is generative rather than reductive."¹⁵ The novel morphogenetic properties of the new models are made possible by the development and animation of "'isomorphic polysurfaces' or what in the special-effects and animation industry is referred to as 'meta-clay,' 'meta-ball' or 'blob' models." Lynn explains that "in blob modeling, objects are defined by monad-like primitives with internal forces of attraction and mass. Unlike conventional geometric primitives such as a sphere, which has its own autonomous organization, a meta-ball is defined in relation to other objects. Its center, surface area, mass, and organization are determined by other fields of influence." Those "fields of influence" can be used to simulate anything from the motion of the sun to the movement of people to changing brand identities, anything whose influence can be assigned a value (figure 4. 4).

Critics like Michael Speaks have noted the apparent contradiction between the responsive dynamism of these animate models and the inherently static nature of buildings.¹⁷ Speaks used his critique of novel and autonomous form to ask for a more flexible form of practice, in effect, opening design processes like that

4.4
Dynamic,
morphogenetic
design model, Greg
Lynn, Cardiff Bay
Competition, 1994,
from *Animate
Form*.¹⁶



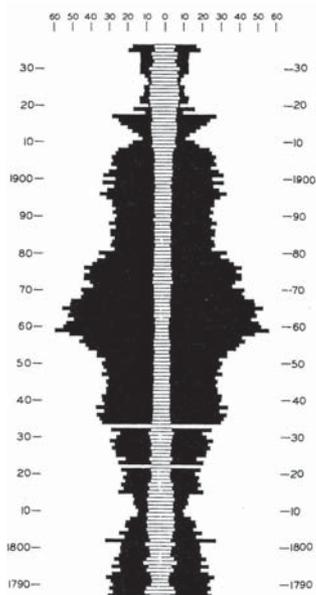


Fig. 6. Skirt width and waist width, dimensions 5 and 6, showing generally inverse relation, 1787-1936.

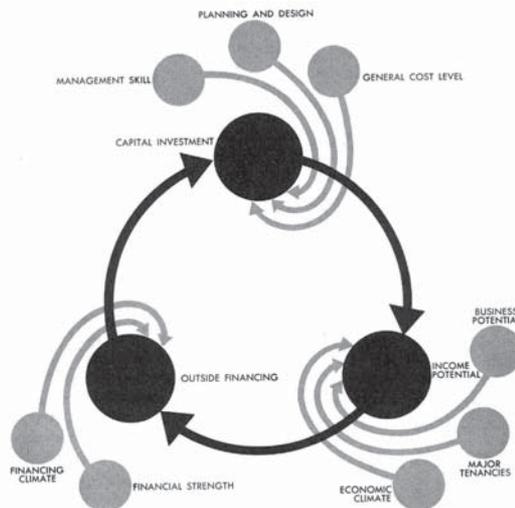
4.5
Dynamic variations in women's dress dimensions from 1787-1936, by Kroeber and Richardson, "Three Centuries of Women's Dress Fashions."¹⁹

described by Lynn to the fluid demands of the market. One could certainly point to many forms of architectural practice that have adapted quite aggressively to market forces, from corporate design-build to the absorption of professional designers into large companies. But the critical aspect of these morphogenetic practices lies in the use of explicit techniques to describe the flows, forces or elements influencing the production of buildings. For the most part those designers have wisely avoided the fully deterministic conclusion of their techniques, using them as generative components in otherwise conventional design relationships. But a few historical examples suggest just how challenging a fully dynamic account of design might be.

In 1940, the distinguished anthropologist A.L. Kroeber and a recent student of his published an article on the "quantitative analysis" of "women dress fashions."¹⁸ They charted the skirt and waist dimensions of women's fashions over three centuries, producing some fascinating diagrams that showed the tendencies, trajectories and limits within those basic clothing forms. Certain limits are physical — dresses can only get so wide or narrow — while the basic trajectories appear to have their own momentum, like Kiesler's technological "laws of heredity." Kroeber and Richardson were

careful not to speculate beyond their data, but, as with architecture, it is quite common to imagine that the changes in women's dresses would correspond to events outside the fashion system, to wars, economic events or the weather, expressing a certain spirit of their time. What that classic approach neglects is the degree to which those trajectories and their momentums are constrained by the dynamics of the fashion business itself — its techniques of production, marketing and sales — and ultimately by the collective changes of taste. And even conceived of as one of Forrester's dynamic situations, such an account cannot predict when new possibilities emerge, when women begin to wear pants, for example, or when some women wear thin skirts, while others wear wide ones (figure 4.5).

To carry the analogy to its conclusion, new clothing possibilities emerge at different kinds of thresholds, when the pace of fashion accelerates beyond a certain point or when too many women (and men) are participating in the fashion system. In his 1960 book on the planning of shopping centers, Victor Gruen sought to illustrate the synergistic conditions that enable a new shopping center to emerge, to understand the necessary "chain reaction between investment, income and financing."²⁰ While the analogy was drawn from physics, the dynamics implied are thoroughly ecological. The emergence of a successful shopping center is explained as a delicate interaction between factors like the "financing climate, economic climate, business potential, management skill, and general cost level." He used the analogy and his decades of experience to describe target values for those factors but, of course, this model would only describe the emergence of the form with which he was familiar, not of something different, like big-box retail (figure 4.6).



Secondary factors in the chain reaction.

4.6
Primary and secondary factors in the "chain reaction" of shopping mall development, from Gruen and Smith, *Shopping Towns USA*, 1960.²¹

BIOTECHNIQUES: BUILDING PRODUCT INFORMATION

For most buildings the critical flows are neither energy nor resources, but money and product information. That situation is exemplified by the ever expanding *Sweets Catalog* and the whole messy system of selling building materials, products and processes. *Sweets* originated in the 1890s as a service of F.W. Dodge Construction.²² The first full catalog appeared in 1906, with an introduction by Thomas Nolan in which he

“very gladly consented to commend the idea [of] a really *scientific standard catalogue and index of building materials and construction*.” He explained that he himself had been working for fifteen years at “finding some practical solution to the ‘Catalogue Problem’ which no architect has been able to work out himself.” His description of offices overrun with boxes, books and piles of information, and of busy architects with “less and less time” to do “more and more work” still applies today.²³ Although the now multi-volume *Sweets Catalog* has certainly prospered since 1906, becoming an essential tool in virtually every American architectural office, the “catalogue problem” has in no way been solved. Like traffic on the highway system, the flow of building information has only increased in volume and accelerated in speed with each new improvement in information technology.

In 1929, a young Danish architect named Knud Lönberg-Holm sent an article to the *Architectural Record* in which he described the “catalogue problem” as a continuing crisis for the architecture profession, arguing that the solution lay in a radical rethinking of the distribution of information in architecture:

... the architect has lost his leadership. From a professional man with a professional ethics he has become a business man subject to the whims of the buyer. The progressive architect acutely realizes that his problem means ultimately the negation of his profession. He has no power to meet his dilemma through his architectural work. As an individual businessman he cannot afford the research work necessary for the proper execution of his ideas; moreover, he is confronted by the gulf which separates him from a client unsympathetic toward an experiment at his expense.²⁴

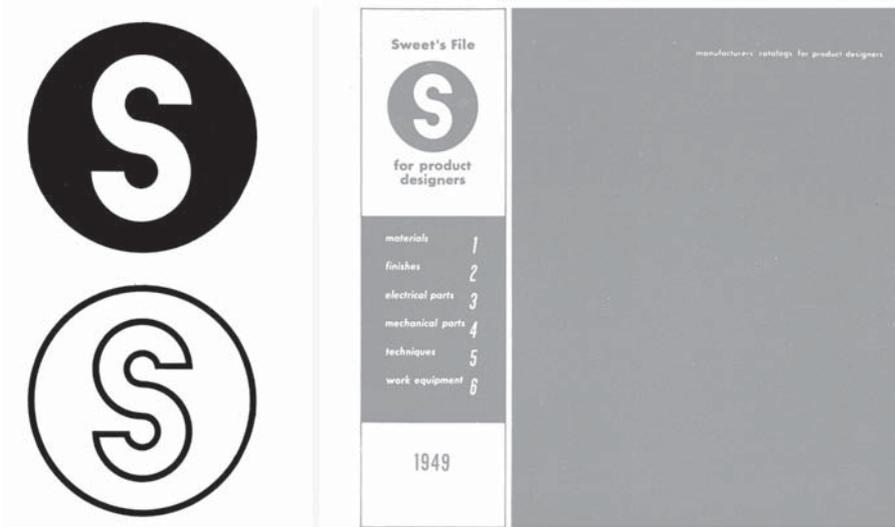
He argued that “collective problems require collective thinking and collective work,” and he proposed the invention of an organization that would act as a “clearing house” and “an economically independent research institute,” setting standards and organizing

information. After a brief stint as a technical editor at *Architectural Record*, he moved in 1932 to found the research office of Sweets Catalog Service. In 1939 he was joined in that effort by the Czech designer Ladislav Sutnar and together they reshaped the look and logic of the catalog, developing the bold graphics and characteristic “S” still used today. Of course Sweets is in no way an economically independent institution. It is produced as a multi-volume bound collection of short catalog sections provided by product manufacturers, whose fees and advertising tie-ins with the *Architectural Record* and *Dodge Construction Reports* directly support Sweets. As a result, most of Lönberg-Holm and Sutnar’s work had to be executed indirectly by persuading and teaching manufacturers. They sought to standardize and discipline their advertising inserts, shaping them into documents readily used by busy architects seeking information. In the late 1940s, they formalized their efforts in a pamphlet prepared for product manufacturers and that work was so popular that they brought out an expanded, full color version called *Catalog Design Progress* in 1950. In the introduction they explained that their aim was to produce “dynamic,” “living standards” that could keep up with the rapid pace of technological advance:

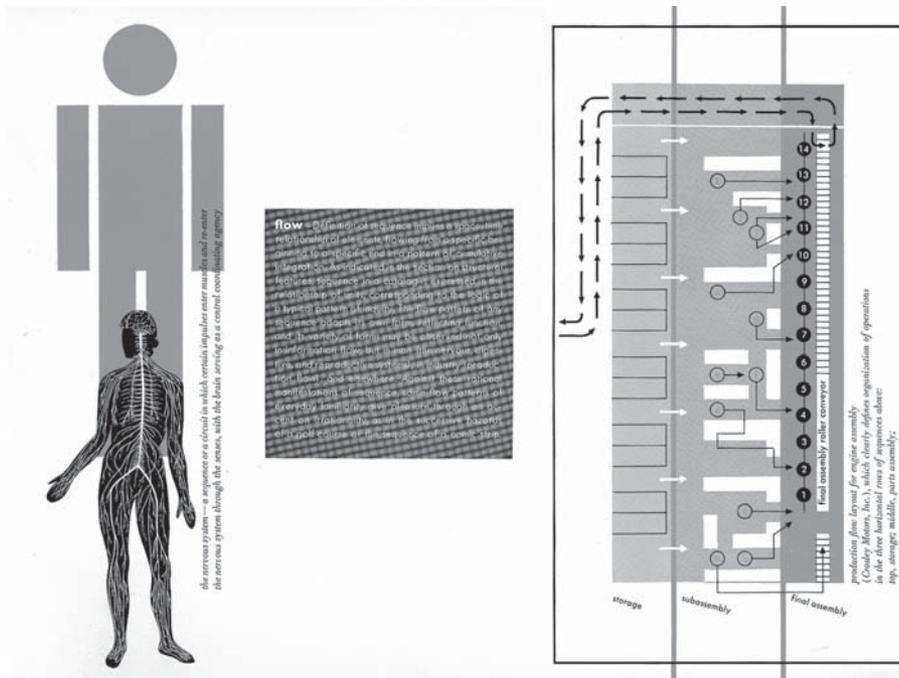
Thus with today’s industrial development and the concurrent higher standards of industry, corresponding advances must be made in the standards of industrial information itself. The need is not only for more factual information, but for better presentation, with the visual clarity and precision gained through new design techniques. Fundamentally, this means the development of design patterns capable of transmitting a *flow of information*...²⁵

Their first section charted the “emergence of new flow patterns” in all aspects of contemporary life — transportation, production, communication — then devoted the body of the book to the visual and structural features with which such information flow patterns should be directed in their catalog. They concluded with a brief theoretical section that offered “flow” as that form of

4.7
Sweet's
Catalog File,
1949.²⁷



4.8
"The flow pattern of any sequence adopts its own form, reflecting function, and its variety of forms may be observed not only in information flow, but in man (the nervous, digestive, and reproductive systems), in industry (production flow), and elsewhere." From *Catalog Design Progress*, 1950.²⁸



information that emerges naturally from the functional demands of architectural practice. It was a clever formulation that overcame the form-function opposition that continues to worry modern architects. They explained the emergent condition of flow analogically, by comparison with a variety of other entities newly understood according to the cybernetic concept of *system*: "The flow pattern of any sequence adopts its own form, reflecting function, and its variety of forms may be observed not only in information flow, but in man (the nervous, digestive, and reproductive systems), in industry (production flow), and elsewhere"²⁶ (figures 4.7 and 4.8).

The management of architectural information by *Sweets Catalog* has continued with the subsequent migration of their catalog information onto compact discs in the 1980s and onto the world wide web in the 1990s, but the original ethic has continued: "Comprehensive information correctly formatted and focused on your customer's needs!"²⁹ In other words, the flow of product information is always channeled according to a powerful network of interests: according to brand identities and sales relationships, on the one hand, and to the ever-shifting expression of needs, desires and identities, on the other. What Lönberg-Holm's original description did not explain was the degree to which they sought to accelerate that flow of information and increase the pace of industrialization:

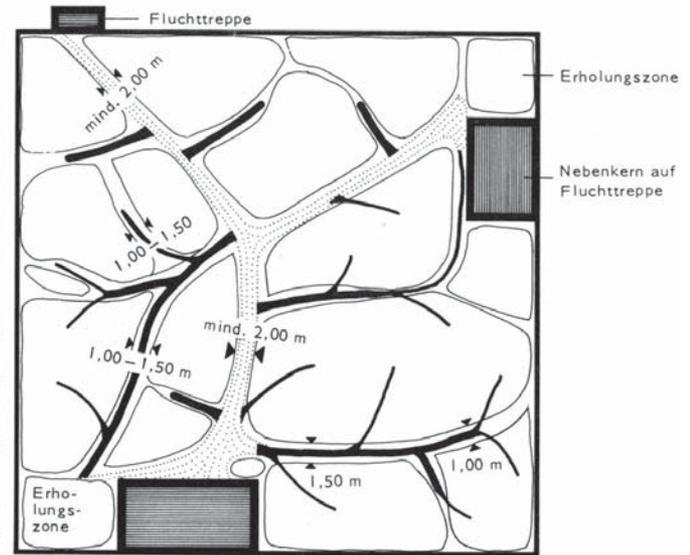
For a continuous advance in production standards there must also be a continuous liquidation of obsolete products, enterprises, and beliefs. This is possible only in an economy where property relations impose no restrictions on the continuous development of new productive forces ... This expansion of social wealth implies increasing industrialization.³⁰

In other words, the system of information flow and industrialized construction has its own momentum fueled by our individual needs, choices and actions. As many critiques have argued, merely fitting better products into normative construction only modulates the effects that industrial development has on the biosphere. To make a difference, it is necessary to understand both the structure and velocities of the flows already in place, and to locate the threshold effects that occur in building.

4.9

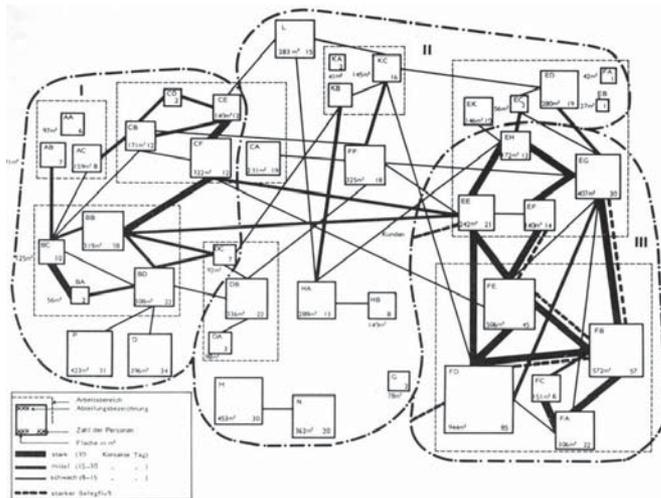
Quickborner office
communication chart and
plan diagram, from *Flexible
Verwaltungsbauten*.³²

Abteilungsbezeichnung	1	2	3	4	5	6	7	8	9	10	11		
Innerhalb des Geschosses	Geschäftsleitung I	1											
	Geschäftsleitung II	2	12										
	Vertrieb	3	32	—									
	Einkauf	4	20	—	126								
	Rechnungswesen	5	8	—	179	80							
	Export I	6	—	2	9	21	65						
	Export II	7	1	7	32	25	90	6					
	Export III	8	—	8	5	4	15	—	6				
	Inland Leitung	9	16	5	46	45	64	22	44	28			
	Inland I	10	—	—	34	62	93	40	9	5	10		
	Inland II	11	—	—	5	14	4	—	1	—	8	22	
Summe je Abteilung		89	24	468	398	600	170	223	68	283	275	54	2.628
Unter- geschoss	Poststelle, Vervielfält.	12	—	—	24	59	19	13	1	—	51	29	25
	Lager usw.	13	—	—	7	117	5	10	7	—	48	39	10
	Firmenfremde	14	2	4	117	96	96	33	15	—	29	109	8
	Summe 12-14		2	4	148	272	89	56	23	—	128	177	43
Gesamtsumme													3.600



4.10

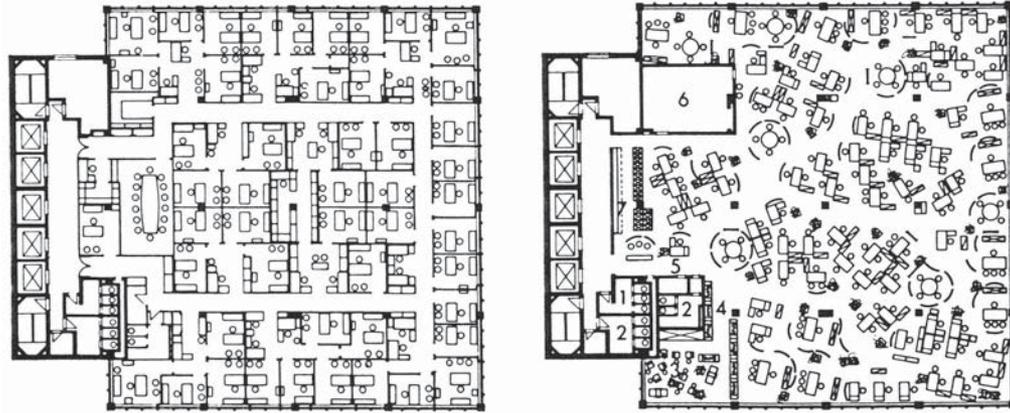
Quickborner
organizational
interaction diagram,
from *Flexible
Verwaltungsbauten*.³³



BIOTECHNIQUES: CUBICLES

The acceleration of biotechniques after World War II became evident in research agendas and the rapid development of digital technology. And even as highly rationalized, seemingly mechanized offices were being built across the United States, the German Quickborn management consulting group were quietly inventing a new form of office layout: the *Bürolandschaft* or office landscaping.³¹ Based on a rigorous analysis of communication patterns within an office, charted through exhaustive interviewing techniques and diagrams, they dissolved the walls of the office-as-production-line. The analogy to a natural landscape was evident in their pathway diagrams, and in the compelling idea that the form of the office layout was not designed, but emerged from the process of analysis. Their detailed diagrams of communication paths and intensities were the tools that generated the landscape plans, which resembled nothing so much as the meandering "desire paths" that animals, savages and undergraduates chart with their feet (figures 4.9 and 4.10).

4.11
Application of office
landscape techniques to
Dupont administrative
offices, 1967.³⁷



Those ideas were rapidly communicated throughout the planning community and by 1964 the Herman Miller furniture company had formalized them in a revolutionary line of office equipment: Action Office I. Under the guidance of their research director, Robert Probst, they developed the first moveable panels, work surfaces and storage units that came to define the cubicle and made office landscaping possible. By the late 1960s, the effects were visible everywhere and the concept of organic office planning offered a new kind of proportion or regulating system for office layouts:

The rigid patterns of office layout that had become standard during World War I, assumed the character of time worn tradition by 1960 ... But it failed for precisely that reason. Classical systems are inherently inflexible. Since they embody intellectual-aesthetic ideals of harmony and order, to disrupt any one element is to destroy the whole. Change is inadmissible. When a classical order is imposed upon an organic system — one whose parts are related by functions and processes that are themselves in flux — the result is apparent order and actual chaos. An office is such an organic system. Its organicism, however, is not revealed in those hierarchical charts that bear so curious a relation to feudal concepts of the social orders on earth and in heaven. But, since the actual relations between office personnel defy the caste system codified in charts and embodied in layouts, attitudinal and physical barriers were created that seriously blocked lines of communication.³⁴

In close sympathy with structuralist ideas in anthropology and sociology, and exhibitions like *Architecture without Architects* and *Learning from Las Vegas*, the naturalistic forms of *Bürolandschaft* planning offered anti-authorial design strategies that appealed to the generation of 1968.³⁵ As Francis Duffy reported about his own efforts to spread such ideas, "Anthropology with its rigorous comparative techniques, its search for cross-cultural patterns between artifacts, behaviour, societal norms and their technologies was an obvious model for architectural research. The interrelated three-part model of buildings, people and technology ... was firmly implanted."³⁶ Even though the organic look of the office landscape passed relatively quickly, the principle of planning around communication, the importance of adaptation and, of course, the cubicle, formed the core of the new biotechniques of the office (figure 4.11).

THRESHOLD EFFECTS: HIGHLY CONDITIONED BUILDINGS

In 1957 the head of the Carrier air conditioning corporation observed that "whenever 20 percent of the office buildings in any one city include air conditioning, the remaining buildings must air-condition to maintain their first class status."³⁸ That process had apparently taken about ten years, and after the late 1950s it was largely assumed that a high-quality office building in an American city would be conditioned to some degree. The technology had been available for many decades, but it took the particular arms race dynamic of post-war real estate development to change it from a desire to a "need." A similar process had occurred among movie houses in the 1930s, which along with luxury hotels had rapidly adopted air conditioning in the pre-war period once its competitive advantage had been

4.12

A bulky building among other bulky buildings. The classic fully-conditioned building of the late 1950s: Seagram Building, 1958.⁴⁰



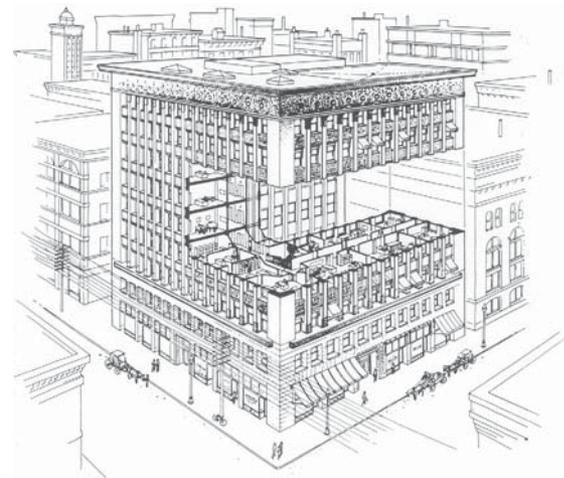
demonstrated.³⁹ Those examples served to introduce the public to the experience of conditioned air, preparing them for the ever-increasing amounts of conditioning (figure 4.12).

This is one kind of threshold effect that occurs in feedback systems, when an arms race develops between competitors. They rapidly adopt new products, strategies and quite expensive technologies if their customers are free to make other choices. Who would go to a hot movie theater or rent a hot office if a cool one is readily available? And in the process, a new, higher standard emerges and is fixed not only in public desires but in normative construction practices and regulatory codes and standards. At that point, the new standard no longer represents a choice, but a culturally and officially recognized need. It is not easily reversed and can apparently only be altered by a similarly dynamic cultural process. The energy supply crises of the 1970s, for example, temporarily altered thermostat settings and some social habits, but the logic of energy conservation quickly receded when prices dropped.

I do not mean to argue that air conditioning is inherently bad, far from it. The relief from sweating simply feels good, and that is precisely why it becomes such an effective element in competitive situations, leading to a steady escalation of expectations. The problems are twofold. The first are very familiar:

4.13

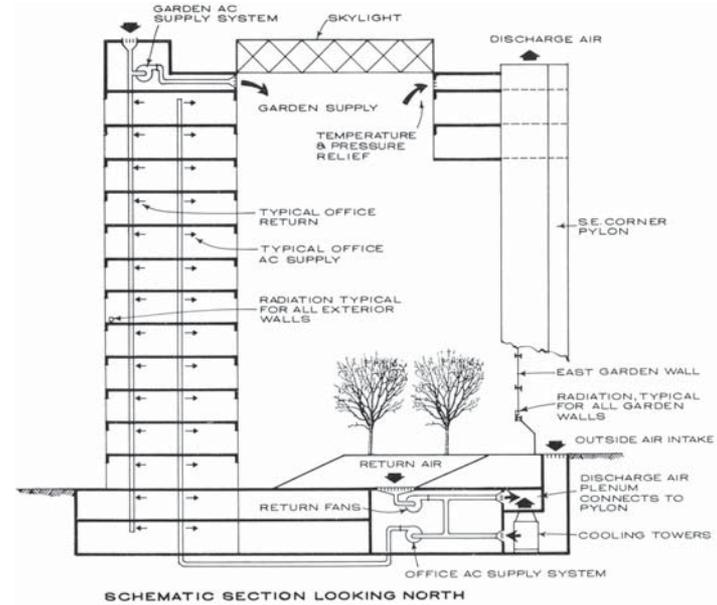
Classic, big-but-thin, unconditioned skyscraper. Sullivan, Wainwright Building, 1891.⁴²



greater levels of conditioning produce a whole host of secondary environmental effects through heat island conditions, the use of greater amounts of energy, the release of CFCs, and so on. Many of these are amenable to better design or greater efficiency, and form the basis of most green design strategies, but the second kind of problems are more troublesome. Not only does the escalating aspect of this process establish ever higher standards, requiring ever greater levels of conditioning, but the techniques of conditioning profoundly alter the size and character of the buildings that can succeed in the marketplace.

In other words, once the real-estate process described in 1957 takes place, and conditioning becomes the norm for commercial buildings, then the scale and configuration of those buildings quickly expands so that they have to be conditioned. The dimensions of a commercial building designed without air conditioning are effectively defined by its external skin, meaning that every inhabited workplace has to have ready access to a window for light and air. As a result, even the biggest of the early skyscrapers were made thin by cutbacks, light courts and reentrants. Once the connection to windows is severed by air conditioning and efficient lighting, the buildings are free to grow (out and up) until they encounter other scale limits: circulation, the size of elevators and so on.⁴¹ And like the escalation of comfort standards, this is simultaneously a technical process of conditioning buildings and a cultural one of conditioning the individuals who inhabit them (figure 4.13).

4.14
Classic, fully-
conditioned, atrium
building with return
air circulated through
atrium space and
plantings. Ford
Foundation, 1968.⁴³



A building's balance-point temperature provides a rough index of when it crosses that threshold, when its spaces are no longer directly connected to the outdoor climate. When a building becomes both sufficiently big and contains a sufficient intensity of internal conditioning and support systems, its balance-point temperature will fall below the average outdoor temperature and it will have to provide cooling for some part of most days of the year (and everyday in their windowless cores). This initiates a fairly simple cascade of effects: first air conditioning and efficient fluorescent lighting make it possible to fill larger interior areas with people and the equipment they use to work, but the people, lights and equipment all produce heat, which requires even more conditioning. As heat removal becomes ever more important, windows are sealed and are designed to exclude as much sunlight as possible, making the interior environment more efficient, but less and less pleasant.

Those two thresholds — higher comfort standards and bigger buildings — were passed for many buildings by 1960, establishing the now familiar norm for commercial and retail construction of highly-conditioned buildings with vast interior spaces. But, of course, that norm has been subject to many criticisms and it has been modified, sometimes radically, in recent decades. Beginning almost immediately in the early 1960s, there were parallel efforts to introduce green plants and natural light into the cores of the newly bulky buildings. The plants

initially arrived as part of the office landscape movement (*Bürolandschaft*) and rapidly found a place in the reinvented (and conditioned) atriums of the late 1960s: the Ford Foundation and the Hyatt Regency of 1968 are typically cited as the first fully developed examples. In addition to its pleasant qualities, the atrium was subsequently identified as an energy conservation technique in the late 1970s and 1980s, and become a hallmark of the higher-quality, more efficient office buildings of that period (figure 4.14).

The purpose of this thumbnail history of conditioned buildings is to illustrate the degree to which the environmental thresholds important to green design also involve social and cultural factors, and to explore why they are so resistant to change. A second kind of threshold, one of intensities, is even more critical and difficult to examine because it involves the wholly subjective experience of the bodies being conditioned.

THRESHOLD EFFECTS: BIOTECHNICAL BODIES

The Environmental Protection Agency (EPA) distinguishes "building related illness," which can be attributed to an identifiable cause, from sick building syndrome (SBS) in which "occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified."⁴⁴ The inability to diagnose SBS continues, though recent epidemiological studies confirm the correlation between mechanical ventilation rates and reports of SBS symptoms, such as "upper respiratory

and mucous membrane symptoms (i.e., irritated eyes, throat, nose, or sinus), and lower respiratory irritation (i.e., difficulty breathing, tight chest, cough, or wheeze)."⁴⁵ In this regard, SBS belongs to a broad class of environmental illnesses (EIs), such as multiple chemical sensitivity and Gulf War syndrome, that are widely reported, but that do not fit any biomedical explanation. From one side of the dispute, it is claimed that such syndromes are wholly somatic, learned group expressions of other psychological issues, while on the other side, serious research continues to seek the biomedical causes and etiologies of the distress.⁴⁶

What seems evident in both bodies of research is that the perception of indoor air-quality, of its freshness, is central to the syndrome. As the early ventilation researchers discovered when they first began to investigate ventilation levels in the 1930s, freshness involves both an assessment of the intensity of odors and a judgment about their quality. Like noise, an odor can be pleasant in one situation and offensive or bothersome in another. What this suggests to psychologically oriented researchers is that sensations such as odors can trigger "social psychological processes of contagion, where complaints and symptoms spread from person to person, and convergence, where groups of people develop similar symptoms at about the same time."⁴⁷ From the other perspective, the remarkable sensitivity of the nose suggests the possibility of very subtle toxicogenic or allergic processes that have not yet been identified. The statistical correlation between SBS and mechanical ventilation systems, for example, appears to offer evidence of the underlying physical causes related to the rates and processes of ventilation, and has quickly been acted on by design professionals.⁴⁸

I can contribute no new evidence or research that might resolve the biomedical question, but I would argue that as with the previous examples, SBS represents the passing of a critical threshold in the conditioning of buildings, a threshold that is simultaneously physical and social. The previous examples appeared after a certain threshold of scale,

after a certain number of buildings were conditioned or after a certain size of building was produced, but SBS and other EIs seem to develop at certain thresholds of intensity. Environmental comfort is defined in these terms, as the intensity of air conditions (temperature, enthalpy, wind, pollution) at which neither our attention nor our coping mechanisms are noticeably required. EI sufferers themselves often explain their symptoms in terms of the cumulative thresholds of toxins or irritants, and they use feedback system theories to explain the disproportionate effects that trace amounts of different substances can cause: "total body load, limbic bundling, and hypersensitivity."⁴⁹ For designers, it ultimately makes little difference whether these are medical or somatic explanations, they are the point at which systems designed to provide comfort paradoxically begin to threaten the health of the occupants with the very intensity of their conditioning. As a recent sociological study observed, the accounts of EI sufferers portray "a body that reacts severely to ordinary commercial furniture designed to offer it at least a modicum of rest; a body that responds violently to air passed through conventional heating and cooling systems designed to make it more comfortable... it is as if this body is in protest against the products of modernity and, in its distress, is calling for a radical change in the conventional boundaries between safe and dangerous."⁵⁰ Environmental illnesses, like SBS, should remind us that the real object of environmental design is not the efficiency of conditioning, but the state of the bodies that occupy them, whose intimate concerns continue to exceed any performance assessment.

LIVING STANDARDS

I have offered this brief outline of biotechniques to make two very simple points about the conditioning of contemporary buildings. First, environmental conditioning is not just a collection of devices whose performance can be optimized. They are complex systems that operate on buildings and people simultaneously, systems with their own history, trajectory and momentum. Second, there are critical thresholds in the scale, velocity and intensity of that conditioning that radically alter the effects they

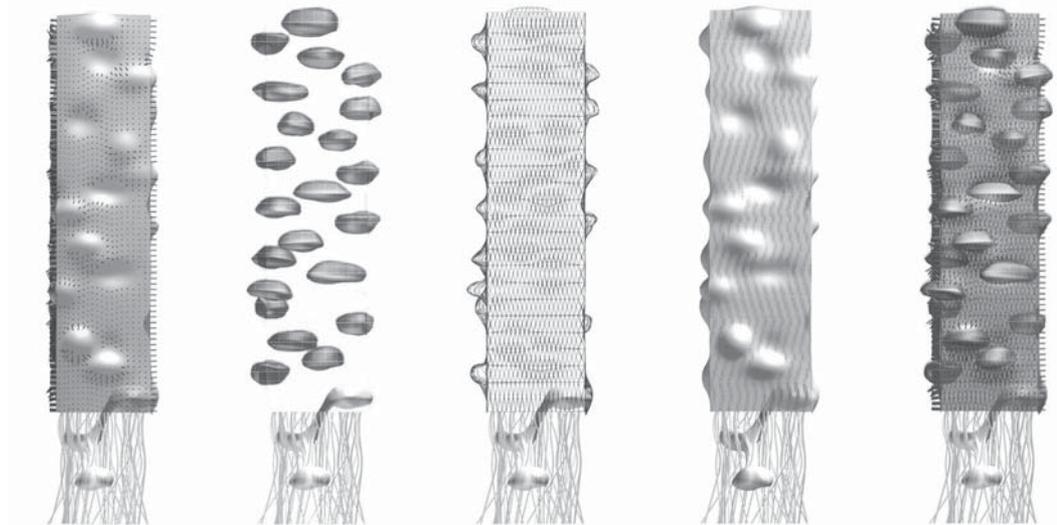
produce, meaning that more, or even more efficient, conditioning is not always the answer. In that sense, Kiesler was correct, if technological systems self-organize or evolve according to their own performance criteria, then the only useful measure of design is human health. The concept of health is now largely associated with biotechnical medicine, but as SBS illustrates, it still includes social and political forms of coping as well. The best term I can offer as a design guideline for healthy thresholds of conditioning is the “living standard” sought by Lönberg-Holm, a standard that adapts to changing arrangements, and which allows overly conditioned bodies to actively influence their own environments.

To understand what such a living standard might mean for current practice, architects must look beyond the narrowly visual terms which have constrained it. Much of the architectural encounter with environmental conditioning has been devoted to issues of formal expression. The initial opposition between the

traditional elements of building — walls, windows and roofs — and the wires, pipes, ducts and devices that invaded them in the late nineteenth and early twentieth centuries, gave way to the “servant” spaces of the Richards Medical Labs, and then to the vigorous display of service elements at the Centre Pompidou. But after fifty years of intensely conditioned buildings, such debates about the expressive role of mechanical equipment seem *passé*.

If we look more closely, however, the history of architectural experimentation reveals a parallel fascination with the symbiotic resolution of buildings and machines. From Le Corbusier’s *mur neutralisant* (neutral wall) and Frank Lloyd Wright’s radiant floors have sprung an entire ecology of integrated building components, from the “hairy” and “blistered” skin of Roche and Levaux’s [Un]plug building (figure 4.15) to the ventilating, double-glass façades of Foster’s Commerzbank. Through such biotechnical elements, buildings are not limited to the symbolic expression of cultural ideas, to merely organic forms, but to active demonstrations of the organic themes that lurk within every mechanism.

4.15
An “absorbent”
concept building,
“hairy” with solar
collector tubes and
“blistered” with
photovoltaic cells.
Roche and Levaux’s
[Un]plug Building,
2002.⁵¹



NOTES

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