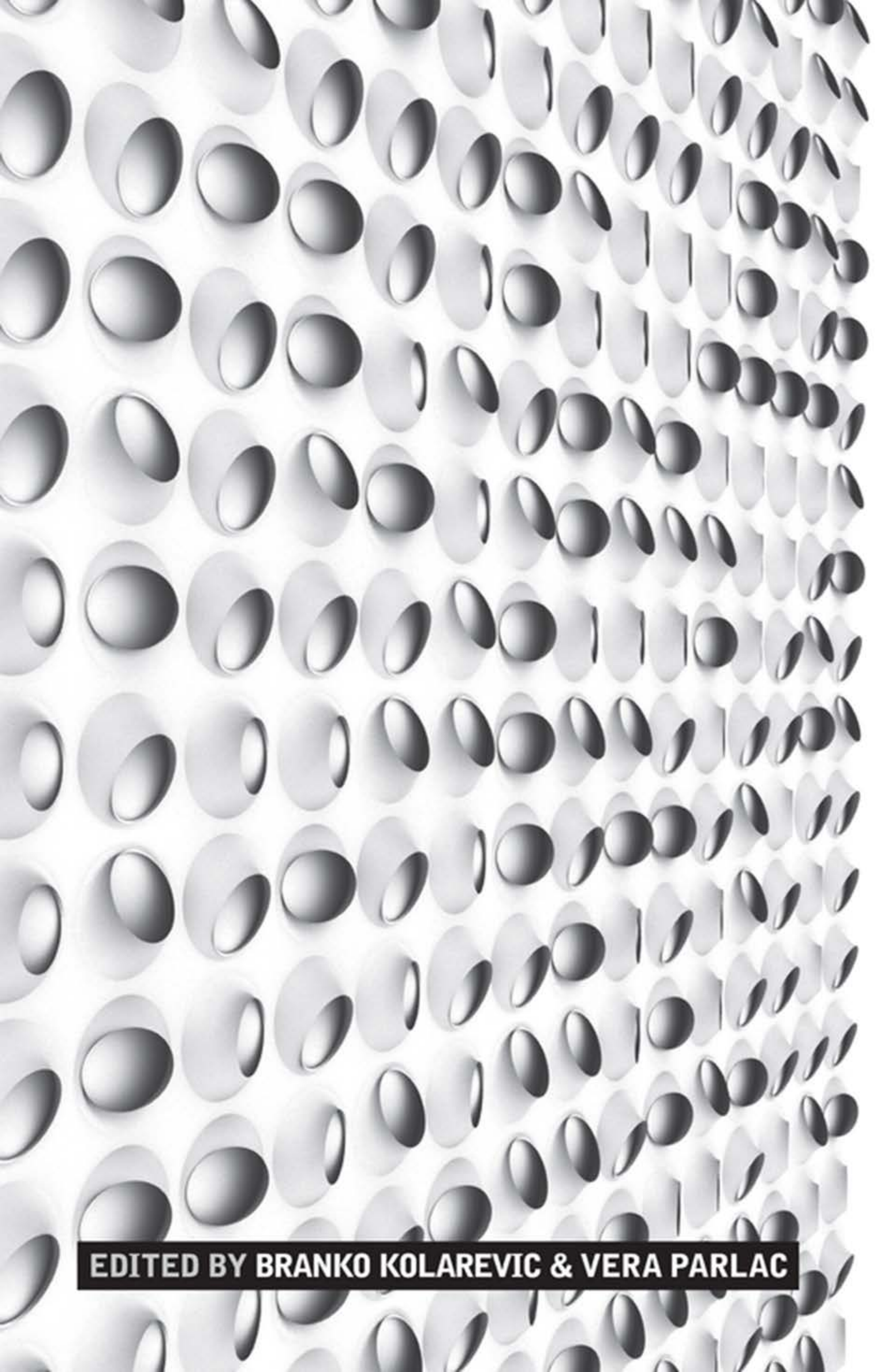

# BUILDING DYNAMICS: EXPLORING ARCHITECTURE OF CHANGE

EDITED BY BRANKO KOLAREVIC & VERA PARLAC

ROUTLEDGE

# BUILDING DYNAMICS:

# EXPLORING ARCHITECTURE OF CHANGE

EDITED BY

BRANKO KOLAREVIC & VERA PARLAC

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# CONTENTS

ACKNOWLEDGMENTS ........ iv

**PREFACE** ........ v

1 **TOWARDS ARCHITECTURE OF CHANGE** (Kolarevic) ........ 1
2 **MAKING SPACE FOR TIME** (Leatherbarrow) ........ 17
3 **FLEXIBLE ARCHITECTURE: CONTINUOUS AND DEVELOPING** (Kronenburg) ........ 29
4 **DEVISING DESIGN: AGILITY, APTNESS, EQUILIBRIUM, IMPERFECTION** (Sinclair) ........ 43
5 **SMART ARCHITECTURE, DUMB BUILDINGS** (Addington) ........ 59
6 **ADAPTIVE, RESPONSIVE BUILDING SKINS** (Kolarevic & Parlac) ........ 69
7 **DYNAMIC, ADAPTIVE BUILDING ENVELOPES** (Hathaway) ........ 89
8 **TRANSFORMABLE: BUILDING STRUCTURES THAT CHANGE THEMSELVES** (Hoberman) ........ 101
9 **BENEFICIAL CHANGE: THE CASE FOR RESPONSIVENESS AND ROBOTICS IN ARCHITECTURE** (Sterk) ........ 127
10 **SELF-ASSEMBLY AND PROGRAMMABLE MATERIALS** (Tibbits) ........ 145
11 **BIO-ROBOTIC ARCHITECTURE** (Fox) ........ 161
12 **MATERIAL AS MECHANISM IN AGILE SPACES** (Parlac) ........ 177
13 **EXPLORING RESPONSIVENESS IN ARCHITECTURE** (Parlac) ........ 191
14 **DIFFUSIVE ARCHITECTURE: A MANIFESTO** (Beesley) ........ 205
15 **RAD: MAKE ALIVE** (el-Khoury & Moukheiber) ........ 221
16 **ARCHITECTURE OF PARTICIPATION: SMART CITIZENS, NOT SMART CITIES** (Haque) ........ 235
17 **POWERLINES** (Oosterhuis & Lénárd) ........ 253
18 **IT IS ALL ABOUT PARTICLES** (Ruiz-Geli) ........ 267

AUTHOR BIOGRAPHIES ........ 284
PHOTO CREDITS ........ 293
INDEX ........ 295

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We thank with the deepest gratitude the contributors to this book — their remarkable ideas and innovative, pioneering projects were the main inspiration for this book and the eponymous symposium that preceded it. In April of 2013, we gathered in Banff, in the Canadian Rocky Mountains, to explore over two days what *change* means in architecture and how it is manifested in buildings today. The symposium presentations, enriched by the ensuing discussions and email exchanges, have been further refined and captured in this book. Not all of the authors were able to join us at the symposium, but have kindly agreed to contribute to the book.

The "Building Dynamics: Exploring Architecture of Change" symposium – and the accompanying exhibition of student work and research projects – were organized by the Laboratory for Integrative Design (LID) at the University of Calgary Faculty of Environmental Design (EVDS) and held at the Banff Centre on April 26 and 27, 2013. We are most grateful to the symposium sponsors: Oldcastle BuildingEnvelope, DIRTT, Haworth, and Faculty of Environmental Design at the University of Calgary; without their support, the symposium and this book would not have been possible. Initial formative research was supported by the grants from the University Research Grants Council (URGC) and by funding through the Chair for Integrated Design and Laboratory for Integrative Design (LID) at the University of Calgary.

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Branko Kolarevic and Vera Parlac
Calgary, February 2015

# PREFACE

The book stems from our interest in architecture that can respond dynamically to changes in external and internal environments and different patterns of use. Buildings are increasingly being equipped with sensors, actuators, and controllers, enabling them to collect information from both outside and inside and then process that information and act on it *autonomously* or *interactively* by reconfiguring themselves, changing some of the environmental conditions, or adapting, i.e., responding in some other way. As a consequence, two-way relationships could be established among the spaces, environment, and users: users or changes in the environment could affect the configuration of spaces and vice versa. The result is an architecture that self-adjusts, that continuously changes – an architecture that is adaptive, interactive, reflexive, responsive ...

In a way, buildings are becoming large-scale robots, "transformers" that are (still) fixed to a particular location but could alter their shape or appearance. This book, however, is not just about such technologically-enabled transformations of buildings. It goes beyond the current fascination with mechatronics, i.e. creative combinations of electronics and mechanical systems that process signals collected from the environment through sensors and then generate output signals, turning them through actuating components into forces, motions, and other actions that result in some qualitatively beneficial change.

Our aim with this book is to explore what *change* means in architecture and how it is manifested: buildings weather, programs change, envelopes adapt, interiors are reconfigured, systems replaced. We are interested in the kinds of changes that buildings could and should undergo and the scale and speed at which they would occur. We want to examine which changes are necessary, useful, desirable, possible ...

The principal motivation behind the book is that change in architecture is far from being adequately addressed or explored theoretically, experimentally, or phenomenologically. But that was not the only driver of our interest in what, why, when, and how things change in buildings. *Time* is implicated in any notion of change in architecture; as a design dimension, time is often neglected and is insufficiently explored either in design studio projects in schools or in real-world projects in firms. We need to "make space for time" as David Leatherbarrow argues in his chapter in this book.

The contents of this book emerged out of the eponymous symposium held at the Banff Centre in April of 2013. That event brought together some of the leading individuals from different realms – architects, artists, engineers, technologists, theoreticians – contributors to this book (not all of whom were able to participate in the symposium), with the aim of providing informed views of what is meant by change in architecture. Their chapters offer a diverse and divergent set of ideas as to how change is manifested in architecture today and how engaging it as a design challenge will be relevant tomorrow for architectural design practices. The projects discussed in the pages that follow provide snapshots of emerging ideas, grounded in actual practices already taking place.

The idea for the symposium was born out of our initial explorations of *dynamic buildings*, which quickly evolved into discussions of *building dynamics* – and *architecture of change* as an overarching theme within which any discussion of the latest and the greatest technological advances should be situated. Our initial scrutiny of the mechatronic technologies and systems that are used to provide dynamic transformation of buildings – the technologies that are increasingly accessible to architects and their consultants – provoked broader questions, such as to what extent *time* actually figures in design thinking and what *change* really means in architecture.

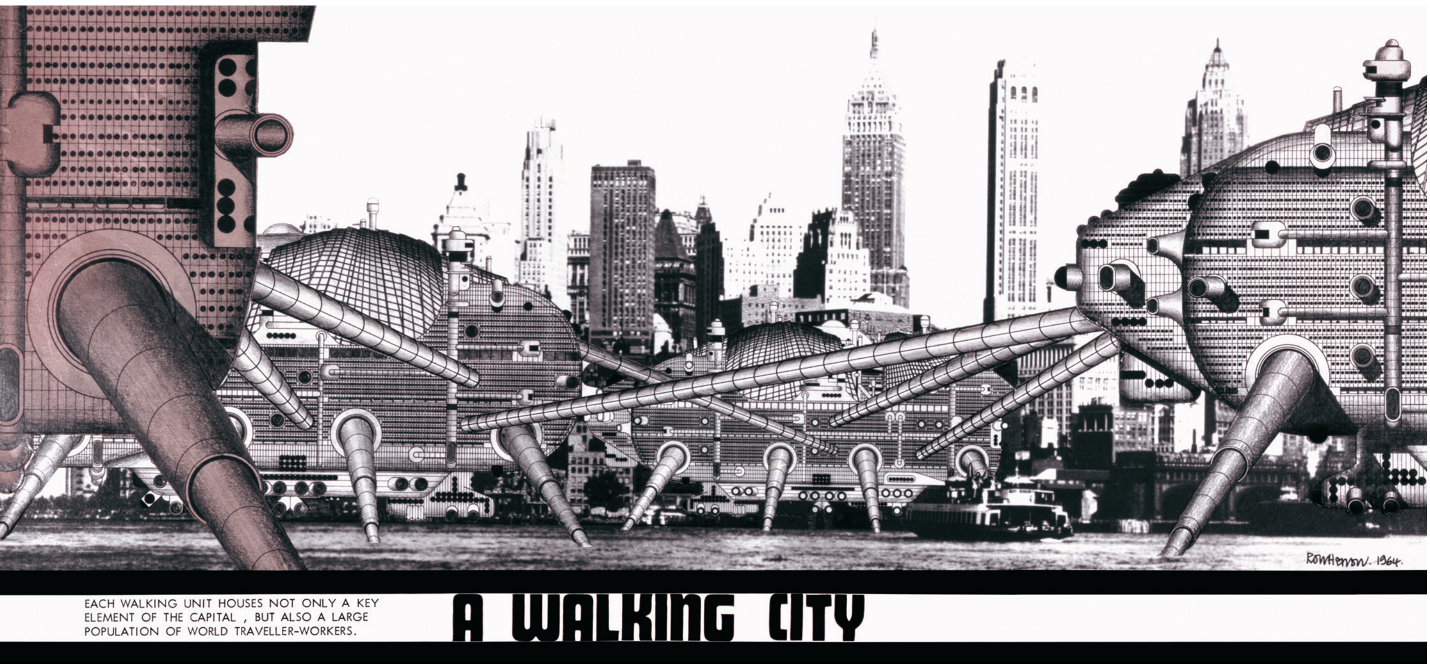
As we engaged the theme in its broader dimensions, we discovered that remarkably little has been written about change – or time – in architecture. We have all witnessed that buildings do change over time; they are added to, they are altered, their spaces repartitioned, doors and windows replaced, walls repainted (often in different colors), etc. Obviously, change in architecture does matter, but, as we have discovered, it means different things to different people. As readers of this book will notice, the meanings of change in architecture are indeed multiple, intertwined, sometimes contradictory, and, as we concluded, they are irreducible to a simple, coherent, and succinct definition. That definition is at best elusive, yet change underlies quite a few discussions in architecture today, and will do so increasingly in the future.

# 1

# TOWARDS ARCHITECTURE OF CHANGE

BRANKO KOLAREVIC

1.1
Ron Herron's *Walking City*
(Archigram, 1964).

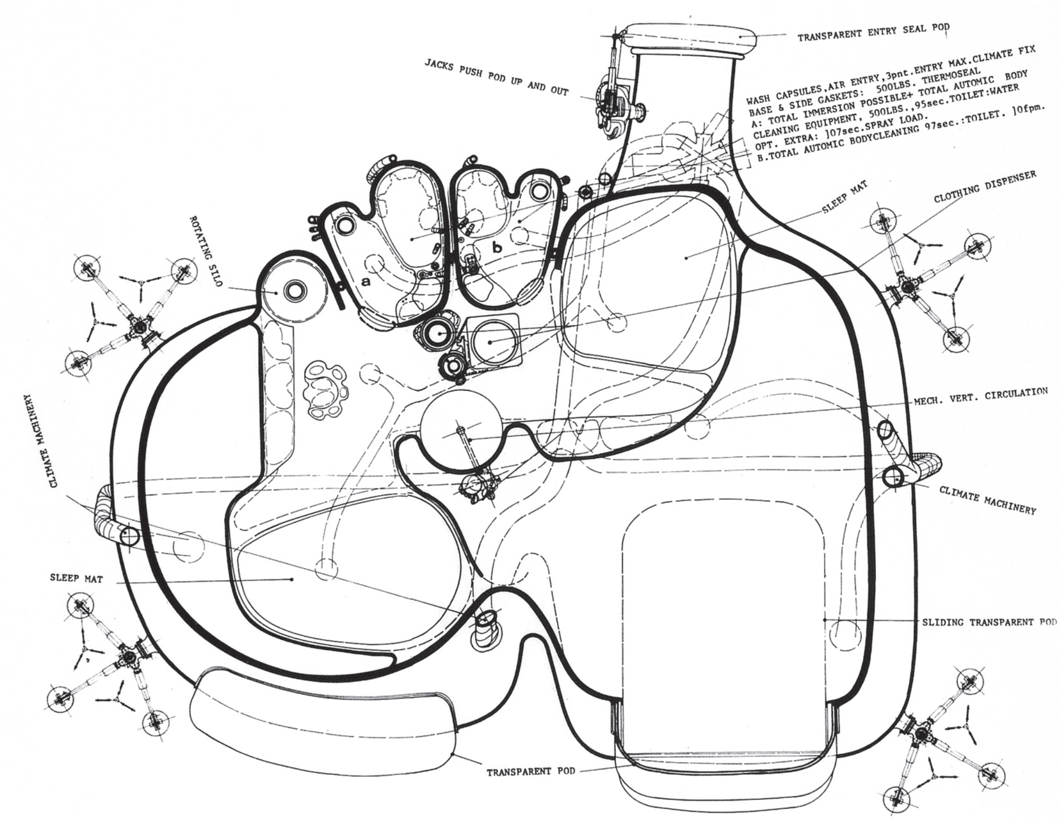



As the external socio-economic, cultural, and technological context changes, so do conceptions of space, shape, and form in architecture. Over the past decade we have seen an increasing interest in exploring the capacity of built spaces to change, i.e., to respond dynamically – and automatically – to changes in the external and internal environments and to different patterns of use. The principal idea is that two-way relationships could be established among the spaces, the environment, and the users: the users or the changes in the environment would affect the configuration of space and vice versa; the result is an architecture that self-adjusts to the needs of the users. Different terms have been used to describe such architecture: adaptive, dynamic, interactive, responsive, etc. As I will argue in this chapter, the principal idea behind it – facilitating and accommodating change – is not new; what has changed are the technologies (and materials) to accomplish it.

## IT ALL STARTED IN THE 1960s

The first concepts of an adaptive, responsive architecture as it is understood today were born in the late 1960s and early 1970s, primarily as a result of developments in cybernetics, artificial intelligence, and information technologies. Such architecture, however, was first envisioned in science fiction. James Graham Ballard, a British novelist, described in a short story from 1962 a "psychotropic house," a machine-like, mood-sensitive house that could respond to and learn from its occupants, becoming "alive" as it was occupied.[1] The imagined responsive house was made from a material Ballard referred to as "plastex," a combination of plaster and latex that allowed the house to change its shape as needed. The house also had many "senso-cells," distributed all over it, which were capable of "echoing every shift of mood and position of its occupants."[2]

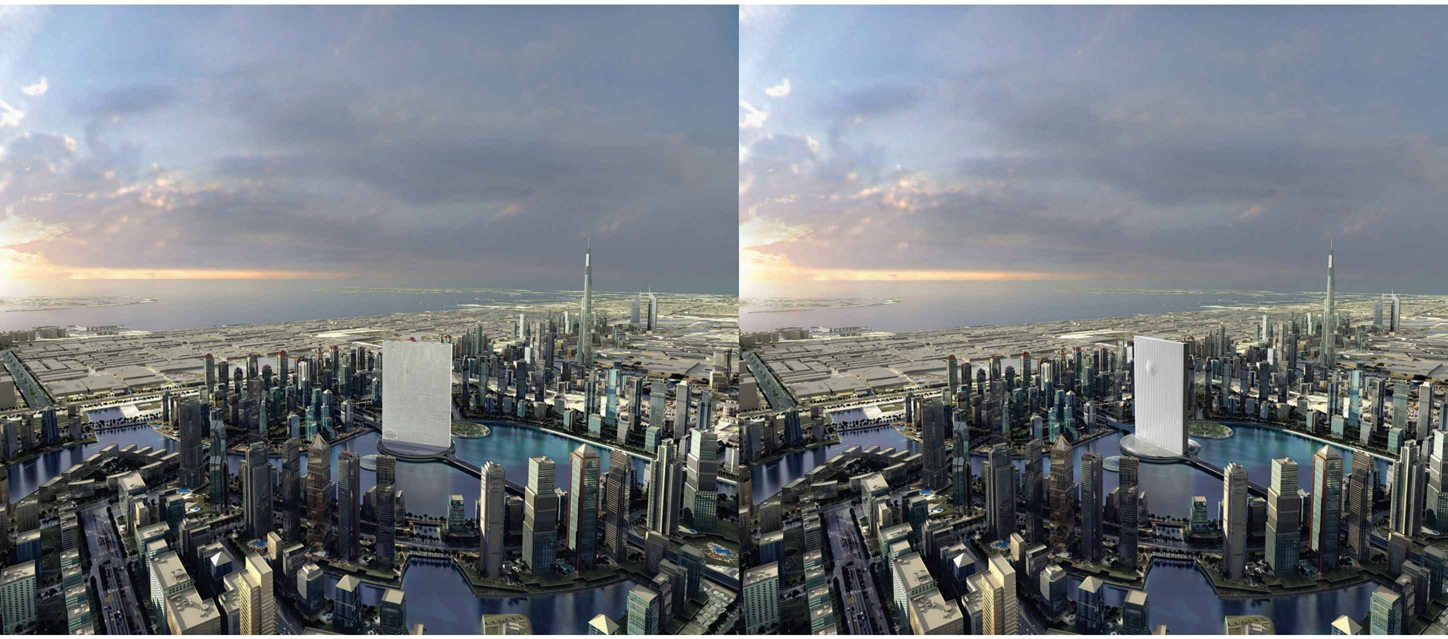
1.2
David Greene's *Living Pod*
(Archigram, 1966).




Ron Herron's *Walking City* hypothetical project from 1964 (Figure 1.1) imagined cities as giant mobile, transformable robotic structures that could move to wherever their resources were needed.[3] Intelligent, robotic buildings – self-contained "living pods" – would move within the cities; the pods were envisioned as independent, yet parasitic: they would "plug in" to way stations to replenish resources, moving, connecting, and disconnecting as instructed (Figure 1.2). The cities could interconnect to form larger metropolises or disconnect and disperse as required or desired.

While Ballard and Archigram's Herron and Greene were among the first to envision "alive," changeable buildings and cities capable of interacting among themselves and with their occupants, Gordon Pask, as an early proponent of cybernetics in architecture, is often credited with setting the foundations for interactive environments in the 1960s with his concept of *Conversation Theory*,[4] intended as a comprehensive theory of interaction. Pask's ideas had a tremendous influence on both Cedric Price and Nicholas Negroponte, with whom he collaborated. Cedric Price adopted concepts from cybernetics to articulate the concept of "anticipatory architecture," demonstrated by his seminal *Fun Palace* and *Generator* projects. Nicholas Negroponte proposed in 1975 that computing power be integrated into buildings so that they could perform better, turning buildings into "architecture machines" that are "'assisted,' 'augmented,' and eventually 'replicated' by a computer."[5] The aim was to "consider the physical environment as an evolving mechanism."[6] In the last chapter, he made a prediction that "architecture machines" (in the distant future) "won't help us design; instead, we will live in them."[7]

1.3a–d
OMA's design for a building in Dubai (2005) that would rotate around its vertical axis, so that main façades would receive no direct sunlight.



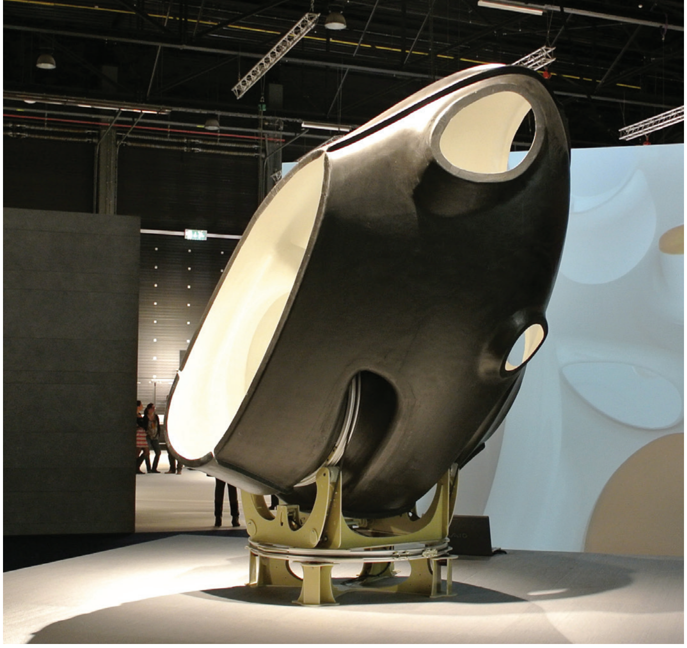
At roughly the same time that Negroponte was working on his "architecture machines," Charles Eastman developed in 1972 the concept of "adaptive-conditional architecture,"[8] which self-adjusts, based on the feedback from the spaces and the users. Eastman proposed that automated systems could control buildings' responses. He used the analogy of a thermostat to describe the essential components: sensors that would register changes in the environment, control mechanisms (or algorithms) that would interpret sensor readings, actuators as devices that would produce changes in the environment, and a device (an interface) that would let users enter their preferences. That is roughly the component make-up of any reactive system developed to date.

## TRANSFORMABLE, FLEXIBLE, ADAPTIVE, RESPONSIVE ARCHITECTURE

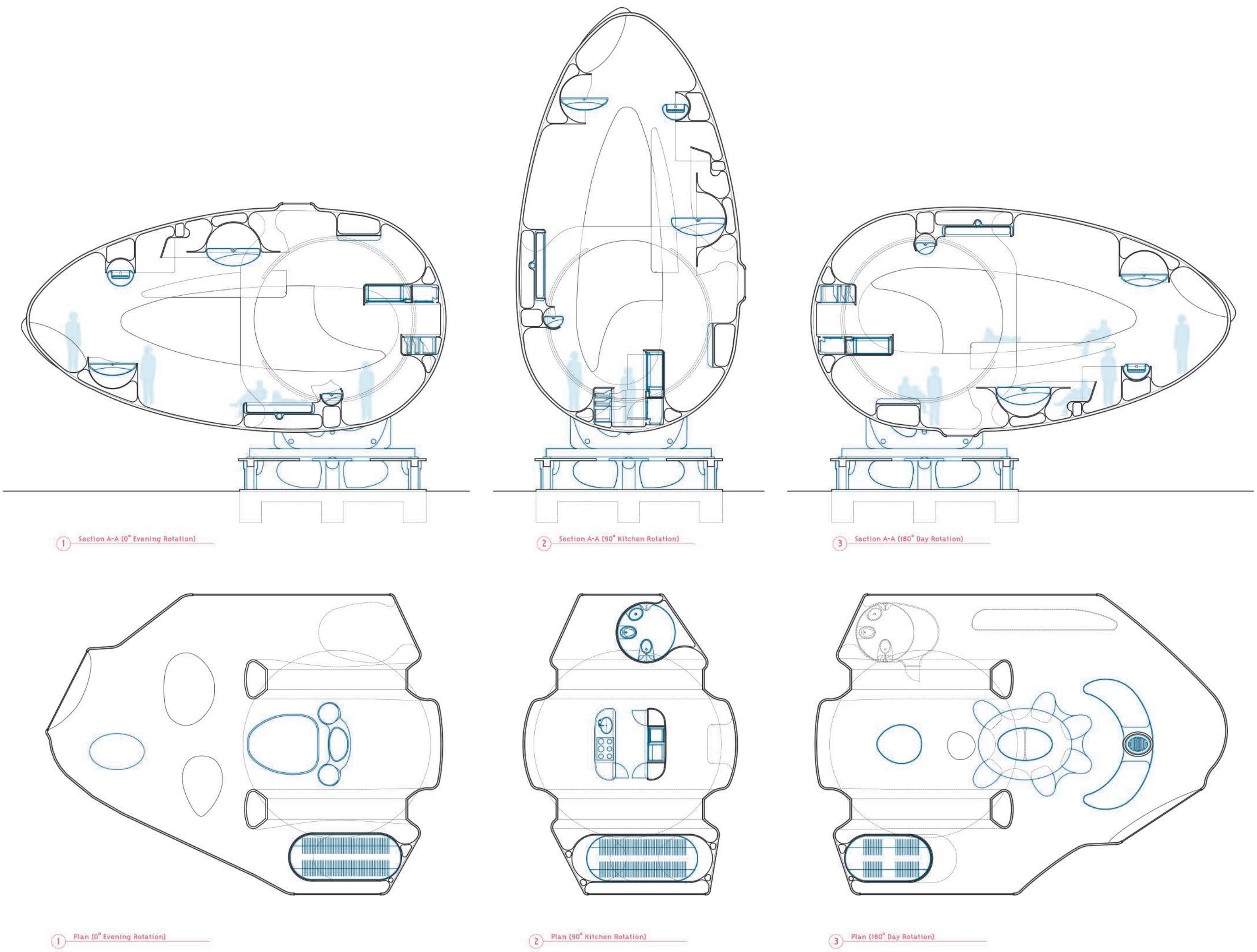
After much initial interest in the late 1960s and early 1970s, not much happened in the next two decades, with the exception of Jean Nouvel's *Institut du Monde Arabe* (Figure 6.2 in Chapter 6 by Kolarevic and Parlac), completed in 1989 in Paris, as the first significant, large-scale building to have an adaptive, responsive façade. With greater attention to buildings' energy demands and increasing capacity to monitor and manage energy use, the building envelope became the locus of technological innovation in the late 1990s. As emphasis shifted away from simply creating energy barriers (to block heat gain or heat loss) towards harvesting energy from the environment and channeling it where it is needed,

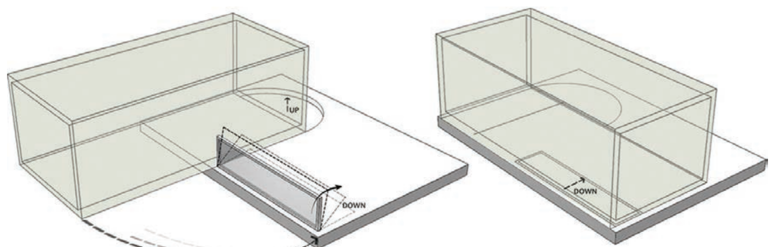
architects and engineers started to incorporate electronically controlled, mechanically activated shading and ventilation systems into building façades. Double-skin façades with a controlled vented air cavity and operable, integrated shades or blinds started to emerge in the 1990s. Then over the last decade, adaptive, kinetic or dynamic façades, active and high-performance building envelopes entered architecture's vocabulary – and practice.[9]

The notions of adaptivity and responsiveness are not limited to building envelopes only. There is an emerging interest in dynamic structures that could enable buildings to change their overall shape and internal configuration, either in response to environmental conditions or different programmatic or use arrangements. If not changing its shape, the building, for example, could reorient itself through rotation so that it always presents a smaller surface area to the sun, as was proposed by OMA in 2005 for a large office building in Dubai (Figures 1.3a–d). Greg Lynn describes his *RV (Room Vehicle) Prototype House* as having a small footprint of 60 m² but 150 m² of usable surface area, which is accomplished by rotating the house around two axes on a robotic base, so that its one wall and ceiling become floor surfaces (Figures 1.4a–c). According to Lynn, the "dwelling challenges the sedentary typologies of a home and introduces a new one based on movement and interaction."[10] The *Sharifi-ha House* (2013) in Tehran, Iran, designed by Nextoffice (Alireza Taghaboni), features entire rooms that rotate in and out of the building's volume to either open or close it, exposing or protecting the interior from the seasonal weather (Figures 1.5a–d).[11]



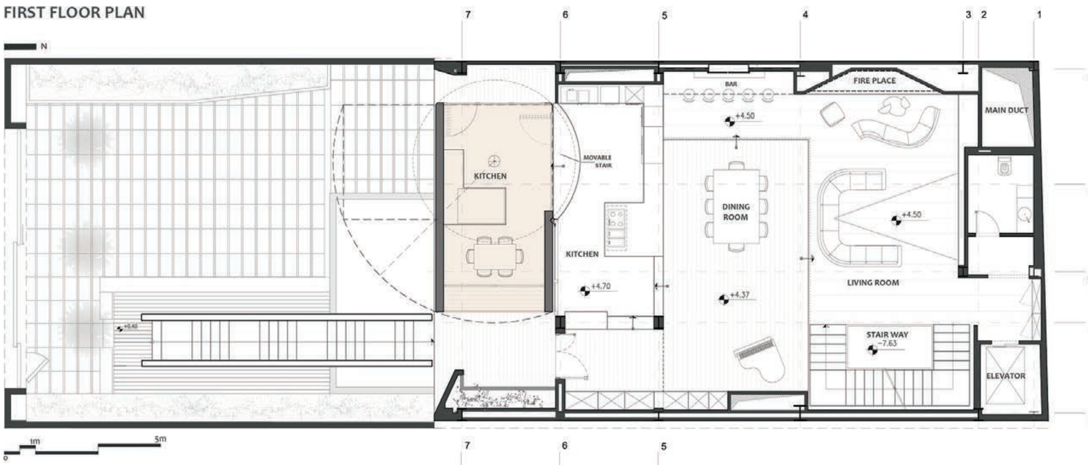
1.4a–c
Greg Lynn's *RV (Room Vehicle) Prototype House* rotates to increase the usable space of a house.



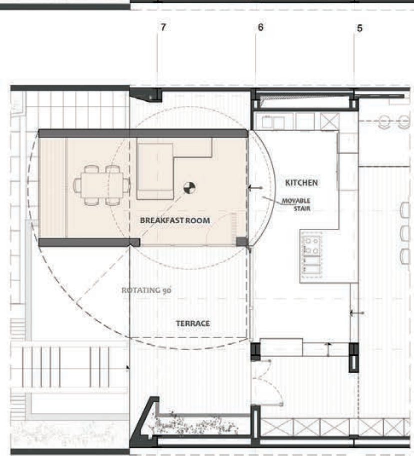



90° ROTATION

FIRST FLOOR PLAN




OPEN BOX




1.5a–d
The *Sharifi-ha House* (2013) in Tehran, Iran, designed by Nextoffice, features entire rooms that rotate in and out of the building's volume.

1.6a and b
The *Living Room House* (2011) in Gelnhausen near Frankfurt features a bedroom that can pop out of the building like a drawer.

Rotation is one simple way of transforming, reconfiguring, or reorienting building components (or even entire buildings). Translation along a linear path, horizontally or vertically, is another straightforward way to transform buildings on the outside or inside. The *Sliding House* in Suffolk, UK, designed by dRMM and completed in 2009 (Figures 6.20a–d in Chapter 6 by Kolarevic and Parlac), features an enclosure that can move along recessed tracks to cover or uncover different buildings along its 28m-long linear path: the house, garage or the annex. The *Living Room House* in Gelnhausen near Frankfurt in Germany (2011), designed by Formalhaut, features a bedroom that can come out from the main volume like a drawer and cantilever over the street below (Figures 1.6a and b). OMA's well-known *Maison Bordeaux* (1998) in France features an open hydraulic elevator platform (Figure 1.7) that enables its wheelchair-bound owner to move vertically between different levels of the house. The elevator platform is actually the owner's office – a room that changes its location within the house throughout the day.

Others are exploring adaptivity and responsiveness in architecture at the other end of the scale – that of materials – and are relying on changing the properties of materials to create an adaptive response in building surfaces and systems.[12] Then, there are issues related to building "intelligence," i.e. controlling the various adaptive responses in buildings and managing potential conflicts that may arise in operation.

1.7
The *Maison Bordeaux* (1998) in France, designed by OMA, features a room on an open hydraulic elevator platform that changes its location within the house.


In *Flexible: Architecture that Responds to Change,*[13] Robert Kronenburg argues that for a building to be "flexible," it must be capable of: (1) adaptation, as a way to better respond to various functions, uses, and requirements; (2) transformation, defined as alterations of the shape, volume, form, or appearance; (3) movability; and (4) interaction, which applies to both the inside and the outside of a building. Such capacities in buildings will be provided by "intelligent" building systems, which will be driven by many factors, from environmental ones, such as the control of energy use, to changing the appearance of the building through varying images and patterns. The systems could be either automatic or "intuitive," suggesting the capacity of the system to infer from the context an appropriate set of responses without overly explicit inputs.

These different strands of inquiry were brought together at the "Adaptive Architecture" conference held in 2011 at the Building Centre in London.[14] At this seminal event, convened by Michael Stacey, presentations were grouped into four thematic categories: *Dynamic Façades*, *Transformable Structures*, *Bio-Inspired Materials,* and *Intelligence*, which could be considered as a taxonomy of current research efforts in this area. The thematic area of adaptive architecture is vast, spanning inquiries that range from highly technical and pragmatic explorations of dynamic, responsive building envelopes to speculative, conceptual explorations of "emotional" responses by built spaces to their occupants' moods.

## FROM PSYCHOTROPIC TO EMOTIVE HOUSES

> It was a beautiful room all right, with opaque plastex walls and white fluo-glass ceiling, but something terrible had happened there. As it responded to me, the ceiling lifting slightly and the walls growing less opaque, reflecting my perspective-seeking eye, I noticed that curious mottled knots were forming, indicating where the room had been strained and healed faultily. Deep hidden rifts began to distort the sphere, ballooning out of one of the alcoves like a bubble of overextended gum.
>
> (J.G. Ballard)[15]

While Ballard's "psychotropic house", mentioned earlier in this chapter, belongs to science fiction, the *E-motive House* by Kas Oosterhuis (2002) edges closer to contemporary technological and material reality. Oosterhuis describes a responsive, interactive house that can develop its own emotions, "a house with a character of its own, sometimes unyielding, sometimes flexible, at one time sexy, at another unpredictable, stiff and unfeeling."[16] The goal is to create an "emotional relationship between the house, its occupiers and the elements." The *E-motive House* can be a "reactor" as well as an "actor," where the "acting will be made possible by a cooperative swarm of actuators like pneumatic beams, contracting muscles and hydraulic cylinders."[17] The house is also capable of reacting: "The movement of the users and the changes in the weather are registered by a diversity of sensors, and are translated by the brain of the house into an action." In this way, the inhabitants and the actuators of the house will develop a common language so that they can communicate with each other.[18]

In 2003, Oosterhuis and his Hyperbody research group designed and constructed the *Muscle*, a working prototype of a programmable building that can reconfigure itself "mentally and physically."[19] The *Muscle* is a pressurized soft volume, wrapped in a mesh of tensile Festo "muscles," which can change their own length and, thus, the overall shape of the prototype. The public connects to the prototype by sensors and quickly learns how the *Muscle* reacts to their actions; the *Muscle*, however, is programmed to have a will of its own, making the outcomes of interactions unpredictable. The ultimate goal of the project is to "develop an individual character for the *Muscle.*" The *Muscle* has demonstrated that the *E-motive House* is not so techno-utopian – and that Ballard's "psychotropic" house could perhaps become a reality of our inhabitation in the future.

## OPEN BUILDING

In the quest to establish a context for change and variety in architecture, an international network for *Open Building*[20] was established early in this decade. In *Open Building*, the focus is on disentangling building systems and subsystems from each other so that they can be better organized to facilitate not only their efficient assembly, but also their disassembly and reassembly in different configurations. *Open Building* separates the major systems into the building site, the structural envelope, the division of space inside the building, plumbing, wiring, heating/cooling, and the cabinets, furniture, and "other stuff that people put inside the building." One of the main distinctions that *Open Building* makes is between "support" and "infill," where "support" refers to the structural envelope, and "infill" to all the other systems that are housed within the envelope. Without referencing the *Open Building* movement, Tristan d'Estree Sterk also separates the components of buildings into two main classes of parts: (1) the serviced spaces (responsive, internal partition systems, and (2) the external shells (responsive building envelopes or structures).[21] Thus, building design operates on two levels: first, the overall structural envelope is designed, and then the infill. Critical to successful implementation are interfaces between different systems, which should be designed to allow different choices of systems and their replacement, as in different fit-out systems applied in each unit, depending on the choices made by the users.

1.8
Gerrit Rietveld's *Schröder House* (1924) features an adaptive large space on the upper floor.

While *Open Building* as a design and building method aims to address the changing social and technical context in which we live and work, it focuses on building systems as a technological enabler for effective changes in use (i.e., adaptive re-use). It recognizes that there are distinct levels of intervention in the built environment; that users may make design decisions, as well; that design is a process that involves many different disciplines and professionals; and that the built environment is in constant transformation (i.e., subject to continuous change) and is the product of a never-ending, ongoing design process in which it is transformed part by part.

Ed van Hinte and the other authors of *Smart Architecture*[22] also articulate a need for architecture to develop ways of designing buildings that can change, but do so with a dimension of time explicitly in mind. According to them, buildings could be divided into seven system-based layers, each with its own lifespan that ranges from centuries, down to a couple of years. The layers are (in ascending order, depending on life span): location, structure, access, façade, services, dividing elements, and furniture. They warn that the dynamics of these layers – and their different life spans – have to be taken into consideration when designing "integrated" buildings. (A building with tightly integrated building systems may not have a capacity for change if the systems are impossible to separate and disassemble.)

## LO-TECH, HI-TECH, OR BOTH?

The notion of adaptive, changeable buildings and spaces is anything but new. It has been present for centuries in building traditions of many different cultures around the world. For example, in a traditional Japanese house any room could be a living room or a bedroom (or a dining room). What makes this adaptability in use possible are two key features: first, all furniture is lightweight and could be removed into large storage closets; second, the size of a *space* could be easily changed using sliding partitions (*fusuma*) that separate adjacent rooms. Such spatial porosity is also present in traditional Korean houses.

The Modernist *Open Plan* is based in large part on these East Asian precedents, as were the associated notions of adaptability and flexibility. Gerrit Rietveld's seminal *Schröder House*, built in 1924, features on the upper floor an adaptive large space that can be left open or subdivided using sliding and revolving partitions into four separate rooms, i.e. three bedrooms and a living room (Figure 1.8). Similarly, Steven Holl's apartment complex in Fukuoka, Japan, completed in 1991, relied on hinged wall partitions to create adaptive apartment units in which spaces could change daily or on a larger time scale as family size changes (Figures 1.9a and b).

1.9a and b
Steven Holl's *Hinged Space Housing* (1991) in Fukuoka, Japan.

As more and more designers and firms begin to experiment with innovative technologies to create kinetic, adaptive spaces and systems, it is worth remembering that wheels and hinges – if used imaginatively – could create very potent transformable environments that need not rely on any fancy mechatronic set-ups. The *Naked House* in Kawagoe, Japan, designed by Shigeru Ban and completed in 2000, features four movable rooms on wheels inside a large, shed-like space (Figures 1.10a and b). The 6 sqm rooms are open on two sides and can be located anywhere within the large interior space or even moved outside; they could be also joined to form larger spaces if needed.

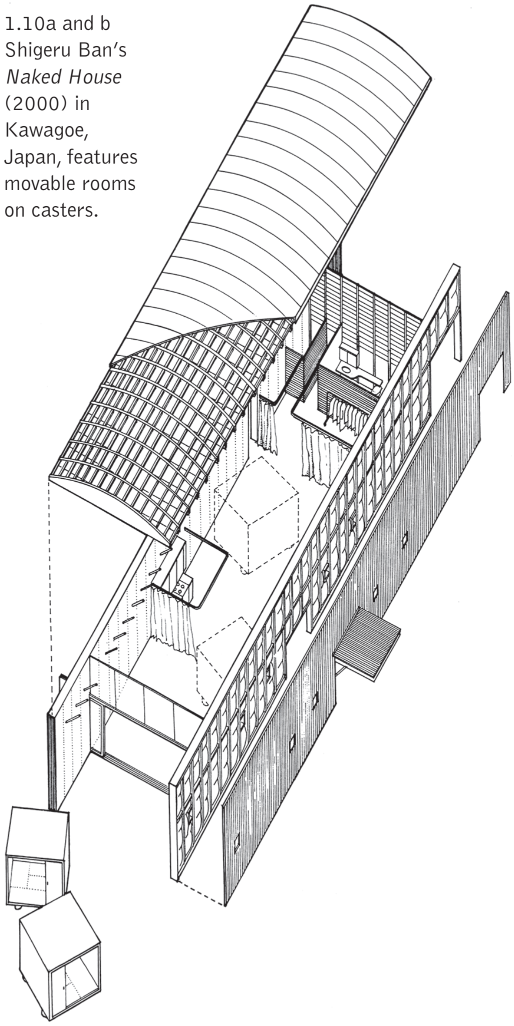
We should not lose sight of simple, low-tech solutions in our current quest for adaptive systems infused with the latest sensing, control, and activation technologies. Oftentimes, simply adding wheels and tracks (and/or hinges) to elements that are then moved by people is all that is necessary for some adaptive designs to be effective spatially and programmatically. It is also worth remembering that any cutting-edge technological system of today becomes an obsolete technology rather quickly. One way of addressing this challenge of obsolescence is to rely on technologies that are already "obsolete," but which could be deployed in an innovative way.

The dimension of time is rather critical for the designers of adaptive, responsive, interactive building systems of tomorrow – not only conceptually, but also operationally, at the most pragmatic, tectonic level.

## REACTIVE, INTERACTIVE, PARTICIPATORY ARCHITECTURE

Another critical issue in the design of any highly automated adaptive, responsive system is the user override. If an installed, automated system requires frequent manual overrides by annoyed users, its "life" will likely be short; a simple, people-activated "high-performance" and low-tech solution would probably more than suffice in such cases. Social and cultural factors need to be taken into account in set-ups that rely on automated systems to attain certain technical performance goals. We shouldn't be blinded by technologies of the day and should not lose sight of the qualitative, i.e. non-quantifiable performative aspects of the project and whether they could be better served by no-tech or low-tech solutions. There is also the ever-present danger of creating "gimmicky" architecture that very quickly becomes boring.

1.10a and b
Shigeru Ban's *Naked House* (2000) in Kawagoe, Japan, features movable rooms on casters.



The primary goal of constructing a truly responsive, adaptive architecture is to imbue buildings with the capacity to interact with the environment and their users in an engaging way. Architecture that echoes the work of Nicholas Negroponte could be understood as an adaptive, responsive machine – a sensory, actuated, performative assemblage of spatial and technical systems that creates an environment that stimulates and is, in turn, stimulated by users' interactions and their behavior. Arguably, for any such system to be continually engaging, it has to be designed as inherently indeterminate in order to produce unpredictable outcomes. The user should have an effect on the system's behavior or its outcome and, more importantly, on how that behavior or outcome is computed. That requires that both inputs and outputs of the systems be constructed on the fly. It is this capacity to construct inputs and outputs that distinguishes interactive from merely reactive systems.

The distinction between interactive and reactive is what enables adaptive, responsive architecture to be seen as an enabler of new relations between people and spaces. When Philip Beesley and his colleagues describe a responsive environment in *Responsive Architectures: Subtle Technologies* as a "networked structure that senses action within a field of attention and responds dynamically with programmed and designed logic,"[23] they are referring to what is essentially a reactive system. In contrast, Michael Fox and Miles Kemp argue in *Interactive Architecture* that the interaction is circular – systems "interact" instead of just "react."[24] The distinction between interaction and reaction (i.e., a system's response) is not clear-cut, because a dynamic action of a component, for example, could be seen not simply as a reaction but also as a part of the overall scenarios of interactivity. Tristan D'Estree Sterk distinguishes direct manipulation (deliberate control), automation (reflexive control), and hybridized models as forms of interaction between the users and the technologies behind responsive systems.[25] For Sterk, "The hybridized model can also be used to produce responses that have adjustable response criteria, achieving this by using occupant interactions to build contextual models of the ways in which users occupy and manipulate space."[26]

As Usman Haque puts it, the goal is

> a model of interaction where an individual can directly adjust the way that a machine responds to him or her so that they can converge on a mutually agreeable nature of feedback: an architecture that learns from the inhabitant just as the inhabitant learns from the architecture.[27]

Thus, one of the principal challenges is how to construct (Paskian) systems that would provide enough variety to keep users engaged, while avoiding randomness, which could lead to disengagement if the output cannot be understood. The key challenge is to design an architecture that avoids boredom and retains a high degree of novelty. As observed by Haque, "Unlike the efficiency-oriented pattern-optimization approach taken by many responsive environmental systems, an architecture built on Pask's system would continually encourage novelty and provoke conversational relationships with human participants."[28]

When it comes to designing adaptive, responsive environments, the "software" side does not seem to present as many challenges as the "hardware" side, the building itself, in which the majority of systems is inherently inflexible. That is perhaps where the biggest challenges and opportunities exist, as buildings would have to be conceptually completely rethought in order to enable them to adapt (i.e., to reconfigure themselves). Then there is the "middleware" that sits among the software and hardware and the users as devices that facilitate the feedback loops between the components of the system. There are other, more operational-based challenges that have to do with resolution of potential conflicts within systems. For example, Sterk discusses the coordination of responses at coincident, i.e. shared boundaries between spaces, as in a movable partition wall between two spaces, which can have actuators accessible through two independent control processes.[29]

Another issue is that while change is desirable, for most purposes, it would have to occur in predictable and easily anticipated ways. If that is not possible, then there ought to be a way (in certain circumstances) for users to preview changes before they are executed, or to choose among alternatives for one (perhaps suboptimal) that fits the current circumstances, needs, and/or desires. Users may need to be informed of the impact that selected changes would have on the environment or the shape and configuration of the space. The overall issue of control is critical, as was already mentioned. In *Smart Architecture*, Ed van Hinte warns that "sometimes a simple and hence ostensibly 'dumb' building is smarter than a technology-dominated living-and-working machine over which the user has lost control."[30]

There are also some fundamental questions that have yet to be adequately addressed. For example, while Beesley and his colleagues predict, "the next generation of architecture will be able to sense, change and transform itself,"[31] they fail to say clearly towards what ends. Even though they ask what very well may be the key question – how do responsive systems affect us? – they do not attempt to answer it explicitly. Similarly, Fox and Kemp, in their *Interactive Architecture* book,[32] avoid explaining fully – and admit as much – why interactive systems are necessary, meaningful, or useful, and simply state, "the motivation to make these systems is found in the desire to create spaces and objects that can meet changing needs with respect to evolving individual, social, and environmental demands." Fox and Kemp position interactive architecture "as a transitional phenomenon with respect to a movement from a mechanical paradigm to a biological paradigm," which, as they explain, "requires not just pragmatic and performance-based technological understandings, but awareness of aesthetic, conceptual and philosophical issues relating to humans and the global environment."[33]

## ARCHITECTURE OF CHANGE = ARCHITECTURE OF TIME

> Accepting the dynamics of buildings and cities … can turn architectural change into an ecologically efficient process as well as a new urban experience.
>
> (Ed van Hinte, *et al.*, *Smart Architecture*)[34]

If we were to accept change as a fundamental contextual condition – and time as an essential design dimension – architecture could then begin to truly mediate between the built environment and the people who occupy it. As Ed van Hinte and his colleagues note, "Instead of being merely the producer of a unique three-dimensional product, architects should see themselves as programmers of a process of spatial change."[35] The principal task for architects is to create "a field of change and modification" that would generate possibilities instead of fixed conditions. The inhabitable space would then become an indeterminate design environment, subject to continuous processes of change, occurring in different realms and at various time scales:

> It is the form that is no longer stable, that is ready to accept change. Its temporary state is determined by the circumstances of the moment on the basis of an activated process and in-built intelligence and potential for change. Not product architecture then, but a process-based architecture whose form is defined by its users' dynamic behaviour and changing demands and by the changing external and internal conditions; an architecture that itself has the characteristics of an ecological system, that emulates nature instead of protecting it and therefore engages in a enduring fusion of nature and culture.[36]

As Ed van Hinte and his colleagues point out, "that would be a truly ground-breaking ecological architecture."[37] But to get there, we need to first answer some fundamental questions pertaining to change as a conceptual and time as a phenomenological dimension in architecture. We need to go beyond the current fascination with mechatronics and explore what change means in architecture and how it is manifested: buildings weather, programs change, envelopes adapt, interiors are reconfigured, systems replaced. We need to explore the kinds of changes that buildings should undergo and the scale and speed at which they occur. We need to examine which changes are necessary, useful, desirable, possible …

In short, much remains to be done: I would argue that change – and time as a design dimension in architecture – are far from being adequately addressed or explored theoretically, experimentally, or phenomenologically. As we probe and embed adaptability, interactivity, and responsiveness into the buildings and spaces, we must not unconditionally and blindly chase the latest technological advancements. As I have argued in this chapter, an effective adaptive, responsive – and responsibly designed – building could be based on simple, low-tech, low-energy solutions. It could be actuated by people who live or work in it, who could push, pull, turn, flip, move things … and it could be intelligently augmented with sensors and an Arduino board here and there, as needed.

## ACKNOWLEDGMENTS

Parts of this chapter have previously been published by the author.

## NOTES

**1** Ballard, James Graham, "The Thousand Dreams of Stellavista," in *Vermilion Sands* (London: Vintage, 2001, originally published in 1962, then 1971).
**2** Ibid.
**3** Ron Herron was a member of Archigram, an avant-garde architectural group formed in the early 1960s in London. Other members of the group were Peter Cook, Warren Chalk, Dennis Crompton, Michael Webb, and David Greene. The group devised a series of hypothetical projects, drawing inspiration from the technological, social, and cultural context of the 1960s.
**4** Pask, Gordon, "Architectural Relevance of Cybernetics," *Architectural Design*, September 1969, pp. 494–496.
**5** Negroponte, Nicholas, *Soft Architecture Machines* (Cambridge, MA: MIT Press, 1975).
**6** Ibid.
**7** Ibid.
**8** Eastman, Charles, "Adaptive-Conditional Architecture," in N. Cross (ed.), *Design Participation: Proceedings of the Design Research Society Conference* (London: Academy Editions, 1972), pp. 51–57.
**9** For a discussion of adaptive building envelopes, see Chapter 6 by Branko Kolarevic and Vera Parlac in this book.
**10** For more information about *RV Prototype House*, see http://glform.com/buildings/rv-room-vehicle-house-prototype/.
**11** The turning mechanism used in the house is a commonly used one for rotating theatrical set-ups and turning car exhibits in showrooms.
**12** For a discussion of adaptive materials, see Chapter 12 by Vera Parlac in this book.
**13** Kronenburg, Robert, *Flexible: Architecture that Responds to Change* (London: Laurence King Publishing, 2007).
**14** See www.buildingcentre.co.uk/adaptivearchitecture/adaptive.html.
**15** Ballard, op. cit.
**16** See www.hyperbody.nl for more information.
**17** Ibid.
**18** Ibid.
**19** Ibid.
**20** See www.open-building.org for more information.
**21** Sterk, Tristan d'Estree, "Responsive Architecture: User-Centered Interactions within the Hybridized Model of Control," in *GameSetandMatch II: On Computer Games, Advanced Geometries and Digital Technologies* (Rotterdam, the Netherlands: Episode Publishers, 2006), pp. 494–501.
**22** van Hinte, Ed, Neelen, Marc, Vink, Jacques, and Vollaard, Piet, *Smart Architecture* (Amsterdam: 010 Publishers, 2003).
**23** Beesley, Philip, Hirosue, S., Ruxton, J., Trankle, M., and Turner, C., *Responsive Architectures: Subtle Technologies* (Toronto, ON: Riverside Architectural Press, 2006).
**24** Fox, Michael and Kemp, Miles, *Interactive Architecture* (New York: Princeton Architectural Press, 2009).
**25** Sterk, op. cit.
**26** Ibid.
**27** Haque, Usman, "The Architectural Relevance of Gordon Pask," in Lucy Bullivant (ed.), *4dsocial: Interactive Design Environments, Architectural Design*, no. 77 (London: Wiley Academy, 2007).
**28** Ibid.
**29** Sterk, op. cit.
**30** van Hinte, *et al.*, op. cit.
**31** Beesley, *et al.*, op. cit.
**32** Fox and Kemp, op. cit.
**33** Ibid.
**34** van Hinte, *et al.*, op. cit.
**35** Ibid.
**36** Ibid.
**37** Ibid.

2

# MAKING SPACE FOR TIME

DAVID LEATHERBARROW

2.1
*Guthrie Theater* (2006) in Minneapolis, designed by Jean Nouvel.

The basic thesis of this chapter is this: through temporality one gains access to the primary order of architectural topography and thus to the reality and meaning of landscapes, streets, buildings, rooms, and their details. Time, I will try to show, is not a contingent attribute of the places intended in design and realized through construction but a key to their essential structure and significance.

For some, I suspect my thesis will seem like "thoughts out of season." Given our steady attention to a building's readiness for immediate experience – I mean the direct perception of the materials, spaces, and dimensions that are *presently* apparent (Figure 2.1) – the work's former and future conditions will seem largely insignificant. We tend to believe that the work is complete when its construction, layout, and look have been brought to the state that was specified in design. From that moment onward we expect the work to stay as it first was, suffering but enduring the effects of inhabitation and environmental influence. Permanence is a building's first premise and greatest virtue.

Uncontroversial as these truisms may seem, they are contradicted by the fact that the building's "move-in" and "photo-ready"' condition never last very long, hardly more than a season, certainly not through the years and decades of its use, well after the builders have left the site. Inhabitation inaugurates alteration. Succession is the inevitable result; new appearances succeed old, each different, even if the modifications are barely perceptible. Retrospective views of resemblance do not overcome, they reaffirm these differences. A key task of design is making space for *this* kind of time, the time of continual change.

There is no good reason to privilege a work's first over its later appearances, nor to judge any present condition as necessarily superior to those that preceded and will follow it. Our tendency to concentrate on the qualities of the work that display the designer's intentions is, I think, a disciplinary prejudice that neglects the building's post-professional life. I realize this observation runs against the grain of most building restoration campaigns, no matter whether they are undertaken by preservationists, historians, or the designers themselves. But the truth of the matter is that many buildings *improve* over time. Sometimes this occurs through intentional modifications that compensate for inadequate foresight. Changes can also result from the operation of manual or digital devices, which aim to improve a work's usefulness – they alter its appearance as well. Today buildings and elements that incorporate these devices are said to be "intelligent." An intelligent façade, for example, is one that incorporates instruments that moderate climate, accepting or rejecting free energy from the external environment, reducing the amount of artificial energy required to achieve comfortable internal conditions. Materials, too, can be endowed with intelligence, more or less.

2.2
*Wells Cathedral* (Cathedral Church of St. Andrew) in Wells, Somerset, UK.

2.3
*Fisher Fine Arts Library* (1890) in Philadelphia, designed by Frank Furness.

But design is not required for changes to occur; alterations can also result from a work's 'natural' tendency to settle into its location, absorbing into its physical body qualifications that often render it more congenial to ambient conditions, even if they alter intended finishes. Georg Simmel, speaking of material change in his paper on ruins, said that eventually "nature reclaims what was taken from it."[1] The spectrum of surface alterations, of course, ranges very widely, from bleaching, absorption, saturation, and staining, to polishing and abrasion. One of the best-known instances of abrasion is the dishing of treads that occurs over years of use, a re-profiling to which thousands of anonymous individuals contribute unknowingly (Figure 2.2). Yet, the result, the path most prefer, is prominently visible – even legible. Another eloquent example is the festive – at least seasonal – whitewashing of vernacular buildings.[2] Obviously, this practice is subtended by extra-architectural ideas and traditions; Easter renewal, for example. The sun also plays a role in *remaking* architectural appearances: a building's sun and shade sides show different degrees of both chromatic intensity and variation. Consider the stone on the north and west sides of Frank Furness's *Fine Arts Library* in Philadelphia (Figure 2.3), or the alternately prominent and recessed parts of a single façade, such as the wooden panels on Kahn's *Salk Institute* (Figure 2.4). The power of light and shadow to animate an architectural surface is similarly obvious. Recently, Kengo Kuma developed a theory of "particles" that elaborates this basic fact of building under the sun (Figure 2.5).[3] Alterations that result from the sedimentation of air-borne particles are also familiar. Surface marks sometimes enrich, sometimes stain. In the case of Marcel Breuer's *De Bijenkorf* department store (Figure 2.6) a radically

2.4
*Salk Institute for Biological Studies* (1966) in La Jolla, designed by Louis I. Kahn.

different façade has resulted from these alterations. I doubt he imagined this but I have a hunch he liked it. Changes that are unforeseen interest me the most because they often enrich works in ways that exceed what design intended. Even if we postpone judgments about the merit of modifications that were never envisaged I think we must admit that unforeseen changes are inevitable in works that last and therefore should be taken into consideration in any account of their concrete reality, as well as in their initial designs.

## TEMPORALITY IN ARCHITECTURE

Nevertheless, when given just a little thought, the temporality that is peculiar to architecture seems contradictory. In architecture, time *maintains* what it has brought into being while it simultaneously *schedules the work's transformation* – ultimately its disintegration. How can the two – sameness and difference – occur concurrently? By virtue of its physicality, suitability, and familiarity every work keeps its past present; now, like then, the walls of this room are still plaster, timber, and glass; its apertures and furnishings allow one to use it as others have and will; *in time* it will still be *this room*. During any of these uses the distinction between what the setting once was and now is has no real force. The only aspects of the setting that show themselves to be "of the past" are the few that have lost their tacit relevance. Practical involvements abrogate the familiar, but essentially conceptual, distinction between now and then. The chief impediment to grasping the reality of change is our uncritical dedication to objective or clock time, as opposed to the time of an event. On this point, William Faulkner offered a blunt observation: "Time is dead as long as it is being clicked off by little wheels, only when the clock stops does time come to life."[4]

2.5
*Nakagawa-machi Bato Hiroshoghi Museum of Art* (2000) in Nasu Tochigi, Japan, designed by Kengo Kuma.

2.6
*De Bijenkorf* department store (1956) in Rotterdam, designed by Marcel Breuer.


Thanks to the qualities I have just mentioned (physicality, suitability, and familiarity), every built setting not only recalls its past, it pre-figures its future; in the case of a lecture room, for example, the moment when the next lecturer or conference will begin, or more prosaically when the floor will be cleaned, lighting repaired, and the overall appearance renewed. In other words, the room's "present state" continually outreaches itself toward its recent past and near future, impinging on each of them simultaneously. Here is the key point: temporality is not only nor always moment-by-moment succession. The chronology of regular intervals, clock time, is not lived time, as Faulkner said. The past lingers into the present, just as the future extends it; every now is also a former future and every future is at the same time a present yet to come.[5] Every "present moment" in the living reality of an architectural work reasserts the presence of a history which it also supplants, while it anticipates what is yet to come, although incompletely. My general point is that past and future define essential dimensions of the work's "present" reality, albeit as conditions that are "no longer" and "not yet" present in the way they once were and will be. Accordingly, we need to reconsider what we conventionally mean by the completion of the construction process. Building materials are *pre-qualified* in the quarry – that's how they recommend themselves for use – then are *qualified* through the labors of construction, and lastly are *re-qualified* through use and patterns of environmental influence. This means the labor of finishing never comes to an end.[6] Can we think of works as essentially unfinished? More importantly, can we design them that way?

Finally, the temporal order that seems to be contradictory – now plus then – unfolds at several levels. Every built work – and by that I mean every room, building, garden, and urban setting – has a stratified temporal horizon, from which it obtains definition and in which it renews itself. I will explain the levels or kinds of time below.

But, first, I shall propose a more compact version of my opening thesis: *architectural permanence realizes itself in time*. I say "in time," not *through time*, not diachronically, as the philosophers say, or pathologically, as Aldo Rossi once said; but

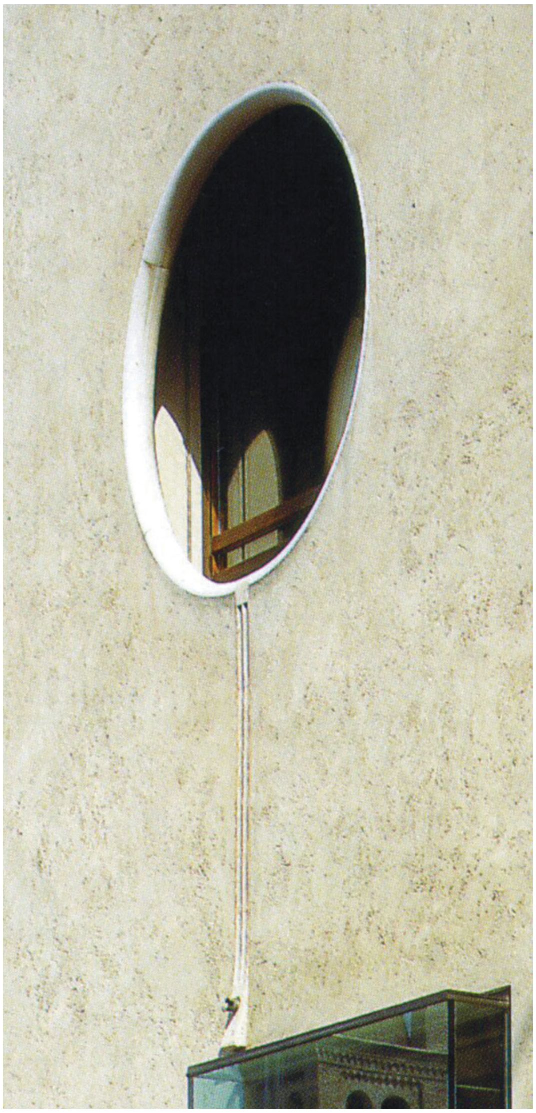
2.7
*Ferrara Cathedral* (*Basilica Cattedrale di San Giorgio*) in Ferrara, Italy.

synchronically, or, in Rossi's terms, a propelling sort of permanence that allows adaptations and alterations.[7] To exemplify propelling permanence he mentions the *Palazzo Ragione* in Padova. An even more eloquent case, I think, is the cathedral in Ferrara (Figure 2.7); particularly the additions and alternations to the flanking walls of the nave, coupling in a fascinating way the side chapels within the church. The principle of propelling permanence has two corollaries: continuance without change is impossible in architecture, and individual buildings like places are co-defined by the "no longer" and "not yet" of their history. Although condensed, these observations should indicate the limitations of the conventional view of architectural permanence, poignantly stated by the great Austrian theorist, August Schmarsow, whose writings show sensitivity to social and historical change. He observed:

> Architecture prepares a place for all that is lasting and established in the beliefs of a people and of an age; often, in a period of forceful change, when everything else threatens to sway, will the solemn language of its stones speak of support.[8]

Even though it contradicts all that I have said, Schmarsow seems right: well-designed buildings defy transience, because they abide, they assure. What land is to sea, architecture is to worldly change, its polar opposite and fix. Moreover, this conceit encourages designers to pursue essences in their

2.8
*Banca Popolare di Verona* (1973) in Verona, Italy, designed by Carlo Scarpa.



work – to dream of infinitely durable form – just as it allows a satisfying sense of cultural authority. But obvious notions are not necessarily true. I have argued, and now want to explain more concretely, that architectural reality appears in time: works last because they change.

## KINDS OF TIME

We can take the next step in understanding how architecture makes space for time by distinguishing the *kinds of time* that are embodied in the buildings. I believe there are three distinct chronologies that co-exist non-synchronically yet indivisibly in all built works.

First, there is what I call *the time of the world*, combining the calendar of environmental change with the schedules of daily life. The former include seasonal, diurnal, and atmospheric changes, the latter include the rhythms, patterns, and cycles of inhabitation. Anticipations and outcomes of these combined histories can be seen in the work's defenses, allowances, and accommodations; which is to say, the material, mechanical, and spatial preparations that anticipate the play of ambient forces and recall it: harder timber for treads than for risers, screens that filter environmental passage and blinds that block it, rainwater conductors and collectors, thermal breaks and expansion joints, and so on. One of the more creative treatments of water handling within a work's façade is Carlo Scarpa's bank in Verona (Figure 2.8). His sill-receptacle, surface-channel, and spout recall marks made on nearby façades, just as they anticipate similar processes in his building's similar forms, and they express his design's synchronization with its location by making these actions legible. Here change is not only managed but shown.

The time of the world is also inscribed on buildings through the ancient and inevitable effects of the sun. A well-known example of sun-screening is the early experiment with the *brise-soleil* undertaken by Oscar Niemeyer, Lucio Costa, and others in Rio de Janeiro at the *Ministry of Education* (Figure 2.9). Here, too, we see the impress of memories and anticipations: adjustable panels wait for and respond to light that is too bright, producing shadows that record the path and progress of their solar source. But listed under this heading should also be changeable elements within the building, all the moveable furniture, deployable equipment, and adjustable lighting that attune the work to variable dwelling requirements. An early modern design that elaborated this temporality very

2.9
*Brise-soleil* at the *Ministry of Education* building (1942) in Rio de Janeiro, designed by Lucio Costa, Oscar Niemeyer, and Le Corbusier.

2.10
*Villa Busk* (1990) in Bamble, Norway, designed by Sverre Fehn.

creatively is Pierre Chareau's *Maison de Verre*. An equally good case is Eileen Gray's *E 1027*. World time is also apparent in the modifications to a building's surfaces that attest to its sufferings and show its enhancements. Consider, for example, Sverre Fehn's *Villa Busk* (Figure 2.10). Outside, the wooden window surrounds have lost nearly all of their color, inside these same timber elements have rich chromatic intensity, especially in shadow – which Mr. Busk seems to have preferred when making recordings. All of these figures provide a visible record of the project's past and a proposal for its future, as if the work were at once a clock, calendar, and chronicle.

The second sort of time that exists in built works is *the time of the project*.[9] The first and most difficult distinction that must be made is between project making and production. For production to occur, one must assume that much, if not most, of the design development has been completed. Like all progressive endeavors, productive work is oriented towards the future. It is unique insofar as it converts an orientation towards what is ahead into a taking hold of it, abbreviating a process of approach in order to accomplish arrival. The prefix *pro* means before or in advance, in front or in favor of. Architectural projects, we say, advance *pro*-posals. Etymologically the word project means "to throw forward"; a *projectum* is something thrust ahead, a projectile. Production *completes* the project's advance, achieves its goal, insulating design's procedures against future interferences. Single-mindedly dedicated to its ends, approximately locomotive, production marginalizes all possibilities but one in order to arrive at the work's concluding stage. This process draws the yet-to-come of the project back into the now, placing the future in the grasp of the present, as if project-making were planning, which it is not. And once projects discard their preliminaries the form they achieve bears little or no trace of its formation.