Exploring Architecture of Change

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ABSTRACT

This paper discusses what may seem to be rather obvious: responsive, adaptive, flexible, etc., architectures are all about change, which in turn, is all about time. It surveys significant past and current projects that deal with interactive, responsive environments. The principal argument is that change in architecture is far from being adequately addressed or explored theoretically, experimentally, or phenomenologically.

TOWARDS PSYCHOTROPIC AND 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 one of the alcoves like a bubble of overextended gum." —J.G. Ballard, The Thousand Dreams of Bellavista

James Graham Ballard,[1] the British novelist, describes in his short story "The Thousand Dreams of Stellavista," a "psychotropic house," a machine-like, mood-sensitive house that responds to and learns from its occupants. The imagined sci-fi house is made from a material Ballard referred to as "plastex," a combination of plaster and latex that allows the house to change its shape as needed. Furthermore, the house features, distributed over it, many "senso-cells," which are capable of "echoing every shift of mood and position of its occupants, such that living in one was like inhabiting someone else's brain."

While Ballard's "psychotropic house" belongs to science fiction, the "E-motive House" by Kas Oosterhuis[2] 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." 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." 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.

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." 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.

TOWARDS ARCHITECTURE THAT IS ADAPTIVE, FLEXIBLE, INTERACTIVE, RESPONSIVE…

A common thread that runs through Ballard's "psychotropic house" and Oosterhuis's E-motive House is a vision of an architecture in which buildings can change their shape, their form, the configuration and appearance of space, and environmental conditions—on the fly—in response to patterns of occupation and contextual conditions (and shape those, in return, too). Buildings will become adaptive, interactive, reflexive, responsive…

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 to changes in the external and internal environments and to different patterns of use). Oosterhuis's Muscle is just one of many experimental projects that have been completed. 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.

The first concepts of an adaptive, responsive architecture where born in the late 1960s and early 1970s, primarily as a result of parallel developments in cybernetics, artificial intelligence, and information technologies, in general, and as a response to architecture's rigid, inflexible articulation of space and its configuration.

Gordon Pask set the foundations for interactive environments in the 1960s; he was one of the early proponents of cybernetics in architecture, whose concept of Conversation Theory,[3] as a comprehensive theory of interaction, is particularly applicable today as various attempts are made to create constructive relationships between humans and machines (as in interactive architecture). Pask's ideas had a tremendous influence on both Cedric Price and Nicholas Negroponte, whose pioneering work in the 1960s continues to inspire; Pask worked with both Price and Negroponte.

Cedric Price was the first to adopt concepts from cybernetics and use them to articulate a concept of "anticipatory architecture," manifested in his Fun Palace and Generator projects. Nicholas Negroponte was among the first to propose in the late 1960s that computing power be integrated into buildings so that they could perform better. In his book Soft Architecture Machines,[4] he moved beyond the "architecture machines" that would help architects design buildings and proposed that buildings could be "'assisted,' 'augmented,' and eventually 'replicated' by a computer." The ambition was to "consider the physical environment as an evolving mechanism." 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," echoing the sci-fi "psychotropic houses" of J.G. Ballard.

At roughly the same time that Negroponte was working on his "architecture machines," Charles Eastman[5] developed the concept of "adaptive-conditional architecture," which self-adjusts based on the feedback from the spaces and users. Eastman proposed that automated systems could control buildings' responses. He used an 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 makeup of any reactive system developed to date.

Jean Nouvel's Institut du Monde Arabe, completed in 1989 in Paris, was the first significant, large-scale building to have an adaptive envelope. The building's kinetic curtain wall, a technological interpretation in glass and steel of a traditional Arab lattice screen, is composed of some 30,000 photosensitive diaphragms that control light levels and transparency in response to the sun's location (the system no longer works due to mechanical problems). Hoberman Associates (led by Chuck Hoberman) is perhaps one of the best-known contemporary practices to have designed several kinetic, performance-based adaptive shading systems for building projects by firms such as Foster and Partners and Nikken Sekkei. More and more designers and firms are beginning to experiment with innovative sensing, control, and actuation technologies to create kinetic, adaptive performance-based systems.

TOWARDS PASKIAN RESPONSIVE ENVIRONMENTS

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. 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[6] as a "networked structure that senses action within a field of attention and responds dynamically with programmed and designed logic," they are referring to what is essentially a reactive system. In contrast, Michael Fox and Miles Kemp[7] argue that in "interactive" architecture, the interaction is circular—systems "interact" instead of just "react." 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 part of the overall scenarios of interactivity. Tristan D'Estree Sterk[8] distinguishes direct manipulation (deliberate control), automation (reflexive control), and hybridized models as forms of interaction between the users and the technologies behind responsive systems. 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."

As Usman Haque[9] 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." 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 question: How does architecture avoid boredom and retain a high degree of novelty—another Paskian challenge. 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."

There are other, more operational-based challenges that have to do with resolution of potential conflicts within systems. For example, Sterk[10] 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 by two independent control processes. 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. In Smart Architecture, Ed van Hinte[11] 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."

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, whose majority of systems are 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 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,"[12] 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,[13] in their Interactive Architecture book, 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."

TOWARDS ARCHITECTURE OF CHANGE

> "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

The quest for an architecture of change is a reflection of the context in which we live and work. An ever-increasing pace of change is what defines contemporary life: socio-economic, political, cultural, and, in particular, technological context are constantly shifting, altering the norms, customs, and expectations and affecting how we use and relate to space. A rapidly changing socio-economic, cultural, and technological environment demands buildings that can adapt quickly. How buildings can adapt and how they respond to change depends on the nature of change (i.e., on the context in which the change occurs [programmatic use, building systems, etc.]).

In Flexible: Architecture that Responds to Change, Robert Kronenburg[14] 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 a capacity of the system to infer from the context an appropriate set of responses without overly explicit inputs.

In a quest to establish a context for change and variety in architecture, an international network for so-called Open Building (www.open-building.org) 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, structural envelope, 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[15] also separates the components of buildings into two main classes of parts: the serviced spaces (responsive, internal partition systems) and the external shells (responsive building envelopes or structures). Thus, building design becomes two-level: 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.

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[16] 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 layersČand their different life spansČave 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.)

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." 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 behavior 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.

As Ed van Hinte and his colleagues point out, "that would be a truly ground-breaking ecological architecture."

ENDNOTES

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