Towards Responsiveness in Architecture

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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. This paper describes essential drivers behind the current interest in responsiveness in architecture.
An increased interest in exploring the capacity of built spaces to respond dynamically and adapt to changes in the external and internal environments is technologically and socially motivated. Advances in embedded computation, material design, and kinetics on the technological side, and increasing concerns about sustainability, social and urban changes on the cultural side, provide the background for the adaptive architectural solutions that have started to emerge.

Thanks to current technological advances, a broadening of scientific knowledge, and an understanding of the underlying processes that govern the metabolisms of the natural world, we are able to see deep connections between the made and the natural worlds. The confluence of various technologies and their assimilation are altering the way we perform our activities. Technological and scientific progress is re-calibrating architecture’s engagement with temporality and change. It seems that now we can expect more from architecture. We can expect buildings not only to house and facilitate various modes of human activity but also to adapt, behave, respond, and accommodate the flows of energy and information. Blaine Brownell (2008) calls for an architecture imbued with foresight; for him, “Foresight shapes architecture that, like life itself, produces as well as consumes, reincorporates all of its waste, and maintains an ecological footprint in balance with the requirements of its context.” According to John Frazer (1995), architecture should be a “living, evolving thing.” For them and others who share similar views, building and consuming architecture should be seen and practiced as life-sustaining metabolic processes. This view of architecture as a responsive and productive participant in a larger ecology is fueled, on the one hand, by “material shifts occurring in the domains of energy, resources, and technology” (Brownell 2008) and, on the other, by grasping a deeper connection between biological and cultural systems.

Architecture, Time and Environment

In a recent essay on responsive environments, Chris Perry (2013) examines the origins of architecture’s involvement with temporality. According to Perry, these were grounded historically (over centuries) in new developments in technology and science and a mindset these changes brought forward. Dividing the last hundred years into three machine ages, Perry lists technologies that progressively shifted a view of architecture from representation to instrumentality. First, machine age architecture bor-
rowed from the dynamism of large-scale machines and factories – it captured the representation of the temporality. According to Perry, the work of Antonio Sant’Elia, a member of the Italian Futurist movement, and his *La Città Nuova* responded to the temporal phenomena by integrating architecture into the mechanical and circulation networks of the city and did so on a spatial level; architecture itself, however, remained static. For Perry, second machine age architecture, as manifested in Cedric Price’s Fun Palace, Archigram’s speculative imagery and Reyner Banham’s writing, was an environment populated by electronics, communication technology, and audio/visual media. While *La Città Nuova* addressed movement and change by orienting architecture towards flows and interaction, Cedric Price’s *Fun Palace* instrumentalizes a programmatic change by allowing movement and change of architectural elements. At the same time, Reyner Banham’s arguments for the inclusion of environmental phenomena and their variability in a design process began to orient architecture towards adaptive environments. Perry then describes the third machine age architecture as influenced by software, information, multi-media technology, robotics, and material science. All those technological advances enabled explorations of dynamic qualities and their effects on architecture, offering an opportunity to position architecture towards a more productive integration within larger ecologies.

Michael Weinstock (2008) discusses the growing interest in the dynamics of fluidity through the concept of nature as a source of interrelated dynamic processes. His studies of metabolisms are aimed at the development of metabolic morphologies for buildings and cities whose organizations and systems are correlated to those of the natural world. Weinstock’s work extends the arguments put forward previously by John Frazer in his seminal book, *Evolutionary Architecture*, in which he suggests a new form of designed artifact, one that is interacting and evolving in harmony with natural forces, including those of society. The metabolic morphologies that “relate pattern and process, form and behavior with spatial and cultural parameters” (Weinstock 2008) would support a symbiotic relationship of architecture with the natural world.

The idea of coupling the responsive technologies with the emergence of constructed metabolic morphologies opens the possibility of an intelligent, environmentally sensitive built environment that is connected to metabolic networks. Recent explorations in materiality and material processes (as seen, for example, in the work of Achim Menges, Neri Oxman, and Rachel Armstrong),
architectural assembly and its construction (as shown in Skylar Tibbits’ projects), as well as localized control of the interior environment (as argued for by Michelle Addington) further this idea by projecting fundamentally different attitudes towards materialization, form, performance, and construction of the built environment. New content for architecture is being formulated that relies on the integration of change and dynamics into architecture – dynamics that not only address kinetic movement but also include flows of energies, material and information. Buildings that could sense and interact with its environment can operate more synergistically within larger ecologies and therefore can move closer to more sustainable participation within the global environment. The responsive architectural systems could act as ecologies in themselves, allowing architecture as a discipline to recalibrate its role in the larger socio-economic context by becoming a more intelligent and operative participant – a participant imbued with foresight.

Information, Energy and Material

As mentioned earlier, John Frazer proposes a new form of a designed artifact, one that is interacting and evolving in harmony with natural forces, including those of society. To achieve that, architectural systems, components or surfaces should have not only a level of kinetic capacity but also capacity to support information transfer, energy transfer and material transformation similar to biological systems.

The relationship between information and the physical response of an adaptive structure is supported by the application of sensors and actuators as well as mechanisms that control and activate the intelligence of the physical environment. Gordon Pask (1969) emphasizes architecture’s “operational” capacity (and its “intimate relationship” to cybernetics) by pointing out that “architects are first and foremost system designers.” From the organizational and operational aspects, the focus on architectural systems supports the idea of the flow of information. Several concepts developed in the late 1960s and early 1970s, such as Cedric Price’s Fun Palace, Nicholas Negroponte’s Soft Architecture Machines (1975), and Chuck Eastman’s (1972) concept of “adaptive-conditional architecture” began to explore “intelligence” and the programmability of architecture’s processes and spaces in order to form a two-way relationship between spaces and users. When a two-way relationship between the user and the structure is achieved, an adaptive structure/space could have a transformative effect on participants and on the environment.
A truly responsive environment would enter into a “conversation” with its users and allow them to become participants. In other words, such an environment not only should sense and respond but also perceive and act (Fox and Kemp 2009). The design of spaces that actively engage with their users goes beyond form and space delineation and requires the design of complex behavioral and informational systems.

On the one hand, energy transfer relates to the capacity of the built environment to sustain itself through energy harvesting. Such functions, as material system morphologies are developed, could be integrated into materials and the skins of buildings. On the other hand, energy transfer relates to the capacity of the built environment (its surfaces and regions) to facilitate movement and the concentration of some forms of energy (heat, light) in order to form the phenomenological, non-physical boundaries of spaces. By forming micro-climatic regions, spaces could densify and generate nodes of activity and gathering. This presents the challenge of finding a non-permeable and clearly defined boundary between inside and outside in exchange for a surface that fosters the constant flow of information and energy.

Rayner Banham (1965) reminds us that there are two basic ways of controlling the environment: by hiding under the tree/tent/roof (in other words, by building a shelter) or by mediating the local environment by a campfire. He points out that “a campfire has many unique qualities which architecture cannot hope to equal, above all, its freedom and variability.” The most recent attitudes to environmental control – where conditions are mediated locally and not globally and in relation to a body and not space – are a testament to this. This is achieved through material that does not need thermal mass but regulates the heat exchange inside a thin zone of a few millimeters (Addington 2008). But a “campfire” as a source of heat and light is localized and specific to its placement within the space. If we think about it beyond its traditional form – and in relation to energy exchange – we can imagine it as a distributed system that can be activated locally and “intelligently,” and only where needed. Viewed in the context of flow and exchange, a “campfire” can become an intelligent surface that can thermally modulate the environment and through that facilitate the circulation and gathering of people.

Current technological achievements as well as the expansion of our understanding of the underlying processes in nature have brought about a new generation of materials that are capable of “decision-making” beyond simple reflexivity (Armstrong 2012). These materials, products of synthetic
chemistry and biosciences, are capable of material or chemical “computing.” A material transformation is triggered by the molecules’ ability to make decisions about their environment and respond to it by changing their form, function or appearance. The availability of such materials offers an opportunity to design material behaviors as opposed to choosing materials on their properties. This would certainly alter the way we design: it would require that we begin to relinquish control of the design process (understood in a traditional way) and find ways to channel the material transformations to produce equally rigorous and reliable architecture, but only more aligned with its own materiality and larger ecologies.

Designing Responsiveness

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.

Furthermore, responsiveness can be achieved at different scales, from the city and buildings down to a single space or surface. But how would omnipresent responsive environments change architecture’s role in the cultural fabric of the society? They would certainly give rise to new social dimensions, enabling new forms of social communication that would emerge from new opportunities of operating within a humanized, technologically augmented space that is dynamic, sensing, and more “alive” than ever before. How would we live in spaces that like very comfortable clothes (or not) respond to our movements? Can we leave the orbit of “fixed”, static architecture and interface fluidly with kinetic and changing environments?

The process of designing responsive environments relies on flows and dynamic behavioral patterns. It is inherently open to new and oftentimes emergent configurations. Cities populated with “intelligent” buildings that communicate among themselves, capable of altering and changing patterns of use, would generate a constant information feedback. “Intelligent and
sensitive” streets, walkways and public spaces could, by varying environmental phenomena such as light, heat, or coldness, create microclimatic zones that attract and encourage particular human activities. Metabolisms behind those changes could create densities of activities that relate to constantly changing networks of information that redirect patterns of movement. This new “intimacy” between the built environment and human movement and the occupation of space can extend into new relationships between the built environment and the larger ecology, through energy, resource and material exchange.

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References


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