Living Bits + Bricks

"Total Fluidity on All Scales" was the title of a Zaha Hadid lecture at the Massachusetts Institute of Technology in April 2007. For several hours the audience stood in front of wondrous forms of all scales that suggested the idea of movement—from objects to buildings, and even cities. The quest for movement in design can be traced back to Baroque times. Baroque master architects like Bernini made static structures appear to be in perpetual motion by representing one moment in which movement is frozen, provoking "the illusion of the eminence of motion."[1] A similar attitude led to the Futurist movement, where visual artists tried to depict movement and change through two techniques: "representing the processes of corporeal movement," and "an interpenetration of the volume that moving entities occupy."[2] A few years later, Le Corbusier offered a theoretical framework for movement in architecture by equating it with a machine for habitation, and speculating how mechanized civilization might find architectural expression with artifacts that would actually "look" like machines.[3] In all of the above examples—and several others that we will not review here—the emphasis was on designs that would *look* moving and alive, creating life or its illusion with human artifice and the proper technology.

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There is, however, another approach to the design of moving, living artifacts, which we believe holds much promise for the future. Often relegated to niche designers and to inventors outside the world of architecture, it focuses not on form, but on process: how movement could actually be implemented, not just represented.

This idea can be traced back to the 18th-century phenomenon of self-operating machines called *automata* ("that which acts on its own will," in ancient Greek). Automata were complex, programmable machines that exhibited perfectly lifelike movements. From the 17th century onward, they became the center of much intellectual and artistic speculation, and found their way into the curiosity cabinets of the royal courts of Europe. One famous example is the Joueuse de Tympanon, a mechanized doll that played a musical device by striking its strings with hammers, built for Marie Antoinette by David Roentgen and Pierre Kintzing around 1784.

The Enlightenment's ideological shift from a natural to a mechanistic world view, represented by Descartes's interpretation of natural organisms as automata, allowed man to reconsider the origins of life: Since any living organism was a mechanism with identifiable rules of operation, and man could create complex mechanical systems, then the ability to create life was no longer the domain of the Almighty.[4] A few decades later, in 1822, Charles Babbage's proposed machines would advance man's quest to create life towards the automated actuation of the physical world. His mechanical control systems could be considered the precursors of today's computers—and one could perhaps claim that Babbage's *Difference Engine* was the first cybernetic mechanism, although the feedback between the system's output and input was mediated mechanically instead of electronically. Cybernetics officially emerged with Norbert Wiener and his principle of expanding human control over the environment via electronic interfaces. As such, computer technology would become a means for extending human capabilities based on what Wiener defined as the feedback principle, which is when a system changes its course of action and mode of operation in response to its current context, including the desire of a controlling human agent.[5]

Cybernetics soon moved into the realm of architecture. Cedric Price's proposal for the Fun Palace was perhaps one of the first examples of an architectural cybernetic system to incorporate Wiener's feedback principle. It centered on new technology that made the Fun Palace responsive to visitors' needs by dynamically adapting its spatial configuration. The proposed building was a kit of pre-fabricated modules that would constitute a variable structure, which Price claimed "[could] be assembled, moved, re-arranged and scrapped continuously."[6]

The vision of architectures capable of soliciting their inhabitants' control over the production and consumption of space also prevailed in Yona Friedman's 1958 manifesto for Mobile Architecture. In it, he described the "dwelling decided on by the occupant" by way of "[loose] infrastructures that are neither determined nor determining," but in constant redefinition by members of a "mobile society."[7] Friedman's concept glorified the role of the *users* of architectural space. He tried to offer simple manuals for visions of cities where dwellers would shape their environments, such as a mobile city where buildings would only minimally touch the ground, allowing them to be dismantled and moved by the occupants. In this utopian mobile city, space effectively becomes an interface through which the inhabitants realize their desires and regulate their needs.

It could be said that all of the above work, dating from the mid-20th century, already contained most of the principles necessary to design responsive, living environments. However, at the time it still lacked that effective communication infrastructure needed in order to acquire global relevance. This has now emerged in the digital net.

Here we need to clarify the concept of network in architecture: "Net talk" is not "new talk." In his 2001 article "Network Fever," Mark Wigley expresses his doubts about the networked condition as a completely new

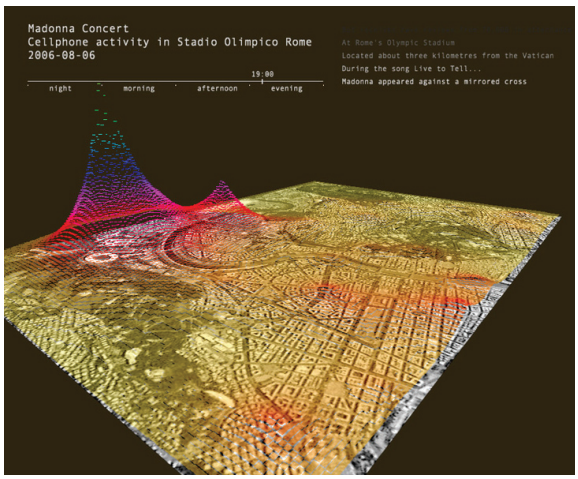
intellectual and socio-technical phenomenon, building his hypothesis on precedents from the 1950s and 1960s that signaled a "radical confusion of architecture and network."[8] He cites Team 10, who, in the late fifties, created urban projects where complex vehicular, pedestrian, and courtyard circulation systems were embedded in a dense infrastructural "mat" of woven, built forms. Additionally, he reminds the readers that the Metabolists wrote about architecture as biological circuitry capable of perpetual self-adaptation to the "metropolitan flux" of the sixties. This fascination with constructed landscapes as networks, Wigley reminds us, is quite clear in Konrad Wachsmann's 1953 *Experimental Structural Web* description of cities "as compact bundles of overlaid net-structures," whose infrastructural network of communication and conveyance of material entities became indistinguishable from the cities themselves, to the extent that in Denis Crompton's (Archigram) 1964 proposal, *Computer City*, "The Network [took] Over!"[9] In its extreme, the city was envisioned as a computer where everything was hardwired to everything else.

Yet the network concept has recently undergone a revolutionary process that led it to reaches well beyond its twentieth century embodiment. Fifties' architectural readings of networks looked at a top-down infrastructure where functions were plugged in, and through which commodities—material and virtual--were distributed from their sources to consumers. Twenty-first century versions of networks are distributed, bottom-up structures that for the first time allow mankind to gain constant and seamless access to real-time information.

Embedded technologies for acquiring information (such as networks of monitoring devices) and delivering information (such as networks of actuating devices) allow for a world wherein every object is connected to all other objects, and has embedded computing and communications powers. Additionally, humans have become part of the network. Mobile technologies digitally extend each individual by providing him/her with a mini-terminal equipped with embedded sensors and a portal for the delivery of information—be it an iPhone, smartphone, or any handheld, personal computing device. Such devices are capable of establishing data connections both to the infrastructural mobile networks and to the more localized, ad hoc networks mediated through Wi-Fi and Bluetooth technologies.

Under these circumstances, Wiener's cybernetics can become a reality at a global scale. At the urban and architectural level, spaces become dynamic and their inhabitants can be incorporated as entities with transient preferences and needs. Instead of generic "occupants" they become hyper-individualized "users." They interface with a world embedded with networked microprocessors, where the digital and the physical merge as anticipated by the Ubiquitous Computing paradigm first proposed by Mark Weiser. [10]

People play key roles in this system as agents of sensing, regulation, and actuation. In terms of sensing, they voluntarily and involuntarily leave digital traces on various networks deployed over space. The network



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records every time a credit card is used, a text message or an email is sent, a Google query is submitted, a phone call is made, a Facebook profile is updated, a photo is tagged on Flickr, or a purchase is made in an online store. Even more interestingly, the network records all content generated and voluntarily uploaded by users. Once the datasets are attached to physical space, landscapes are transformed into new info-scapes. In turn, these info-scapes provide citizens with a better knowledge of their environment, and allow them to make more informed decisions. Indeed, this seems to be the most promising characteristic of the city of the future, which becomes "smart" through the collaborative activity of the sentient, self-reporting agents who are its citizens.

The sensor-actuator citizen is a new subject emerging from the hybrid of technology and biology: a neo-cyborg. Traditional cyborg theory proposes either the gradual disembodiment of each subject, who leaves behind physical existence to move towards a new digital status, or a disconcerting integration of machine and human that results in android monstrosities.[11] However, the neo-cyborg has a much more positive characterization: it is a proper body that uses various networks to extend its physical boundaries.

Instead of merging humanity with machines, the neo-cyborg merges humanity with real-time information. What type of society could result from this? The answer, we believe, is a peer-to-peer collectivity, or "multitude." In both *Empire* and *Multitude*, Hardt and Negri introduce the "multitude" as a postmodern form of collectivity. It differs from other forms of collectivity that reduce diversity to a single unity, in that subjects in a multitude retain specific differences, becoming hyper-individuals. The multitude is an "open and inclusive concept," [12] meaning that subjectivities are not excluded or included based on their singularities. Hardt and Negri equate the multitude to a distributed network where separate nodes are all connected and "the external boundaries of the network are open such that new nodes and new relationships can always be added."[13]

Figure 1: Example of Info-scape: Real-time Rome. Aggregate picture of data transferred through the cellphone network during a concert by Madonna. Copyright MIT SENSEable City Lab, for full credits see http://senseable.mit.edu/wikicity/rome/

Figure 2: Example of Info-scape: visualization from the Trash Track project. Tracking of a tagged aluminum can as it travels through the garbage collection. Copyright MIT SENSEable City Lab, for full credits see http://senseable.mit.edu/trashtrack/

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Figure 3: 'Smart', enters our everyday life: the Copenhagen Wheel quickly transforms ordinary bicycles into hybrid e-bikes that also function as mobile sensing units. It captures the energy dissipated while cycling and braking, and saves it for when the biker needs a bit of a boost. It also maps pollution levels, traffic congestion, and road conditions in real-time. The bikers can also share their collected data with friends, or with city—anonymously if they wish–thereby contributing to a fine-grained database of environmental information from which all city inhabitants can benefit. Copyright MIT SENSEable City Lab - for full credits see http://senseable.mit.edu/copenhagenwheel/

Thus, subjects in a multitude are "becomings" instead of beings—capable of establishing new connections and perpetually in a state of change. In the multitude of a peer-to-peer network, the central authority is replaced by collaborative relations. "Flashmobbers," "Generation Text," "Thumb Generation," "Collective Intelligence," "Smartmobs," and "Me++" are manifestations of this phenomenon: they describe the denizens of a looming new generation of living, responsive architectures. ◆

ENDNOTES

1. Jorge Silvetti, "The Muses Are Not Amused: Pandemonium in the House of Architecture," in *The New Architectural Pragmatism: a Harvard Design Magazine Reader*, ed. William S. Saunders (Minneapolis: University of Minnesota Press, 2007), pp.176-198.

2. *Sigfried Giedion*, "Space-Time In Art, Architecture and Construction," in *Space, Time and Architecture* (Cambridge, MA; London: Harvard University Press, 2008), pp.429-477.

3. Le Corbusier, *Towards a New Architecture* (London: Architectural Press, 1970).

4. On automata, see Derek J. de Solla Price, *Automata and the Origins of Mechanism and Mechanical Philosophy*. Technology and Culture. 1964; 5(1):9-23, and Silvio Bedini, *The Role of Automata in the history of technology*, Technology and Culture. 1964; 5(1): 24-42.

5. For more on *Feedback Principle* see Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine* (New York : M.I.T. Press, 1961).

6. For more information on Fun Palace, see the Canadian Centre for Architecture, in Montreal, where the Cedric Price's archives (including the Fun Palace) are located <http://www.cca.qc.ca>.

7. Yona Friedman, *Pro Domo* (Barcelona : Actar, 2006)

8. Mark Wigley, "Network Fever," *Grey Room* 4 (Summer 2001): pp. 82-122

9. ibid.

10. Mark Weiser is the father of *Ubiquitous Computing* or *Ubicom*. In his 1991 paper, "The Computer for the Twenty-First Century," Weiser discusses the idea of integrating computers seamlessly into the world: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." Mark Weiser, "The Computer for the Twenty-First Century," *Scientific American* (September 1991): 94-100.

11. In *How We Became Posthuman*, Katherine Hayles presents a specific version of the cyborg that focuses on the idea of erasing the body from the matrix of our existence, which supports the whole idea of consciousness-uploading. This vision discards the body. The result would be a lack of affect, since an affective existence is bound to the condition of embodiment. These readings are in contrast with Andy Clark's sense of a human being whose cognitive apparatus is expanded by technology and other forces. N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999), and Andy Clark, *Being There: Putting Brain, Body, and World Together Again* (Cambridge, MA: MIT Press, 1997), and Michael Carlson Kapper, "Affect as Epistemic Source in a Posthuman Age" (Ph.D. diss., Purdue University, 2004).

12. Michael Hardt and Antonio Negri, *Empire* (Cambridge, MA: Harvard University Press, 2000), and Michael Hardt and Antonio Negri, *Multitude: War and Democracy in the Age of Empire* (Cambridge, MA: Penguin, 2004).

13. Iran's electoral fraud in 2009 sparked an unprecedented popular resistance against its totalitarian regime. Known as the "green movement," this could be seen as an example of *multitude* at work. The resistance acted as a headless, grassroots, self-organizing phenomena that relies on peer-to-peer social networking platforms such as Twitter, Facebook, and YouTube to disseminate information and maintain a socio-political voice. Perhaps this is one of the reasons that, at the time of writing, the resistance is still in full operation, despite the extreme measures to quash it taken by the central government. This can be considered as *Multitude* resilience!