Building is a Network for Living in: Toward New Architectures

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Abstract

Our societies today are beginning to think, communicate, interact and live differently as everything in the human world is beginning to be networked wirelessly at the speed of light with everything else in the world (including architecture). This article looks at the big picture and outlines a series of recent developments in digital technologies that would enable architecture to become sensate, supple and globally networked at the speed of light. New thinking, new commerce, new polity, and new architectures are emerging out of the apparently disparate yet closely related design and technological inventions. We are on the verge of moving from the outmoded notions of space and time to the post-spatial notion of sensate and supple space-time.
Introduction

“Architecture of intelligence is the architecture of connectivity. It is the architecture that brings together the three main spatial environments that we live in and with today: mind, world and networks.”

Derrick de Kerckhove (2001)

It is the author’s contention that something phenomenal and previously unforeseen is emerging from a series of small yet important developments in architecture and related fields. By infusing computational abilities into architecture, by enabling architecture to become sensate, intelligent, responsive and adaptive, a number of apparently disparate developments are resulting in the emergence of a new way of thinking and being. These new developments are pointing toward a paradigmatic shift in the evolution of architecture as a discipline. Our thinking is beginning to shift from the notion of computers in architecture or computers affecting architectural design to the notion of architecture as the computer. Our notions of architectural practice are shifting from the model of a lone architect standing in front of a drawing board to architect as a conductor of events and resources that are globally distributed yet digitally connected into a networked practice. This paper is an attempt to bring together seemingly far-flung developments in various fields into a coherent framework to reveal the emergence of this paradigmatic shift. As de Kerckhove has pointed out, connectivity is the keyword for the architecture of intelligence (de Kerckhove, 2001). We are at the dawn of the era of fully networked buildings.

A Building is a Network for Living In

A network is an interconnected system with a certain structure of relationships. Kevin Kelly, executive editor of WIRED magazine summed up the essence of the current paradigmatic shift: “the central act of coming era is to connect everything to everything. All matter, big and small, will be linked into vast webs of networks at many levels. Without grand meshes there is no life, intelligence, and evolution; with networks there are all of these and more” (Kelly, 1994). Nearly five decades ago, long before the computer or the Internet became popular, Teilhard de Chardin prophetically proclaimed that the human evolution is heading toward a global coalition of an interconnected world (de Chardin, 1961). He called such a world noosphere (the sphere of interconnected human consciousness). A recent CNN story chronicles how the new WiMAX technology buoys these possibilities by preparing to introduce cell phone-like ubiquitous and wide-ranging network coverage for laptops and other computational devices. A WiMAX-equipped laptop or computational device can stay connected to the Internet all the time without any wires. Intel is planning, according to this report, to package WiMAX into laptop chips by 2006. Such a technological network would be a crucial turning point in the journey toward the emerging noosphere.

At a time when even the toasters and refrigerators are being hooked up to the Internet, architecture is not going to be left too far behind, despite the best efforts to resist the evolution by the profession’s conservative core. Connection is the keyword, the buzzword and the overarching concept of how buildings could become networked computer systems. General Motors’ OnStar ® vehicle security system has already transformed our automobiles, which are now controlled by dozens of embedded computers and networked via satellites, into GPS-powered real-time network nodes. An OnStar operator can access most of the critical systems of an automobile remotely and suggest or coordinate a course of action at the touch of a remote button. The biggest evolutionary jump for automobiles is not in their growing engine size or seductive body shape; it is in the pervasive computerization and wireless digital networking. The mobile space of the automobile has been transformed into an interactive real-time network node capable of keeping us connected to the rest of the world. Automobiles are already a part of the emerging noosphere. Later on we will discuss the OnStar At Home® pilot program, which extends the OnStar’s automobile network services to the home market. Architecture is becoming a part of the post-spatial network ecosystem.

We are temporarily burrowing our way across the globe to form supply chain networks, transnational organizations, trans-continental firms and 24-hour workdays spread across time zones. We do not necessarily connect in a spatially contiguous manner any longer. Our economies are dependent on temporal connectivity between the globally
distributed manufacturing, sales, marketing, and administration networks.

In such a world, work or performance is broken down into a series of events or tasks that can be assigned in real-time to any part of the globe with no heed paid to national boundaries (geographic space), cultural barriers (cultural space), economic disparities (economic precincts), and other spatial logic. The author calls such a condition of going beyond the dualistic Newtonian and Cartesian notions of space and time Post-spatial. A more elaborate discussion of the theoretical dimensions of the post-spatial world can be found elsewhere (Senagala, 2003).

**The Shift from Timeless Space to Timed Space**

“The new produced and projected space has less to do with lines, surfaces and volumes than with the minutiae of viewpoint, the dynamite of tenths-of-seconds. These viewpoints are simultaneously time-points in the tele-topological continuum of long-distance projection and reception.”

Paul Virilio (1991)

Architecture of stone and brick has always been the one sphere of life that embodied a sense of timelessness. Edifices of stone resist time and define a pattern of space for thousands of years. We no longer build our world in stone for a number of reasons. The notion of timelessness, however, has stayed rooted in the profession, its thinking, and in what people expect to see embodied in architecture. Except for minor deviations, most of architectural thought has been focused on establishing a single inert spatial footprint that is programmed to stay immobile 24 hours a day and 365 days a year. Compare this to television, which is programmed to the second. Imagine holding a single pattern of pixels on the television screen 24 hours a day. Despite the fact that architecture and television have different tasks and purposes, both can benefit greatly from understanding the value of timeliness and intelligent interactivity.

Architects and other professionals working in the related fields are indeed giving up their millennial allegiance to the notion of timelessness. They are beginning to work with accommodating real-time responsiveness into an array of local forces and global conditions. Such terms as smart architecture, responsive architecture, adaptive environments, and kinetic architecture are being used to describe the post-spatial developments. These different terms have different connotations and agendas of significant variation. What the plethora of terms indicates, despite their encampments, is the desire for architecture to be thought of as an active and interactive being.

**Smart Architecture** is the term currently popular in the sustainable design communities, where smartness often refers to the ability to regulate a variety of environmental parameters for an efficient energy usage (Park, 2003, Kienzl, 2002, Pagani, 1999, Daniels, 1997).

**Responsive architecture** puts a performative emphasis on increasing the interactive nature of building elements in response to environmental or social or commercial needs in real-time (Ishii, 1998). Responsive environments might involve any form of responsiveness.

**Kinetic architecture**, which can be traced back to the 1960s, is preferred by those who see architecture as a literally more mechanical, kinetic and moving organism (Zuk, 1970) where spatial, mechanical movements are essential to its definition and existence. However, all of these terms represent directions in architecture that involve active, instantaneous response to either internal or external conditions through a central computational agency.

**Architecture: Supple and Sensate and Connected**

“A building is made up of other spaces within it that move and change, even if its own walls remain fixed. The idea of the mobility of building and within building is one possible idea of Deleuzian thought that might be of tremendous value in architecture. Building is not only a movement of sedimentation and stabilization but also a way of opening space and living.”

Elizabeth Grosz (2001)

William Mitchell has put it lucidly when he said “we become true inhabitants of electronically mediated environments rather than mere users of computational devices” (Mitchell, 1999). If we can simply transform the role of the wall, window, floor and roof, we can redefine what architecture is all about. Such a redefinition would be an historic transformation in and of itself. And, we are not even talking about what might emerge from such a transformation. This revolution is already
taking place. Traditionally, walls, roofs and floors have always been delimiters and separators of space, not connectors. Typically, when an architect draws a wall, it usually denotes a spatially static separation of activities. Architects, in general, have come to embrace spatial separation and segmentation as the primary modes of design thinking. A number of inventions and design developments—often from outside of architectural profession—are questioning the ontology and epistemology of walls, floors, windows and roofs. What is the reality of a wall or a floor? How do we know a wall or a floor and, more importantly, how do these architectural elements know us? How can these elements be digitally networked, controlled and connected? In the next few pages we will see select examples that manifestly demonstrate different ways of answering these questions.

One more paradigmatic shift that can be noticed, from the projects discussed in this paper, is the shift from static, frozen and fixed architecture to supple, kinetic, responsive and parametric architecture. The form, environment, qualities and characteristics of a building become linked, connected and dependent on certain parameters. Thus, a building can become more flexible, interactive, connected and more sustainable over longer periods of time.

**Architecture as Immersive Interface / Architecture as Info Pump**

It is believed that in less than a decade, more than one billion people all over the world will be spending half as many hours in front of the computer screen as they will in physical space (de Kerckhove, 2001). The computer screen has become the 17" gateway to all the digital information out there. What if we are able to expand the ways by which we see, hear, touch and sense information? What if we can release more people from the screen for more hours by distributing the interface around the architectural environment? What if the walls, floors, lighting, ventilation and other facets of the architectural environment begin to communicate information to the user? What if architecture, as a whole, becomes a gigantic immersive interface to send and receive information? What if architecture becomes a spatial synesthetic pump to channel, amplify and process the temporal flows of digital information?

The Tangible Media Group of MIT has demonstrated that more than simple bits of information can be communicated through architectural interface. The group created the so-called ambientROOM, which is remotely connected to a number of devices (Ishii, 1998). In the Active Wallpaper project, sensors in a remote location pickup the activity level and transmit it to the ambientROOM where the information is revealed in the form of a pattern of illuminated patches. When the activity is high, the movement of the patches is high and vice versa. In the Pinwheel project, colorful pinwheels spin at different speeds based upon their information input. Ishii points out that these efforts “envision that the architectural space we inhabit will be a new form of interface between humans and online digital information” (Ishii, 1998). He sums up the project thus: “the ambientROOM surrounds the user within an augmented environment – ‘putting the user inside the computer’ – by providing subtle, cognitively background augmentations to activities conducted within the room.”

**Teleporting a comprehensive experience** is at the heart of these experiments. Two or more spaces, in this scenario, could be in sync with each other despite their physical separation by vast distances, presumably even interplanetary distances! This kind of connectivity radically redraws the map of spatially fragmented geographic locations into a map of temporally contiguous experiences. Inventions such as these, question our outmoded notions about context, region, and neighborhood.

**Talking to the Walls**

Acoustic Tap Tracking system, developed by the team led by Joseph Paradiso of MIT Media Lab, is capable of transforming any large flat surface such as a wall or a window or a table into a tap sensing interactive responsive surface (Paradiso, 2000). In distinction, the other higher tech devices developed elsewhere that use optical cameras, touch screens, lasers, pens and light curtains, have many inherent problems. From cost to portability, from effectiveness to scalability, these systems have not had much success in transforming things at architectural scale.
The ingenuity of Paradiso’s system is that it is buildable for under $500 and can be scaled to be installed on large architectural surfaces. Earlier version of this device came from Paradiso’s collaborations with Media Lab’s Tangible Media group, which resulted in the so-called PingPongPlus demonstrated at SIGGRAPH 1998. In the experimental prototype, four transducers sense the taps on a 4’x8’ shatterproof glass pane. The analog audio signals are analyzed for peak timing and fed into the computer as intelligible taps such as mouse clicks. Thus, it is possible to transform any shop front window into a simple interactive screen. If we stretch our imagination around this invention, we can think of walls and tables becoming interactive interfaces. The dumb, blank, abstract walls that divide can become interactive, intelligent, sensing, smart surfaces that could truly connect in real-time. Information becomes immersive. Walls could become portals to spatially distant lands or culturally other worlds.

**Soft, Supple and Sentient**

More and more architects are beginning to explore the form and format of sensate and supple architecture. The Muscle, a prototype featured at the Non-standard Architecture exhibition ii, which was designed by the Dutch design firm Oosterhuis.NL (ONL), dons a pneumatic structure that behaves like a gigantic, digitally mediated muscle. The building would flex, contract, expand and mold itself to suit changing programmatic conditions over time and in real-time. The architects propose that the place be used for a variety of activities such as a disco or a television studio or a meeting place. The synthetic muscles of the Muscle react as people move near the sensor points. Another way to manipulate the structure is by moving the sliders on a remote computer screen. Thus, the building becomes spatially interactive and can be plugged into the Internet. This alien-looking blob is not necessarily how buildings might look as a whole in the future. Some buildings might look that way. However, the Muscle, as ONL proposes, can literally be used as a series of muscles in a building to control any environmental or other parameters in real-time. Perhaps the buildings might be able to literally express their feelings by flexing their facial and spatial muscles, thereby leading to new and supple expressionism in architecture.

**Swift, Supple and Sentient**

In 1998, design firm dECOi, led by Mark Goulthorpe, won a competition to design an interactive art piece for the foyer of the Birmingham Hippodrome. The piece functioned as a mediator between events happening inside the theatre to the human activity outside the theatre, forming a link between the public plaza and the theatre itself. Aegis Hyposurface was conceived as a responsive surface which reacts physically in real-time to the events happening around it.
Figures 4, 5 and 6. The Muscle by Oosterhuis.NL

Figures 7 and 8. Aegis Hyposurface
The responsive wall surface was made of a pliable material or skin stretched over 896 highly responsive and sensate pneumatic pistons (known as actuators). These computer-controlled actuators generate coordinated movement across the surface, allowing it to create complex patterns that rapidly reconfigure its appearance in response to a variety of digital input such as user movement, light and sound (Zellner, 1999). This structure differs from the Muscle by ONL in significant ways. Aegis Hyposurface translates given information into a four dimensional matrix of triangular surfaces. It is a 4D screen. It is as if we have been liberated from the world of flat two-dimensional pixels into the world of dynamic four-dimensional experiences. Much has been said and written about this project. However, the true implications of this post-spatial construct go beyond its kinetic nature. The responsive wall can respond in real-time to any digital instructions that would arrive either from local sensors or via the Internet from remote sensors located anywhere else in the world. Thus, the very ontology of wall, its relationship to space, time, and its connectivity to local and remote phenomena are brought into critical focus. The sensate space-time of the installation can potentially extend to all corners of the globe. The post-spatial wall could become a threshold between spatially discontinuous yet temporally connected worlds. We are witnessing the beginnings of a radical redefinition of architectural reality.

**Floors That Know**

The Responsive Environments group at MIT Media Lab has devised a sensate floor system called Magic Carpet. It cannot fly, but the magic carpet does know a lot about who is on it. In this system, a series of piezoelectric wires in X and Y directions are used to sense the footstep dynamics such as pressure and movement. The sensing medium used here is an inexpensive shielded wire that is capable of producing a small voltage (around 15 Volts) spike when pressed. These signals are then processed using various filtering and clustering algorithms to decipher the location and pressure information.

The Magic Carpet system has led the team to develop networkable floor tiles called Z-Tiles. In this system, a series of interlocking tiles, equipped with embedded processors, form an adhoc network and communicate the prexel (pressure pixel) information to the main computer for further programmable action. Thus, with this relatively inexpensive and robust flooring system, it is possible to transform any floor into a sensing surface capable of forming an intelligent environment. The possibilities that this invention opens up are immense. It is possible to control such architectural characteristics as lighting levels, location, ventilation, security and other environmental parameters. It is possible to estimate the number of people and the kind of activity through analyzing the data in real-time, which can increase or decrease the heating and cooling levels in a room or control the room illumination or activate the entertainment system or open up the walls or lead to many other architectural possibilities. Perhaps a walk on the floor during October could activate the sound of the rustle of...
leaves. Perhaps a dance on the floor could adjust the acoustic characteristics of the walls to better suit the music. Thus, the very meaning of floor stands redefinition. A sensate interactive floor-equipped room can literally come to life and, in the process, transform our life-world.

The system consisted of a kinetic spaceframe driven by three sets of Festo pneumatic pistons. The original prototype was designed to sense the audience movements through pressure sensitive mats and translate the impulses into valve operations controlled via the computer. The scenario depicted in figures 13 thru 17 envisages some dramatic architectural possibilities. This invention was an attempt to question the conventional notions and limitations of architectural programming. In conventional programming, spatial configuration is held more or less static by walls and floors, while people and events are orchestrated. Topotransegrity proposes to program the walls and floors along with people and events in an all enthralling four-dimensional framework. This project represents a truly groundbreaking shift in architectural thinking.

At Home (from) Anywhere

The Internet Home Alliance (www.internethomealliance.com), a remarkable cross-industry collaboration between GM’s OnStar, Invensys, ADT Security Systems, HP, Panasonic, and many other corporate partners have launched, in early 2002, a post-spatial initiative to integrate OnStar’s Virtual Advisor® service with home security control, telecommunications control, and climatic control from any Internet enabled appliance anywhere in the world. This system also gives the customer visual access to his or her house at any time. Garage doors, access doors, windows, all the major home appliances, HVAC system, security system, and telecommunication systems are networked using the HP Application Server 8.0 framework as gateway. The participating customer would be able to access any and all of these aspects in real-time from any computational device such as a cell phone or a PDA or a laptop. The customer would be able to remotely turn on or off the kitchen stove or refrigerator. Panasonic’s smart doorbell would notify the customer anywhere, through audiovisual access, anytime his or her doorbell is rung.

One interesting fact about this whole enterprise is that the alliance was not initiated by architects, not overseen by architects, and certainly not controlled by architects. Once the OnStar At Home® technology matures, it will be a matter of extending, scaling, and porting the technology to all building types.
The notion of *architects as visionaries* seems to have become passé. Non-architects are taking over that role. The question now facing architects and designers is to take ownership of this emerging mode of thinking, which goes beyond making merely well-detailed boxes or blobs, and enters the realm of designing networkable architecture.

Architects’s usual clerical obsession about *making* static things should yield to *connecting dynamic space-times* as the primary mode of crafting new realities. Architects have the opportunity *now* to take a proactive step to become a part of the leading edge of this revolution than to wait and continue to ride the trailing edge of technological advancements. Architects need to shift the discourse from *fabricating shiny surfaces* to *designing intelligent interfaces*. If architects fail to take notice today, the world might continue to be plagued by the banality and spatial mediocrity of suburban homes simply extended into the cybernetic realm. The majority of the architectural profession still thinks in terms of static, immobile, non-interactive, and unwired buildings. As de Kerckhov (2001) said it rightly, “the opportunity for the architect is not merely to improve the drafts or the elevations, or even benefit from the CAD system, it is to rethink the real. How do architects greet this opportunity?”
Figure 15. Topotransegrity System Layout

Figure 16. Pneumatic Pistons

Figure 17. Topotransegrity Scenario
Conclusions

Looking at big picture scenarios, which is what this paper attempts to do, is like peering through a foggy landscape. Things are blurry at best from a distance and become clearer as we get closer. Back in 1969, ARPANET was formed when we hooked up a computer to a computer to a computer to another computer. A global network was then born that led to the emergence of the Internet. No one had thought, at that time, that a network of four hosts would later give rise to novel political campaigns, new commerce, and a hundred million connected homosapiens dwelling online. The principle to understand here is that once a system reaches a critical level of connectivity and complexity, something new emerges that is beyond anyone’s comprehension.

When we infuse computational intelligence into our environment, when we transform our environments to respond to the post-spatial network society, and when we redefine the fundamental meaning of the basic architectural elements such as walls, floors and windows, we transmute architecture into a connection machine. More importantly, by digitally connecting a building to a building to a building to another building, something revolutionary might emerge that goes beyond what has been envisaged in this paper. That would be the day when your homepage truly merges with your home.

Acknowledgements


Web Sites

www.media.mit.edu
www.oosterhuis.nl
www.internethomealliance.com
http://www.5subzero.org

End Notes


ii. See www.oosterhuis.nl for this and its more current version as well. The exhibition was held at Centre Georges Pompidou from December 10th, 2003-March 1st, 2004.

Figure 18. OnStar At Home® Architecture. Courtesy Internet Home Alliance
References


ACADIA05: Smart Architecture