Interactive Systems in Architecture:
Eliminating the Communication Barrier between Humans and the Built Environment

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Nature is in a constant state of flux. The vast majority of the built environment is completely static, opposite of the continuous alterations the natural environment endures. Parallel with nature, humans are constantly dynamic; moving, changing, sensing, and reacting to their surroundings and the information they process. These characteristics of humans and the buildings they occupy are utterly contrasting, thus creating a barrier between the two. This barricade is hindering the level of communication and response between both humans and the built environment. If this obstruction were to be eliminated, the built environment could adapt and react to humans and their needs which would amplify the experience of the space. Kinetic systems are implemented into architecture for this very reason; to create a level of interaction in conjunction with an interdependent relationship between humans and the spaces they inhabit.

The majority of buildings as we know them are architectural objects without movement. These buildings are seen as stable and robust, due to the fact that they are large and static. Kinetic objects are seen exactly opposite of this; they are unpredictable, unstable, and in motion. Bringing the traditional static buildings and dynamic design together is known as kinetic architecture.

> Kinetic architecture is defined as buildings and/or building components with variable mobility, location and/or geometry. The general implications of utilizing such systems in architecture include, but are not limited to: space efficiency, shelter, security, transportation, safety, economics, and aesthetics. The specific applications are enormously varied and include novel applications that arise out of the changing patterns of human interaction with the built environment.[1]

The built environment can become interactive with humans in three main ways. There are interactive systems that describe the environment in which the person occupies, systems that define and alter space according to the user, and systems that directly communicate with a person or allow for communication between people. Interactive architecture is made possible through the use of micro-controllers, sensors, and actuators. Advancements in electrical and mechanical engineering, material innovation, and fabrication techniques such as computer numerically controlled (CNC) fabrication, have made many concepts in the kinetic architecture realm come to existence.

Interactive systems that portray the environment can be a beautiful aesthetic addition to a structure. These systems can convey a wide variety of information about the surrounding environment of a building or building component. Most of these systems detect where people are, and somehow display this information to the public; it is basically a traffic graph. Therefore, the system is describing to the public where other people are and what they are doing. The Interactive Façade by Michael Fox and Axel Kilian, and Enteractive by Electroland are both great examples of environment response

systems. Both of these designs are controlled by the pattern of human traffic and relay the information they process to the general public for viewing.

Interactive Façade was designed by Michael Fox and Axel Kilian of the Kinetic Design Group of the Massachusetts Institute of Technology. This interactive system "fosters direct interaction between an architectural - scale installation and pedestrian activity on the street. The 160' long band of responsive 'whiskers' that will wrap around the building in the heart of Manhattan allows pedestrians to walk up and interact with the installation."[2] These whiskers are long poles that extend outward from the façade of the building and sense the presence of people in motion, and in a "wave-like rhythm"[3] they will follow the pedestrians. An observer when looking upon the structure can see these arms tracking people while they move past the building. This project is certainly a kinetic system that describes the environment. Through the use of sensors, the façade system is able to detect the pedestrian movement below, and mimic this movement to create a traffic graph that is displayed to the rest of Manhattan.

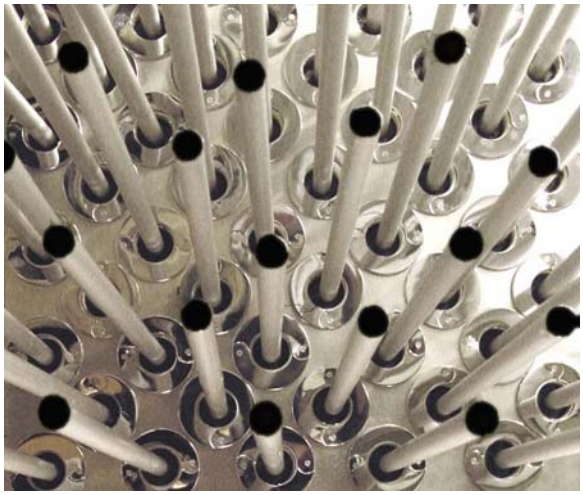

Figure 1.0 – whiskers of Interactive Façade. Kinetic Design Group. Cambridge, MA.

Enteractive, located on the corner of 11th Street and Flower Street in Los Angeles and designed by Electroland, is an interactive system that also displays pedestrian traffic information to the public, but in a much different fashion than Interactive Façade. Located in the entry walkway of the building, there is a large grid of illuminated squares.

If a person steps on a square that is in the illuminated state, other squares light up in a beautiful pattern. The pattern that is shown depends on the amount of people and their location on the grid, as well as the position of the illuminated squares. If enough people perform the tasks the grid wants all of the squares will light up, giving a sense of accomplishment to the user. This project consists of "environmental intelligence and surveillance of human activity…combined with a video-game sensibility."[4] There are televisions located in the lobby that display the activity occurring on the grid. This information is also displayed on the exterior façade of the building for the city of Los Angeles to view. The façade also consists of a grid of illuminated squares which replicate the lobby floor. As a person interacts with Enteractive, they are not only changing the pattern on the floor, but they are changing the façade pattern as well. This project is one of the best examples of congregating the built environment with people. A person truly has control over what is displayed onto the exterior façade for the surrounding community to view.

Figure 1.1 – Lobby floor of Enteractive. Electroland. Los Angeles, CA. 2006.

Figure 1.2 – Exterior Façade of Enteractive. Electroland. Los Angeles, CA. 2006.

Interactive Façade and Enteractive both interact with their surrounding environments, and reveal the processed information to the community. Though achieved in different manners, both systems accomplish the same goal. Interactive Façade follows

people as they walk by the structure, and allows the public to view the traffic pattern. Enteractive tries to dictate traffic by enticing users to step on certain squares, and then portrays the results to the community. Despite their differences in the methods of actuation, both systems are basically devices that demonstrate the pedestrian movement within the system's surroundings.

In addition to interactive systems that describe their surrounding environment, there are systems that can actually alter the physical space depending on the location and actions of the users. This includes walls, roofs, and furniture that morph and adapt to the environment. These systems will detect where the people are and what they are doing, and adapt and change to meet the needs of the users. A project that accomplishes this is the temporary interactive installation: Bubbles.

Bubbles was designed and built by a rather large team of people including Michael Fox, Juintow Lin, Axel Kilian, Scott Franklin, and Miao Miao. This project was recently displayed at the Materials & Applications site in Silver Lake. Bubbles "is an adaptable spatial pneumatic installation at an urban scale. The installation…[consists] of large pneumatic volumes that inflate and deflate in reaction to the visitors coming to the site."[5] The overall structure is thirty-seven feet tall, and incorporates a total of sixteen "bubbles," or balloons that are eight feet in diameter. Half of the bubbles are located toward the ground, which allow for interaction with the people within the space. The other eight sacks are located

Figure 1.3 – View of Bubbles from the street. Michael Fox. Los Angeles, CA. 2006.

Figure 1.4 – View from above of Bubbles. Michael Fox. Los Angeles, CA. 2006.

above the lower ones; each lower bubble is paired up with an upper bubble. "Sensors in the bubbles cause a fan in the manifold to transfer air to the bubble directly above,"[6] thus creating a path for movement through the rest of the space. When idle for a long period, "the lower bubble in the pair refills with air and awaits another interaction."[7] When a visitor enters the space, they must create a path throughout the installation. This is accomplished by hitting the first bubble, which causes the system to activate and begin altering the space according to the user's preference. This interactive system glows at night, creating a beautiful space that has the ability to completely define and re-define the space, making the experience of the space both entertaining and delightful.

Another project that fits into this category is Meta-Morphic Architecture by Miles Kemp. This project was only tested on a small scale, and was never actually developed into an architectural-scale project, but the concept is certainly worthy of mention. The idea is that these diminutive cubes could interact with one another and create a new configuration of a space at the user's will. These cubes, about the size of a grape, have a brain of their own, and have the

Figure 1.5 – Meta-Morphic Architecture cubes. Miles Kemp. Los Angeles, CA.

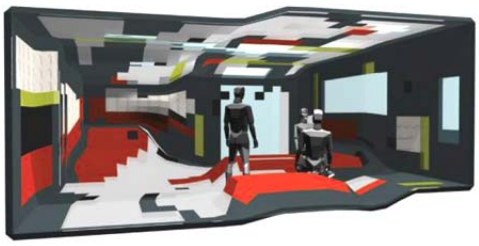

Figure 1.6 – Possible space configuration with Meta-Morphic Architecture. Miles Kemp. Los Angeles, CA.

ability to pick up, move, and place each other in the desired locations. Any architectural component of a space can be configured of these cubes, including walls, ceilings, floors, and furniture. This system would allow for a complete alteration of a space, giving total flexibility in the configuration of the inhabited space. In a quick manner, the user could have the system rearrange furniture, divide and undivided areas, and adjust ceiling heights.

Bubbles and Meta-Morphic Architecture are two very opposing approaches to a similar concept. Both of these systems are capable of altering the space in which they are located. Bubbles is a fun interactive system that is designed to create pathways throughout the site, allowing for human passage. Kemp's project also manipulates the space, but on a more practical level. This system is simply used to change and alter the space where the user may live. Both projects carry out the same objective, which is to redefine a given space based on the human users.

A system that directly interacts with a person or creates an interaction between people is the last type of interactive design. These systems generally change what the person is able to perceive, but do not actually alter the size of the space they occupy. Light, aesthetics, sound and even smell can be manipulated with the use of these designs. Aperture by Frederic Eyl and Gunnar Green and Party Wall by nArchitects are both models of this interactive typology.

Similar to Meta-Morphic Architecture, Aperture is in the conceptual stage, and has not been implemented into an architectural project. This system is designed to allow for views only where the user is present. The project consists of an interior wall with a series of circular perforations that have irises embedded into them. Sensors detect if a

Figure 1.7 – Two apertures or irises. Frederic Eyl and Gunnar Green.

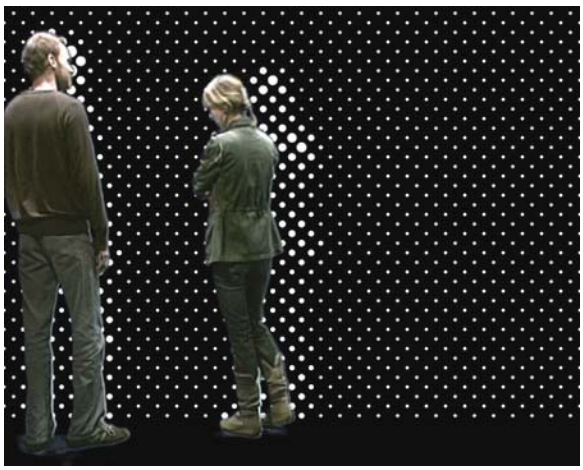

Figure 1.8 – Apertures capturing the location of users. Frederic Eyl and Gunnar Green.

person is located in front of an iris, and will open to allow for natural lighting as well as a view if a person is present. Therefore, the only light coming into the space, as well as the views to the outside, is controlled by these irises.

"Analogously to the process of taking a photograph, people standing in front of the wall are exposed to the aperture grid, just like to photographic film. The duration of the image fading out, as the apertures close, is itself a reflection of how long a person has been standing in front of *aperture*."[8] This project not only interacts directly with the user, but also informs the public of the actions of the user and the duration of the interaction between the person and Aperture.

Just like Aperture, Party Wall by nArchitects is also an example of an interactive system that interacts directly with a person, or governs interaction between people. Party Wall is a system that divides a space into two, and interacts with users as well as allow users on both sides to communicate with each other. This is a wall that is devised of several two inch thick bands of foam that run parallel with the floor. When the systems actuates, the foam pieces create long, organic objects which dictate the communication

Figure 1.9 – Party Wall allowing two people to communicate. nARCHITECTS. 2005.

level between the two sides of the wall. "Proximity sensors embedded in the foam detect the presence of "neighbors" and trigger tiny servo motors. The motors exert tension on synchromesh pulley cables attached to the foam layers, causing variable compression and expansion, and resulting in varying apertures and densities of foam."[9] When people on each side are located across from each other, the wall will adjust itself to allow the two to converse. Not only does it respond to the presence of several people, but the system in fact interacts with a single human as well. Party Wall could be implemented as a property divider; it can act as a fence, but would permit communication between the neighbors. It can open up gaps in the wall system to allow for views or light, for instance, with only the attendance of one person.

Aperture and Party Wall either directly communicate with people or they allow for interaction between people. They are both vertical applications that can manipulate the qualities of the space such as natural lighting and views. Aperture and Party Wall both sense the position of the interacting people, and adjust themselves accordingly. These systems create an exciting and intriguing form of kinetic design when imagining the concept of direct interaction between buildings and people.

Although accomplished in different approaches, all three types of interactive systems eliminate the communication barrier between humans and the built environment. Whether the systems describe their environment, alter the physical space, or directly interact with humans, they all interpret actions of people and respond to them.

> Architecture has traditionally been perceived as enduring, permanent structures. For centuries the architect has aspired to permanence…It is apparent that the monument syndrome of static, permanent architecture has persisted throughout history into these dynamic times.[10]

It is important to explore the notion of kinetic architecture and the concept of humans communicating with the built environment with the constant advancement in technologies that affect our routines daily, which is exactly opposite of how architecture has been known. As the fields of electrical and mechanical engineering progress, and the technology to fabricate more precisely and more rapidly is enhanced, the capability of implementing complex kinetic design into the built environment is certainly possible. These interactive systems have the capability of enhancing the spatial efficiency, security, transportability, aesthetics, and the overall experience of the built environment. Interactive design in architecture is able to diminish the communication barricade that is so dominate in our society today.

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