Towards a "Liveliness" in Architecture:

The notion of "Liveliness" in architecture has its roots in previous lineages of thought in the area of responsive architecture. One of the first examples can be found in Cedric Price's and Joan Littlewood's unrealized 1964 Fun Palace. The Fun Palace was a theater consisting of a system of movable containers, scaffolding, and a crane. This framework was meant to allow the occupants to reorganize the space based on their needs and activities. The building acted as a tool, a framework for interaction rather than enclosure. (Beesley, Khan 2009) Price and Littlewood seemed to be more concerned with orchestrating action and creating a place for interactions to take place. It was a feedback system between users occupying the space with ever changing needs and a framework that was responsive and changed to meet those needs.

This idea of architecture as a responsive system was picked up and pushed further with the influence of Cybernetics. Cybernetics called for a reactive and adaptive environment that was interested in a constant information feedback loop. Architecture theorist Gordon Pask stated, "Architects are first and foremost system designers." (Pask, 1969) He was interested in the "operational" capacity of architecture and argued that architecture could be treated as a program or a system in which specific variables and parameters could be set to create spaces. Architecture was to be approached the way a computer programmer programs a system. The ideas that was architecture was a framework for ever changing interactions began to develop into the idea that this framework could be a system of spatial change that created a field where modification would generate possibilities instead of fixed conditions. (Parlac, 2016) Here the 'event' taking place inside of architecture is now what is being designed for. Ignasi speaks about this in what he calls "weak architecture"; an architecture that embraces the "precarious nature of the event" by not calling attention to itself. (Ignasi, 1987) He suggests that the ability to resonate and amplify situations was a stronger strategy for architecture rather than attempting to contain and control situations. (Beesley, Khan, 2009)

Marcos Novak explored a new form of event based architecture in the 90's known as liquid architecture. He described it as, "[Liquid architecture] is a symphony of space, but a symphony that never repeats and continues to develop. If architecture is an extension of our bodies, shelter and actor for the fragile self, a liquid architecture is that self in the acting of becoming its own changing shelter. Like us, it has identity; but its identity is only revealed fully during the course of its lifetime." (Benedikt, 2009) He explored ideas of events and interaction in virtual architecture. He introduced sophisticated notions of event, interaction and customization to architectural discourse. (Sterk, 2009) Greg Lynn built on Novak's work through the idea of "animate form". Lynn explains, "Animation is a term that differs from, but is often confused with, motion. While motion implies movement and action, animation implies the evolution of a form and its shaping forces; it suggests animalism, animism, growth, actuation, vitality, and virtuality." (Lynn 1999) He tackled architecture more straight on by developing ways to bring to life the ideas he spoke about through new forms of digital modelling and fabrication. He used the smoothness of dynamic form to imply and suggest animism in architecture. He added a language of dynamics, fields, and forces to the architectural discourse. (Sterk, 2009)

Around this time John Frazer stated, "architecture should be a living evolving thing" (Frazer, 1995) The idea of architecture that did not just respond to your presence, but could actually perceive your presence and interact with you began to develop. Architecture was no longer a single place or event, but could act as a living ecology that actively participates with its surroundings. (Vera, 2016)

The work of Phillip Beesley suggests notions of living architectures and ecologies. His various installations mimic living organisms by adopting their likeness and movements. One of his projects Hylozoic Soil creates "jungles" of individual pieces that interact among themselves and interact with inhabitants through small life like movements in single elements but also as a whole ecology with a chain reaction of lights and energies registering a person's presence. The individual reactions change the resonance of the collective surface. (Beesley, Khan 2009) There is a sensitivity to the work where individual pieces are stretched near their limits and operating near failure. They create "precarious" fields.

Current Avenues of Exploration in Responsive Architecture:

Current projects in the realm of responsive architecture fall into several branches. The current trend is that of public media screens and interactive electronic installations. Also, environmentally charged systems such as responsive façade systems are prevalent along with smart material and hybrid material response systems. This section will give a brief overview of the latter two.

Shape Shift:

This project explores the use of Electroactive Polymer as a building shading and ventilation system. EAPs are a type of polymer that can alter its shape and configuration based off of an electrical charge. This system consists of an array of biologically inspired panels. Each panel is framed in acrylic with the center being layered EAP. When an electronic charge is placed, the system can morph its shape. This project was completed at (ETHZ) in the Computer Aided Architectural Design Chair, 2010.

Bloom:

Bloom is a structure designed for shading and ventilation. This project incorporated Bimetallic strips as its actuator. This is a process by which two different types of metal with different expansion coefficients are attached. As heat is applied, the metal expands, but because they expand at different rates deformation occurs. Bloom consists of a large surface array of bimetallic panels, when heated by the sun, curl to allow heat to escape the space and as they cool, close again. This project was by Doris Sung 2011.

Living Glass:

Living Glass is a project that incorporates shape memory alloys. These allows have the ability to recall their original shape when heated. This process can happen repeatedly giving the materials a 'memory'. Living Glass uses a lightweight silicon skin with gill like slits in it as a building ventilation system. The Dynalloy Flexinol wires when electrically heated cause the slits to open, ventilating the space. The opening and closing of the system is regulated through sensors that measure the space's carbon dioxide levels. Project by David Benjamin and Soo-in Young 2004-2005.

Smart Screen III:

Smart Screen III uses SMA wire to replace the mechanism inside of window blind units in a building. Instead of having a mechanical solution to raise and lower blinds, the SMA wire replaces that assembly.

As the sun heats the façade the wire slowly retracts raising and lowering the blinds. Project by Decker Yeadon, New York 2010.

Wood and Embedded Responsiveness:

Performative Actor:

Recent developments of "performative" materials offer an opportunity to design material behaviors as opposed to choosing materials based on their static properties. These performative materials behave in response to the active energy fields existing within and around the "systems" we program. However, the introduction of these materials calls for careful consideration of all of the building elements we use. The behaviors exhibited within "smart" materials can be physically programmed or even naturally found in materials such as wood. These materials exist in a variable environment and therefore we should explore the embodied potential each of these materials has to respond to its environment if we are to design with material behaviors in mind. This idea of performative materials changes our notion of materials as a static element to one in which the material acts as a mediator. (Rashida, Patel 2013) This allows us to view the interface between materials, people, and their environment all as actors within a system. Material information should become a generative driver rather than an afterthought in design computation. (A. Menges, 2012)

Hygroscopic Behavior:

Hygroscopy in wood is the ability to alter its volume when absorbing or dismissing water to the environment. This alteration results in a non-uniform three axis deformation of its body which is described as anisotropy and affects its structure and strength. (A. Menges 2009) An example of this can be found in nature in the conifer pine cones. The pine cone's seeds rest behind the scales. Even after falling from the tree the scales, have the ability to open and close multiple times. It will open when dry and close when wet. In traditional wood construction this process resulted in bowing of wood members, rendering them in some cases unusable. However, through digital planning tools, we can begin to 'physically program' the materials natural grain patterns to react in predetermined ways. The dimensional change of wood is directly proportional to changes in moisture content. (A. Menges, 2012) This allows for the same response to planned for and built with.

Tensile Properties / Active Bending:

Due to the fiber direction caused by the distribution of cells in the wood, wood inherently has a directionality to it. This directionality and orientation can be understood as variable strengths and stiffness. (A. Menges, 2012) This allows us to design structures that account for this pliability and use it as a strength. Wood also shares properties with synthetic composites, such as glass-fiber-reinforced plastics which have a high strain at failure, low stiffness, but with a high amount of structural capacity. (A. Menges 2012) These properties lend themselves to constructing systems using bending methodologies. This creates an embedded energy in the wood through which the force can be used to a structural advantage. This allows for the creation of very lightweight, thin structures with a high structural capacity when grains and stiffness are planned for.

Force Driven Design:

Tension driven material systems are not a new design in architecture. They were widely explored and implemented in the tensile systems designed by Frei Otto. Force can be used as a way of defining form that has multiple states of equilibrium. This means however that the systems by which the form is generated and the systems of operations become intimately aligned. (Ahlquist, Menges 2012) This creates interdependencies in any force driven system whereby localized instances of change can affect the overall homeostatic performance. Here form is no longer static, but rather serves as a system itself that embodies the interactive systems by which it was formed and how it operates. (Ahlquist, Menges 2012) Force driven systems become sensitive to the surroundings and have the ability to react with energies being put into and taken away from it. The systems create multi-hierarchical material behaviors that all interact between themselves and the surroundings, or rather a collection of internal and external energies acting in a constant state of fluctuation. (Ahlquist 2016)

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