OPERABLE TECTONICS AS AN ARCHITECTURAL LANGUAGE

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Architectural vocabulary consists of the components and construction practices used by designers to assemble a built entity. Movement in architecture (defined in this study as physically animate components) is historically present in even the most primitive of structures. The concepts of collapsibility, foldability, and transportability were all main components in many Native American and nomadic structures. Many similar ideas regarding movement are re-emerging in modern architectural practices as architects begin to introduce operable tectonic components as signature and practical elements in their designs. Tectonic adaptability and augmentation have become responses to the ever-changing needs and desires of occupants as well as the environment. How do contemporary architects utilize the concept of augmented space as a new vocabulary in order to foster an adaptable architectural solution for a multi-variable design challenge? How do these elements become a language that accentuates and magnifies an architectural solution in order to step above the most economical answer to a problem?

INTRODUCTION

Architectural vocabulary consists of the components and construction practices used by designers to assemble a built entity. Movement in architecture (defined in this study as physically animate components) is historically present in even the most primitive of structures. The concepts of collapsibility, foldability, and transportability were all components in the earliest of architectures, specifically Native American and global nomadic structures. These qualities not only served a practical purpose, but also defined the occupants’ dwelling space, and, in turn, their daily lives. Many similar ideas regarding movement are re-emerging within modern architectural practices as architects begin to introduce operable tectonic components as signature and practical elements in their designs.

Tectonic adaptability and augmentation have become necessary and poetic responses to the constantly changing needs and desires of the modern occupant, diversified programme, and the environment. How do contemporary architects utilize the concept of ever-changing, augmented space as a new vocabulary in order to foster an adaptable architectural solution for the modern, multi-variable design challenge? How do these elements become a language that accentuates and magnifies an architectural solution in order to both step beyond the most economical answer to a problem, as well as fulfill it?

PRECEDENT

Operable architecture and coinciding concepts appear throughout the annals of architectural theory. Vitruvius’ primitive hut (Figure 1) was in its own right a temporary structure constructed of tree limbs and natural materials. The image’s main focus is no doubt one of structural and programmatic organization; however, it can be extrapolated that the impermanent semblance of the structure is the first example of a structured, yet modifiable architecture. Vitruvius even identified “kinesis” as one of the main principles of an architectural construction. More modern examples come from the architect Le Corbusier, whose concept of a “machine for living” suggests a state of mechanical architecture that fulfills the basic needs of the human condition. Expectations of a static, inadaptable building typology cannot be stretched to fulfill the ever-changing, radically complex needs of the modern occupant. Ignasi de Sola-Morales discusses the “roots” of architecture, but “maintains a rigorous and nonconformist position.” He argues for “systems that move independently...
according to their own logic.” His concepts of weak architecture discuss architecture without grounding—although mostly in a cultural sense—referencing a lack of ties to an absolute reference. In a way, operable tectonics allows architecture to operate along this periphery. Instead of a direct architectural affront, both the form and underlying reference are constantly modified and, in a way, weakened. The space becomes more about what occupies the space created, rather than the space itself as a descriptive form. 

Operable tectonics cannot possibly be studied without examining the work of the architect/engineer Santiago Calatrava. Throughout his thesis “Zur Faltbarkeit von Fachwerken (On the Foldability of Space Frames”), he describes the need to classify movable components into a “operable thesaurus.” Calatrava’s work, although highly stylized and specific, provides an excellent base by which to study the complexities of architectural movement. Consequently, Calatrava’s methodology of classification became the basis for this study. 

The work embodies an incredible juxtaposition between operation on the periphery and a highly technical precision. Calatrava’s process is that of periphery (with media such as watercolor, ink, paint) subsequently constructed with technical prowess. This process brings about a sense of ethereal incomprehensibility that can be attributed to view and interaction of the onlooker. “How” the object moves is a bit of a “magical” fascination. Operable buildings on a scale similar to Calatrava’s work tend to create a sense of bewilderment around them. The technology required to facilitate operation is usually un-designed and hidden in service space, whereas the tectonic expression and concealment is of paramount importance in Calatrava’s work. The earliest reference of this phenomenon can be found at the Temple by Hero of Alexandria (Figure 2), where a system of pneumatic doors opened the temple doors automatically at times of important ceremonies. In a sense, “wonder” was actually scripted through the architecture, utilizing an advanced system of technology not yet comprehensible or understood.

STUDIES

Goals

Four main goals were present at the initial time of study:

- To investigate operational typologies in conjunction with operational tectonics.
- To consider the implications of each typology and determine/implement them at a scale.
- To develop a design solution emerging from an initial operable tectonic proposal.
- To analyze the successes and faults of the proposals at their given scale and typology.

The goals were designed to facilitate projects directly influenced by the design of operable tectonics. The design proposal would respond to the design problem with an operable tectonic solution, and subsequently adapt that solution to fit the developed parameters (site/occupation/etc.).

Methodology

The classification of each movement type came from analysis of current precedent project on many scales. Scales from entire buildings down to operable shade devices and doors displayed a wide range of usages and typologies. It became most fitting to classify each of the types mainly by scale, as each scale was usually articulated with similar goals within their respective design proposals. The following categories were developed and further defined. Category 1 consisted of movement utilized on a small scale, usually repetitiously. Category 2 consisted of a medium scale modular element within an intervention, usually a singular element, which modulated interior space. Category 3 classified projects identified by operable qualities before its static ones, projects where the architecture was almost entirely impermanent and reconfigurable. Each project was the result of further typology analysis, followed by an architectural application that best displayed the typologies benefits and attributes.

THE PROJECTS

Category One

The first category of tectonic movement was studied at the smaller scales of operable elements. These elements included items similar to the scale of screens, window shading devices, doors, and windows. At this scale, the elements usually are identical, or at the very least similar, in form, type, and construction. The interplay between these items and their operational nature allows their repetitions to become valuable within the realm of operable tectonics. Many items at this scale are either controlled by an automated system of some kind (for example, building
integrated systems that open/close exterior windows), or become operable by the occupant within the building. This particular scale provides opportunities that many of the other classifications do not possess: for example, the ability for direct occupant interaction between the component and the individual. Many components within the works of Carlo Scarpa would fall into this category. Details, joints, and fittings become increasingly more important (and subsequently call for greater amounts of design) at this level because they are highly expressive and exposed opportunities much of the time.

Human interaction aside, the scale of these elements provides another very unique opportunity, that of patterning. The study was in no way heavily devoted to the concept of “a pattern,” but explored the issue as far as basic scale and modified repeated elements.

The project developed from this analysis (Figure 3) was that of an operable building façade, which was located on a residential tower in an urban setting. Conceptually, both the pattern and the interaction between the occupant and the operable device were considered to be vital issues. The device had to serve as a mediator between the interior and exterior and as a weather control device (wind/water/sun) and also had to be aesthetically pleasing to the resident.

The design resolution became a foldable accordion panel on the exterior of a mediating roof deck (Figure 4). Each panel was constructed of a steel frame sheathed in a transparent metal fabric. The benefit of the accordion panels included the varying sizes of apertures created, when compared with a swinging panel. It also allowed for fins to exist along the façade, bringing in a vertical shadow-casting element, to vary the patterning (as compared to a sliding panel). The façade as a whole created a random, uncontrolled (and unexpected) patterning that could not be constrained by anything but the parameters of the movement.

Implicit within the occupational nature of the intermediate space (between the screen and the interior façade) was the ability to “read” the building through the interactions on the façade. Activities and attitudes of the occupants were now immediately expressed along the façade to the rest of the city, engaging them with the façade and its occupants.

**Category Two**

The second category explored was that of the medium scale elements, which usually exist as singular, multifunctional components that seek to create a variable space through their different positions. Operable wall, ceiling, and floor components would fall under this categorization. Elements at this scale organize and reorganize the spatial dynamics within a given frame. Medium-scale elements also tend to have a visual and tectonic weight and scale, making them integral pieces (and usually highlights) of their respective architectures. Tom Kundig’s Chicken Point Cabin is a prime example of a space-modifying element (Figure 5).
The operation of the main focal wall completely changes the diagram of the space into a “before and after” sequence. The change is simple, from a closed wall to an open wall, but the impact on both the space and the interaction between occupant and the architecture is extraordinary. The simple diagrammatic modulation found in this work is at the core of operating at this particular scale.

Scale of the element and its individual operations and articulations must be carefully choreographed in balance. The breaking down of the medium element through motion had the potential to disassemble the component into too many pieces, losing the weight and scale of the element. This had to be carefully avoided and tested-through in order to preserve the categories main identities.

The second project was derived from the scale of a storefront window. The task was to work within the intermediary zone between the street edge and the interior space of the shop.

A standard-static architectural response would have required the selection of an expressed opinion on the store façade (Does the façade display with transparency? Does it mask with opacity? Or does it reside somewhere inbetween?) The operable tectonic response allowed for all of these possibilities to occur on one storefront. Specifically installed was a singular, foldable wall that dominated the entire front of the store (Figure 6).

![Figure 6. Operable Store Façade (from street)](image1)

Motions of the front wall were developed through simple diagram as two different “open” conditions and one “closed” condition (Figure 7). The closed condition displayed nested transparent display boxes through the otherwise solid wall. This stage allowed an equal level of transparency and opacity at the static level. Opening the front façade to the outside provided for a shading structure, a signifying gesture to the street, along with erasing the physical boundary between the shop and the street. Folding into the interior space allowed for a modulation of the interior space by means of the roof, permitting different display types and floor layouts.

![Figure 7. Facade Operation Diagram](image2)

**Category Three**

Category three consisted of projects defined by their usage of operable tectonics. The projects’ responses, or challenges to an architectural problem, were in some way resolved with an operable system that reacted through physical modulation of components. Scale at this level becomes rather questionable because some projects can be entirely defined by an operable solution but are very small in scale. The examples here, however, are mostly selected for their large building scale operations. This category seeks to modulate space within the project in a defining way: usually the occupant experiences the motion as an architectural event, not just a singular stage at a singular time. The concept of sequencing becomes incredibly important; experience of the component at a singular time is very different from experiencing several stages of motion over a singular encounter. The Wyly Theater by REX/OMA presents an ideal case of sequencing. The programme of theater was challenged by the implications of a completely modifiable theater within a “black box” volume. Each type of theater (proscenium, thrust, flat floor, etc.) can be created and reassembled within the space. The concept of “multi-procession” developed an idea of sequence within the architecture. Performances in theory can be scripted by moving in and out of the theater, returning each time to a different interior setup and reacting to a change in the performance.
The third and final project was seen not only as an exercise of large scale, operable-component based architecture, but also as a culmination of the concepts of the previous two typologies. Sequencing the movement of the structure became of paramount importance, and an understanding of the space over time became as rigorous a study as the project itself. The project began somewhat scale-less, as physical operations were formed into spatial volumes over time. Diagramming the transitions between movements became a methodology for exploring the spatial consequences of operable action (Figure 8). Each component left traces into its theoretical setting, creating a “performance” of the actual building structure. The programmatic classification of the project became “performance space,” and was to take advantage of the eroded and modifiable qualities of the prior studies.

The element of water was introduced into the project as a means to highlight not only the operational components and allow for unique performance types, but also to incorporate itself into the traces left behind by the operable components. Virtually every surface is considered operable (Figure 9), from the ceiling that contains theater mechanics and storage to a complex underground system that allows for many different types of staging, from fully aquatic to fully dry, and all ranges in between. The space between both the roof and the ceiling is modified by the change in theater typology, consisting of operable seating elements and balcony components. The theater is intended to be sequenced by using the eroded landscape. A performance would consist of movements between the performance volumes and the exterior landscapes, where the return would not necessarily be the same as the exit. This theater is seen as an adaptable response to what occurs within it: the performance no longer needs to conform to the venue in which it is placed, but the theater now adapts entirely to the performance. Modifiable components on this scale allow for a new link between architecture and occupant, by allowing the intervention to become plastic and susceptible to its environment.
CONCLUSION

Operable tectonics present opportunities for architectural responses as varied as their initial inputs. In a world dominated by technological advances and connectivity, the appropriateness of a non-rigid architecture of diverse response becomes more widespread.

Operable components are compatible in response to almost any scale, and allow for a greater connectivity between the occupant and its architecture. The spatial modulations inherent within this architecture not only allow for a more successful incorporation of the physical occupant, but also a symbiosis of the programmatic nature of the space and the architecture that contains it.

Through study, these components and typologies can be studied to create new and intriguing uses for operable tectonics. Variable architectural responses have the ability to challenge the inherent nature of static programming, in an attempting not only to super-activate the architecture, but the programmatic experience as well.

ENDNOTES

1 Alexander Tzonis and Liane Lefaivre, Movement, structure, and the work of Santiago Calatrava (Boston: Birkhauser, 1995).
2 Le Corbusier and Frederick Etchells, Towards a new architecture. (United States: BN Pub, 2008).
5 Tzonis and Lefaivre.