Re-Skinning the Airstream Trailer: Studio Investigations Into Responsive Systems

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RESPONSIVE ARCHITECTURE

> "We hope for a profound participation in the world around us."[1] —Philip Beesley et al, in Responsive Architectures, Subtle Technologies.

INTRODUCTION

In the distant past, the exterior surface of a building passively protected, shielded and separated man from nature. Thick walls, small openings and heavy roofs ensured this security. "Rigidity and resistance to the external environment [were] normal qualities in building."[2] In the 1930s, the modern movement and industrialization rejected the physical segregation of the indoors and outdoors and encouraged the use of glass walls as a means to visually bring the outside in. But, even though the glass was thin and transparent, the window wall remained physically impenetrable. This design/build investigation revisits the ongoing discussion of the Primitive Hut with a new position on balancing man with nature: skins of buildings can be designed to be porous, animated, and sensitive, performing as a tool, rather than an object. By making a skin that is responsive on the outside to changes in the climate AND on the inside to the movements of the body, it can connect man and nature harmoniously despite its material and physical presence. The manifestations would occur on the opposing surface of the skin: the outside skin's reaction would appear on the inside and vice versa, redefining "the 'body' whose expanded border embraces the surrounding environment."[3] It would, in effect, blend inorganic matter with the organic.

This basic characteristic of building skins as a responsive skin is not new. It is one component of a sustainable low-energy concept, where performance is the primary criteria. One famous example is Jean Nouvel's Institut du Monde Arabe, where the skin responds to the changing light with camera-like shutters of its façade, reducing the heat gain for the building. Ironically, the kinetic wall was set too sensitively and subsequently was adjusted to not react to every minor change in light. Bodo Rasch's Medina Umbrellas is another responsive system that unfolds at dawn to shade the courtyard for morning prayers. The effect, although beautiful, is completely dependent on electronic sensors and motors. More recently, Fluidic Muscles, a silicon-coated polyamide rubber tube system, which cause linear movement as the "muscles" expands and contracts using compressed air (created by a German company called Festo KG), were incorporated on a façade design by Kas Oosterhuis in the Adaptive Facade in the Netherlands. "Oosterhuis suggests the Fluidic Muscles can be used in conjunction with an inflatable cushion-shading device, fitted to the external skin of the building."[4] The character of the façade changes with the passing of the sun on the exterior or the changing needs of the users for shading. Similar to this last example where interactivity occurs on both sides of the skin, the studies presented in Part I of this investigation attempt to consider the many layers of responsiveness. They consider conceptual soundness, programmatic flexibility and human interactivity as major elements as a means to define responsiveness in a more comprehensive manner. Robert Kronenburg states this eloquently in the preface to his book, Flexible: "Flexible architecture consists of buildings that are designed to respond easily to change throughout their lifetime.

The benefits of this form of design can be considerable: it remains in use longer; fits its purpose better; accommodates users' experience and intervention; takes advantage of technical innovation more readily; and is economically and ecologically more viable. It also has great potential to remain relevant to cultural and social trends."[5]

Responsive Context: The Airstream Trailer

In search of a context most suitable for the study of a responsive skin, it was clear that the architecture itself would have to be flexible or adaptable. A mobile structure that can travel one place to the next would be ideal in this case, since it has the flexibility to position itself in a select climate, ideal orientation and controlled setting. If its needs are not met and the context incompatible, it can simple move. The Airstream trailer, an American icon and architect favorite, became an obvious choice for this skin project. Selected for its ideal grafting medium, the Airstream trailer is an independent, inhabitable unit, continuous on all sides (including the roof and the belly), and easily transportable. Each lightweight rendition since 1934 was a different study in aerodynamics, aluminum cladding and monocoque construction. "Monocoque is in an airplane fuselage a kind of construction in which the skin or outer shell bears all or most of the stresses. In an Airstream, it is the kind of construction in which the body and chassis are one unit."[6] The actual model used in this study is a 1948 Weewind Airstream (see Figure 1). Its body length is 14' long, which is 4' shorter than its famous cousin in the permanent MoMA collection, the Bambi. Stripping the trailer of its skin removed a large part of its structural integrity and technological innovation. For this reason, the Airstream shape was used an envelope, rather than a framework. A completely new model was developed and the monocoque construction removed.

Figure 1: 1948 Weewind Airstream Trailer.

The Weewind trailer was segmented into fourteen imaginary and equal parts so that different designs of low-tech responsive systems could be developed and built at full-scale. The composite reproduction of the trailer was a patchwork or sampling of different skin, juxtaposed abruptly one alongside the next. Each design attempted to challenge different conceptual, programmatic and technological aspect of flexible living. For purposes of this report, the interior, although completely designed, is not presented.

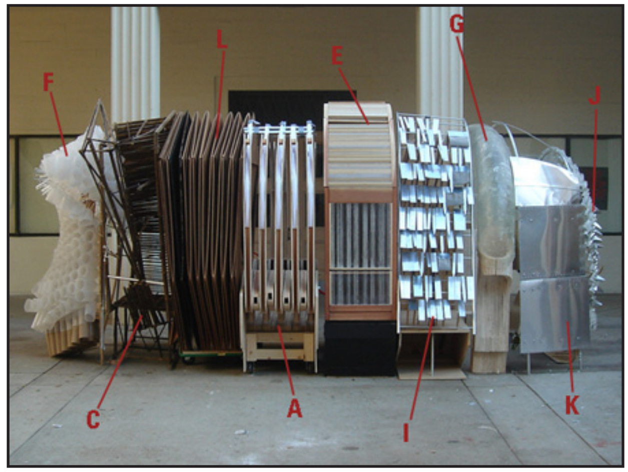

Figure 2: Reconfigured trailer with responsive skin studies.

FOURTEEN TECTONIC STUDIES

Framework of Study

The following series of studies were designed in a studio setting of undergraduate students. With the premise that technology can respond to physical stimuli and that theories of flux can manifest itself in technology, each study focused on a specific facet of responsiveness (Figure 2 and 3). Even though the studies speculated on the potential that interior program and conceptual ideas of flux could inform the development of the skin of the building, the final themes of categorization were based on the resulting responsive systems as defined by Robert Kronenburg.

Those categories are as follows:

1. 'Adapt' includes buildings that are designed to adjust to different function, users and climate change. It is architecture that has a loose fit and is sometimes called 'open building.'

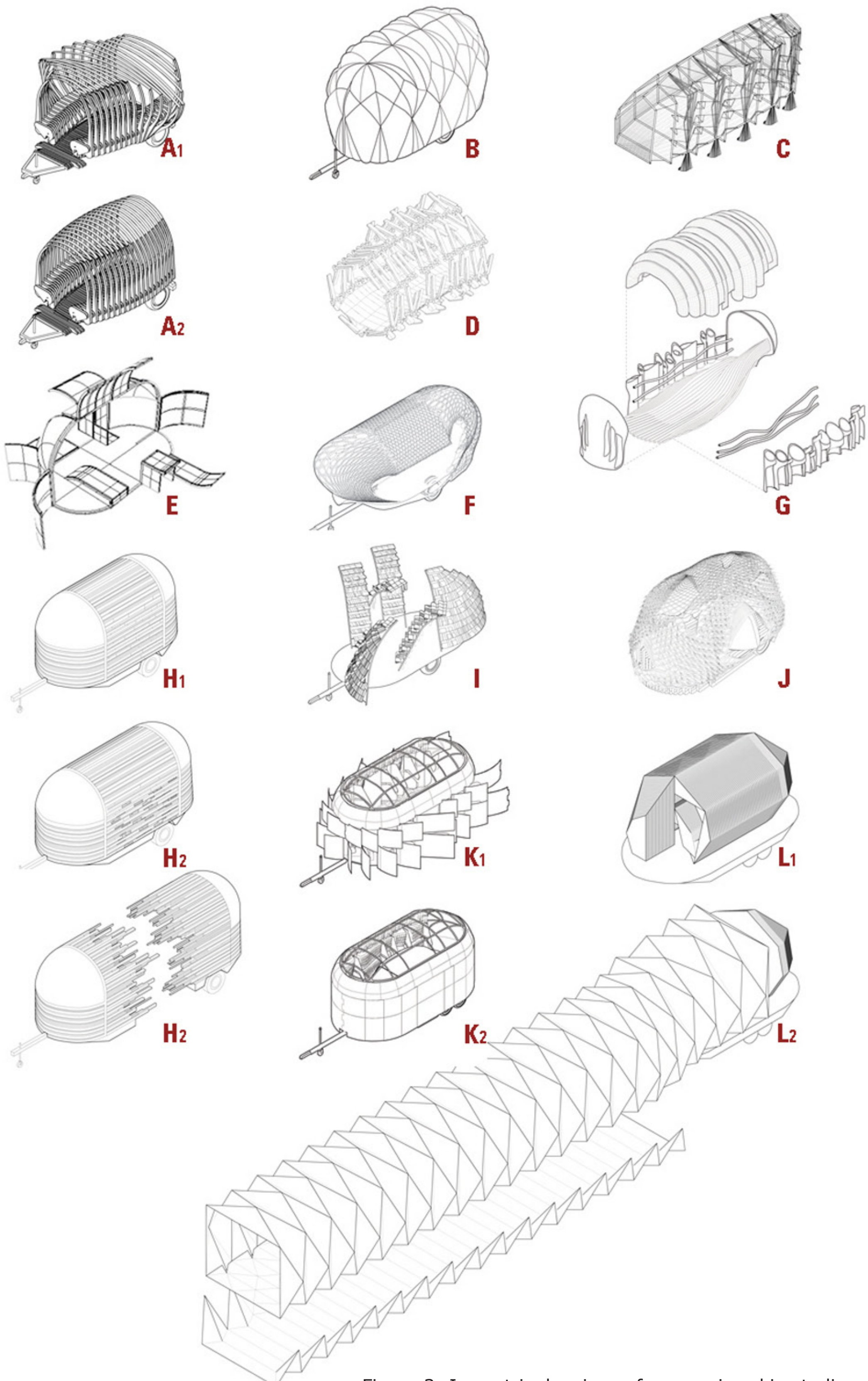

Figure 3: Isometric drawings of responsive skin studies.

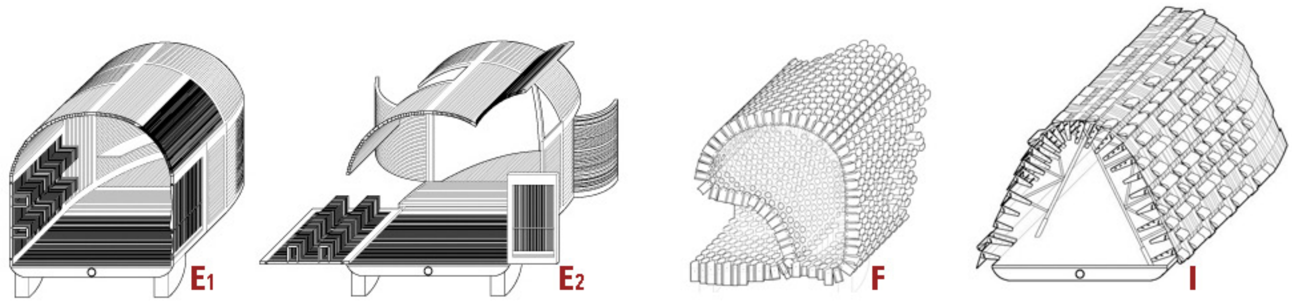

Figure 4: Wall sections.

2. ‘Transform’ includes buildings that change shape, space, form or appearance by the physical alteration of their structure, skin or internal surfaces. It is architecture that opens, closes, expands and contracts.

3. ‘Move’ includes buildings that relocate from place to place in order to fulfill their function better—it is architecture that rolls, floats or flies.

4. ‘Interact’ includes buildings that respond to the user’s requirements in automatic or intuitive ways. It is architecture that uses sensors to initiate changes in appearance and environment or operation that are enabled by kinetic systems and intelligent materials.[7]

Limited to a tight budget, unskilled labor and simple woodshop tools, the group of students produced phenomenal results in a short amount of time. Brief descriptions of the studies accompany the wall sections and three-dimensional application of the skin.

1. ADAPT

Study E: Mobile Cabinet: Removing the Skin, Removing the Structure, Removing the Walls (Cizek)

This study attempts to marry the structure with the skin so that when opened, the exterior wall would begin to disappear and the relocated elements would be transformed for some other use. The entire exterior skin is made of doors that would fold in or out leaving no framework behind. Each door then transforms into a chair, table, shelf, bed or other programmed element so that what was wall became door, what was door became furniture, what was indoors became outdoors. All movement is limited to hinging—vertically or horizontally. Materials are limited to wood and stacked plexiglass (laser-cut), so that all the elements are camouflaged in a transparent surface. When fully deployed, this cabinet-like domicile has strong references to Andrea Zittel’s Living Units (1994)□. In this case, unlike the others, the monocoque concepts of the original Airstream design is taken one step further. Materials: Redwood, plexiglass, fluorescent light. (Figures 2, 3 and 4: Element E)

Study F: Illegal Immigrant’s Rest Station: Camouflage of Found Objects (Arias-Ballesteros)
The skin of this investigation is intended to be so beautiful that it could mask what was hiding behind, so useful that it could incorporate discarded liter-sized soda bottles as building blocks and so performative that it could provide shade and ventilation in a hot climate. The result is the transformation of a mundane household waste product (the liter bottle) into an unrecognizable ethereal building material and ephemeral structure. White plastic ties are used to attach the bottles together and cardboard tubes for structure underneath. It is important to point out, that in keeping with the concept of using found objects, all materials were either found or donated. No money was spent on the purchase of materials. Materials: Plastic, cardboard. (Figures 2, 3 and 4: Element F)

Study X: Circus Fat Lady: The Theatrics of Water Collection (Van Hartesvelt)

Designing a folly that collects water can be a spectacle in itself. This study investigates water as a dynamic building material. Rainwater is captured and stored in stretchy latex bladders that bulge to “plus” sizes. Finding a material that could retain the water laterally and designing a structure that could support the weight vertically were the challenges in this project. Although ETFE is the ideal

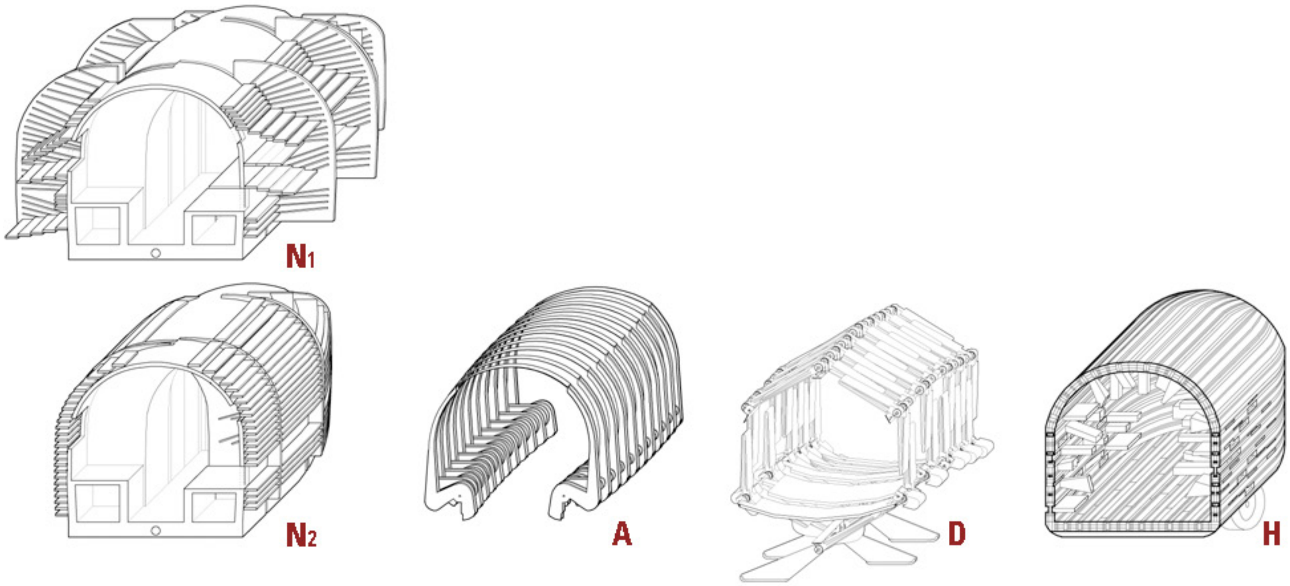

Figure 5: Wall sections.

selection, the affordable material for the construction is high-strength neoprene weather balloons. As the amount of water increases, the gravity forces the structure down until it eventually sat directly on the ground. Hydraulic devices lower the trailer as the weight increased. To become mobile, the water is dispensed and bulk removed. Materials: Wood, latex, plastics, water.

Study I: Unmanned Charging Kiosk: Rain resistant and SAPs (Phung)

Anyone at any time can walk up to this charging kiosk and plug in their cell phone, laptop, pda or mp3 player, powered by solar energy. The entire surface of the trailer is a set of vertical panels, pivoted open and outward. Exposed to the elements, the entire structure, program and safety is readily compromised by a change in weather, namely rain. The focus of the design is on the development of an automatic system that could partially close with light rain or completely shut down when a downpour appeared. By capturing the raindrops in sacks of SAPs (Super Absorbant Polymers), the finely tuned, counter-balanced louvers instantly close from top to bottom. Given more water and weight, the larger panels begin to rotate on its pivot and close the trailer into its iconic form. Once the rain stops, the reversible SAPs dry and return to its original form. Materials: Sheet aluminum, stainless steel mesh, wood, SAPs. (Figures 2, 3 and 4: Element I).

2. TRANSFORM

Study N: Reverse Objectification: Magnification and Reduction in the Skin (Perry)

Gender spaces often refer to the interrogation of the female space within the framework of male architecture. In Adolf Loos' Muller house, he objectified the female owner by setting aside an elevated space with controlled openings and theatrical positioning. Similar to Loos' design, this skin study initially presents an objectifying view of the occupant. As the occupant moved several interior panels, the view of the voyeur changes. The result is an interior program transformed from seat to bed by pushing interior panels connected to the exterior surface out, thickening the exterior wall and strategically positioning a series of louvers in such a way to hide, hinder or divert the view. In doing so, the gendered condition becomes neutralized and asexual. Materials: Wood. (Figure 5: Element N)

Study A: Reality Architecture: Internet Polling and Physical Indexing (Chinn)

Reality TV, internet polling, and cell phone texting have fueled our interest in popularity voting, top-ten lists and surveyed statistics. Architecture too can respond to this cultural phenomenon in a three-dimensional, epigenetic surface.□ In this case, the

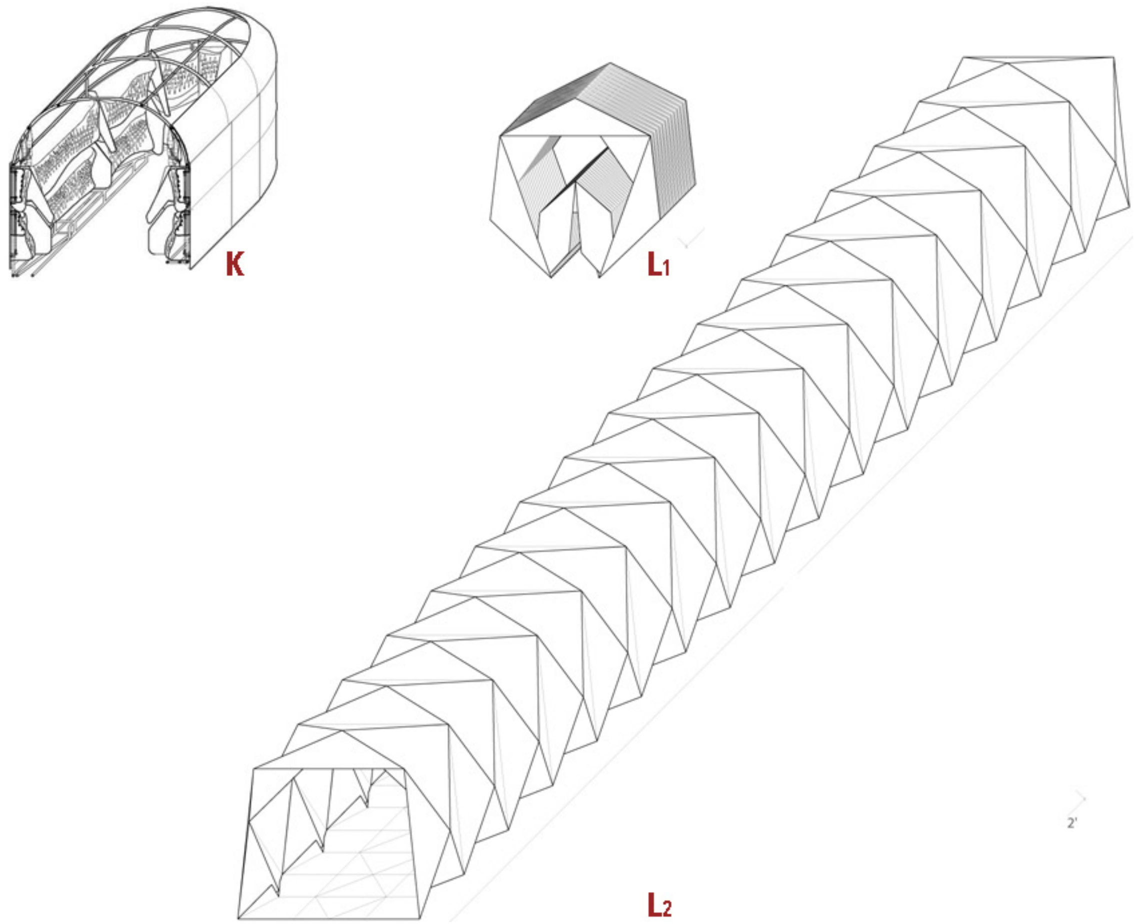

Figure 6: Wall sections.

trailer reacts to changes in information technology as opposed to the environment or human occupation. Both the latter stimulants become bystanders to the spectacle of the information highway. As people vote offsite, the gears and ratchets move to represent the popular or unpopular vote in a shape or surface landscape, derivative of data graphs. The overall structure can crawl across the ground as voting continuous around the clock. Materials: Cast aluminum, cast resin, galvanized steel ratchets. (Figures 3 and 5: Element D)

Study D: On Waiting: Unsocial Aspects of Sitting (Blaine)

Controlling heat gain is a basic function of architecture. There are many hi-tech, electronic devices and actuators that track light or heat. This low-tech one actively shades the user from the sun, utilizing the input and weight of the human as he/she shifts from one seat to the other. Consolidating the structure, the skin, the seating and the movement into the repetitive frame, the overall form will distort to expose the moving organisms on the inside, while minimizing the surface area facing the sun, and ultimately reducing heat gain. Made out of rigid members, the new trailer will appear to be extremely flexible and strangely pliable. Materials: Plywood. (Figures 2, 3 and 5: Element A)

Study H: Threshold: Maximizing the Peephole, Minimizing the Passage (Abiva)

The smallest pinhole can allow enough light in to cast an image. The inhabitable version of this space is called the Camera Obscura. A keyhole, the size of the pupil of the eye, can allow one to peep to a space beyond, establishing a situation of voyeurism. An even larger opening like a window can frame a display and feed a fetish. And yet even a

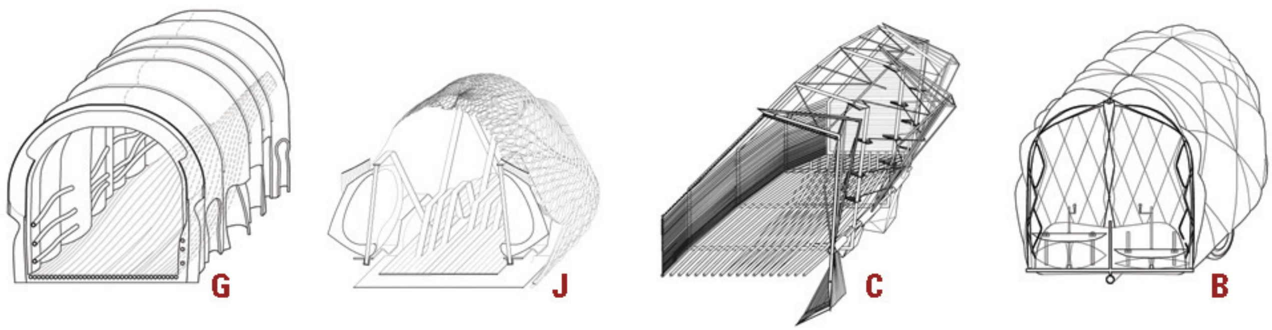

Figure 7: Wall sections.

larger opening would be considered a passage. The design of this skin toys with the various sized openings and our psychologies associated with them. Divided in two parts, the trailer slides apart initially revealing small openings. These openings grow larger as the trailer continues to stretch. By the end the entire trailer extends by several feet, exposing its contents fully. Materials: Douglas fir and pine wood, Teflon. (Figures 3 and 5: Element H)

3. MOVE

Study K: The Portable Nesting Garage: Bringing the Outdoors In (Flascha)

If clothing can be considered an extension of the human body, can the automobile be considered another layer and the trailer even yet another? Borrowing from the iconic "drive-in" scenario, the classic Volkswagen bug hauls the Airstream shell to its destination, and then disconnects the tow to drive into the Airstream from the rear. The entire skin of pivoting panels stand open when the Airstream is empty. As the VW bug enters, the skin clamps down to hug the automobile and privatizes an interior garden□ of hydroponic plants. Ironically, the outdoors is brought in, but is still outside (there is no roof on this trailer). With no hat on one's head, no moon roof on one's car and no roof on one's Airstream garden, how far or close are we actually to nature? Materials: Sheet aluminum, vacuum-formed plastic, aluminum tubing, plants. (Figures 2, 3 and 6: Element K)

Study L: Disposable Emergency Shelter: Creativity with Cardboard, Tarp and Community (Hovsepian)

Corrugated cardboard is a readily available material in most countries around the world. It is cheap, disposable and lightweight with small amounts of insulation, making it an ideal material for emergency shelters. Using simple origami techniques to increase structural stability and ensure compact ability, standard sized boxes were folded with minimal waste and secured by Velcro at select points to a folded tarp-laminated cardboard floor. The result is an expandable structure that can house a large number of occupants, and even a community. Sections of the structure can also be detached and distributed to families or individuals as needed. Openings for light and access are designed into the system. Materials: Corrugated cardboard, plastic tarp, Velcro, liquid water-proofing. (Figures 2, 3 and 6: Element L)

4. INTERACT

Study G: Whispering Confessional: Wind, Secrets and Sound (Choi)

Similar to the whispering arches found in gothic architecture, this study investigates how the phenomena of sound travel can inform the shape and structure of architecture, especially in the use of non-loadbearing materials like resin-coated fiberglass. In this study, participants can whisper their secrets on one side of the trailer while others can listen to the anonymous monologue on the opposite side. The partial tubes take the shape of the Airstream trailer in one of the simplest structural forms, the arch. Lateral stability is gained by attaching rigid sound tubes to all the arches from front to back. As the trailer travels on the highway, these hollow tubes, like musical instruments, capture wind at its front and emit haunting sounds out the rear. Materials: Resin-coated fiberglass, plywood, aluminum tubing, aluminum expandable duct, silicon. (Figures 2, 3 and 7: Element G)

Study J: The Moving Image and Optometry: Blurring the 2D and 3D Surface (Chen)

Uta Barth, a photographer famous for her blurry photographs, captures the space of in-between by setting the focal length on her camera to a location between her body and the subject. Likewise, the Blur Building by Elizabeth Diller + Ricardo Scofidio also challenges the common hard-edged architecture by making a structure, or cloud, made predominantly of water vapor. This study challenges those same concepts, however, using tangible materials. When wind hits the surface of the trailer, the surface vibrates with blurry material. Hundreds of pinwheel-like units spin, making the skin translucent or even invisible. During the day, the metallic surface of the pinwheels reflect light in and out of the trailer, while at night, the movie projected from the inside oscillates from the inside of the skin to any surface outside, extending the surface beyond the shell of the trailer. Materials: Fiberglass, resin, aluminum, laminated wood. (Figures 2, 3 and 7: Element J)

Study C: Indexing the Quality of Water: A Study with Bamboo (Aguirre)

Many rivers around the world are contaminated with industrial run-off. Lacking the scientific technology necessary to detect acids or other poisons in the water, some places use lichen as a natural indicator for ph and other contaminants. It is readily available and can grow aeroponically, or without soil. This study, in addition to the lichen, considers the use of bamboo, another readily available material, in a building system that can be built wherever needed. Using the power of water running downstream, a large bamboo lever activates a simple pump, spraying the river water across the roof of the structure and soaking the lichen. If safe, the lichen is green. If not, it is orange. When safe, the mist becomes a natural cooling device. Materials: Bamboo, metal joints, lichen. (Figures 2, 3 and 7: Element C)

Study B: Dirty and Clean Oxygen: Air as Material (Gustafson)

For lightweight construction, nothing can weigh less than air. Combined with a program of air collection and dissipation, this study examined air as a building material and as a commodity. The two programs of opposite nature, smog collection and oxygen bar, were incorporated into the skin and the structure. Held up by structural air tubes of compressed air (and an adjustable low-tech system of compression panels in the floors), the skin was partially filled with clean O_2 and acted as insulation, which is necessary to keep the smog samples cool. Patrons could breathe clean O_2 from nozzles on the surface of the skin while collection devices for smog could suction air through the upper crevices of the design. As the exterior temperatures become cooler in the evening and the O_2 pillows would become depleted and deflated, the insulation was less necessary. The interior could be accessed unconventionally by squeezing between the pillows. Materials: ETFE, aluminum, compressed air, oxygen. (Figures 3 and 7: Element B)

CONCLUSION

Our climate has begun to change dramatically. Global warming will ensure its course. Political, economic and technological developments produce dynamic and globalizing cultures and virtual workplaces among other changes at logarithmic rates, pressuring architecture to respond in an adaptive manner. In order to keep up with this dynamic world, architects need to reconsider the design of technology even beyond the digital medium. As BIM (Building Information Modeling) and parametric modeling have advanced well beyond construction capabilities, more attention must be focused on the low-tech side of architecture—on construction. The development of new and smart materials, fabrication of affordable and customized parts and implementation of complex building skins and structures, must rise to the level of high technology, of digital design. The earlier one can be exposed in education to this facet of design, the better.

Mobile structures are inherently responsive as a system. It is in these architectures that responsive systems should be and can be designed for true performance. They travel from climate to climate; their context and orientation is continuously changing; and, they are possibly more related to the contemporary condition of home-ownership or lack thereof. Bringing these two scales of responsiveness into the studio environment is responsible and energizing. Students today will be living in a different world tomorrow. Rather than fighting change, embracing adaptation is the alternative. To become comfortable with active sustainable design, more information, access, education, materials and applications of responsive systems must be made available to the public. Ultimately, we need to believe that architecture can be sensitive, interactive extensions of our own bodies and not just protection from the changing environment.

ENDNOTES

1. Beesley, Philip et al, Responsive Architectures: Subtle Technologies 2006 (Toronto, Canada: Riverside Architectural Press, 2006), 10.
2. Beesley, 6.
3. Beesley, 10.
4. Kronenburg, Robert, Flexible: Architecture that Responds to Change (London, England: Laurence King Publishing, 2007), p. 216.
5. Kronenburg, 7.
6. Burkhart, Bryan, Airstream: The History of the Land Yacht (San Francisco, California: Chronicle Books, 2000), 89.
7. Ibid, 7.
8. Zittel, Andrea, Andrea Zittel: Critical Space (Munich, Germany: Prestel, 2005).
9. Allen, Stan, Points+Lines: Diagrams and Projects for the City (New York, NY: Princeton Architectural Press, 1999).
10. The third definition of garden, according to the Random House Webster's Unabridged Dictionary, 2nd edition (2001), is "a fertile and delightful spot or region."

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