A decision was made to upload the hypermedia videos to a YouTube channel to ensure maximum viewership. Additionally viewers are directed to a website where there are more options for educational advancement, links, featured videos, and partner companies. There is also a comment area where questions can be answered by program administrators.

The basic design for the videos is a series of animations (visual) with a voiceover narration (auditory), which is also known as the modality effect. Animation sequences are constrained to 7 "chunks" (Miller 1956) of new information not longer than 20 seconds each to ensure that the duration limitation of working memory is not exceeded (Peterson & Peterson 1959). Whole building topics are presented in 3-5 minute video segments. Using a hypermedia environment within the YouTube format allows viewers to proceed at their own pace and take pathways that make the most sense to their learning styles. For instance, some people are audio/visual learners and benefit most by having the lesson proceed sequentially, building knowledge incrementally. But a visual/spatial learner needs to step back at the beginning of a lesson and see the whole picture before delving in deeper. And although most conventional educational programs are designed for the audio/visual learner, as they are the easiest to teach in this linear manner, studies show that 63% of learners perform best if taught in the visual spatial style (Silverman 2002). Periodically, while watching the videos, viewers will be guided via links to self-tests offered on the website to evaluate what they have learned. In this way, if there are areas that are more important, the viewer can be redirected to that portion of the video, or offered additional links in order to get a better understanding.

EVALUATION

The test group for this program is adults who are more adept at making visual images without prompts and have practiced learning strategies (Rieber 1990). Rieber also suggests that although many studies on the educational benefits of using animation to deliver lessons overstate their results, educational animation may still be useful if three recommendations are followed: (1) animation attributes are congruent with the learning task, (2) relevant clues are displayed prominently so that learners attend to them, and (3) animation is interactive.

The website and YouTube will be used to monitor how many hits have been generated and this information will be used to evaluate whether or not the videos are an effective and attractive educational tool. Follow up studies will also be conducted to determine key performance indicators. A test group of New England homeowners between the ages of 25-65 who live in the greater Amherst area, will be recruited to assess retention rates, evaluate program scope, and generate lessons learned. Participants will be asked to take short pre- and post-tests to gauge prior knowledge and lesson assimilation and to fill out evaluation forms on the videos.

CONCLUSION

Convincing homeowners to commit to implementing efficiency improvements is a significant challenge. Improving the energy performance of existing homes is key to mitigating global warming and securing our energy future. It is becoming increasingly clear that the way to motivate homeowners to invest in energy retrofits is by educating them on where their homes use and lose energy and what they can do about it. Using hypermedia and animation are proven educational tools for a wide variety of professions. The development of interactive hypermedia and educational animations may help to more rapidly increase consumer confidence in energy retrofits thereby spurring the energy retrofit market.

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Material Ecologies in Parametric Design Software

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ABSTRACT

A renewed cultural attitude towards recycling has given designers the agency to once again consider alternative products as a growing part of mainstream construction materials. However, the 21st century use of these materials must be predicated on the idea that they be employed in elegant and efficient construction processes. We ask: How can the building and construction industry more readily employ non-toxic, industrial by-products in the creation of efficient and expressive building form? Our solution proposes that form not be tied to a preconceived surface or form-making process, but that form be responsive to material components as the primary and delimiting factor in its articulation.

By designing the geometry of a form through its material constraints, we can minimize the amount of customized components while maximizing form-making possibilities and ease of construction. This paper will outline our research demonstrating how architects might expand these systemic processes to larger objects and systems using a combination of relatively simple geometric definitions along with parametric modeling software to map fixed-sized objects across complex surfaces.

The primary scope of the investigation involves the geometric analysis and modeling of recycled industrial waste and the prototyping of assembly methods using digitally manufactured supports and connections. By recycling industrial by-products, which pose no health hazards, we demonstrate that sustainable design practices can effectively mitigate waste while contributing to alternative energy discussions in our local community.

Material Ecologies in Parametric Design Software

A renewed cultural attitude towards reuse and recycling has given designers the ability to once again consider alternative products as an evolving segment of mainstream construction materials. However, the 21st century use of these materials must be predicated on the idea that they be employed in elegant and efficient construction processes. We ask: How can the building and construction industry more readily employ non-toxic, industrial by-products in the creation of efficient and expressive building form? Our solution proposes that form not be tied to a preconceived surface or form-making process, but that form be responsive to material components as the primary and delimiting factor in its articulation.

By designing the geometry of a form through its material constraints, we can minimize the amount of customized components while maximizing form-making possibilities and ease of construction. This paper will outline our research demonstrating how architects might expand these systemic processes to larger objects and systems using a combination of relatively simple geometric definitions along with parametric modelers (Grasshopper and Digital Project) to map fixed-sized objects across complex surfaces.

In the following sections, we describe how today's advanced parametric tools may be used to model and test systems of 'remaindered components'. These components retain their material identities while at the same time being given new life as recycled agents. In addition, they have the ability to be linked through information models to alternative sources both local and global (local would be preferred). As such, our process is a response to the frustrating tendencies of a construction industry that values efficiency–which often results in waste — over environmental steadfastness.

The primary scope of the investigation involves the geometric analysis and modeling of recycled industrial waste and the prototyping of assembly methods using digitally manufactured supports and connections. By recycling industrial by-products, which pose no health hazards, we demonstrate that sustainable design practices can effectively mitigate waste while contributing to alternative energy discussions in our local community.

Responsive Material Agents

Process-based form-making has become a normative method for the development of conceptual ideas in design. At a multitude of scales, architects define systemic parameters or networked linkages that value relational dynamics over traditional, linear notions of design.

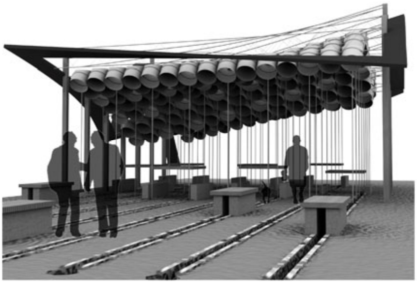

Figure 1- Design for quilt of 55 gallon

From SHoP Architect's material and construction systems-based methodology (Dunescape, Mulberry, Porter House) to urban-scale ecological system interventions, like those outlined in Charles Waldheim's text "The Landscape Urbanism Reader", designers find themselves drawn away from the metaphor and more tangibly back to logic-based (responsive) form-making devices. These processes, as they have been used to date, are tied to unit-based logics or systems which are often limited in scale and scope by relatively tight parameters. For instance the precast brick veneer used on SHoP's Mulberry development is constrained to a 3/32" overlap brick to brick. These processes can be described as "material agencies". These material agencies account for other intangible characteristics embedded not through physical form, but through their embodied political, social, and ecological characteristics.

A systematic design process, applied to ubiquitous, recycled industrial waste, could bring a new awareness to complex webs of interconnectivity that remain undiscovered through the mediums of ecology, parametrics, and fabrication. In David Gissen's article "APE" (2010) he outlines an architectural ideology based upon the acronym "APE" or Architectural Political Ecology. Gissen outlines a variety of concepts to accomplish a "production of nature". They are as follows: Essentially, Gissen is attempting to look beyond the superficialities of so-called "green" design to a set of strategies that embrace substantive design rather than mundane aesthetics of environmental architecture.

Parametric software modeling creates systems defined not by Cartesian coordinate systems, but by linkages and constraints between geometry. By their nature parametric systems do not have a specific solution but are capable of accommodating a range of possibilities. In Cynthia Ottchen's article "The Future of Information Modeling and the End of Theory: Less is Limited, More is Different", (2009) she highlights the opportunities that information modeling and parametrics can harness when applied to the rigorous complexities of building design and production. She says that 'soft' data is typically not considered quantifiable in information models. Ottchen argues that the combination, overlap, integration, and variability of qualitative information can be analyzed and used through not only parametric algorithms but also through the inclusion of underlying and sometimes more difficult to perceive of information.

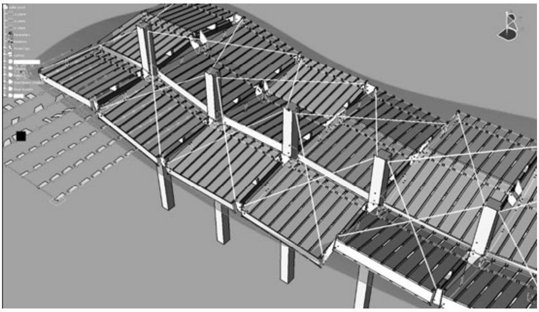

Figure 2- "Quilt" of pallet in Digital Project

In our research, this information is embodied through the use of industrial waste products as recycled agents, or materials with underlying political agendas. Through their visually obvious reuse they can assist in articulating a public argument for alternative material uses. We cannot necessarily map how an identifiably recycled building component might inspire alternative uses elsewhere in our community, but know that we must establish expectations and that our installations serve as a benchmark and precedent for others to build upon.

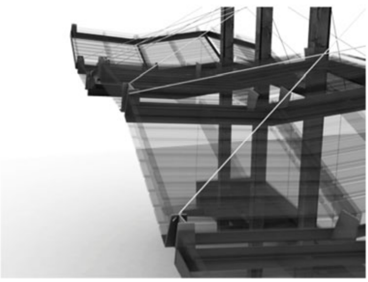

Figure 3- Model detail

Figure 4- Final constructed pallet canopy

Additionally, we can consider how a BIM model could include data about alternative building processes or alternative materials, and their location. For instance when an architect logs into a moddfel one morning, the model might indicate that there is a surplus of pallets at a particular location and that the use of pallets instead of the current material might save "X" dollars, or might save on "X" tons of material wasted.

Reverse Parametric Methodologies

Recycled, physical objects, embedded in a parametrically responsive environment, was used to initiate our process-based, form-making system. We have used this responsive system to map various objects including, shipping pallets, 55-gallon drums, and standing seam metal roofing, across complex, topological surfaces. The key difference between these projects and others is that we are able to predefine relationships between each object and its neighbors. These relationships are linked to the type of physical connection at each edge and the overall geometric capacity of the system. The system creates a "quilt", a formless parametric model of components, both structure and skin, linked to each other through geometric definitions. Each model is constructed of a pattern, made of fixed objects with variable "hinges" or linkages that give us the ability to "drape" the quilt across any surface. If the geometry of the surface does not comply with the built in geometric limitations of the "quilt" it will not update and therefore is beyond the limits of the system. The form is ultimately defined by its material definitions.

We have been using Gehry Technology's Digital Project, to design and test these systems. Digital Project uses geometric, organizational relationships to calculate components for complex surfaces out of custom building systems and skins, as used by many designers. However, the modeler can just as easily be used "backwards" to design responsive complex systems of off-the-shelf or recycled components, and link them to yet-to-be-defined surfaces.

We use the flexibility of the software to define our own responsive information modeling. The underlying geometric definitions within Digital Project allow us to map limitations across a surface or across its edges, as well as limitations to identify when surface deviations becomes too dramatic for the system. The topological nature of the surface, when combined with the complexities of parametrics, allow for variation that arises through relations instead of individual components. We have also used Knowledgeware, built into the software, to map the maximum deviation of each piece of the system away from the original surface. When the deviation becomes too great compared to our standards for aesthetic pairing or legibility of form, the system will identify the portions of the system, which are beyond those limits, so they might be corrected or the surface might be updated.

The most significant hurdle we engaged was that there existed no apparent digital method for mapping responsive fixed objects and systems to one another across undefined surfaces. We were not simply trying to translate geometry onto a surface but we were searching to limit the relationships between the edges of those objects. Working with Gehry Technologies, we explored many methods, based both in geometric definitions and by using smaller fixed edges of each component to define relationships. The final process we developed was comparatively simple, using spherical intersections to triangulate relationships of fixed dimensions across the surface.

We used the premise that if we know the lengths of the sides of a object, and therefore its diagonal, we could intersect two spheres, on a flexible surface, with radii equal to the length of one side and the hypotenuse of the object. The intersection of the two circles is the location of the end of the hypotenuse, on the surface and on the object. Triangulating fixed sized objects across the surface allows us to trace any other set of geometry across the entire surface. The fourth corner of a polygonal object is linked to the others and typically floats off the surface within a geometric limit. (Refer to Figure 5, Page 7)

We could use this method to translate any fixed sized object across a complex shape. This process is at the core of the progression of this research and has implications for many other possible relationships within architecture. Complex surfaces in architecture have previously been defined by creating individually defined pieces of a surface, which together define the surface. Now we are capable of using the material qualities of a "building block" to constrain and define the formal qualities of a buildings surface. We can use this process to create complex surfaces for design without the mass-customization of each building component.

By testing this process with recycled components we are demonstrating that a building can create novel and expressive forms while using the most mundane or most available materials. We used a grant supplied by the EPA to develop this premise and to create a computer simulation, though we also wanted to prove this idea by constructing a full-scale installation of this project.

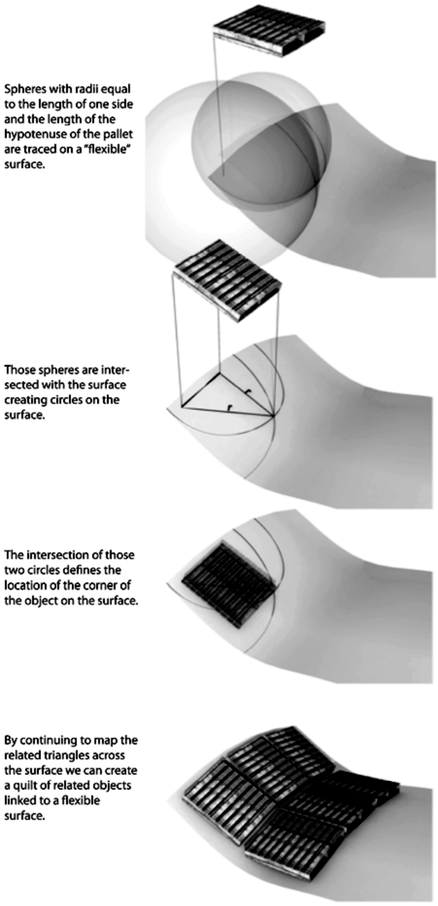

Figure 5- Step-by-Step mapping process 1

Constructed Form

Having established a clear problem, hypothesis, and method, the challenge became proving the validity and feasibility of the proposed structure through implementation. Inherent to this challenge was the dilemma which faces any digitally designed proposal: achieving environmental responsiveness with architecture requires the designer to go beyond solving a problem with a computer simulation, to proving the value of an idea through real world application. Ultimately we needed to test the process by constructing an example: designing, fabricating, finding useful recycled components, and moving the project through our City's Code Enforcement office.

First, we collected a variety of large-scale recycled goods to experiment with as alternative building materials. We digitally modeled their material, physical, and structural properties. Through this analysis we determined that the use of 40" X 48" shipping pallets had the most merit, for proving our concept:

- Pallets are readily available behind most any retail store. They are so prolific that they are often resold for far less than the value of their component parts.

- Pallets have unique material properties; they are capable of functioning as a structural diaphragm, transferring loads uniformly across their surface.
- Through our analysis we determined that we could construct relatively complex forms, while minimizing the customized componentry.

We have also worked to use recycled products throughout the mockup installations and in the final installation. We have used recycled steel from our local salvage yard, to create the structural beams and connections for the pavilion. We wanted to minimize the amount of custom components that were to be cut. We used only a single 2' X 6' sheet of ¼" thick mild steel, welded to 40" lengths of 3" steel angle. Each of these custom beams functioned as not only a structural device, but also as a method for mapping the assembly of each beam and ultimately the construction of the canopy. Built into the geometry of each beam are all of the angular relationships between each bay of the pavilion.

Fabrication of the structure's steel armature was achieved while minimizing the use of customization. Plates, cut on a CNC-plasma cutter, were welded to standard sized, steel angles and then galvanized, creating the structural beams used as a framework for the pallets. The entire structure is supported by a series of wood columns with stainless steel cables to create strength and rigidity while minimizing secondary structural components. Benches and tables were attached to the vertical members using recycled steel brackets and pallets for seating and tables. Finally, through collaboration with a local artist and textile designer, the overhead structure was clad with recycled awning material obtained through ncwastetrader.com (a local web-based exchange for remaindered industrial by-products). The fabric covering increased both the structures shading capability as well as its aesthetic quality.

We sought out a partner in the community and found one in a local visual arts organization who provided us with a portion of their property to install a permanent pavilion constructed using our system. We also worked closely with one of our region's top engineering firms (who worked pro-bono) to develop a clear structural diagram for the project. We have worked with local contractors to get materials and equipment rentals donated. We have, and will continue to, engage our local community in a substantive discussion about the nature of sustainability and technology. Additionally, we wanted to see the resources and energy that were directed to our project rendered in a way that can provide years of enjoyment and benefit for a community in need.

Additionally, we worked with our local code and zoning enforcement to obtain permissions and a construction permit, this proved to be a substantial impediment to our experiment. Although shipping pallets are made of conventional materials, because of the unexpected complexities of their geometry the Code Enforcement office chose to treat them as an undefined or unknown material, meaning that they would need be reevaluated by our engineer throughout the