ReFab

GROCS 2009

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1 Research Question, Problem or Goal

As is now widely being recognized, current increases in population size, material consumption and energy usage cannot be sustained. There are simply not enough resources to accommodate our current rate of growth, and the problem only grows more acute as time passes without meaningful action toward a solution.

ReFab seeks to tackle this problem by exploring sustainable strategies that can increase material repurposing and decrease energy demands. Our investigation will explore methods towards this end as they relate to current construction practices—an area of particularly high energy requirements and material usage. Specifically, we are attempting to address three issues of sustainability as they relate to design/construction:

Material Scarcity: We seek to identify discarded materials currently in the waste stream and salvage them as building components.

Energy of Production: High energy costs are associated with the traditional industrial fabrication of construction materials (i.e. cutting, forming, creasing, etc.) as well as the process of breaking down discarded objects so that their raw components (i.e. metals, plastics, etc) can be reused. We intend to address this wasteful practice by identifying discarded prefabricated materials which require minimal alteration before they can be repurposed, thereby reducing the energy costs of fabrication and eliminating those of the traditional scrapping/recycling process (see image of the "Windshield Chapel" on the following page for an example of such a practice).

Energy of Transportation: We will limit ourselves to discarded materials which are available locally in Ann Arbor/Detroit to help reduce the fuel costs associated with the shipment of building components from the site of their production to the site of their use in construction.

The goal of developing sustainable design strategies is one which will undoubtedly require complex and inventive solutions, drawing from many perspectives and disciplines in a non-traditional manner. The final problem ReFab seeks to address is the traditional mode of interaction between architects, engineers, and environmental analysts. Over the course of the winter the project aims to develop a methodology for open collaboration across disciplines which can identify solutions which are as effective and imaginative as possible.

2 Project Objectives

To work towards an open and adaptive methodology for collaboration between the Departments of Engineering, Architecture, and the School of Natural Resources and the Environment (SNRE) by means of the GROCS program and facilities, with the hope that such interaction will become commonplace within the campus's collaborative spaces.

To address the 3 sustainability issues listed above by identifying new building strategies using local materials (see following section on method for more detail)

To gain a larger understanding of the local waste stream by visiting area scrap yards and conducting relevant systemic research/analysis.

To produce a catalogue of our findings which can serve as a tool for designers, and as a driver for others to conduct similar investigations and share their findings
To develop a mode of working between digital 3-d modeling and physical construction resulting in a reciprocal relationship where material and Computer Aided Design speak to one another.

Sam Mockbee's "Windshield Chapel" is part of the inspiration for ReFab's approach to materials and design. Constructed in 2000, the glass wall of the chapel space was constructed from 80 Chevy Caprice windshields salvaged from a scrapyard for atotal price of $120.

3 Project Activity/Benefit of Collaboration

Method

ReFab envisions its exploration being conducted in the following manner over the winter semester:

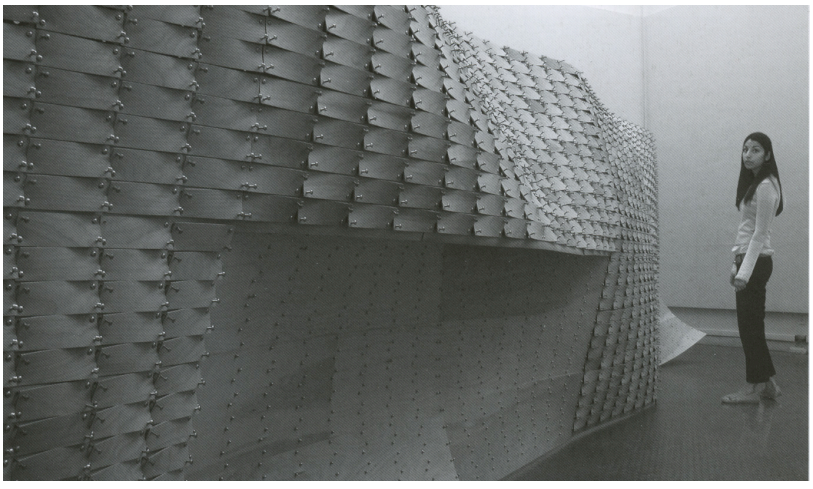
Identifying and visiting local scrapyards. Regular trips will be made to disposal and reuse centers to identify potential prefabricated materials for repurposing, and to gain a larger understanding of their role in the life cycle of industrial materials. Samples of prefabricated materials which appear to be worthwhile candidates will be purchased and brought back to the University of Michigan.

Material testing and shop work. The purchased materials will be cut, pounded, folded, creased and otherwise put to the test

in facilities currently available to engineering and architecture students across north campus. These exercises will be conducted with an eye towards identifying the particular strengths and weaknesses of the material, particularly as they relate to their possible use as a building block in larger structural systems.

Open digital exploration/parametric modeling. Once a sense of a prefabricated material's qualities and behaviors have been gained through empirical investigation, ReFab will take advantage of local resources in the Digital Media Commons and elsewhere to digitize the materials and rapidly prototype scale models and schematics of potential new systems of usage for them. While the project is inspired by Sam Mockbee's "Windshield Chapel", by incorporating digital platforms such as parametric modeling into this process, however, ReFab hopes to achieve an even greater level of efficiency and inventiveness than Mockbee's studio was capable of achieving by spontaneous design work in the fields of Alabama.

Systemic investigation of industrial practices and sustainability. Explorations of local scrap yards will be informed by a larger understanding of material life cycles and disposal practices as they relate to sustainable practices and trends. Relevant research extending from the SNRE and the affiliated Center for Sustainable Systems will be used at both ends of the process, both in targeting worthwhile waste centers and prefabricated materials to explore, and to frame finalized design strategies within the larger context of building sustainably.



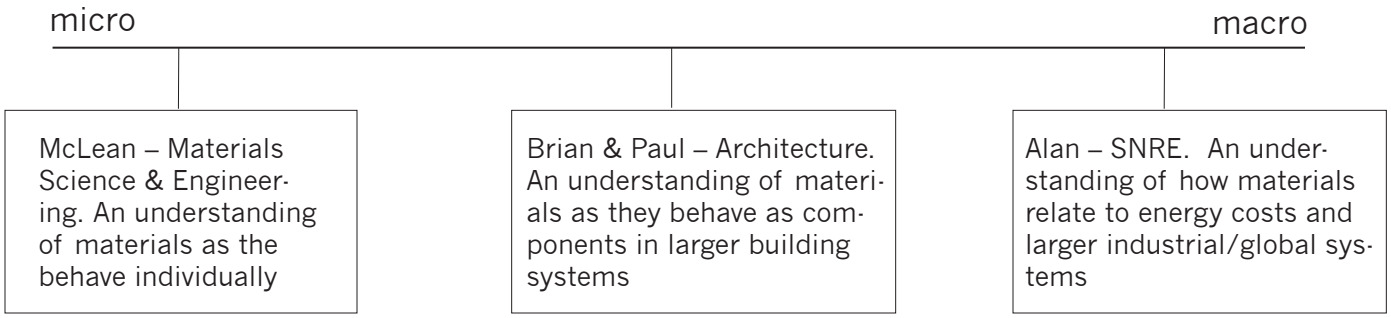
As can be seen from the exterior detail on the left, the chapel's use of traditional design methods resulted in a somewhat inefficient tiling of windshields to enclose the space of the building. On the right is aless redundant and more dynamic use of materials produced by parametric design software. By combining these two approaches, ReFab hopes to identify more efficient and imanginative means of repurposing materials as building components.

Team Philosophy

ReFab seeks to maintain a flexible approach to its objectives which allows the team to approach the problem from both the micro scale and the macro scale, and to regularly shift between working in the field and working in the lab. It intends to capitalize on the

Individual strengths of its team members, to embrace the unexpected, and to adapt its methodology to best suit the complexities of the problem at hand.

While we believe our commonality of vision and overlapping skill sets will allow us to be more than the sum of our individual abilities, we believe that the relative strengths in terms of approaching this problem can be broadly understood as a spectrum moving from the micro to the macro scale:



Biographies

Alan Bush is a Masters candidate at the SNRE. His current work includes complex systems modeling, industrial ecology, and principles for sustainability. He has a background in international relations, and his previous work has included projects developing community assets and resilience in southern Africa, New Zealand, and India. He aspires to promote the emergence of the necessary-but-missing institutions for a sustainable society.

McLean Echlin is a PhD candidate in Materials Science Engineering. His current work includes 3d modeling and laser analysis of the material properties of steel. He has experience with metal working including the design and installation of pieces around Ann Arbor, as well as ties to the local scrap yard community. He is an avid runner and bicyclist.

Paul Tierman is a Masters candidate in the Architecture program. His current work includes parametric modeling, digital fabrication, as well as investigations into the limits of modes of representation. He has a background in the visual arts and sculpture which has included work with more traditional modes of fabrication and metal work. He recently attended a 2 month architectural studio in Beijing, China.

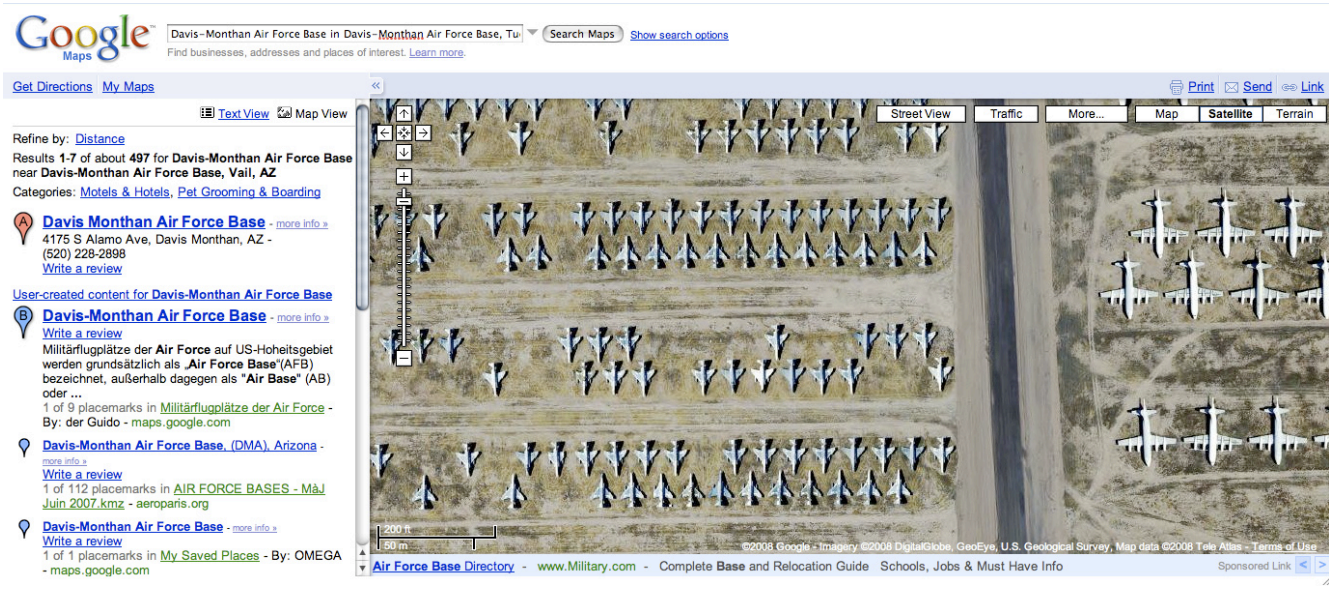
Brian Trump is a Masters candidate in the Architecture program. His current work includes digital modeling and fabrication, as well as critical investigations into the discourse of architecture. He has a background in political science and music. He recently attended a 5 week studio in Brazil focusing on sustainable strategies for addressing flooding in the favelas of the city of Belo Horizonte.

Karl Daubmann (advisor) is an Assistant Professor of Practice in the Architecture Program. He received his MS in Architecture from MIT and is cofounder of the firm PLY Architecture. His work investigates the role of digital technology in design through techniques of fabrication and methods for the description of complex form. He teaches design and construction, and leads graduate seminars in digital fabrication and parametric modeling.

4 Other Collaborative Learning Impact

ReFab seeks to inform, enhance and encourage collaboration by the following means: Building bridges between the departments of Architecture, Engineering and the SNRE. Developing a method for collaboration which can employ the diverse facilities of North Campus, and more fully utilize the centralized resources of the Digital Media Commons/ GROCS facilities as a base for this and future interdepartmental efforts.
Establishing a wider network of contacts to consult with during design investigation, including persons from the Center for Sustainable Systems, the Detroit Institute of Art and Cranbrook.

Envisioning a broader impact of the ReFab catalogue, as both a catalyst for similar investigations in other locations, and as a provocation for the reevaluation of our approach toward materials and design.



The "boneyard" at the Davis-Monthan Air Force Base in Tucson, AZ is a landscape populated by over 4,000 retired military aircraft. They are stored in the desert climate to avoid rusting, and will likely ultimately be ground up into small pieces so that their raw materials can be rendered to fabricate new metal components. An alternative design project such as ReFab would seek to circumvent this high-energy recycling/fabricating cycle and instead employ the unique forms and shapes of aircraft components as a low-energy building resource for construction in an around southern Arizona.]

5 Special Equipment Requirements

ReFab has discussed the possibility of pursuing the installation of certain digital modeling platforms for computers in the GROCS lab to establish a base for this and future design efforts within the Digital Media Commons. Likely software candidates include Rhino, Digital Project and/or SolidWorks. Student or temporary licenses are relative inexpensive for these items ($100-$150), though most of these programs are already installed on other computers around campus. Acquisition of these items by GROCS would not be necessary for the success of ReFab, but may be something the department would consider pursuing.

6 Relevant Literature

While there is a wealth of technical literature surrounding the issue of sustainable/digital design, we feel that ReFab is representative of a larger cultural shift in society's approach towards materials and resources. The following is a brief list of works which reflect this ethos and inform our approach:

Birkeland, Janis. *Design for Sustainability: A Source book of Integrated Eco-logical Solutions.* 2002 A wideranging resource for sustainable design topics.

Braungart, Michael & McDonough, William. *Cradle to Cradle: Remaking the Way We Make Things.* 2002 A reanalysis of the idea of recycling and waste streams.

Dean, Andrea Oppenheimer. *The Rural Studio: Samuel Mockbee and An Architecture of Decency.* 2002 An overview of the work of the late architect Sam Mockbee, who led architecture students to design homes for an impoverished region of Alabama using innovative material strategies.

Hensel, Michael. *Techniques and Technologies in Morphogenetic Design.* 2006 Covering topics related to parametric modeling, this publication explores the idea of "emergence" in contemporary digital design technology, which is the way complex patterns can be derived from numerous relatively simple rules or interactions.

Mau, Bruce. *Massive Change.* 2004 An investigation of hybrid technologies and global trends that seeks to identify strategies toward a more sustainable model for society.

Metzger, Wolfgang. *Laws of Seeing.* 1936 A work of gestalt theory, this relates to how the eye perceives larger systems and meaning.

Reiser, Jesse. *Atlas of Novel Tectonics.* 2006 A free flowing work of short chapters which explores the design process and the potential for new forms in Architecture.

Serizawa, Takashi. *Honeycomb Tube Architecture.* 2007 The results of an open digital/conceptual investigation of the architectural implications of using honeycomb structures in building systems. One precedent for the idea of the catalogue ReFab seeks to produce.

Definition of parametric modeling from PC Magazine (http://www.pcmag.com/encyclopedia_term/0,2542,t=parametric+modeling&i=48839,00.asp)

paramod.net

*SUPPLEMENT – ReFab Contacts

Name	Department	Area of Specialization/Information
Karl Daubman	Architecture	Parametric Modeling, Digital Fabrication, Professor, Principal of Ply Architecture
Robb DeKline	NSRE	Engineering Sustainable Systems Graduate Student
Nataly Gattegno & Jason Johnson	Architecture	Parametric Modeling, Conceptual Design, Principals of Future Cities Labs, Visiting Fellows
Amit Ghosh	Engineering	Material Science, Mechanical Engineering Professor
Peter Green	Engineering	Chair, Material Science
Helaine Hunscher	NSRE	Center for Sustainable Systems Program Coordinator
James Jones	Engineering	Material Science, Metallurgy Professor
Jerome Lynch	Engineering	Civil & Environmental Engineering, Structures Lab Professor
John Redmond	Engineering	Mechanical Engineering Graduate Student
Matt Shlian	Art & Design	Paper Engineering, Tessellation Professor, DIA instructor, Cranbrook Graduate
Max Shtein	Engineering	Materials Science, Solar Cell Design Professor
Toby Teorey	Engineering	Academic Programs Director
Chris Torbet	Engineering	Research Engineering, Parametric Modeling Senior Research Engineer
Tresa Pollock	Engineering	Materials Science, Metallurgy, Superalloys Professor