Decon Recon: Parametric CADCAM Deconstruction Research

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ABSTRACT
The deconstruction (DeCon) and repurposing (ReCon) of existing structures and materials are worthwhile and relevant endeavors given the potential for such procedures to be more economically and environmentally sustainable than conventional construction methods. Conventional construction methods often utilize virgin materials for the production of architecture, requiring extensive energy to harvest, process, and manufacture the materials for use. Today, we must face the fact that we exist in a carbon-sensitive economy, and demand design approaches that reduce architecture's impact on the environment. Our goal was to develop a CADCAM ReCon design methodology that would have the potential to mitigate carbon consumption. To explore this goal, students engaged a design research project that looked for novel and innovative approaches to the DeCon and ReCon of an existing barn. The student researchers created parametric models and surface designs derived from the existing materials. The digitally fabricated tectonic design constructions resulted in economical, novel, and material-efficient design methodologies for DeCon and ReCon.


Figure 1 Interior of Barn

1 INTRODUCTION
Deconstruction allows for the reuse of many building materials, with fundamental savings in the area of "embodied energy," the total energy consumed in the creation of the building and its components (Steward and Kuska 2003). The U.S. EPA estimates that American companies generate 136 million tons of building-related construction and demolition (C&D) waste per year, of which 92 percent is from renovation and demolition assemblies (Rodgers-Smith 2009). Researchers have been exploring design for deconstruction as a strategy for a zero waste industry. This laudable goal, if implemented at a large scale, will have an immediate and lasting impact on design and construction. Currently, the DeCon material stream relies on upfront design strategies or downstream, end-of-life reuse and recycling to pull used materials back into use in new ways.

As pointed out in the Design for Deconstruction Guide, "The real challenge for DfD [design for deconstruction] is to expand the range of materials and components beyond a few specialty items that can be cherrypicked out of a building, to the components and materials that make up the bulk of the building" (Shell, et al.). To begin our research on the DeCon material stream, we targeted the use of parametric software and digital fabrication strategies for the ReCon of materials from a 1920s wood-frame barn, shown in figure 1.

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Deconstruction research from the SmartScrap project sought to ReCon catalogued scrap limestone pieces that were deployed in parametric design models (Kolarevic and Klinger 2008). Like many DeCon efforts, the amount of time required to catalogue the available sizes, shapes, and quantities of waste materials can be cost and time prohibitive, limiting their ability to be reused. Therefore, the DeCon ReCon project sought a generic methodology with parametric modeling that could accommodate the shifting dimensional variables inherent in the DeCon material stream.

RESEARCH PROJECT

To begin the material inventory, students visited the site in order to complete a rough survey of the barn to be deconstructed, in addition to the surrounding area. It was important to take into consideration the rough dimensions and quality of the repurposed material, some of which was moderately weathered, as it would inform the structural limitations of the design. Students did not catalogue all the materials but, rather, used an approach that generalized the amount of materials. The ambiguity of the survey was intentional to force a digital tectonic design approach that could maximize the amount of ReCon materials.

To deal with the material variety between the pieces, the parametric model, developed in Rhinoceros and Grasshopper, first needed to have the flexibility to adapt to the several sizes of construction lumber that were reclaimed from the original 1920 wood-frame barn. A parametric box within Grasshopper that could be variable across the surface was one method used to resolve the dimensional shift. By using three integer sliders and the interval box component, a parametric box was created. Each slider controls the x, y, and z parameters of the box, allowing for the variances of the lumber reclaimed from the existing barn.

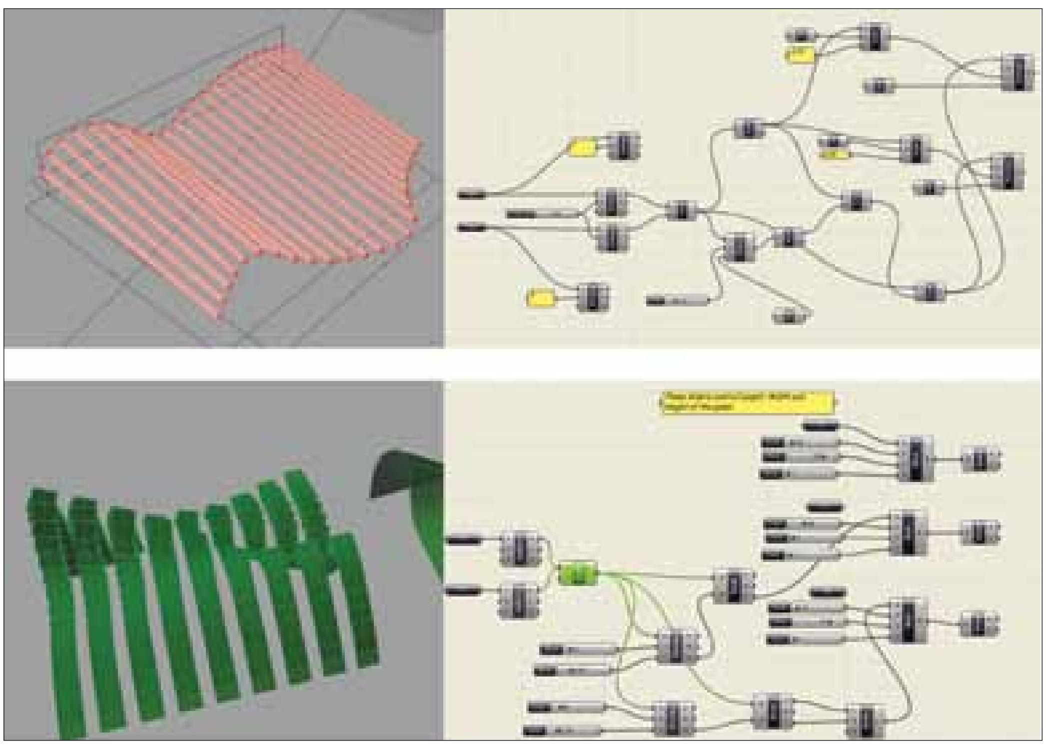

Figure 2 ReCon Design Alternatives by students Nicholas Pajerski (above) and Brian McCracken (below)

With one method developed to accommodate the different sizes of lumber reclaimed from the barn, students focused on how to generate building skins (fig. 2), which would be constructed from the reclaimed lumber. The skin or surface was developed in Rhinoceros, using the cage edit command and implicit history, which quickly allowed various study models to be generated. Next, the surface was managed with Grasshopper to allow various paneling systems to be applied. Once a surface was finalized, a structural support system was developed, as shown in figure 3.

Another exercise currently under development explores the jointing and assembly methods of various DeCon materials; we are building prototypes and detail mockups that utilize digital fabrication equipment: a CNC milling machine, laser cutter, and 3-D printer. A component of this activities includes wood joint research that will incorporate parametric of details (fig. 3) followed by the fabrication of various joints, using samples of existing materials gathered from the site.

CONCLUSION

The methodology proposed in the design and implementation of CADCAM for the DeCon and ReCon of a 1920s wood-frame barn provides a framework for the ReCon of waste from the material stream. The parametric model enabled quick, formal input changes, based on a variety of material constraints. The digital tectonic enabled through CNC milling provided a flexible jointing strategy to construct the Recon pavilion (fig. 3).

Critical to pedagogy is the acquisition of capabilities and skills directly related to the professional activity (Benedetto et al., 2001). Students learned by doing as they analyzed existing construction practices and designed DeCon methods and used CAM tools for ReCon activities. Ultimately, these small experiments will lead to further DeCon and ReCon design methods and ongoing carbon-neutral research that could be applied to the larger deconstruction industry.

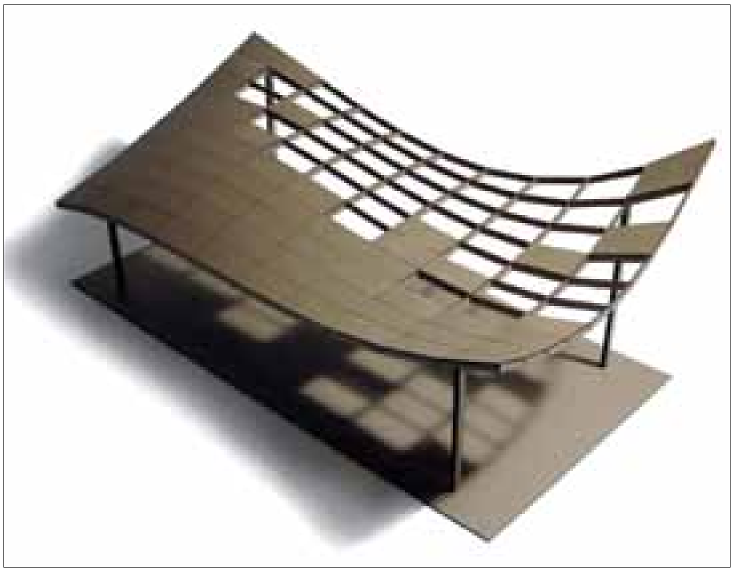

Figure 3 Model of ReCon pavilion and joint study by student Darin Russell

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