
Decon | Recon: Design Strategies for Repurposing Materials

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INTRODUCTION

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 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 pedagogical goal was to develop a project framework to enable flexible ReCon design methodologies with potential to mitigate carbon consumption. To explore this goal, Architecture and Interior Design students at the University of Nebraska-Lincoln have engaged in a series of design studios and research projects that have looked for novel and innovative approaches for the DeCon and ReCon of materials and assemblies. The students used computation techniques such as parametric models, material prototypes, design speculations, and digital fabrications derived from the existing materials. The DeCon|Recon pedagogy sought to subvert material constraints and enable creative exploration of economical, novel and material efficient design methodologies for repurposing materials.

DECONSTRUCTION BACKGROUND

Deconstruction allows for the reuse of many of the building materials with fundamental savings in the area of "embodied energy", the total energy consumed in the creation of the building and its components.¹ The larger goal for design research is for a deconstruction strategy for a zero waste industry. This laudable goal if implemented at a large scale will have immediate and lasting impact on design and construction. Currently, the DeCon material stream relies on upfront design strategies such as designing for disassembly or end of life reuse & recycling downstream following building use to pull old materials back into use in new ways.

As the Design for Deconstruction Guide has pointed out, "The real challenge for DfD [design for deconstruction] is to expand the range of materials and components beyond a few specialty items ... to the components and materials that make up the bulk of the building."² This suggests a necessity to expand the strategies we employ in the DeCon and ReCon of building materials. Additionally, current DeCon methods imply a reconsideration of design to include end of life outputs as beginning constraints. For the purpose of this paper, our research on the DeCon material stream specifically investigated the end of life repurposing or ReCon of materials from older wood frame structures.

The materiality of wood framed barns provided a rich context for the purposes of our pedagogical exercise. Early barns are constructed with roofs materialized from thatch, shingles, slate and walls of hand sewn pine or douglas fir wood framing. The labor, craft, tradition, and values that informed the development of these historic structures can never be duplicated. It is a fact that the historic barns of the Midwest and the overall nation have become endangered due to neglect, abandonment, and age. To reinforce Decon and Recon attitudes as they relate to the structure and materials of architecture, the importance of programmatic design, analysis of event, and contextual awareness were also integrated into studio discussions and project briefs. The reuse and redesign of existing structures and skins of irrelevant buildings can only be a responsible and successful practice to the built environment if the purpose, use, and character of the structure are innovative, valued, and reconstructed itself.

BEGINNING DESIGN RESEARCH

Deconstruction research from the SmartScrap³ project completed by Ball State University sought to ReCon catalogued scrap limestone pieces deployed in parametric design models. Like many DeCon efforts, to complete the SmarthScrap project a large amount of time is required to catalogue the available sizes, shapes and quantities of waste materials. This activity can be cost and time prohibitive limiting the ability to invest in the reuse of a larger quantity of material. Therefore, our DeCon ReCon projects and design methods sought generic flexibility developed from parametric modeling, programmatic briefs, and student projects that could accommodate shifting variables, dimensional, material or programmatic constraints inherent in the DeCon material stream.

From a material perspective, it was important to take into consideration the rough dimensions and quality of the repurposed materials, some are moderately weathered, warped, checked, split. These defects caused by weathering inform the structural limitations of possible designs. Students were encouraged in their methods to not meticulously catalogue all the materials, but look broadly at their general character. The ambiguity of the survey was intentional to force a design methods and approaches that could maximize the amount of recon materials.

The following four examples discuss in more detail outcomes of the pedagogy, computational tools, material constraints and represent a range of DeCon | ReCon strategies from parametric, programmatic, refabrication and assemblage design methods.

PARAMETRIC RE|SURFACING

To deal with material variety inherent in the reclaimed wood, one student developed a parametric model. The model required a flexibility to adapt to several sizes of construction lumber used in the original construction. The parametric model was developed in Rhinoceros and Grasshopper and relied on the development of a flexible system to ultimately allow for the ReCon of various sizes of lumber reclaimed from the existing barn.

One solution for this variability was to create a parametric box within Grasshopper to resolve the dimensional material 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, to allow for the variances of the lumber reclaimed from the existing barn. The resulting model enabled students to quickly iterate different arrangements of reused materials arrayed across various NURB surfaces.

Another student solution used a ruled surface constructed from variable lengths of wood framing. This strategy was effective by allowing the variable lengths of wood mined from the building to easily be aggregated into the larger design solution.

As students developed design methods to accommodate different sizes of lumber reclaimed from the barn several strategies emerged to focus on how to generate building skins (figure 1). The ruled parametric surface or the NURB surface in Rhinoceros 3d allowed quick generative iterations. The surfaces were controlled with Grasshopper to allow for various paneling systems based on the existing material constraints. Small prototype models were built as a method to test various designs. Facing a reality of structure and material support systems based on the parametric model and creating a small pavilion, shown in figure 4.

PROGRAMMATIC RECON

The second semester of the second year design studio at the University of Nebraska-Lincoln em-

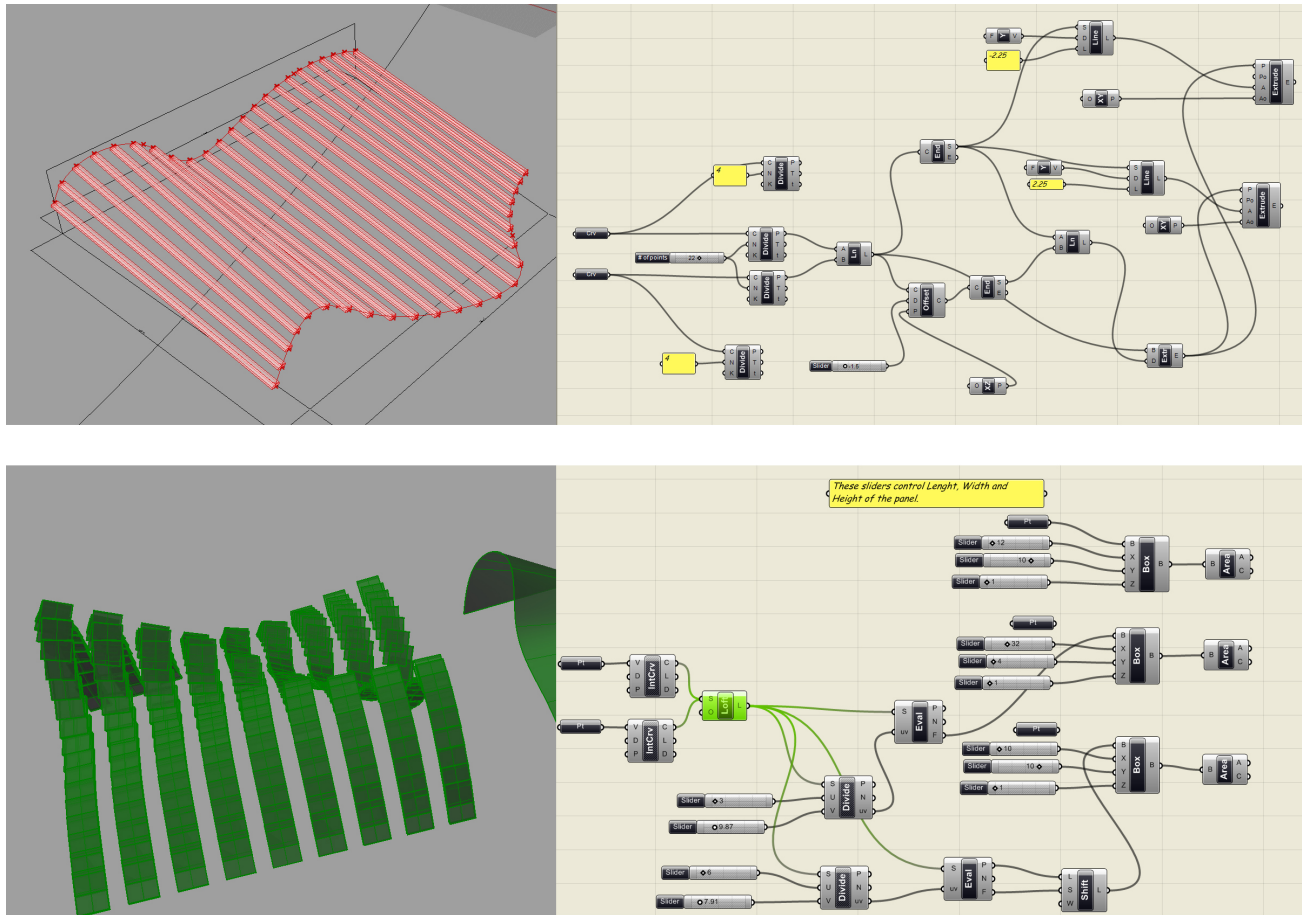


Fig. 1. ReCon design alternatives developed by students Nicholas Pajerski and Brian McCracken.

phasized analytical and diagrammatic processes of site and event [program] as they relate to the establishment of architectural ideas and expressions of space. This objective encouraged students to innovatively consider elements of design beyond the interiorities of architectonic expression, and begin to think about design as not just a product, but a responsible, inspiring, proactive contribution to our communities and daily lives.

Projects in the studio require students to deconstruct patterns, analyze associations between program and form, and reveal opportunistic connections to site and context. In the end, students begin to realize that deconstructing uninspiring trends in design allows us to reactivate extraneous architectural solutions in our landscape. In order for the reconstruction to be successful beyond its materiality, a sensitivity to program as it relates to the user, design and community are essential.

Programmatic reconstruction converged ideas of material reconstruction in a basic design terminal project called *Squash Blossom Farms: A Crash Pad*. Students are introduced to modern, and an environmentally responsible Community Supported Agriculture (CSA) system on the fringe of sprawling suburban developments.

The notion of evolving program and site relationships of typical agricultural farmstead was the beginning of the students understanding and awareness of programmatic reconstruction. With this programmatic change to the existing farming system, the use and need for existing structures on the site have changed and a new kind of typology was needed. Students were asked to define these new building and programmatic typologies and propose a "Crash Pad" for community, or migrant farmers, and the neighbor investors whom share in the return of the goods themselves.

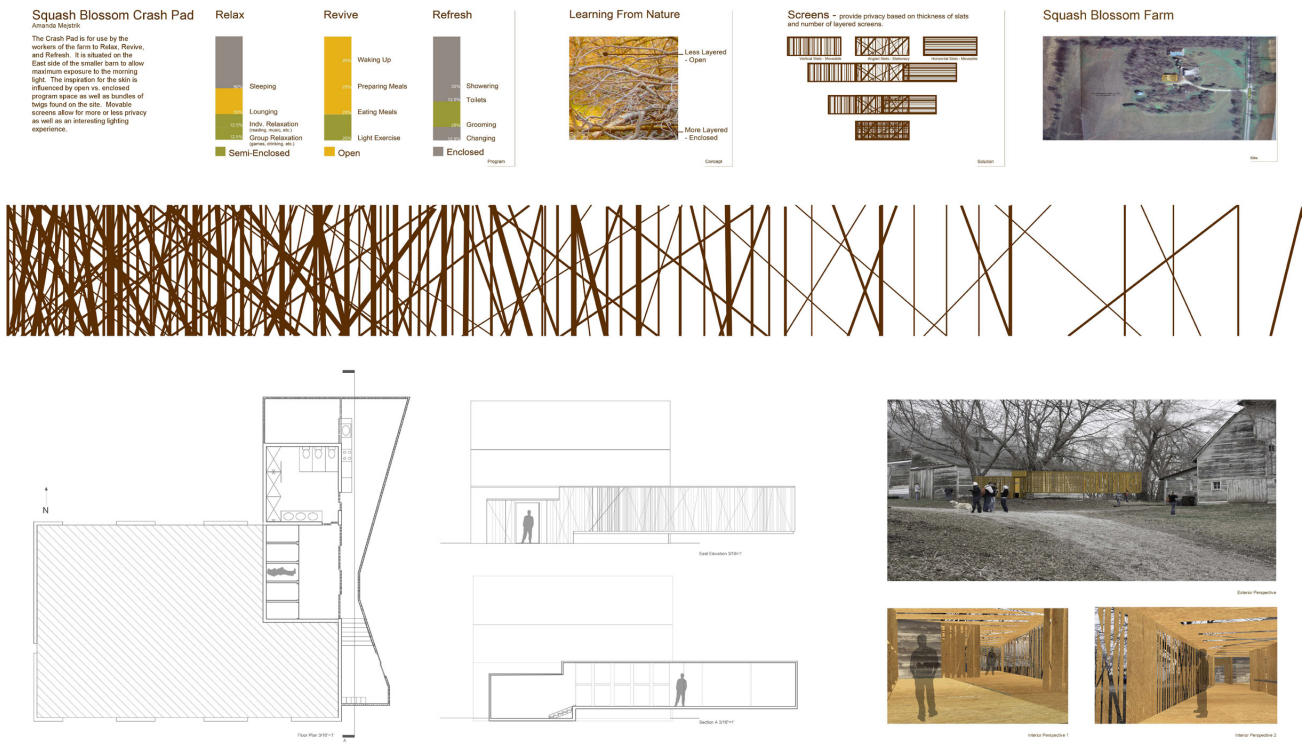


Figure 2. Squash Blossom ReCon proposal by Amanda Mejstik.

This programmatic reconstruction was supported by material reconstruction, when students are required to have a minimum footprint of 100 square feet on the land itself. This gesture requires them to think about utilizing existing architectural structure, material, and space. At the completion of the project students designed a new programmatic use of a former farmstead and were encouraged to innovatively think about new ideals and event relationships between rural and suburban practices as they relate to harvesting and obtaining food. These new programmatic ideas are realized through the reconstruction and addition of architectural structures express themselves through the manipulation and innovation of material, light, scale, sequence, and structure.

RE|FABRICATING JOINTS

A ReCon exercise currently in development explores the jointing and assembly methods of various De-Con materials through building prototypes and detail mockups utilizing digital fabrication equipment; CNC milling machine, laser cutter and 3dprinter. The

wood joint research incorporates the digital design of details. The wood joint designs are parametric models, which generate various conditional connections. The curves or line work created is then translated and fabricated into various joints using salvaged materials from the barn, figure 3.

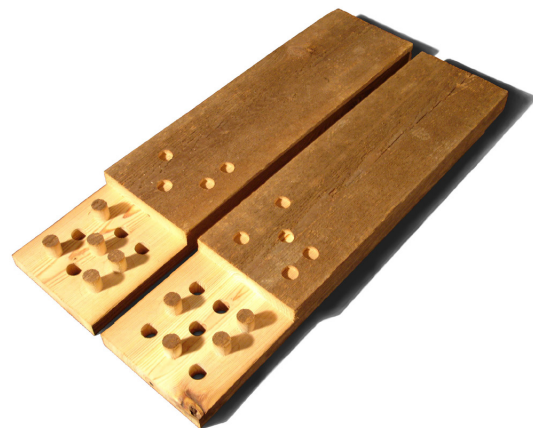


Figure 3. Wood joint study.

From a conceptual perspective, the re-joining of existing materials would increase the range of their reuse and design potential. In addition the variability of possible connection types, angles, and tectonic expressions enables a proliferation of architectural affects to occur across a larger field. The computational conception of ReCon joints opens a diverse horizon expanding the existing material's territory.

PATCHWORK ASSEMBLY

The final project incorporated derelict barns in a basic design studio project to challenge students in DeCon and Recon strategies. They were encouraged to graft onto, into, between the structures new programmatic elements that would add life. One design strategy developed was derived from observing the patchwork repairs made to the existing barns. Over time the landowner would repair various damaged parts of the barns with newer materials, creating a patchwork various materials across the barn façade. The student design developed capitalized on this design language to formulate their new building design.

The overall methodology pursued offers a different way to look at the ReCon model. In lieu of cherry-picking select pieces, the student project highlights how larger assemblies might be extracted and arranged to create a building. The similarities of this approach parallel new construction methodologies pursued by Kieran Timberlake in their book, *Re-fabricating Architecture*. Inspired by automotive, aerospace and shipbuilding approaches, which utilize assembled components aggregated into the larger construction, Kieran Timberlake has demonstrated this methodology in projects such as the *Levine Wall*⁴.

Combining ReCon with the component based assembly methodology for DeCon could result in a patchwork design approach. Instead of traditional deconstruction methods where salvaged building materials and separated and broken down into individual pieces, larger component based assemblies could be salvaged and repurposed into new designs.

CONCLUSION

The design methodologies pursued by students in this paper integrates sustainable design principles, material reuse, tectonic explorations in the design and implementation of a DeCon and ReCon peda-

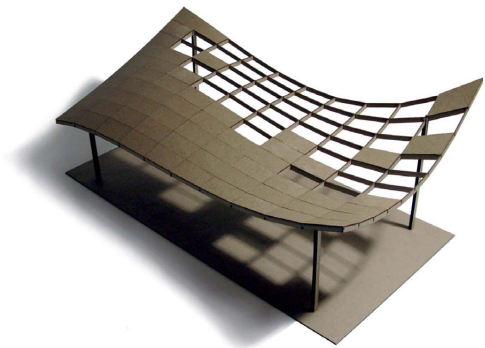


Figure 4. Model of ReCon pavilion.

gogy. The larger goal is for flexible design methods for repurposing materials we hope will save valuable embodied energy and waste from the material stream. In the case of the 1920s wood frame barn for our projects, we felt it provided a framework for ReCon exposing students to issues of the lifecycle of a building. The projects that used parametric models to subvert various material constraints enabled students to quickly generate formal possibilities derived from the barn.

The digital tectonic enabled through CNC milling provided a flexible jointing strategy we hope to utilize to construct the Recon pavilion (figure 4). However, this method is largely untested and full of potential faults, which need to be addressed. Critical to the pedagogical component in our research is the acquisition of capabilities and skills directly related to the professional activity.⁵ Students are learning by doing through analyzing existing construction practices and designing DeCon|ReCon methods. Several projects highlight computational design approaches that incorporated CAM tools and parametric models offering flexible iterative design approaches that could optimize material reuse.

Other project methodologies explored a component assembly based technique to mining existing buildings of materials as well as the programmatic tactics related to an existing farm. These ReCon strategies developed in the classroom we feel lead to students in-depth understanding of material properties, navigating the contextual complexity of an existing building or site and broader research questions needed for ReCon activities. Materials strengths, tol-

erances, landscape and context played a critical part in the ongoing research and design development. Ultimately, these small experiments contribute to DeCon and ReCon design methods and ongoing carbon neutral research that could be applied to the larger deconstruction industry.

ENDNOTES

- 1 W.C. Steward, and S.S.B. Kuska, "Structuring Research for 'Design for Deconstruction,'" *Proceedings, DECON04 Deconstruction and Building Materials Reuse Conference*, Oakland, California, September 2-3, 2004.
- 2 S. Shell, O. Gutierrez, L. Fisher, et al., "Design for Deconstruction: The Chartwell School Case Study" for U.S. Environmental Protection Agency Region 9 <http://www.lifecyclebuilding.org/files/DFD.pdf>
- 3 B. Kolarevic, and K. Klinger, *Manufacturing Material Effects*, (Routledge: London; N.Y., 2008).
- 4 S. Kieran, and J. Timberlake, *Refabricating Architecture: How Manufacturing Methodologies are Poised to Transform Building Construction*, (McGraw-Hill: New York, NY. 2004), 140-143.
- 5 C. Benedetto, C. Salvatore, P. Giuseppe, "Construction or Deconstruction: Which is the Best Way to Learn Architecture? Architectural Information Management," in *19th eCAADe Conference Proceedings*, Helsinki (Finland), August 29-31, 2001, 299-304.