Architecture Students Fabricate Sculptural Benches at the University of Houston

In the heart of the Gerald D. Hines College of Architecture and Design at the University of Houston, a groundbreaking project brought together architecture students and cutting-edge technology to design and fabricate outdoor benches that challenge traditional approaches to form and structure. The *Infill Bench* project was developed as part of the *Design Media* course "Hola, Robot," led by Joaquin Tobar Martinez, an architect and manager of the Keeland Design Lab at UH.

Tobar Martinez, a former employee of the 3D printing company PERI 3D Construction, aimed to bridge the gap between industry and architecture students, exposing them to new technologies at an early stage in their academic careers.



COLLABORATIVE DESIGN PROCESS & LEARNING EXPERIENCE

The project involved the creation of sculptural benches for the Burdette Keeland, Jr. Design Exploration Lab and the Hines College, which were to be fabricated using additive manufacturing techniques. Students were divided into four teams, each tasked with designing a series of outdoor seating arrangements. The teams speculated on the benches' form, structure, and performance, with a focus on exploring the potential of 3D printing using ready-mix concrete.

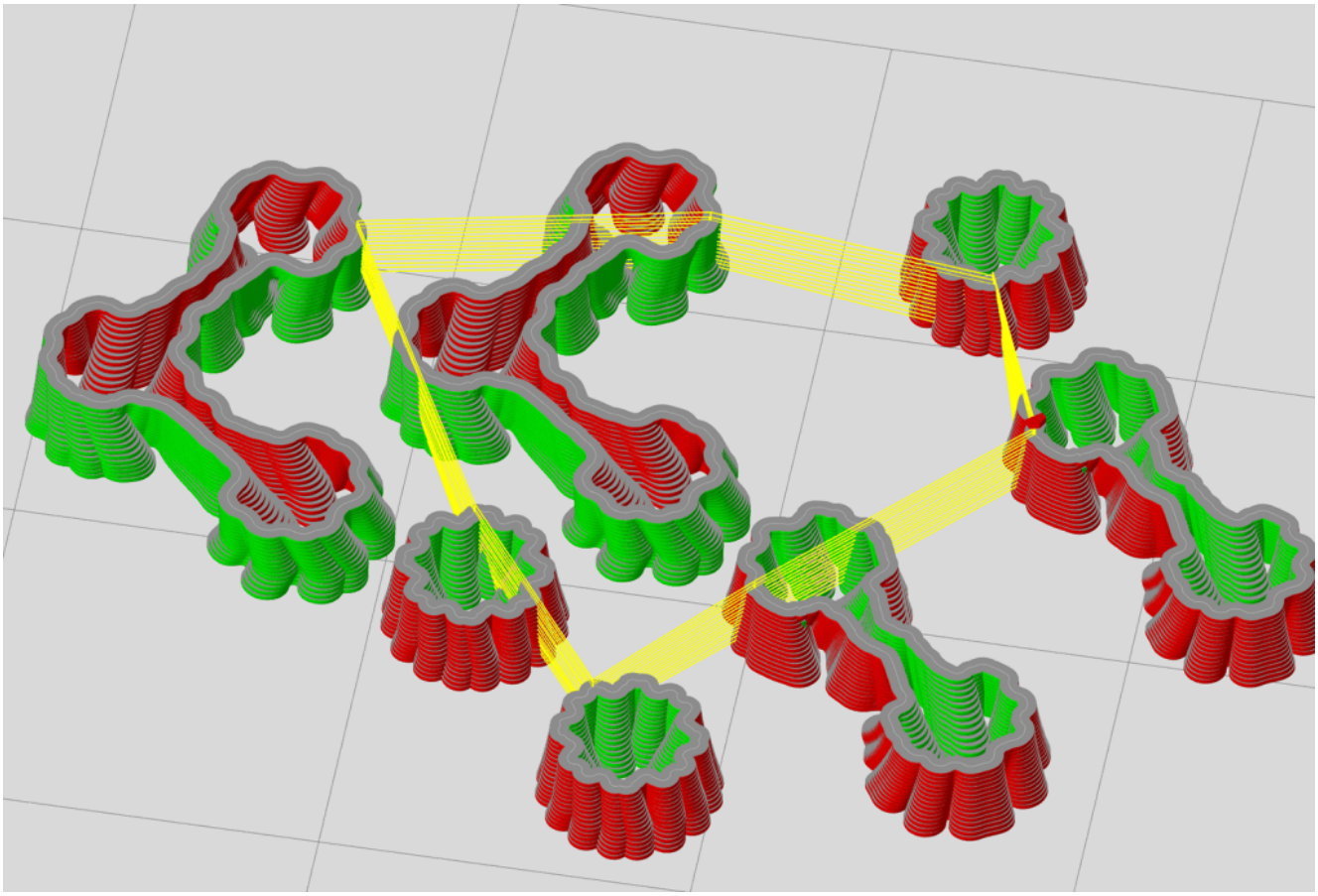
A visit to PERI 3D Construction provided students with hands-on exposure to 3D printing technology, specifically the use of a large gantry system that pumps concrete through sophisticated equipment. Students were also inspired by the first 3D-printed two-story house in the United States, located in Houston, Texas. This exposure to both industry and cutting-edge technology shaped their understanding of how to push the boundaries of architecture with additive manufacturing.



LEVERAGING RHINO & GRASSHOPPER FOR PARAMETRIC DESIGN

Rhino and Grasshopper played a crucial role in the design process, allowing students to explore complex geometries, calculate volumes, and estimate the weight of each component. By using parametric design plugins, they were able to generate intricate models that were optimized for fabrication. One of the most important aspects of the design process was visualizing the toolpaths, which helped students understand the relationship between materials and the changes they undergo during fabrication.

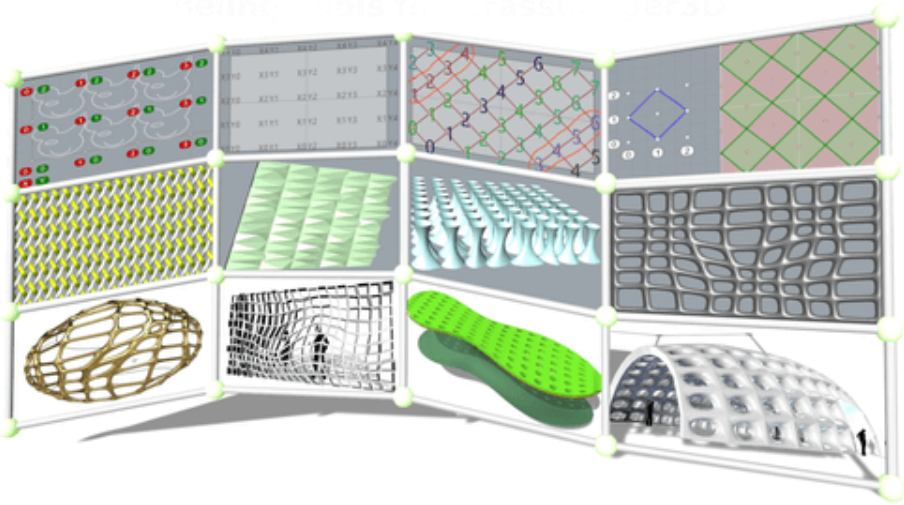
Through a series of analog experiments and simulations using slicer software tailored for the COBOD 2.0 printer, students refined their designs and anticipated how their digital models would be translated into physical form. This step ensured that each component met the structural requirements while also addressing aesthetic and functional considerations.



INNOVATIVE USE OF PLUGINS & ORGANIC PATTERNS

To generate the incremental growth patterns of the benches, students utilized plugins like Kangaroo in Rhino and Grasshopper. The team created an organic and seemingly chaotic design language by applying single curves that populated multiple contours. The “infill” concept emerged as a formal expression in the design, transitioning from controlled to expansive, unpredictable patterns.

This iterative process allowed students to experiment with different configurations and adjust their designs in real time, taking full advantage of the flexible and adaptive capabilities of the digital fabrication process.



See Also

PANELING TOOLS FOR GRASSHOPPER

OVERCOMING CHALLENGES IN ADDITIVE MANUFACTURING

While the design process was exciting, it also came with challenges that tested the students’ problem-solving skills. A major hurdle was the steep overhangs in some of the geometries, which could have resulted in collapsed 3D-printed layers. To address this, the students developed an innovative solution—flipping the benches upside down before fabrication. This adjustment allowed for more material to be deposited at the bottom of each element, ensuring a smoother surface for seating and enabling the printing of higher-angle overhangs without collapse.

Thanks to their ability to quickly iterate and collaborate with engineers at PERI 3D Construction, the students refined their designs and resolved these technical challenges before proceeding to the fabrication stage.

FINAL RESULT: SCULPTURAL IMPACT ON CAMPUS

The final product of this ambitious project was the creation of sculptural benches made from highly complex geometries, achieved without the need for traditional formwork. The benches stand as a testament to the power of digital fabrication and the potential of 3D printing in architecture. The project not only proved the feasibility of using large gantry systems for additive manufacturing but also showcased the possibilities of working with innovative materials in architecture.



The benches are now a permanent fixture on the campus, between the Keeland Lab’s fabrication space and the postmodern UH Architecture Building. This project had a profound impact on the students, allowing them to learn directly from experts in digital fabrication and gain invaluable experience working with state-of-the-art technology. It reinforced the importance of embracing alternative construction methods while maintaining an appreciation for traditional approaches.

By pushing the limits of design and materiality, the *Infill Bench* project serves as a powerful example of how architecture students can shape the future of the built environment through experimentation, collaboration, and the integration of advanced technologies.

CREDITS

PERI 3D Construction:
John Griffin, Laura Manhard – Field Engineers

Photography:
Marcel Omen
Joshua Peterson

Students:
Lia Ragle, Tessa Daines, Marco Inofuentes, Cole McDowell, Fernando Mata, Stephen Brodnan, Simon Chiquito, Jeffery Moisant, Ezequiel Alvarenga, Elena Wolf, Emannuella Pereira, Deena Cuatete, Alonso Villela Alverde, Madeleine Price, Orlando Gomez, Elizabeth Ramos, Esmeralda Patlan

Support:
Andrew Kudless – CRAFT Lab director
Jason Logan – Keeland Design Lab Director
Gerald D. Hines College of Architecture and Design