Building with Bricks

Workshop conducted for First Year Students 2023-24


TRACTOR
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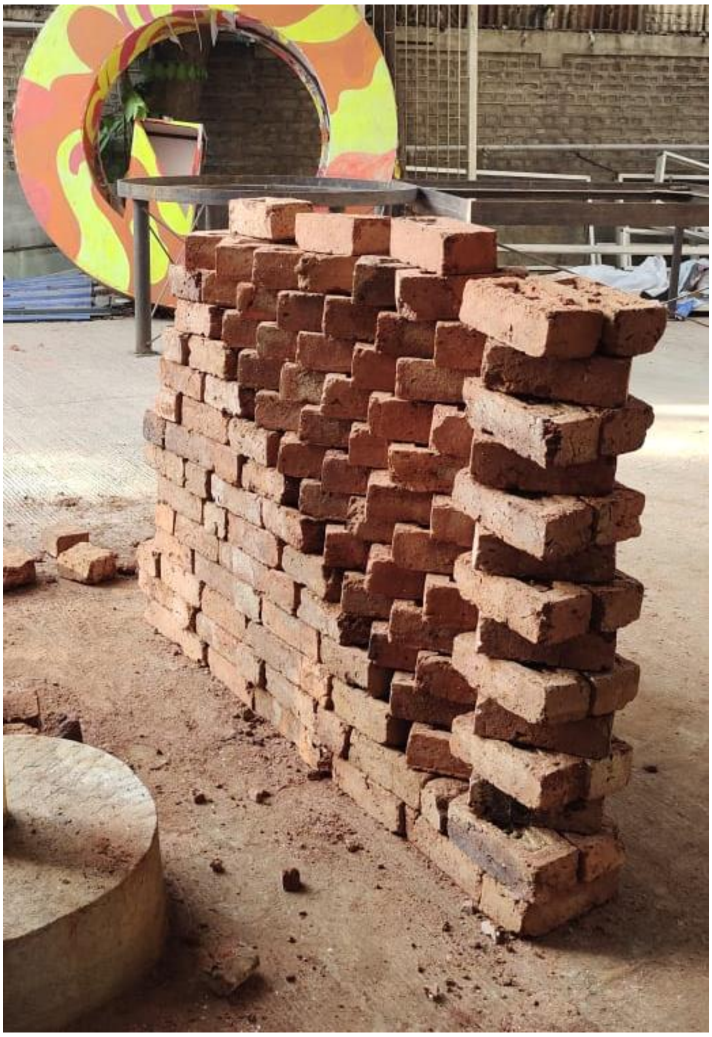


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EXPERIENTIAL LEARNING THROUGH DESIGN AND BUILD

M.Arch DIGITAL ARCHITECTURE PROGRAM

The realm of Digital architecture focuses on innovative and nonstandard design pursued via various subjects in the curriculum of Master's in Digital architecture program. Parametric design thrives on experimentation, often push engineering boundaries towards design of unconventional forms/Nonstandard design

Unconventional forms /Non-standard design need specialized expertise to construct forms that deviate from standard practices. In the realm of non-standard parametric design, the institute promotes the culture of design and build of large-scale prototypes to augment experiential learning .This student centric approach of encouraging the design and build process is supported by funds from the department allocated in the annual budget of the institute.

Herein students use the fabrication lab and use the funds to realize a large scale prototype of their design ideas.This ecosystem of design and build is facilitated to realize the complexity, customization, and innovation that non-standard design demand. It ensures that the creative potential of parametric models translates into feasible, efficient structural solutions.

The institute has an established ecosystem in the form of the Digital Fabrication Lab that houses digital tools like 3d printers, Laser cutters, CNC millers, and a KUKA KR 30-3 Robotic arm. Students often make tabletop study model before they take up the design and build exercise

This part of experiential learning via the design and build initiative guarantees that the envisioned design can be fabricated and constructed without losing its integrity as sought in the computational medium and help students learn the technological deviation needed from standard fabrication practices.

Large-scale prototypes in parametric design education transform abstract digital concepts into concrete experiences, equipping students with practical skills, critical thinking abilities, and a deeper understanding of the interplay between design, materiality, and fabrication. They foster creativity, innovation, and readiness for real-world challenges

The institute is committed to continue this activity where the institute immersive mediums digital fabrication facility and other resources are used to its fullest. Though resource-intensive, this activity fosters deeper hands-on learning about construction challenges. Involves hands-on experience with actual construction techniques, tools, and equipment. Provides practical knowledge of tolerances, alignment issues, and challenges like weather, human error, or site constraints

Since most of the design that are built in these exercises are designed through computational mediums the students also understand the impact of small errors in digital models on real-world fabrication and assembly while building them. The use of digital fabrication processes requires attention to micro-level details, such as precise connections, material finishes, and joint mechanics, which otherwise cannot be taught via theoretical lessons.

In the case of robotic fabrication, it is employed for its ability to augment human craft and dexterity and offers precision and efficiency, its use requires overcoming significant technical, material, and operational challenges.

Students learn the following while using the robotic fabrication for the design and build exercises

- Translating Digital Design to Robotic Workflow: - File-to-Machine Compatibility, Software Integration
- Precision and Tolerances of every tool and end-effector limitations: - Robotic arms have to be precisely calibrated for position, orientation, and tool alignment. Even minor misalignments can result in errors in fabrication.
- Cumulative Tolerances: In multi-step processes, small errors in one step can compound in subsequent steps, especially for large or intricate designs.
- Tool-Material Interaction
- Real-Time Feedback and Adaptation:-Robots often lack the ability to autonomously detect and correct errors during fabrication, requiring additional sensors or human supervision.
- Error Detection and Dynamic Adaptation: Adjusting to real-time variables, such as material deformation or tool wear and tear.

Addressing these issues involves a combination of technological advancements, skilled personnel, and iterative problem-solving to ensure that the promise of robotic fabrication aligns with the complexities of non-standard, parametric design

As an activity engaged every year the department has seen students engaging in team work and that encourages skills in communication, negotiation, and resolving conflicts in a practical context. Contributing to experience that mimic real-world construction processes.

Case 1:- Ay2022_2023

This year the students explored the robotic Jenga via pick and place After explorations of the initial ideas, the students learned how a modular wooden assembly stabilizes with overlap in a non stand form of a curvilinear wall. This exercise involved the building of a computational models via grasshopper script that responded to feedback from table top analogue models of wooden assemblies to understand tolerances and overlap for module stability.

the design was then taken to the design and build premise that involved two stages ie preliminary assembly through pick and place and Global assembly and stacking via MR HoloLens

First stage assembly:_

The blocks were stacked using the Kuka Robotic Arm. This layers were nailed to create individual segments. There are 3 segments in 1 row and 14 such rows achieving a height of 2.1m.
The gripper for the pick and place action was created in house. Grasshopper definitions were generated. Simulations were run to determine the source and placement in accordance with the reach of the Robotic Arm.

Students interacting with the KUKA pick and place and physically nailing the layers

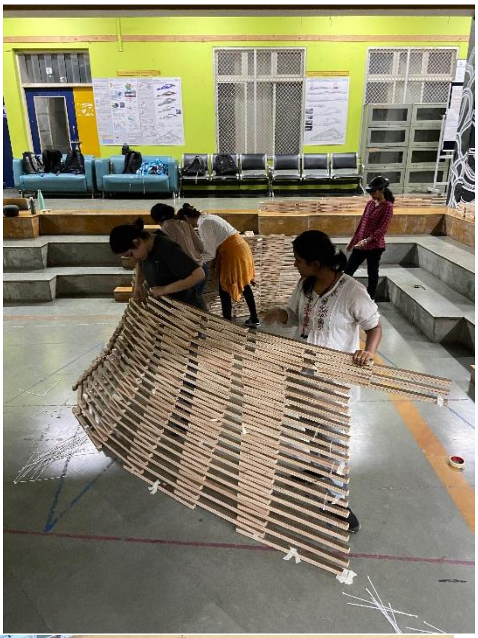
Students interacting with the KUKA pick and place and physically nailing the layers

Second stage assembly:-

Once the 42 segments were fabricated, they were assembled together. A model was generated in mixed reality on site at 1:1 scale. This was created using the Fologram app and visualised through the Microsoft Hololens Headset.

This arrangement marked the exact positions of the 42 segments in 3d helping to align the position and the angles of the segments.

Students physically stacking the assembly with the help of Microsoft hololens



Students physically stacking the assembly with the help of Microsoft hololens

AY 2023_2024 :- L system non seriality

The students designed a dynamic branching structure using L-system algorithms, merging computational design with cutting-edge fabrication techniques. The project showcases the potential of robotic fabrication in architecture, pushing the boundaries of what’s possible in both form and function.

They employed a KUKA robot for drilling holes at custom angles, achieving precise, accurate cuts for each wooden component. The wooden pieces were manually cut, with profiles derived by unrolling the member surfaces in Rhino to create the exact cut shapes needed for assembly.

To ensure flawless assembly, they used Microsoft HoloLens to overlay the digital model onto the physical structure, allowing them to make real-time adjustments and align the pieces with precision. This seamless integration of robotics and augmented reality highlighted the immense possibilities of combining technology with craftsmanship to create innovative architectural designs.

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Students engaging in the ***L system non seriality***

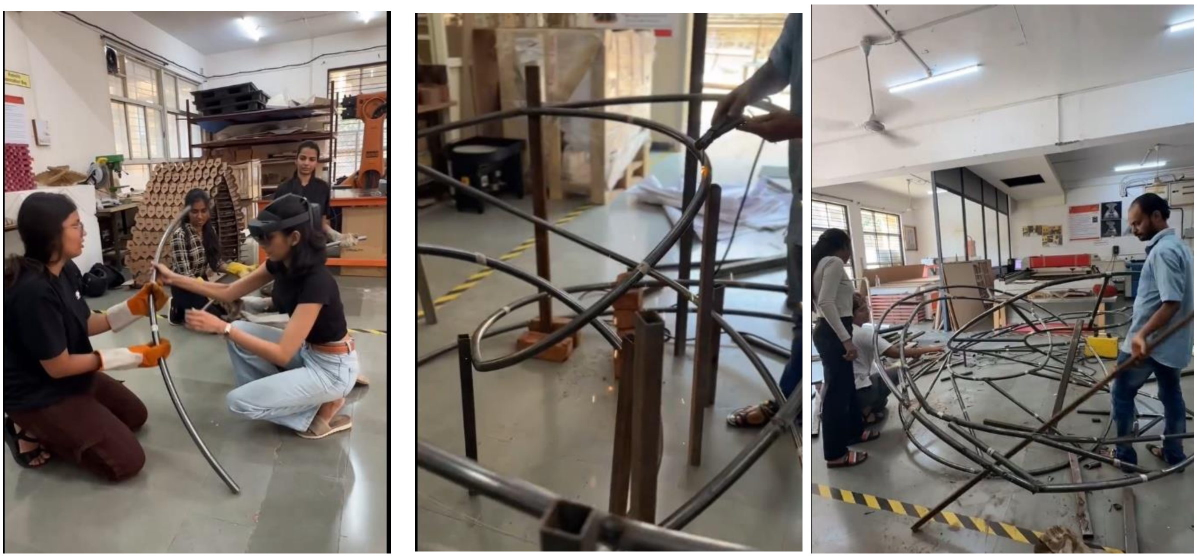
2024_2025 :-Mobius geometry

For this design and build the students designed a Möbius strip that needed precision metal bending and welding techniques to be employed to realize it. This unique design, with its continuous loop and single twist, was to serve as both a functional structure and a work of art.

What sets this project apart is the innovative use of Microsoft HoloLens for assembly. By projecting the virtual model directly into the physical space, the studentscwere able to align the real-world components with the digital design in real time, ensuring flawless precision. This blend of traditional metalworking and cutting-edge augmented reality technology allowed us to create a seamless, accurate assembly process.

The result is a stunning Möbius strip that not only demonstrates the skill of metal fabrication but also highlights the potential of immersive technology to enhance the design and construction process.

This project demanded the use of a metal bending mchine and eternal agency students worked at the external workshop to shape their metal pipes



Using the MR for checking the precision and welding the complex assembly

The complex assembly