Modular Variations: Standardization and Variation in the Design of Reconfigurable Molds

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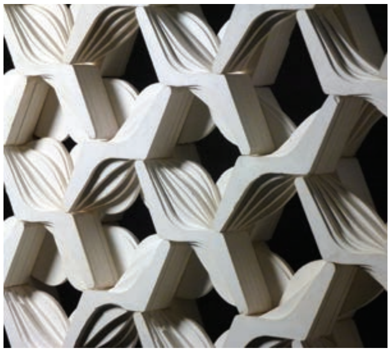
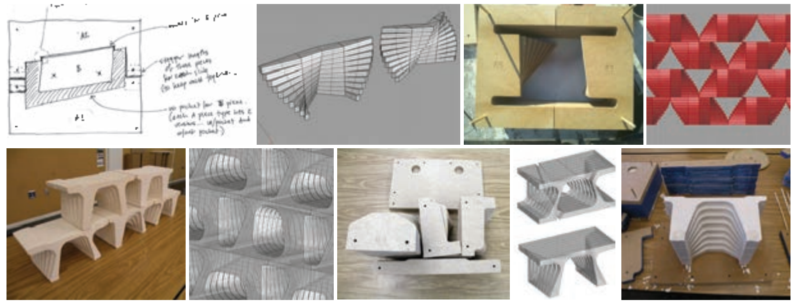
Modular Variations is a design research project that investigates the notion of variation as it relates to contemporary techniques of computational design. The advent of such technologies has enabled architects to design with an unprecedented abundance of variable geometries, and with unprecedented ease. Yet the question remains: to what end? The project explores this question by developing reconfigurable molds constructed from a set of finite, simple components and capable of producing a large range of variable cast plaster modules that can be stacked into a wall assembly. Molds consist of removable components that can be assembled in numerous sequences and configurations. The logic of the variation of the cast modules is driven by careful calibration of the interstitial apertures; this behavior is integrated into a digital parametric model that enables visualization of design iterations while also continuously updating the fabrication files and assembly instructions for the mold components.

The impetus for the project has several dimensions. First, the research builds upon the rich history of decorative masonry walls in architecture, from the hand-carved jali of the 16th century Mughal city of Fatehpur Sikri to Erwin Hauer's modernist screens of the 1950s. This project expands upon such precedents by exploring ways to introduce variation into contemporary processes of precast masonry fabrication—practices which typically rely on standardized mass production—and to do so in a relatively economical way. Second, the project reflects a fatigue with two-dimensional digital fabrication technologies, which have resulted in a glut of custom-perforated surfaces and overly complex flat-cut assemblies, and focuses instead on casting as way to explore more volumetric possibilities. Furthermore, rather than focusing upon file-to-fabrication workflows as the primary interface between the digital and the material, Modular Variations takes a step back and proposes a more logistical application of computation: leveraging the power of the computer to help structure a largely analog fabrication process.

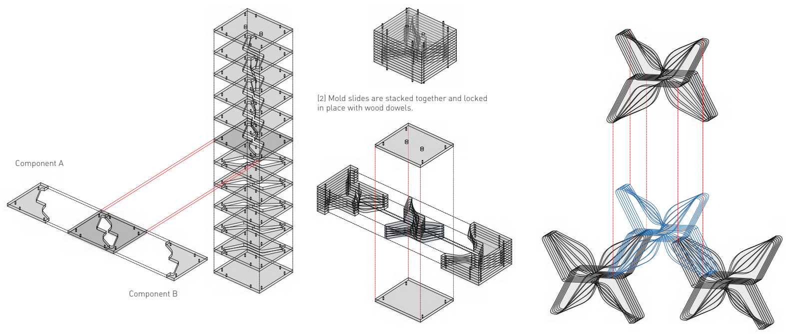
The design of reconfigurable mold systems became the primary means for exploring these issues. The final mold consists of ten stacked components of custom-routed ½" plastic stock. The mold components are extracted from a parametric model that is used to visualize not only the single resultant cast module, but also all the possible modules that the reconfigurable mold can produce. The model also enables the designer to evaluate the aesthetic and performative implications of large field configurations of stacked modules, and to test different strategies for deploying variation across the field. The mold components are robotically fabricated using toolpaths output directly from the digital model, but more importantly, the parametric model also outputs assembly instructions in the form of a shop drawing to help direct both the casting process and assembly sequence. This workflow of constant feedback between digital and analog modes offers a robust model for designing variable systems that perform in highly calibrated ways. The final full-scale wall prototype demonstrates the system's versatility; its 27 unique cast plaster modules, all produced from a single mold, stack uniformly into a wall that exhibits a range of transparent and opaque behaviors.





PROTOTYPES

A series of full-scale prototypes were produced in order to test casting techniques, materials, tolerances, and different approaches to adjustable formwork. The focus of the research became the development of a reconfigurable mold made of stackable components that could be rearranged and reordered to produce variable cast modules.

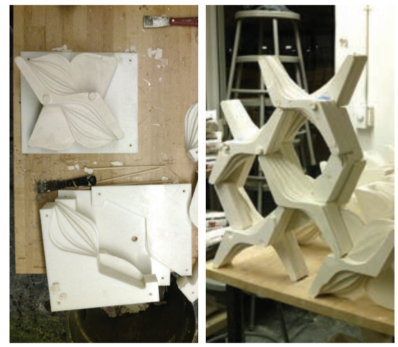


(1) Each mold slide consists of two types of components, each of which has several variations.

(2) Mold slides are stacked together and locked in place with wood dowels.

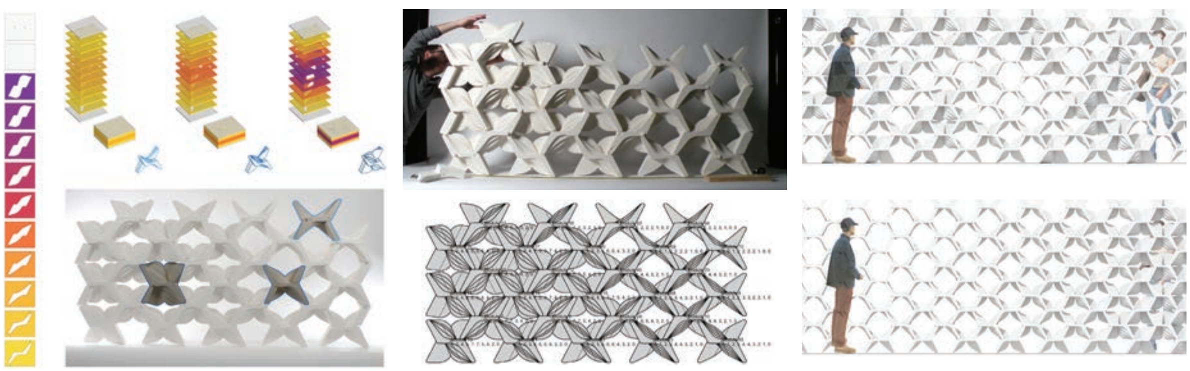
(3) After plaster is poured, mold slide components are removed to reveal the cast module.

(4) Final cast module and stacking logic. Legs of module interlock with adjacent modules to form a structurally integrated wall system.



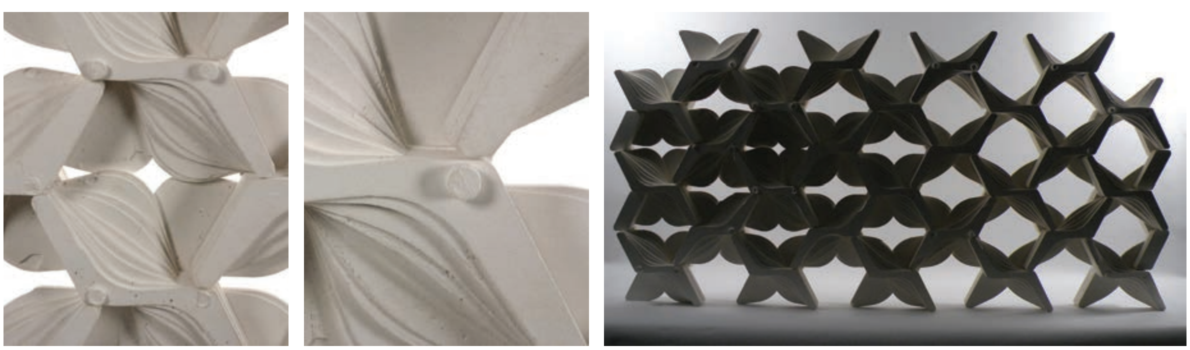
MOLD DESIGN

The final mold produces a butterfly-shaped cast module that, when aggregated into a wall, develops a remarkable structural rigidity due to its nested stacking logic. The mold consists of ten stacked planar components that form an internal void, into which the plaster is poured. Changing the sequence of the mold slide components produces a variety of cast modules that, when stacked, yield a range of opacities and transparencies within the larger wall assembly.



COMPUTATION

The diagram on the left describes the reconfigurable mold's ecology of variation: the logic by which the re-ordered mold slides generate cast modules of variable transparency and opacity. A parametric model was used to link the design of the mold components to the resultant cast geometry, to output fabrication and assembly instructions (center images), and to visualize different possibilities for deploying the variable modules in a field (image on right).



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