BUILDING BYTES: 3D-PRINTED BRICKS

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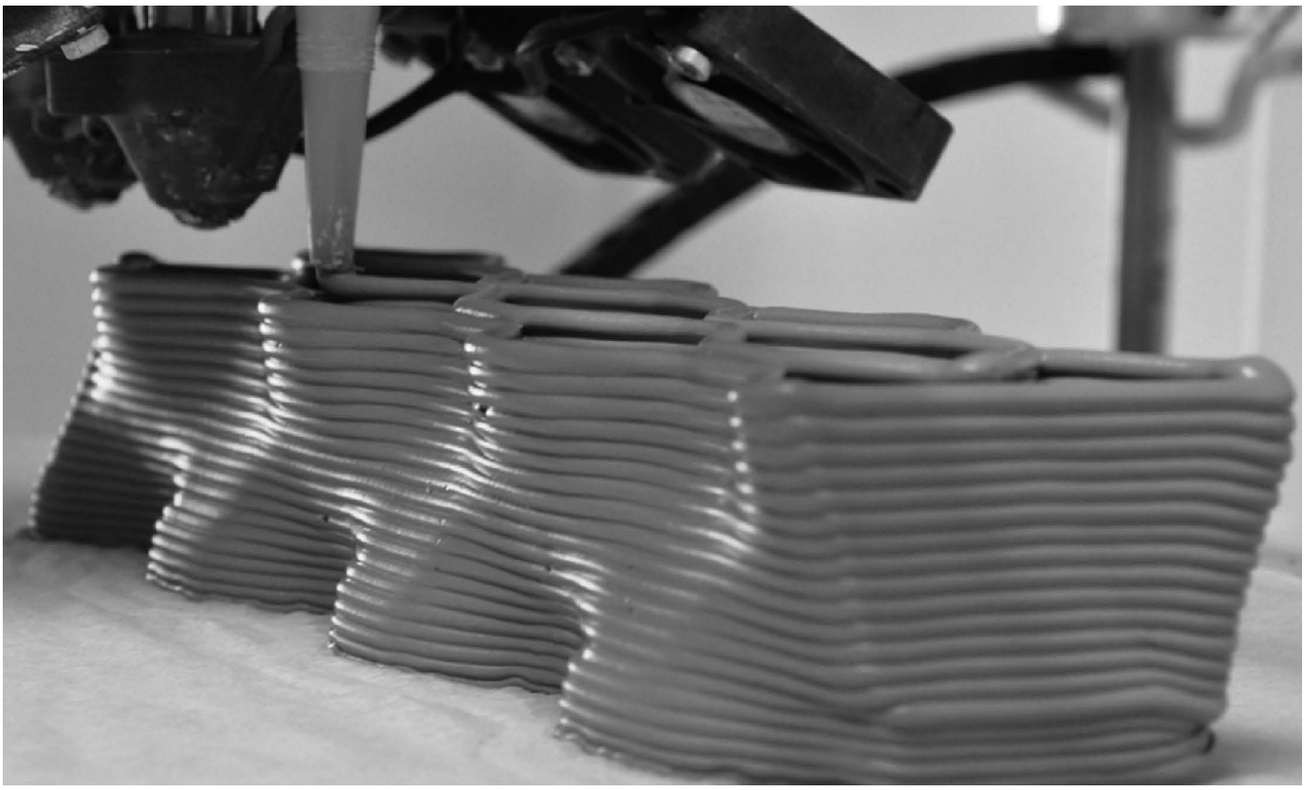


1 Brick being printed on a desktop 3D printer

INTRODUCTION

The first phase of this research was conducted during an eight-week residency at the European Ceramic Work Center in the Netherlands, and focused on how to 3D-print with ceramics at the scale of architecture. Working within fixed limitations (the size of a desktop 3D printer, capacity of the material storage system and the properties of clay) led to research into bricks. While the material and building unit are ancient and fairly universal, Building Bytes proposes an alternative fabrication technique.

FABRICATION SYSTEM

A simple, custom extrusion system was attached to a standard desktop 3D printer (Figure 2), allowing bricks to be fabricated with a liquid slip cast recipe of earthenware ceramics, which is commonly used for casting ceramic moulds. The bricks were printed in 2mm thick layers (Figure 1) following a single polyline and the printing time for each brick was between fifteen and twenty minutes.

DESIGN PROCESS — PARAMETRIC DESIGN

Both the overall form and the individual bricks were designed using a parametric design software, Grasshopper. The combination of Grasshopper and 3D printing allowed for quick adaptation to different parameters, applications and sites. The software also minimized the time spent redesigning and modifying the bricks by providing quick visualizations of design options and a direct link between the digital models and physical tests, which was essential since the printing process and material were highly experimental. Information about each brick was also embedded in the model, such as the material cost, printing time and position within the full scale assembly.

DESIGN

Building Bytes outline opportunities for more ingenious design than a standard extruded brick, as they can have complex exterior surfaces, interlocking joints and embedded unique labels to help during assembly (Figure 3). Additionally, the internal structure can incorporate necessary electrical or mechanical infrastructure and be engineered to increase the strength at certain stress points in a wall.

Three brick types were developed to test and demonstrate the potential of this fabrication system and its applications in architecture. Each type was tested at three scales: (a) Full scale prototype —single brick, (b) Full scale prototype —stacked aggregation of fifteen to thirty bricks, (c) Scale model of final application to communicate design intent.

HONEYCOMB BRICKS

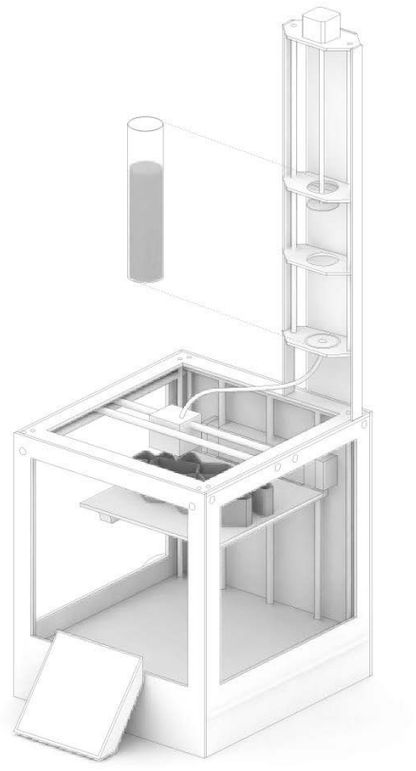
Honeycomb Bricks are modular and can be stacked in three different orientations, allowing for design flexibility within a single module. The potential applications for this type of brick include interior and exterior privacy or sunscreen walls.

RIBBED BRICKS

Designed for column applications, Ribbed Bricks' distinct outer surface is both structural and ornamental. The material stability while printing drives the unique outline, which can be designed in any number of ways with no increase in fabrication complexity.

X-BRICK

The X-Brick was designed to maximize visual opacity through walls, optimize printing time, limit material usage and test non-modular constructions. The X-Brick prototype structure creates an undulating surface by using unique bricks per row.



2 Diagram of desktop 3D printer with custom extrusion system

BRIAN PETERS is a designer and architect who founded DesignLabWorkshop in 2008 as an incubator for research into emergent design and fabrication techniques. Brian received a Master's of Architecture from the University of Illinois at Chicago and worked for five years as an architect in Chicago. In 2009, he moved to Barcelona where he attended and then taught at the Institute of Advanced Architecture in Catalonia (IAAC). After Barcelona, Brian spent two years in Amsterdam, working on several projects investigating the role of 3D printing in architecture. Currently, Brian is an assistant professor with a focus on digital technology at the College of Architecture and Environmental Design at Kent State University.