



ACADIA // 2016

POSTHUMAN FRONTIERS:
DATA, DESIGNERS, AND COGNITIVE MACHINES

Projects Catalog of the 36th Annual Conference of the
Association for Computer Aided Design in Architecture

University of Michigan Taubman College of Architecture
and Urban Planning, Ann Arbor

Edited by Kathy Velikov, Sandra Manninger,
Matías del Campo, Sean Ahlquist, Geoffrey Thün

M TAUBMAN COLLEGE
architecture + urban planning
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GRAPHIC DESIGN

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PRINTER

IngramSpark

COVER IMAGE

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Conference hosted by the University of Michigan, Taubman College of Architecture and Urban Planning, Ann Arbor, Michigan.

Issued in print and electronic formats

ISBN 978-0-692-77095-5 (print)

ISBN 978-0-692-77096-2 (epub)

PROJECTS

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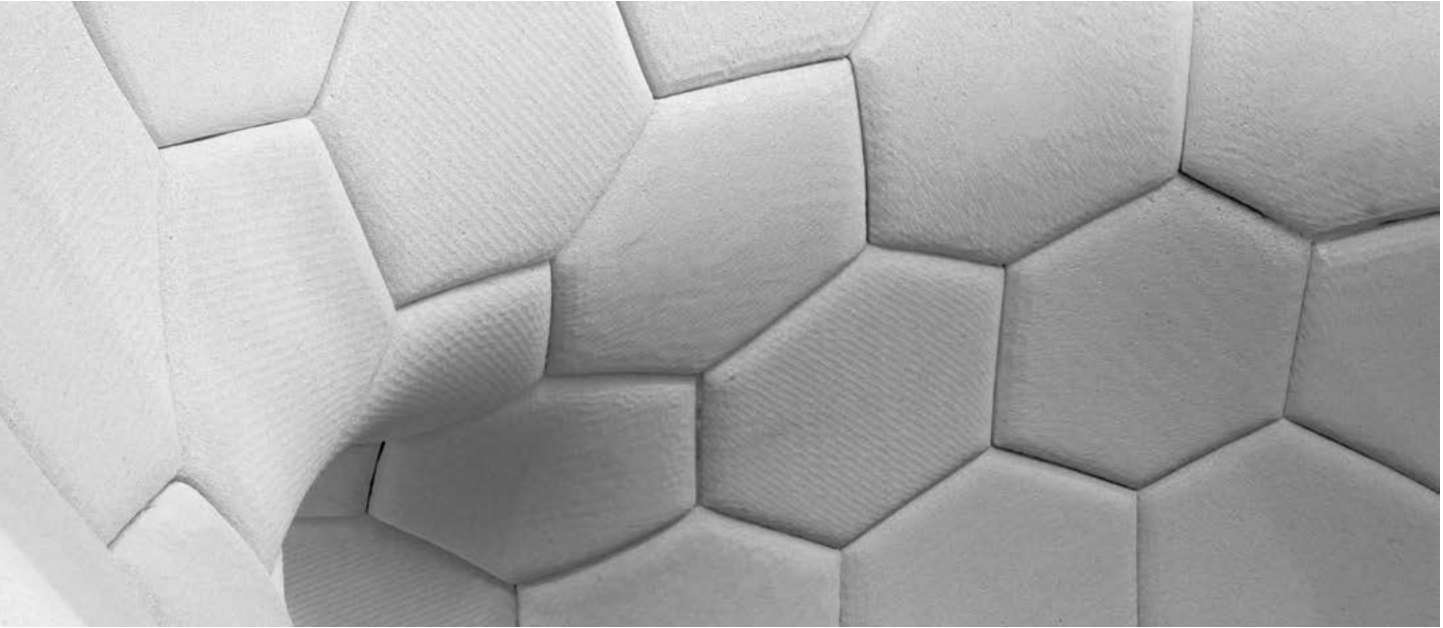
acadia

Round Room

Brandon Clifford
MIT / Matter Design

Wes McGee
University of Michigan /
Matter Design

James Durham
Quarra Stone



1 Image of the interior of the *Round Room* masonry assembly (Clifford, 2014, © Matter Design).

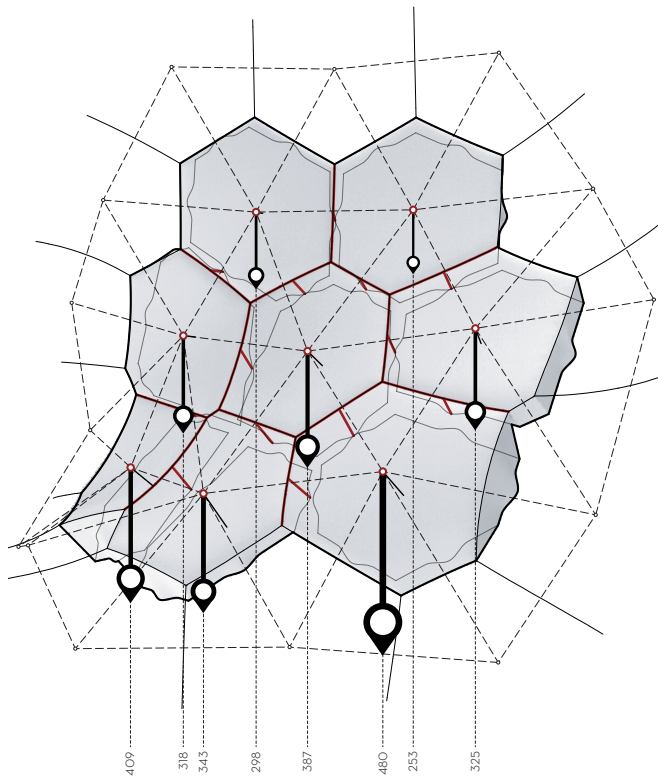
So much speculation surrounds the mystery of Inca stone construction. How did a pre-mechanized civilization produce these massive, voluptuous, complex, and precise assemblies of stone? The answer lies in a 'primitive' tool—the hammerstone. Archaeologists Jean-Pierre Protzen (Protzen 1985, 1993, 1997), Graziano Gasparini and Luise Margolies (Gasparini and Margolies 1980), best explain the process and use of hammerstones. Though commonly assumed to be mortar-less assemblies, the vast majority of Inca stones are only aligned on the front edge. The back face opens, producing a wedged gap between the stones, which is packed in with rubble fill. This wedge method allows the use of hammerstones to nibble and peck the 'dressed' precise front face and edge, and then rapidly remove large chunks of material on the backside with a drafting stroke. This wedge method can also be seen in other cultures that employed hammerstones, from primitive Egypt to Rapa Nui (Easter Island). This similarity in stone construction gave rise to the baseless claims of Thor Heyerdahl that the Inca settled Rapa Nui (Heyerdahl 1958). Further evidence that advances in technology has blinded a rational method of assembly.

Round Room

The *Round Room* project is an experiment in translating this ancient knowledge into a contemporary practice of robotically carving unique units of assembly, which can, without the aid of falsework, formwork, or templating, auto-inform the masonry assembly of complex shell-structure geometries. It is composed of Autoclave Aerated Concrete (AAC) units uniquely carved with a water-fed robotic

PRODUCTION NOTES

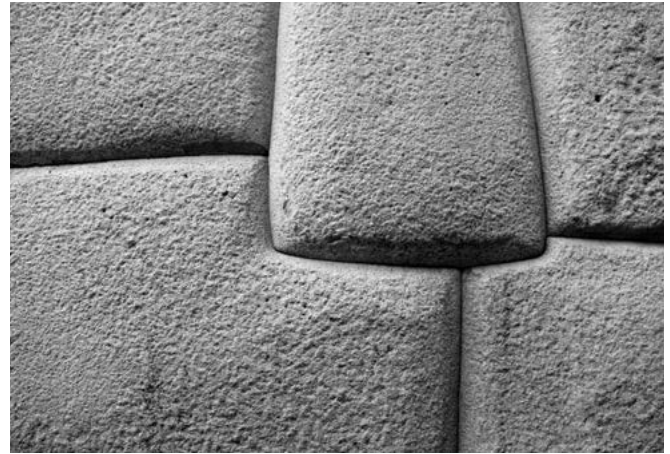
Architect: Matter Design
Year: 2014
Site: Cambridge, MA
Location: MIT Keller Gallery
Material: AAC



2 3d Diagram of the Variable-Volume Particle-Spring Calculation.

arm. Each unit is slightly pillowed to ease the brittle nature of the material from breaking—this method, though visually similar to Inca stonework, resulted as a realization throughout the prototyping stage. The sides of the units are carved with a swarf machining process in a similar manner to this paper (Clifford 2014), which rapidly reduces the carving time. A slight nub is produced on the side of the stone, allowing the unit to index a rotation angle relative to the stone's neighbor. These units are held in place by one installer with the edges aligning each stone in space, while another installer pipes in plaster from behind, filling in the wedge. In a manner similar to the Catalan and Guastavino approach (Ochsendorf 2010), the plaster holds the units rapidly in place. For more on the *Round Room* process, see this paper (Clifford 2015).

In contrast to typical masonry construction of in-situ adjustment that employs mortar for tolerance, this method of neighboring alignment relies on precision carving to inform the assembly. In this case, the mortar is fill. Inherent to this process is a direction



3 Inca wall construction, Inca Roca, Cusco Peru (photo by Clifford © 2011)

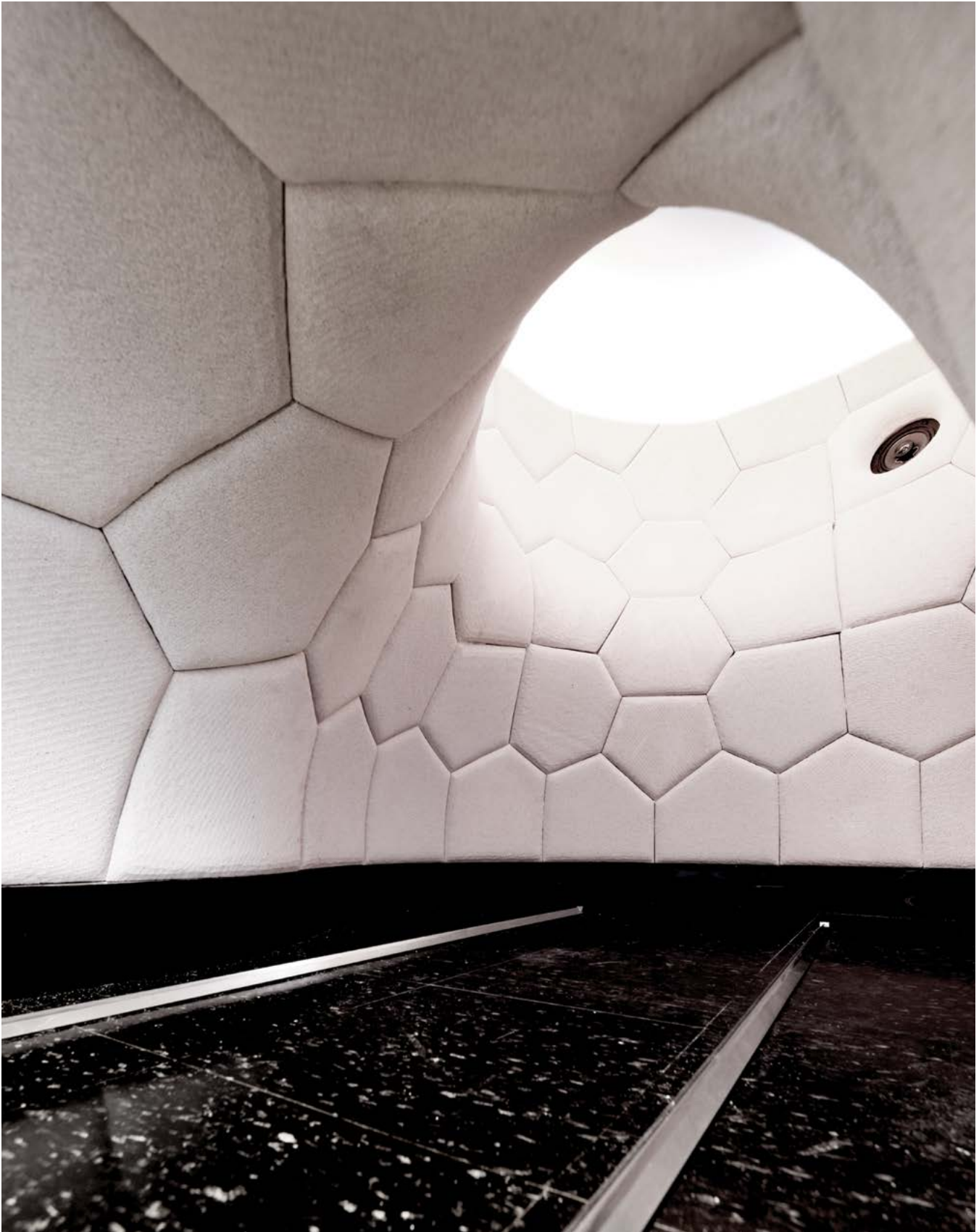


4 Detail of units (Clifford, 2015, © Matter Design).

to the assembly—an interior and an exterior condition—thus re-engaging a ubiquitous type in the history of volumetric architecture—the rubble-fill wall—whereby precision is visible, and fill is utilitarian.

The *Round Room* is installed in a tiny pocket gallery. A large blue box occupies a majority of the space. When the visitor wraps around the corner, they are greeted with a custom creeper, inviting them to lie down on their backs and roll into a small entrance below. As they roll backwards, looking upward into the space, music amplifies, filling the room. This experience is a serene, tranquil, and solitary one. Though it appears as if the music is amplified for each visitor, it is the geometry and material of the room that entraps the acoustics.

While this project samples knowledge from the Incas, it advances this ancient knowledge by rolling their method into three-dimensional space. The complex figure of *Round Room* is assembled without the requirement of alignment jigs or



5 View from the entrance into the *Round Room* (Clifford, 2015, © Matter Design).



6 Exterior of the gallery (Clifford, 2015, © Matter Design).



7 Upon entry to the gallery (Clifford, 2015, © Matter Design).



8 View of the custom creeper (Clifford, 2015, © Matter Design).

formwork. This research goes beyond the direct reproduction of Inca stone construction by conflating it with performative criteria of structure, acoustics, and assemblies of complex geometries. It contributes to ongoing research into shell structures (Andriaenssens 2014) and the use of AAC (Ramage 2006) as a volumetric material.

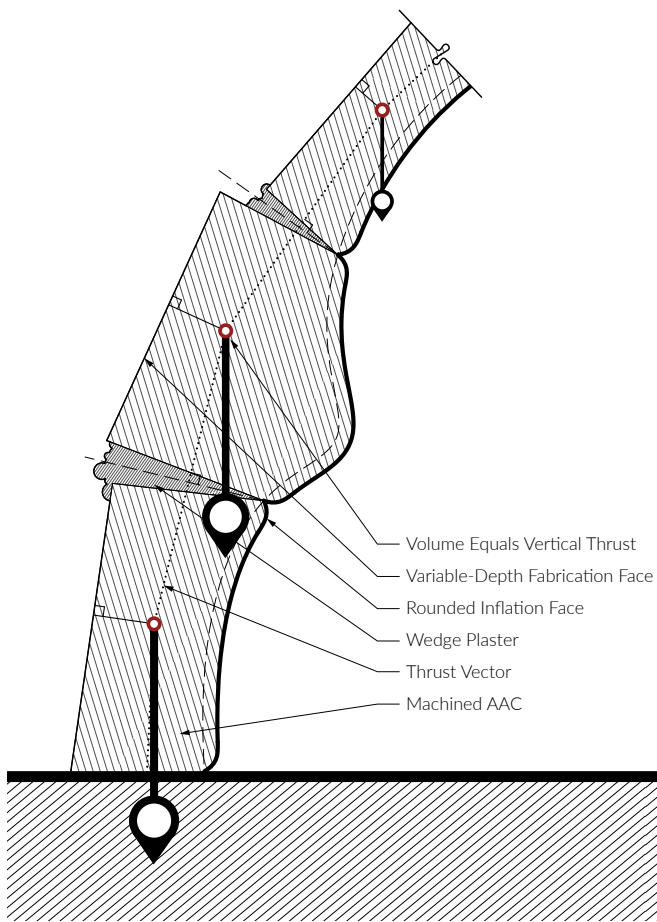
ACKNOWLEDGEMENTS

The *Round Room* is the result of a partnership between the authors (www.matterdesignstudio.com) and *Quarra Stone* (www.quarrastone.com) as fabricators with structural engineering by *Simpson Gumpertz & Heger* (www.sgh.com). Prototypes were produced at the *University of Michigan FABLab* and the installation was installed at the *MIT Keller Gallery*. Graphic design for the exhibition by *Johanna Lobdell* (www.johannalobdell.com). This project is funded in part by the *Council for the Arts at MIT* and the *Belluschi Lectureship*. The thick-funicular calculation employs Kangaroo (www.grasshopper3d.com/group/kangaroo) as the

physics engine solver for the particle-spring system developed by Daniel Piker to work inside Grasshopper (www.grasshopper3d.com), a plugin developed by David Rutten for Rhinoceros (www.rhino3d.com), a program developed by Robert McNeil. The project lead was Austin Smith. The project team includes Myung Duk Chung, Sixto Cordero, Logan Cudd, Lincoln Durham, Frank Haufe, Juhun Lee, Patrick Evan Little, Rebecca Lubrano, Chris Martin, Dave Miranowski, David Moses, Alexis Sablone, and Luisel Zayas.

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9 Wall section describing the various components of the system.



10 Back side of the masonry assembly (Clifford, 2015, © Matter Design).

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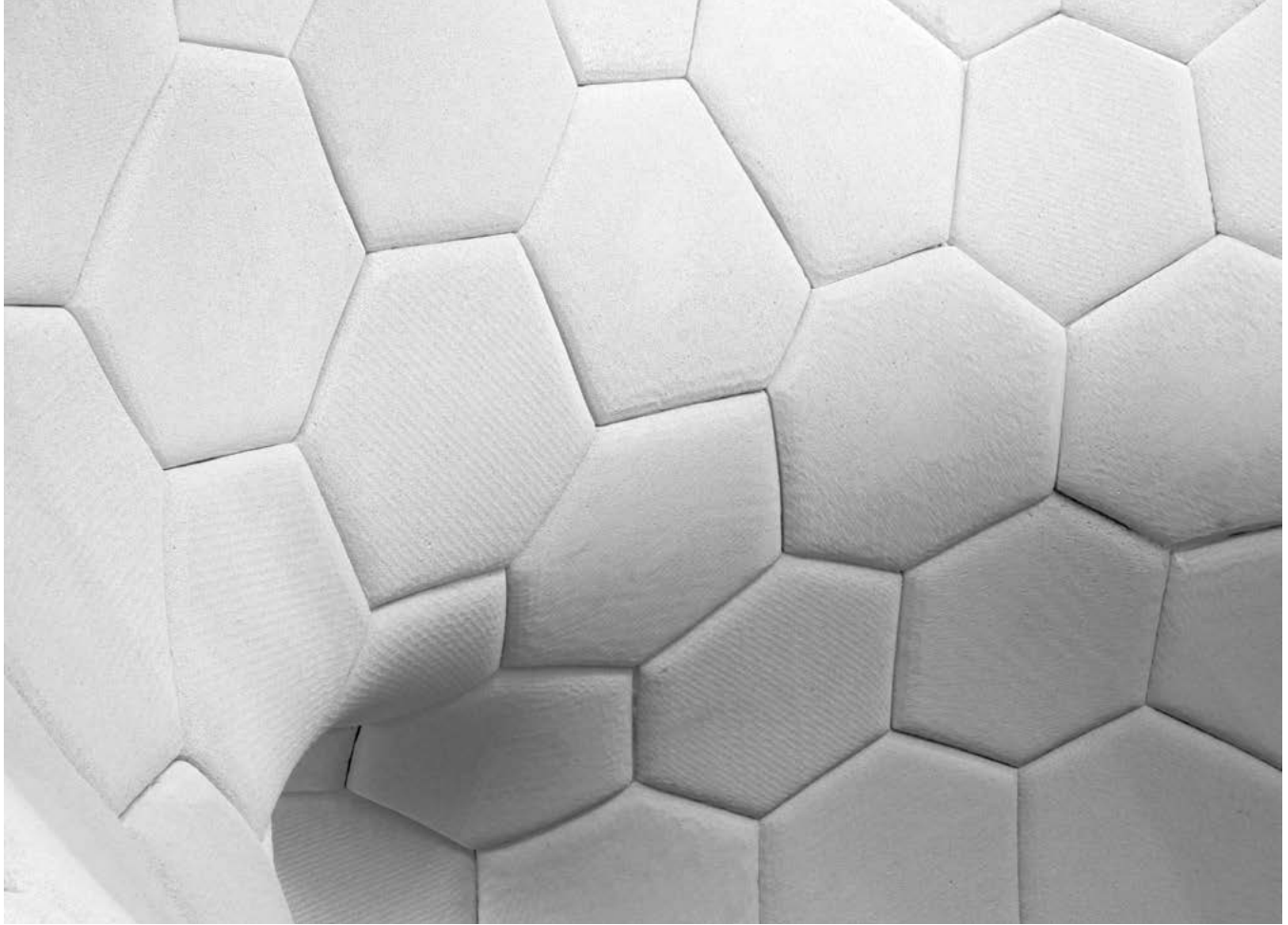
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11 Interior visible assembly of the custom masonry units (Clifford, 2015, © Matter Design).

Brandon Clifford is an Assistant Professor at the Massachusetts Institute of Technology and Principal at Matter Design. Brandon received his Master of Architecture from Princeton University in 2011 and Bachelor of Science in Architecture from Georgia Tech in 2006. He worked as project manager at Office dA from 2006–09, LeFevre Fellow at OSU from 2011–12, and Belluschi Lecturer at MIT from 2012–16. Brandon has been awarded the Design Biennial Boston Award, the Architectural League Prize, as well as the prestigious SOM Prize. Brandon's translation of past knowledge into contemporary practice continues to provoke new directions for digital design.

Wes McGee is an Assistant Professor in Architecture and the Director of the FABLab at the University of Michigan Taubman College of Architecture and Urban Planning. His work revolves around the interrogation of machinic craft and material performance, with a research and teaching agenda focused on developing new connections between design, engineering, materials, and process through the creation of customized software and hardware tools. As a founding partner and senior designer in the studio Matter Design, his work spans a broad range

of scales and materials, always dedicated to re-imagining the role of the designer in the digital era. In 2012 Matter Design was awarded the Architectural League Prize.

James Durham is founder (1989) and owner of Quarra Stone Company, LLC. James is a graduate of Earlham College and majored in Chemistry. For over 40 years, James has operated stone quarries, fabricated and sold cut and carved limestone, marble, limestone, granite, sandstone and quartzite (the famous Vals quartzite used in Zumthor's Therme Spa in Vals, Switzerland). His companies have carved stone for the US Capitol (Visitor's Center 2003–2008), US Supreme Court (2006–2008) as well as 6 state capitol restorations. James is a recognized US Federal Court Stone Expert and in 2012 received an honorary degree as Master Carver from the German State School for Stoneworking in Wunsiedel, Germany. He has recently done stone consulting for a major government project in Washington, DC. James's company is a leading producer in digital manufacturing of natural stone.