A metal ring woven with mesh, like a giant embroidery hoop, suspends from the ceiling. Suddenly, the netting moves and breaks the plane of the ring in opposing directions, creating three convex or concave funnels. Within seconds, the infundibuliform (meaning funnel- or cone-like) shapes shift again, collapsing into themselves, transitioning from mountain peaks to vortices and back again.

This exploration of kinetic architecture is the culmination of years of research and development in digital modeling, fabrication, and robotics by Kathy Velikov, AIA, and Geoffrey Thün, directors of Ann Arbor, Mich.–based RVTR, in collaboration with fellow University of Michigan faculty member Wes McGee, a principal and co-founder of Boston-based Matter Design. Computational design tools have made kinetic architecture increasingly attainable in theory, but translating digital simulations into physical objects has remained a stumbling point. Using Rhino, Grasshopper, and Kangaroo, the team created a design program that simulates what shapes and movements are possible given the constraints of physics and space, and tested applied forces on an extruded-elastomeric mesh. “It allows designers a one-to-one and immediate way to visualize something that’s very complex,” Velikov says.

Data gathered by the simulations guided the unique geometry of a mesh pattern that would enable the form to lie flat, stretch up, or distend down. Using a custom-built extruder, the team 3D printed flat panels of the tensile net surface with the thermoplastic elastomer. The physical net mimics the behavior simulated in the digital model spot-on.

Kinetic forms can be used to tune rooms acoustically or to alter the geometry of an enclosure for different lighting conditions. The team’s digital modeling and physical fabrication process is an “ingenious new technique,” juror Elizabeth Whittaker says. “The formal possibilities seem endless.” —N.B.
Jury

Mic Patterson is founding principal of Los Angeles–based Design Tectonics, a consultancy that focuses on innovative façade technology applications and research. He was formerly the vice president of strategic development at Enclos. Patterson is a Ph.D. candidate in the University of Southern California School of Architecture with a focus on sustainable façade renovation practices.

Douglas Stockman, AIA, is a founding principal at El Dorado in Kansas City, Mo. He also serves on the Kansas State University College of Architecture, Planning, and Design Dean’s Advisory Council, and is chair of the Downtown Council of Kansas City. Stockman received a B.Arch. from Kansas State University.

Elizabeth Whittaker, AIA, is founder and principal of Merge Architects in Boston. In 2015, she was a recipient of the AIA Young Architects Award and the Emerging Voices award from the Architectural League of New York. Whittaker received an M.Arch. from the Harvard Graduate School of Design, where she is an assistant professor in the practice of architecture.

Credits

Cricket Shelter: Modular Edible Insect Farm, page 112

Design Firm: Tereform ONE, Brooklyn, N.Y. · Mitchell Joachim, ASSOC. AIA, (co-founder and primary investigator); Jiachen Xu, Lissette Olivares, Cheto Castellano, Ivan Fuenzalida, Sung Moon, Kamila Valela, Yucei Guven, Chloe Byrne, Miguel Lantigua-Inoa, AIA, Alex Colard, Melanie Fessel, Maria Aiolova, ASSOC. AIA, Vivian Kuan (project management); Felipe Molina, Matthew Tarpey (research assistants)

Consultant: Seek Food · Robyn Shapiro Fabricators: Shandon Hassan, Christian Hamrick

Funding: Art Works for Change; Tereform ONE

Photography: Mitchell Joachim, Matthew Tarpey

Special Thanks: David Stewart, Christian Hubert, Heather Lord, Scott Pubiner, New Lab, Brooklyn Navy Yard, GMD Shipyard, New York University Gallatin School of Individualized Study

BayArc: A Tidal Responsive Barrier, page 16

Design Firm: Skidmore, Owings & Merrill, San Francisco · Craig Hartman, FAIA (concept and interdisciplinary leader); Mark Schwettmann, AIA, Alex Cruz, Ross Findly, David Kwon (project team)

Project Adviser: Moffatt & Nichol

Drawings: Skidmore, Owings & Merrill

Structural Engineer: Mark Sarkisian, Eric Long, David Shook, Geoffrey Brunn

Marine Engineering Concept: Moffatt & Nichol · Dilip Trivedi, Richard Dornhelm

The Tower at PNC Plaza, page 116

Design Firm: Gensler, San Francisco · Doug Gensler, AIA (principal-in-charge); Hao Ko, AIA (principal and architectural design director); Benedict Trelar, AIA (principal and technical director); L. Atkins, AIA (project manager); Anastasia Huggins, AIA, David Hall, Gunwook Nam, Alison Wilkinson, AIA, Daniel Nauman, AIA, Jorge Barrero, AIA, Ethel Macleod, Eugene Lee, Joe Chisholm, Brent Van Gunten, AIA, Len Sciarra, Philip Kaefer, AIA, Joel McCullough, AIA, Rich Peake, Mariana Vaida, Jessica Yin, Yooju No (project team)

Rendering: Space Matrix; Tangram 3DS

Construction Manager: P. Dick

Lighting Designer: Fisher Marantz Stone

Structural and M/E/P Engineer: Buro Happold

Sustainability Consultant: Paladino & Co.

Photography: Connie Zhou Photography

LELU Exit Sign, page 122

Client: Architectural Safety Components

Design Firm: Interloop—Architecture, Houston · Mark Wamble, Dawn Finley, AIA (design principals); Eric Hughes, Peter Muesig, Jack Mussett (project team)

Project Adviser: Architectural Safety Components · Sam Youdal

Consultant: Martin Co. · John Martin

Fabricators: Moore Fabrication · Kerry Krumbeck; Professionalized Products and Services · Jerry Huang; Southwest Electronic Energy Group · Alex Marin; Andozing Graphics of Houston · Linda Sayers

Special Thanks: Underwriters Laboratories · Abdul Ahad (investigating engineer)

Tally, page 124

Design Firm: KieranTimberlake, Philadelphia · Roderick Bates, Stephanie Carlisle, Billie Faircloth, AIA, Elizabeth Friedlander, AIA, Ryan Welch (project team)

Development Partners: Autodesk; Thinkstep (previously PE International)

Project Team: Autodesk · Jonathan Rowe; Thinkstep · Heathen Gaddoniex, Nick Santero, Maggie Wildnauer

Special Thanks: Emma Stewart, Jacky Liang

Pulled Plaster Panels, page 128

Design Firm: Young Projects, New York · Bryan Young, AIA (principal); Jon Cielo, AIA (project architect); Noah Marciniak, Samantha Eby, Nayoung Kim (project team)

Lighting Designer: Architectural Lighting · Rick Shaver

Structural Engineer: Silman · Nat Oppenheimer

Electrical Engineer: Engineering Solutions · John Ryan

Consultants: Butter and Eggs · Judy Dunne (interiors); Tacon (general contractor)

Drawings: Young Projects

Fabricators: Kammel (stainless steel screen); Balmer Architectural Mouldings

Photography: Young Projects and Jon Cielo

Chicago Horizon, page 130

Client: Chicago Architecture Biennial, Chicago Park District

Design Firm: Ultramoderne, Providence, R.I. · Yasmin Vobis, Aaron Forrest, AIA, Emily Yen, ASSOC. AIA, Tida Osotsapa, Will Gant, Hua Gao, Ronak Hingash (project team)

Design Structural Engineer: Guy Nordstrom and Associates · Brett Schneider

Structural Engineer of Record: Thornton Tomasetti

Architect of Record: Animate Architecture · Joe Lambke

Fabricator: Nordic Structures

Funding: BP; Chicago Park District; Chicago Architecture Biennial; Rhode Island School of Design, ReThink Wood; Nordic Structures

Photography: Naho Kubota

Special Thanks: Laura Briggs

Spray-On House, page 132

Design Firm: Patrick Tighe Architecture, Los Angeles · Patrick Tighe, FAIA, Zachary Teixera, Evelina Sausins, ASSOC. AIA, Risa Tsutsuji, Bran Arifin (project team)

Structural Engineer: Neus Engineering · Matt Melnyk

Consultant: Demilac

Fabricator: Machineware

Life-Cycle Assessment: Department of Civil and Environmental Engineering, School of Engineering, Stanford University

Prototype: Built at Southern California Institute of Architecture (SCI-Arc), as part of the SCI-Arc Gallery Series

Drawings, Renderings, and Photography: Courtesy Patrick Tighe Architecture

Special Thanks: SCI-Arc team
Vegas Altas Congress Center and Auditorium, page 134
Client: Junta de Extremadura
Design Firm: Pancorbo + de Villar + Chacón + Robles, Madrid · Luis Pancorbo, Jose de Villar, Carlos Chacón, Inés Martin Robles (project team)
Drawings and Lighting Designer: Luis Pancorbo, Jose de Villar, Carlos Chacón, Inés Martin Robles
Structural Engineer: Mecanismo · Juan Rey, Pablo Vegas, Jacinto Ruiz Carmona
Electrical and Facilities Engineering: Urculo Ingenieros · Rafael Urculo, Sergio Rodriguez
Acoustics: Araú Acústica · Higinio Arau
Models: Gilberto Ruiz
Construction: Placonsa · Eloy Montero; Julio Oreja (site manager)
Ropes Installation: Cotesa; Lastra & Zorrilla
Funding: Junta de Extremadura
Cost: €10,505,187 ($11.7 million, approx.)
Photography: Jesús Granada (building); Ignacio Bisbal Grandal (model)

Nanobiome Building Skin, page 136
Design Firm: Michael K Chen Architecture (MKCA), New York · Michael Chen, Justin Snipes AIA, Alan Tansey, Natasha Harper, Ellen M. Chavin, Breaden Caldwell, AIA, Julian Anderson, AIA (project team)
Drawings: MKCA
Landscape Architect: Local Office Landscape Architecture · Walter Meyer, Jennifer Bolstad, AIA, Jenny Hindelang
Conservation Consultant: State University of New York College of Environmental Science and Forestry, Department of Environmental and Forest Biology
Danilo Fernando (associate professor and graduate program director)
Façade and Structural Engineer: Buro Happold
General Contractor: IA Construction Management
Manufacturer: Boston Valley Terra Cotta
Photography: MKCA

Infundibuliforms: Kinetic Tensile Surface Environments, page 138
Design Firms: Matter Design, Boston · RVTR, Ann Arbor, Mich., and Toronto · University of Michigan
Primary Investigators: Wes McGee, Geoffrey Thün, Kathy Velickov
Design Research Associate: Daniel Tish
Fabrication Assistants: Asa Peller, Dustin Brugman, Andrew Kiemers, Andrew Wald, Iram Moreno Pineda
Wireless Sensing Adviser: Jerome Lynch
Technical Partners: Buckeye Polymers; Industrial Fabricating Systems; Beckhoff
Funding: Taubman College of Architecture and Urban Planning; 2016 Research Through Making Program; University of Michigan Office of Research; Small Projects Grant
Photography: Peter Smith

Timber Waste Modular Unit ("TwMU"), page 140
Design Firm and Fabricator: IKD, Boston · Yugon Kim, Tomomi Itakura (leaders); Yuki Kawae, Steven Hien, Brenden Casimir, David Morgan, Erin Kim, James Fan, Miguel Lorenzo Gumilla (student research assistants)
Drawings: IKD
Funding: Heritage Museums & Gardens; Rhode Island School of Design
Photography: IKD
Special Thanks: Windy Hill Farm Sawmill

Grove, page 141
Client: Design Biennial Boston, Boston Society of Architects (BSA)
Design Firm and Fabricator: GLD Architecture, Brookline, Mass. · Joel Lamere, Cynthia Gunadi, Sophia Cheson, Grigori Enikolopov, Zain Karsan, Dohyun Lee, Elizabeth Galvez (project team)
Drawings: GLD
Funding: Design Biennial Boston; GLD
Photography: Jane Messinger
Special Thanks: Rose F. Kennedy Greenway Conservancy, Boston Art Commission, Pinkcomma Gallery, BSA Space, Boston Mayor’s Office of New Urban Mechanics, David Cordero, Caitlin Mueller, Steven O. Anderson, John Skibo, Matt Wagers, Chris Dewart, Christopher Gunadi

Blooming Bamboo Home, page 142
Design Firm: H&P Architects, Hanoi, Vietnam · Doan Thanh Ha, Tran Ngoc Phuong, Chu Kim Thinh, Erinescu Patricia, Nguyen Van Manh, Nguyen Khanh Hoa, Nguyen Quynh Trang, Tran Quoc Thang, Pham Hong Son, Hoang Dinh Toan, Pham Quang Thang, Nguyen Hai Hue, Nguyen Khae Phuc (project team)
Fabricator: H&P Architects
Photography: Doan Thanh Ha
Cost: $2,500
Special Thanks: Nguyen Tri Thanh