The reinterpretation of Frederick Kiesler’s Grotto for Meditation was initiated with a digitally fabricated replication based on a 3D scan of the original bronze model made by Kiesler for the unrealized project in 1963. Kiesler designed the Grotto for a patron in New Harmony, Indiana and it was his last architectural commission. Based on the biological morphology of shells and leviathans, the Grotto was to be built out of monolithic concrete and covered with a repeating tile that would adapt to the curvature of the surface. Our team’s design process used reverse engineering as a point of departure and transitioned to a revision of the shell typology applied to a new site and climate next to a pond landscape. Kiesler’s tile was dilated into a open cellular pattern generated with a Voronoi algorithm to develop a gradient of apertures that adjusted according to their location in the surface. The frame was built from stainless steel plate material that transitions in thickness based on FEA analysis and empirical testing through extensive prototyping to optimize material usage and fabrication details. The Grotto, named for New Harmony, is situated in a landscape developed with Kiesler’s site plan as a source of inspiration. Earth berms embrace the structure in an enclave of native planting and water. A gate designed by Kiesler was reintroduced in the new design as a nod to the original plan. A footbridge traversing the pond completes the figure in the landscape.
and provides another referential counterpoint to the new Grotto, not unlike the dolphin’s relation to the shell in the original design. The structure was completed through Kiesler’s original client and awaits the second phase of interior articulation. The frame of the Grotto anticipates an aggregation of cellular infill components with various geometric, material and programmatic responses. The relationship to Kiesler’s tile was maintained as a formal and organizational reference to inform methods of analog construction that reacted to the digitally fabricated primary structure.

Where the surface curls under and floats above the foundation a seating system is introduced. Pillowed concrete tiles fill the cells and provide a variety of ergonomic opportunities for seating and reclining in the space. Fabric-formed concrete is cast into frames that match the profile of the Grotto cells. The surface tension is influenced by the natural catenary form produced by the weight on the surface and points of resistance pushing into the concrete. These intrusions become drainage holes for the surface of the seating. By adding volume the Grotto becomes voluptuous like Kiesler’s interior spaces.

In the upper region of the cellular surface skylights were proposed to modulate sunlight and to subdivide the primary openings with a softer volumetric surface quality. The cells are reproduced in frames, and fabric tubes are stretched inside the void and joined at the edges. This emergent form is arrested with resin and eventually a composite shell will complete the thickened surface. The logic of subdivision follows that of the pillowing of the seating and a third system of sheet metal packed cylinders that form a gabion trellis for a living wall in the lower region of the Grotto that spreads out on the ground to connect to the soil.
Voronoi Steel
Guardrail and Tertiary Structure
Concrete Voronoi Tiling
Ipe Wood Herring Bone Decking
Steel Primary and Secondary Structure
Concrete Structural Infill
Concrete Piers

1. New Harmony Grotto
2. Kiesler’s Gate
3. Footbridge
4. Earthberms
5. Pond
6. Lawn

New Harmony Grotto
Site Plan
Footbridge
The footbridge has been further developed as a unique structure that curves in plan and section. The pathway in the revised site plan diverges at the exit and a bifurcating form was introduced. The cellular pattern was further researched referencing the cantilevered efficiency of the dragonfly wing and the emergent patterns found in cracked mud. The primary structure aligns to create spanning members and support for the herringbone pattern of the deck that provides lateral bracing. As the structural pattern migrates up the sides into the guardrails, a staggered pattern of points produces a frame that distributes loads in multiple directions. Dynamic re-meshing was used to optimize the form and density of the cellular organization.

ANDREW VRANA is an Architect who has structured his practice at Metalab around design informed by advanced computation and digital fabrication as well as a working knowledge of materials and building culture. This expertise was cultivated at Columbia GSAPP (MArch '98) were he was awarded the McKim Prize upon graduation and though employment at the offices of Enric Miralles/EMBT and Renzo Piano Building Workshop. Now through working with a network of capable fabricators at Metalab since 2007, the integrated delivery of design, custom building components and construction management is achievable on architecture, civic art and product design projects. Recent awards at Metalab include AIA Houston Artist of the Year, Architect Magazine R+D Award and AIA Design Awards. In academia as a Visiting Assistant Professor at the College of Architecture at the University of Houston he has co-taught digital fabrication seminars and studios since 2005. Andrew seeks to merge the formal and material possibilities of contemporary design with a localized sensibility toward craft and quality of execution. In 2009 he co-founded TEX-FAB Digital Fabrication Alliance, an educational non-profit, to expand his interests in pursuing design research through the application of digital technology within the Texas region and beyond by organizing workshops, lectures and design competitions.

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