Casa Covida

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CASA COVIDA

Mud Frontiers III - Zoquetes Fronterizos III

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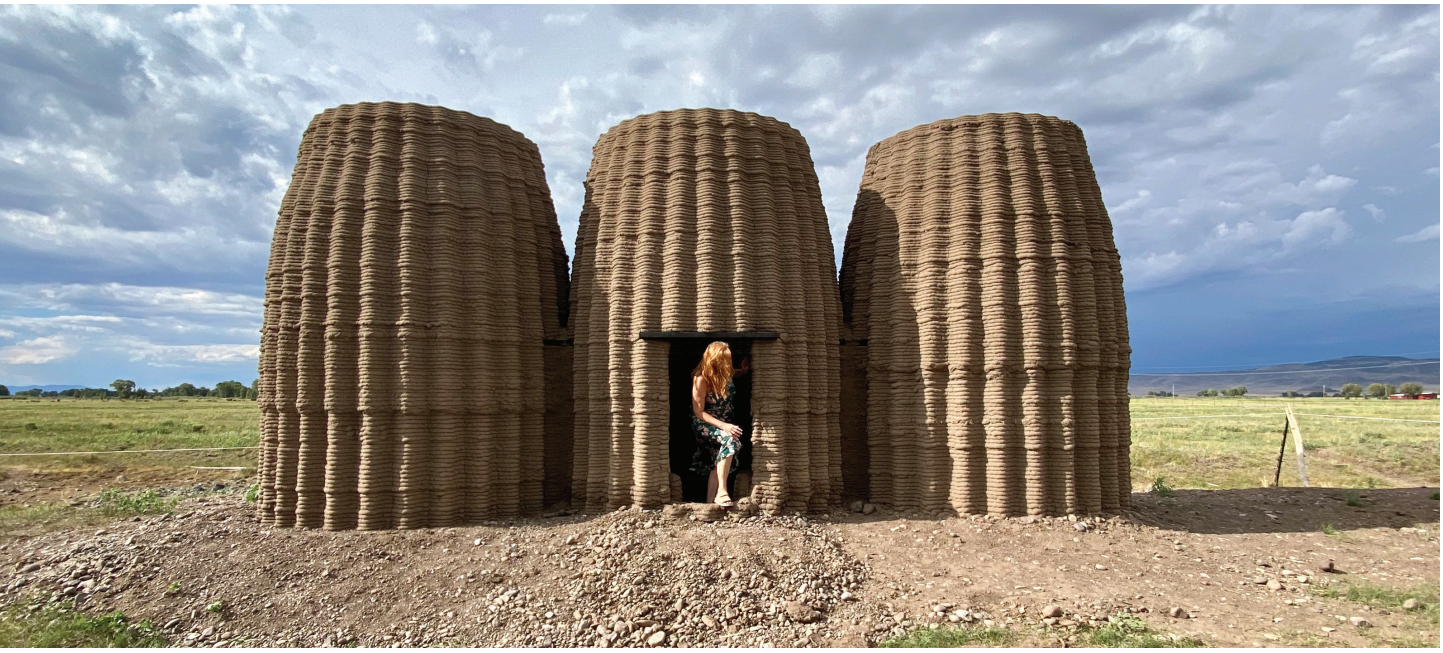


1 Casa Covida, 3D printed in-situ with a mixture of local earth, straw and water.

Abstract

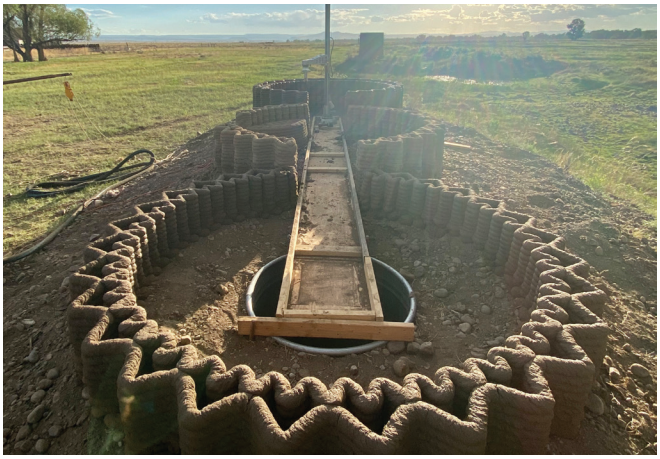
Casa Covida advances large scale earthen additive manufacturing by establishing new methods for the creation of interconnected, partially enclosed dome structures using a lightweight SCARA robotic arm and custom toolpathing software in combination with traditional earthen construction techniques. In the time of Covid-19, digital fabrication and construction are made difficult by a diminished supplychain and the safety concerns associated with a large team. In this project local material, dug from the site itself is used for construction coordinated by a team of four people working in a remote location. Three rooms are printed on site 500mm at a time by moving the 3D printer between stations connected by a low cost 4th-axis constructed from plywood. This system allows essentially simultaneous construction between domes, continuously printing without waiting for drying time on one structure so that a continued cycle of printing can proceed through the three stations 2-4 times in a day, thereby minimizing machine downtime. The machine control software used in this project has been developed from the framework of Potterware, a tool built by our team to allow nontechnical users to design and 3D print functional ceramics through an interactive web interface.

PRODUCTION NOTES

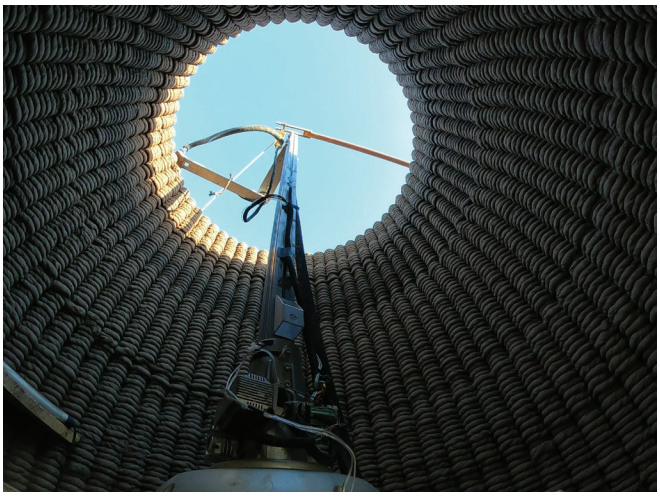
Designer: Emerging Objects
Status: In Progress
Location: San Luis Valley, Colorado
Date: 2020 - ongoing

Local earthen material

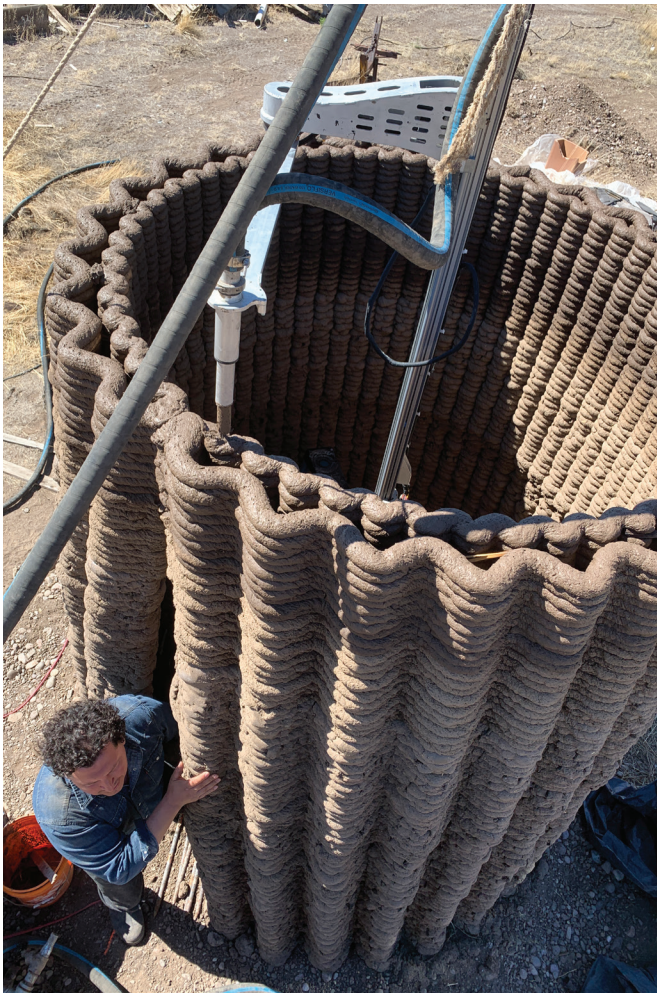
All material is excavated from the alluvial soil deposits in a field adjacent to the site (within 500 meters) and processed by hand through a 1/4" (1 cm) screen to remove any large gravel from the mix. Chopped wheat and barley straw from a local supplier (14 miles, 26



2 A static 4th axis constucted on site facilitates multiple printing positions.



3 The SCARA arm printing from within the structure.



4 The first doubly-walled prototype frustrum space under construction..

km) is combined with water and local soil, which contains an ideal mixture of clay, sand, silt and aggregate, in a portable cement mixer before being loaded into the hopper of the mortar pump. The foundation consists of a two foot (0.6 meter) compacted gravel pad collected in the earth sifting process. The system is designed to demonstrate the feasibility of sustainableconstruction through use of local earthen material and low cost robotics. The material used in the project contains no synthetic stabilizers or cement, it is local soil mixed with straw and water, left to dry using only wind and sun (Rael 2010).

Lightweight, low cost construction robotics

The 3D printing system combines a 3-axis SCARA (Selective Compliance Articulated Robot Arm) purpose built for on site additive manufacturing, with a continuous flow, stator driven mortar pump (Makino, 2014). The printing system uses a stator driven mortar pump to deliver material to the toolhead. For the latest application of this system we have mounted the arm on a 4th axis rail which creates a rigid structure between printing positions, greatly expanding the range of the machine. The total build area is 8000mm x 2667mm (~26'x8'). This setup was carried to the site by two people, assembled and calibrated in less than an hour. Relocation between stations on the 4th axis takes around five minutes. The complete robotic system was developed for a fraction of the cost of a gantry printer system of equal build area.

This lightweight, quick to assemble system does not share the fine precision of an industrial milling or inspection robot arm, however it performs within the tolerances of the material and process for which it is intended.

Flexible toolpathing software

The machine control software used in this project has been developed from the framework of Potterware, a tool built by our team to allow nontechnical users to design and 3D print functional ceramics through an interactive web interface. For this application Gcode is organized into 4-8 layers segments which are drip fed to the SCARA arm via WiFi. Pauses and positional checks are programmed into

5 Two full prototypes exploring the integration of functional aperatures and stairs.

6 A space for bathing occupies east room of Casa Covida.

7 The central hearth space of Casa Covida with integrated, printed furniture, including space for sleeping in adjacent room.

the toolpath to allow time for operators to load the pump hose into the machine nozzle at each station and confirm accurate z-height relative to the previous layer. By taking this piecewise approach we are able to detect and compensate for inconsistencies in the structure resulting from non uniform drying due to prevailing wind direction, rain and sun. Layer height progressively decreases relative to slope angle to ensure better layer adhesion. Feedrate can be adjusted in real time by multiple members of the team via WiFi using a tablet or smartphone.

ACKNOWLEDGMENTS

Project Team: Ronald Rael, Virginia San Fratello, Logman Arja, Alexander Curth, Mattias Rael and Danny Defelici at 3D Potter.

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