

Multidisciplinary Senior Design Project Readiness Package

Prepared by Sarah Brownell on 080519

Project Title	3D Concrete Printer (Small Scale)
Project Number	P20652
Primary Customer	Sarah Brownell
Sponsor	MSD
Faculty Champion	Sarah Brownell
Other Support	[As applicable]
Project Guide	[Assigned by MSD]
IP Considerations (must pick one)	<ul style="list-style-type: none">a) IP assigned to [organization]b) Limited use agreement to allow [organization] to use outcome, team retains ownershipc) Team retains ownership, no additional requests for use ORd) Client requires result to be placed in the public domain

Project Information

Overview

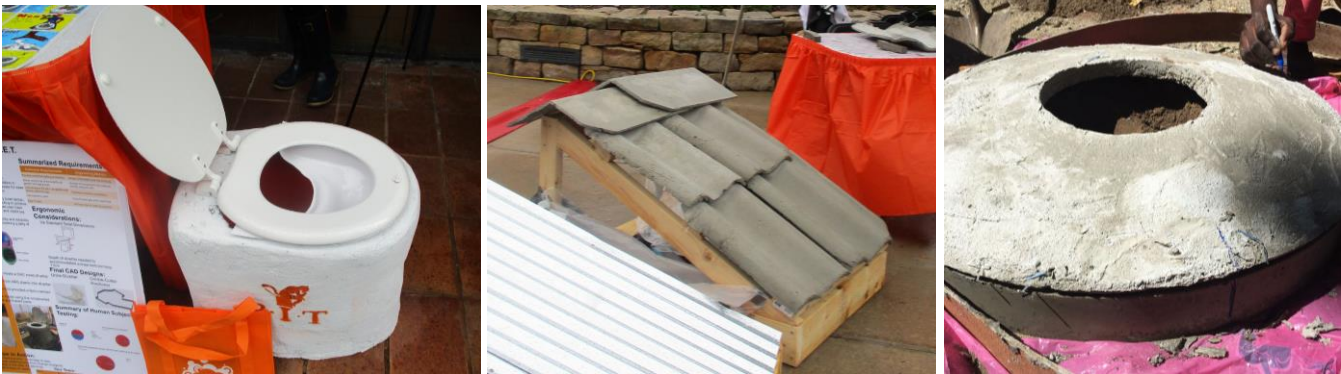
New technologies for 3D printing concrete may someday alter the way homes and other concrete objects are constructed. Concrete is one of the least expensive building materials around and has many advantages over other materials in terms of flexibility of form, fire and weather resistance, and durability. In recent years, many MSD teams have had the need to prototype concrete objects. Currently prototyping requires expensive, time consuming, or inaccurate molding processes using CNCed foam, hand cut cardboard or expensive wood. The goal of this project will be to develop a prototype 3D concrete printer and appropriate concrete mix formula for MSD team use for prototyping. The printer should be able to print concrete objects up to 36" diameter and 18" high.

Here are some examples of existing 3D concrete printers in action:

<https://www.youtube.com/watch?v=UFWg6Qb8yYI>

<https://www.youtube.com/watch?v=blyUdESHr-g>

Some of the previous MSD projects that could benefit from 3D concrete prototype printing include:



P19416, the base for SOIL's urine diverting toilet seat (left), P18485, concrete roofing tiles for 4-walls (middle) and P18416, the arborloo (right).

All of these teams spent more time researching and creating their molding processes than building their actual prototypes due to limited funding for molding materials like higher quality foam, plastics, and wood blocks. A quick internet search did not produce any projects using concrete as a printing material for smaller objects than houses, so there is possibly a market opportunity for this technology!

This team is tasked with developing a 3D printer that can print with a mixture containing cement or a similar material that will cure without losing its shape. Some of the challenges include developing a stiff concrete mix that can be printed, controlling flowrates, translating drawings into commands for the printer (perhaps there is existing software?), and maintaining accuracy of the shape.

Preliminary Customer Requirements (CR)

Prints objects using cement or similar inexpensive material that can be used in prototyping and mold making.

Prints objects up to 3' in diameter and 18" tall.

Dimensionally accurate printing

Concrete "ink" holds shape when printed

Doesn't clog
Cures in a similar time to regular concrete
Final object has a strength better than half that of standard concrete
Easy to clean
Easy to load concrete mixture or add more
Adjustable flowrate
"Ink" system can be removed for cleaning
Can be disassembled for storage when not in use
Can be used indoors without making a mess

Preliminary Engineering Requirements (ER)

Prints up to 3' diameter objects
Prints up to 18" tall objects
Dimensionally accurate within 0.5" or better
Cures enough to be removed from the printer in less than 48 hours
Printed object strength is better than half the strength of standard concrete in compression and tension
Cleanup time after printing < 1 hour
Time for disassembly < 30 minutes

Constraints

Must be able to be used and stored in MSD or Construct space
Budget—depending on what funding is available, the team may need to prioritize parts of the project to complete or scale the dimensions.

Project Deliverables

Minimum requirements:

- All design documents (e.g., concepts, analysis, detailed drawings/schematics, BOM, test results)
- Working prototype
- Technical paper
- Poster
- All teams finishing during the spring term are expected to participate in ImagineRIT

Budget Information

Ideally needs \$1500, but we can do some preliminary work with \$500 or whatever is available.

Intellectual Property

Students may retain the IP. If they are not interested, information should be placed in the public domain.

U.S. Citizenship

No requirements

Travel Opportunities

Students are highly encouraged to submit their work for a conference!

Project Resources

Anticipated Student Staffing by Discipline

Department	Expected Activities
Biomedical Engineering	
Computer Engineering	(1-2) programming, control system
Electrical Engineering	(1-2) control system, power management
Industrial & Systems Engineering	(1) systems design, user considerations (loading, cleaning), engineering economy, design for manufacturing and assembly (esp. disassembly), project management
Mechanical Engineering	(2) structure, motion of the printer head, flow of concrete,
Other	(1-2) Chemical engineering—designing a concrete mix suitable for printing, Civil Engineering Tech student?

Required Resources

Faculty	Denis Cormier, Mike Buffalin and other 3D printing expertise on campus, Civil Engineering Tech expertise.
Environment	Workspace without a rug...may need shop space? Could use Chem Eng. lab for preliminary testing.
Equipment	CET concrete testing lab or KGCOE materials lab for testing mix strength
Materials	Cement and additives
Other	