Agenda

- Team Introductions
- Problem Definition
    - Current State, Desired State, Stakeholders
- Deliverables
- Use Case
- Customer Requirements
- Engineering Requirements
- Draft Project Plan
- Benchmarking
- Issues and Corrective Actions

Introductions

Name	Major	Role
Nick Claver	ME	Communicator
Alexander Pegot Ogier	ISE	Facilitator
Seth Deane	CE	Documentation Master
Mary McCombs	EE	Mediator
Chad tenPas	ME	Purchaser
Amiee Jackson	ME	Systems Engineer
Joseph Bragg	EE	Co-Project Manager
Alex Kelly	CE	Co-Project Manager

Problem Definition

- Current State
  - Large-scale 3D concrete printers
    - Homes, buildings
- Desired State
  - Solution for medium-scale objects
  - Allows RIT MSD students to prototype with concrete
- Key Goals & Deliverables
  - Develop proprietary concrete mix, at least half as strong as regular concrete
  - Functional prototype by the end of the year
- Constraints
  - Print envelope
  - Print accuracy
  - Storage
  - Budget

Current State

Molds of CNC'd foam, hand cut cardboard, or wood

- Expensive
- Time-consuming
- Inaccurate

No printer has been built for MSD for this purpose

Similar Projects:

- P18652: Medium-Scale 3D Printer
- P17551: Sandia Instrumented 3D Printer
- P15416: Lightweight Concrete Arborloo
- P14551: Multi-Process 3D Printing

Desired State

- Low Budget 3D concrete printer for MSD prototyping
- The concrete dispenser mechanism is mobile and moves through space to deposit on a recipient surface without clogs or interference
- Use of industry standard machine language, G-code

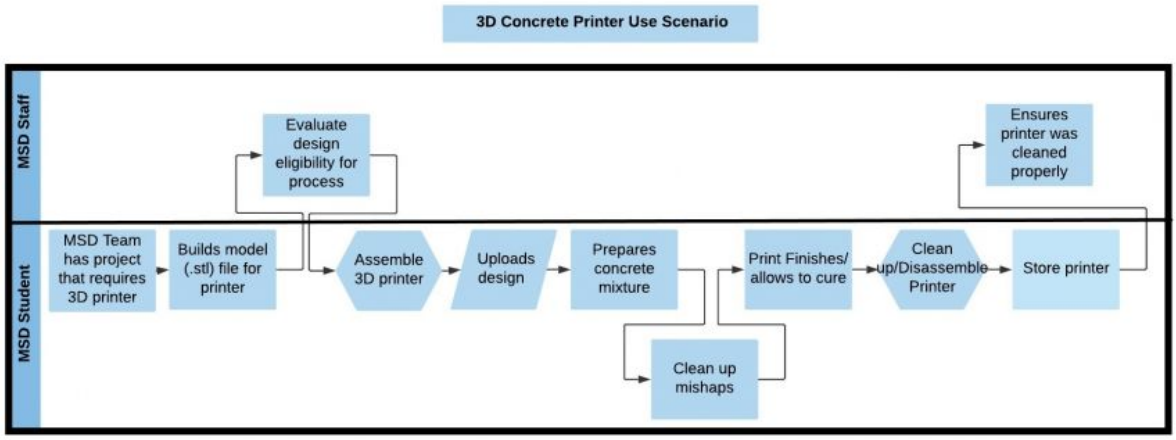
Stakeholders

- Client: Sarah Brownell
    - Prototyping 36” diameter by 18” height Arberloo bases
- MSD students:
    - Prototyping cement based objects for MSD projects
- RIT Faculty:
    - Maintaining/servicing the printer, training users

Deliverables

- The project will include material specifications to choose concrete best-suited to the system.
- Develop a medium-sized 3D printer that can be disassembled for storage.
- Develop a concrete mix that is at least half as strong as standard concrete.
- The expected result is a functional prototype MSD teams may use for their projects.

Use-Cases



Customer Requirements

Requirement #	Priority Rating	Category	Customer Requirement Description
CR1	3	Machine Size	Storage volume is less than occupied while printing
CR2	3	Machine Size	Small machine footprint for use in MSD or Makerspace
CR3	9	Capability	Uses an inexpensive and ubiquitous material, such as a cement based mixture, as 'ink'
CR4	9	Capability	Rapid prototyping of concrete objects
CR5	9	Capability	Printing envelope must include 36"x36"x18"
CR6	9	Capability	Strength of printed objects is comparable to traditional methods
CR7	3	Capability	Dimensional accuracy of 0.5" minimum
CR8	9	Usage	Intuitive machine work-flow
CR9	3	Usage	Ergonomic set-up, operation, clean-up, and take down
CR10	3	Usage	Material is fed to machine in ready-to-print form
CR11	3	Maintenance	Minimal mess is generated in the work area
CR12	3	Maintenance	Accessible material delivery system for cleaning and maintenance
CR13	9	Cost	$1500 budget is adhered to (unless outside funding is sought)
CR14	9	Cost	Concrete prototype production is less expensive than traditional mold forming

Engineering Requirements

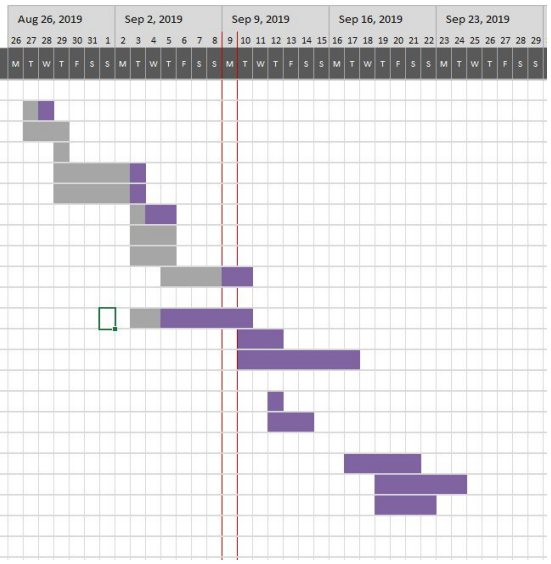
#	Priority Rating	CR Reference	Category	Engineering Requirement Description (metric)	Unit of Measure	Target Value
ER1	9	CR9	Process Time	Setup time	min	< 15 min
ER2	9	CR9	Process Time	Calibration time	min	< 3 min
ER3	9	CR9	Process Time	Takedown time	min	< 15 min
ER4	9	CR4	Process Time	Printing time for a standard 0.5 m x 0.25 m concrete block	min	< 10 min
ER5	3	CR2	Machine Size	Printable envelope	in	
ER6	3	CR2	Machine Size	Footprint	in	
ER7	3	CR1	Machine Size	Storage volume	in	
ER8	3	CR4	Speed	Max printing speed	mm/s	
ER9	3	CR4	Speed	Max travel speed	mm/s	
ER10	9	CR6	Mix	Mix strength	psi	
ER11	1	CR9	Mix	Mix tank capacity	m^3	
ER12	3	CR9	Mix	Aggregate size range	mm^3	
ER13	3	CR5	Printing	Printing width range	cm	
ER14	3	CR1	Printing	Printing thickness range	cm	
ER15	9	CR7	Printing	Dimensional accuracy	cm	
ER16	1	CR7	Printing	Nozzle diameter	mm	
ER17	3	CR12	Printing	Nozzle life	hours	
ER18	3	CR8	Printing	Flow Rate range	ml/s	
ER19	9	CR4	Computer	Compatible operating systems		
ER20	9	CR4	Computer	Compatible model file types		
ER21	9	CR8	Safety	Collision detection time	ms	
ER22	9	CR8	Safety	Auto-shut down on impact	binary	Yes
ER23	9	CR13	Cost	Material Cost	Dollars ($)	< 1500$

Project Agenda

Project Start: Tue, 8/27/2019

Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Project Definition Phase				
Draft Problem Description	Team	95%	8/27/19	8/28/19
Formulate Customer Interview Questions	Individual to Combine	100%	8/27/19	8/29/19
Complete Customer Interview	Team	100%	8/29/19	8/29/19
Customer Requirements Draft	Individual to Combine	95%	8/29/19	9/3/19
Engineering Requirements Draft	Individual to Combine	95%	8/29/19	9/3/19
Draft Design Drivers	Team	50%	9/3/19	9/5/19
Draft Team Values and Norms	Team	100%	9/3/19	9/5/19
Select Team Roles	Team	100%	9/3/19	9/5/19
Benchmarking	Individual to Combine	75%	9/5/19	9/10/19
Benchmark other concrete 3D printers	Material Team	0%	DATE	DATE
Prepare Presentation and EDGE for Design Review	Team	25%	9/3/19	9/10/19
Draft Risk Management	Team	25%	9/10/19	9/12/19
Detailed Risk Management Analysis	NAME	0%	9/10/19	9/17/19
Formulate Work Breakdown Structure	NAME	0%	DATE	DATE
Complete Design Review	Team	0%	9/12/19	9/12/19
Peer Evaluations	Individual	0%	9/12/19	9/14/19
System Design				
System Design	NAME	0%	9/17/19	9/21/19
Functional Analysis	NAME	0%	9/19/19	9/24/19
Concept Generation and Morphological Table	NAME	0%	9/19/19	9/22/19
Consult 3D Printing lab	NAME	0%	DATE	DATE
Talk to Ivancic about concrete thesis	Material Team	0%	DATE	DATE



Benchmarking

Parameter	Current Range	Project Goal	ICON - Vulcan II	COBOD - BOD 2	WASP - BigDelta WASP
Cost ($)	1,500-300,000	1,500	Not for Sale	300,000	Not for sale
Print Height (m)	0.5 - 12	0.5	2.6	6.6	12
Print Width (m)	0.9 - 2.2	1.0	8.5	7.2	7
Print Speed (max) (m/s)	0.4 - 1	-	0.1 - 0.2	1	0.4
Water usage (L/min)	-	-	7.5	Not reported	Not reported
Portability	Yes	Yes	No	No	Low

Risk Management

What type of risk is this?	***Describe the risk briefly***	***L*S***
Technical	Failure to produce/develop a cement-based mixture which has the qualities desired be successfully implemented in a printing capacity	3
Technical	The mechanical complexities of printing circular geometry with a semi-liquid material such as concrete.	6
Schedule	Scarcity of resources or parts that comply with our budget and will provide the specifications that our designs require.	2
Schedule	The team encounters time commitment difficulties	4
Safety	A program controlled, robotic machine presents physical danger to operators and bystanders.	3