Senior Design II | Spring 2021

Experimental 3D Printing for Optimization of Rapid Prototyping

Mentors

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Project Overview

Optimize the process of 3D printing by incorporating a systems engineering approach to rapid prototyping for a pulley. The main goal is to:

- Break the process into subassemblies
- Minimize:
  - Production Time
  - Material Consumption
- Maximize:
  - Load Capacity (Breaking Point)

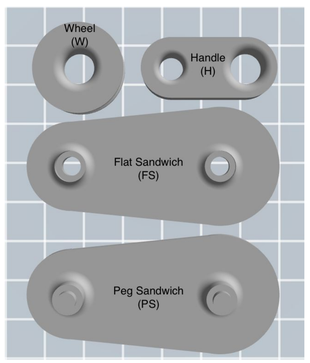
Specifications

PS1: Process times should be less than 2 hours.

PS2: It is desired that less than 6.5 m of material is used.

PS3: The pulley prototype should withstand a minimum weight of 20 pounds.

Prototype



A pulley was chosen to prototype due to its functionality in many fields. The team used an ABS material for printing this prototype.

Baseline Values

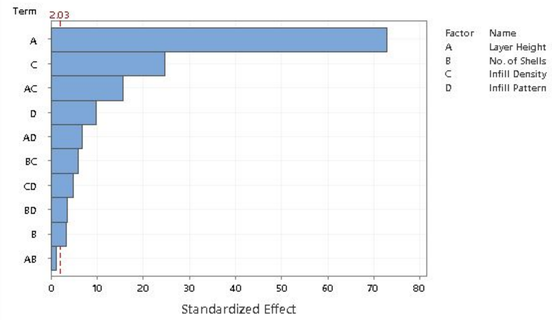
Print Time
72 min

Material Consumption
4.52 m

Breaking Point
55 lbs

Factorial Design Analysis

Print Time

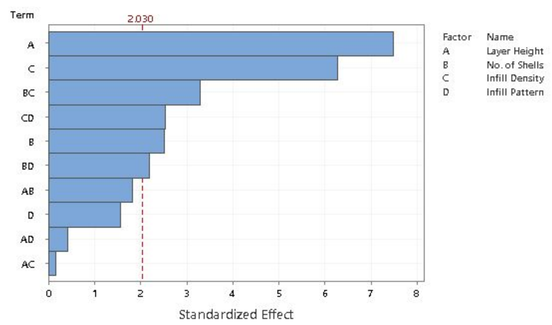


Significant Factors: Layer Height, No. of Shells, Infill Density, Infill Pattern

Material Consumption

Significant Factors: Layer Height, No. of Shells, Infill Density

Breaking Point



Significant Factors: Layer Height, No. of Shells, Infill Density

Cost Optimization Results

	Priority Rank	Criteria Weight
1.	Material Consumption	0.2672
2.	Breaking Point	0.1171
3.	Print Time	0.6158

Optimal Factor Levels

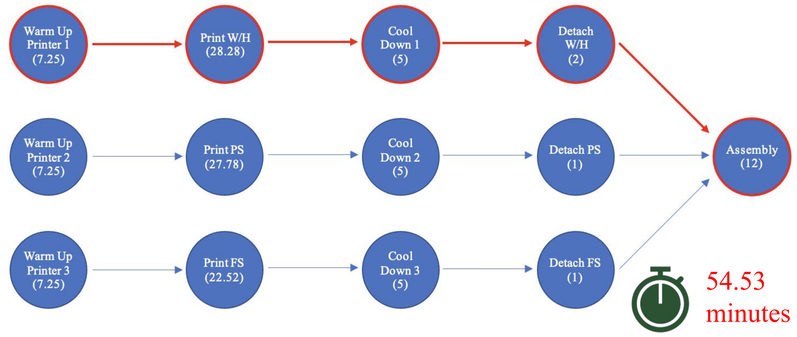
Layer Height	0.15
No. of Shells	1
Infill Density	40
Infill Pattern	Triangle

Expected Output

Breaking Point (lb)	119.67
Material Consumed (m)	5.0352
Print Time (min)	87.29

Cost Subassembly Process

(Single Assembly Time: 106.25 min)



Time Optimization Results

	Priority Rank	Criteria Weight
1.	Print Time	0.1172
2.	Material Consumption	0.6144
3.	Breaking Point	0.2684

Optimal Factor Levels

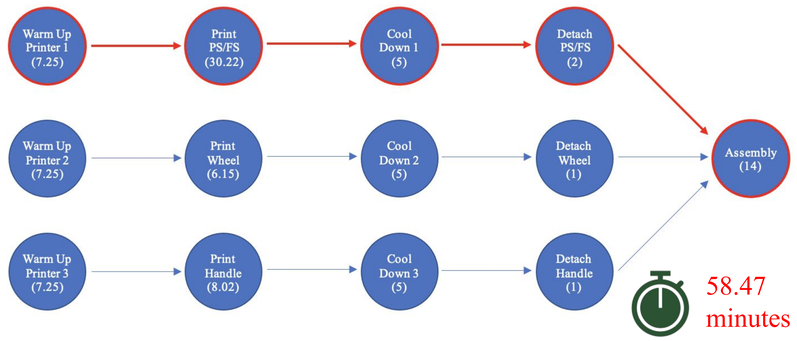
Layer Height	0.36
No. of Shells	1
Infill Density	40
Infill Pattern	Triangle

Expected Output

Breaking Point (lb)	83.25
Material Consumed (m)	5.5582
Print Time (min)	43.38

Time Subassembly Process

(Single Assembly Time: 59.47 min)



Quality Optimization Results

	Priority Rank	Criteria Weight
1.	Breaking Point	0.6786
2.	Material Consumption	0.1077
3.	Print Time	0.2137

Optimal Factor Levels

Layer Height	0.15
No. of Shells	5
Infill Density	53%
Infill Pattern	Triangle

Expected Output

Breaking Point (lb)	146.08
Material Consumed (m)	5.7605
Print Time (min)	95.49

Quality Subassembly Process

(Single Assembly Time: 135.75 min)