

Bio-Printer

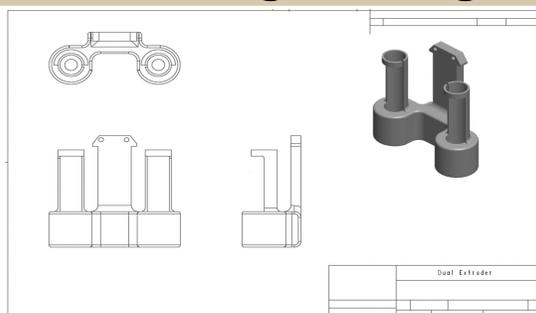
Problem Statement

Bio-printing, or organ printing, uses a three-dimensional (3D) printing technique to fabricate 3D tissue scaffolds. In this technique, living cells are encapsulated into a biomaterial which is then deposited layer-upon-layer, and a 3D scaffold structure is obtained. Therefore, a 3D printing system capable of printing a wide variety of complex and biomimetic porous structures with biocompatible materials is required in this process.

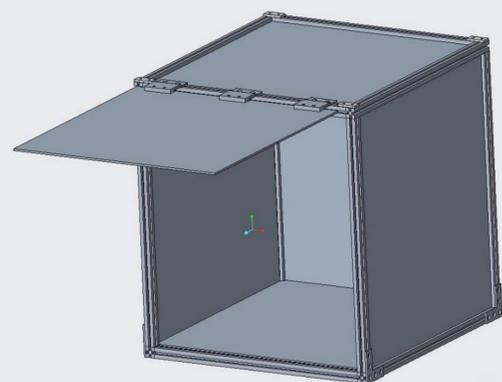
Requirements

Number	Requirement Description	Value or Limit	Other information
1	Enclosed, with positive air pressure	High	Cells will need a clean environment
2	Extruder needs to print multiple biomaterials	Moderate	Not all prints will need the same material
3	Printer's parameters need to be fine tuned	High	If the parameters are not met the print will fail

Engineering Designs

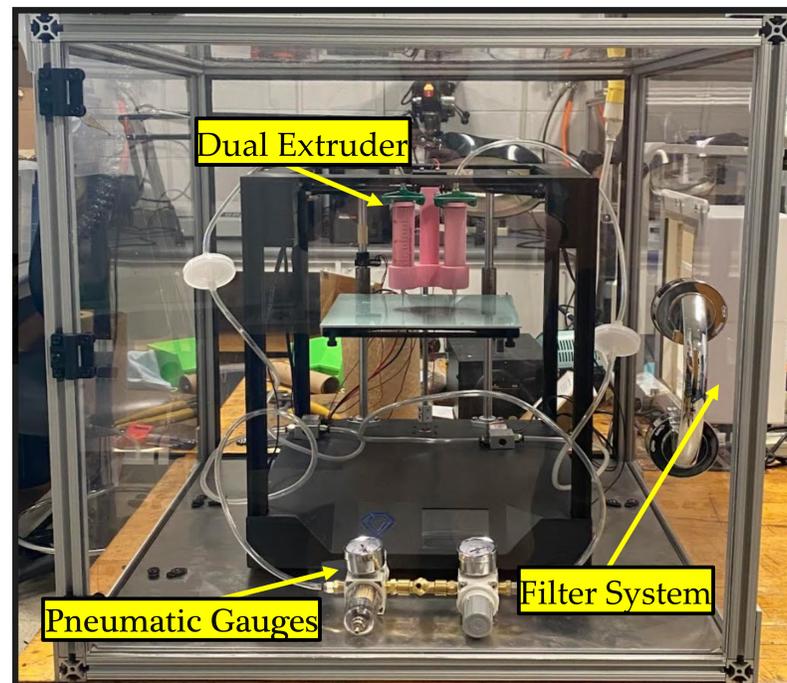


- Final design for Dual extruder



- Final assembly for encloser

Final Design



Bio-printer in the enclosure as final assembly



Dual extruder close up

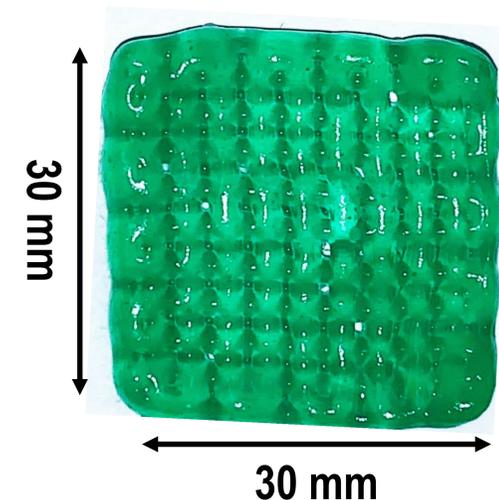
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9 ;LAYER: 1
10 ;-----
11 G1 F750 X120 Y100 ;move to first infill point
12 M400 ;read all the code
13 M42 S255 P35 ;Solenoid Extrude
14 G1 F750 X100 Y100 Z0.1 ;speed, x, y, z
15 G1 F750 X100 Y102
16 G1 F750 X120 Y102
17 M400 ;read all the code
18 M42 M1 S0 P35 ;Solenoid Exhaust
19 Z1 ;raise z for next layer
20
21 ;LAYER: 2
22 ;-----
23 G1 F750 X120 Y120 ;move to first infill point
24 M400 ;read all the code
25 M42 I1 S255 P16 ;Solenoid Extrude
26 G1 F750 X185 Y100 Z.6 ;speed, x, y, z
27 G1 F750 X183 Y100
28 G1 F750 X183 Y120
29 M400 ;read all the code
30 M42 I1 S0 P16 ;Solenoid Extrude
    
```

Dual extruder sample G-code

Results

•Bio-Gel: 3% Alginic acid sodium salt, high viscosity , 1% Carboxymethyl Cellulose (CMC), 96% water, keeps consistent viscosity even over the course of 3-4 days and when introduced to a 2% Calcium Chloride/water mixture hardens from a gel into a rubbery, malleable material



Successful 20 Layer Scaffold

Summary

The team was successful in optimizing the printer parameters to fit the bio-gel material created, but the team struggled to formulate more than one bio-material to use for the dual-extruding system. The printer can successfully print a scaffold of bio-material 20 layers high without failure, and future work would include finding another material to fill the second syringe and optimizing the dual-extruding capabilities.

Team & Acknowledgements

- Morgan Patton (BSE, EE)
- Zachary Hoots (BS, ET)
- Devin Berry (BSE, ET)
- Anderson Royston (BSE, ET)
- Tyler Manigault (BSE, ECET)
- Dr. Nazmul Ahsan (Faculty Advisor)