3D-PRINTED REACTOR KIT FOR DISTRIBUTED LEARNING

REACT3D

Problem: COVID-19 has limited student's ability to obtain experiential learning in a laboratory setting.

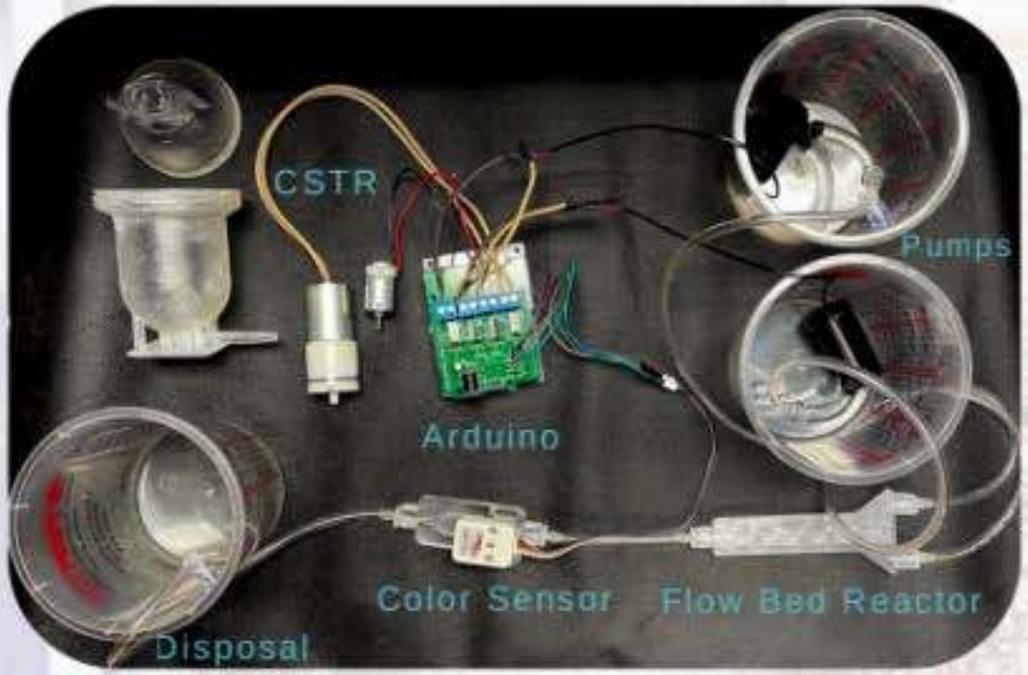
Solution: Design a 3D-printed chemical reactor that can measure the rate of a safe colorimetric reaction.

Reactor Kit

- Lab kit shipped to students
- Kit assembled at home
- Reaction rates related using Beer's Law
- Kit modular and open source

Product Specifications

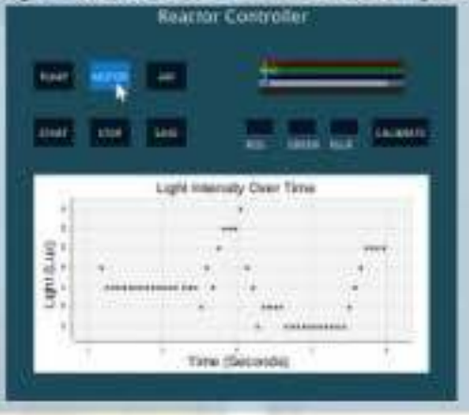
Total Cost	Kit Weight	Amount of parts	Hazardous Rating
< $100	< 1 kg	< 20	< 2/1/1



Colorimetric Reaction

- Safe chemicals: Ferric Thiocyanate & Iron Chloride
- Easily trackable
- 1st order reaction
- Drastic color change

Graphical User Interface (GUI)



Business Case

- 3D Printing 23%
- Chemicals 5%
- Tools 16%
- Electronics 56%

UF CHE

Liaison Engineer Dr. Carlos Rinaldi

Faculty Coach Dr. Philip Jackson

REACT3D

Team Members

Lezhou Ma, Valentina Martinez, Yusef Mostafa, Mikiya Paul, Sherlyn Wee, Ivan Zovko

IPPD APRIL 2021

UF Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

POWERING THE NEW ENGINEER TO TRANSFORM THE FUTURE

Department of Chemical Engineering
Integrated Product & Process Design

Final Design Review

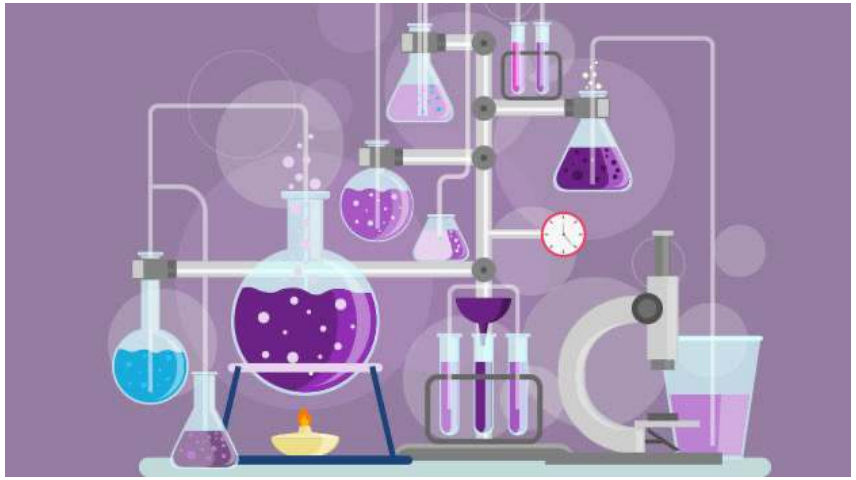
3D Printed Reactor Kit for Distributed Experiential Learning

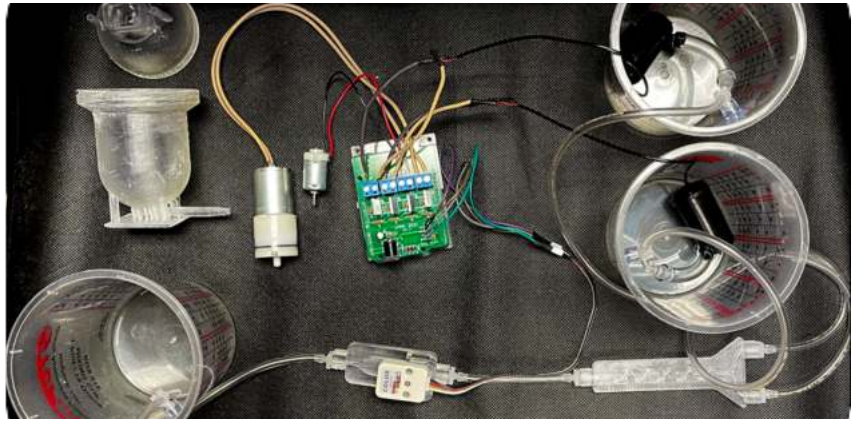
April 20th, 2021

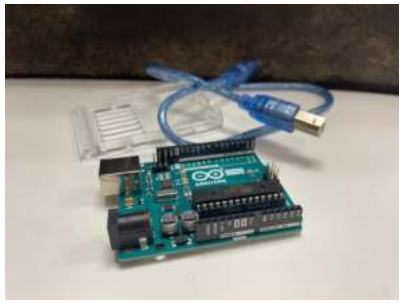
Lezhou Ma · Yusef Mostafa · Mikiya Paul · Ivan Zovko
Valentina Martinez · Sherlyn Wee

REACT3D

Introduction








USER
GUIDE

Product Specifications

Cost

< $100

Weight

< 1kg

Components

< 25

Hazard Rating

< 2/1/1

Others

Open source

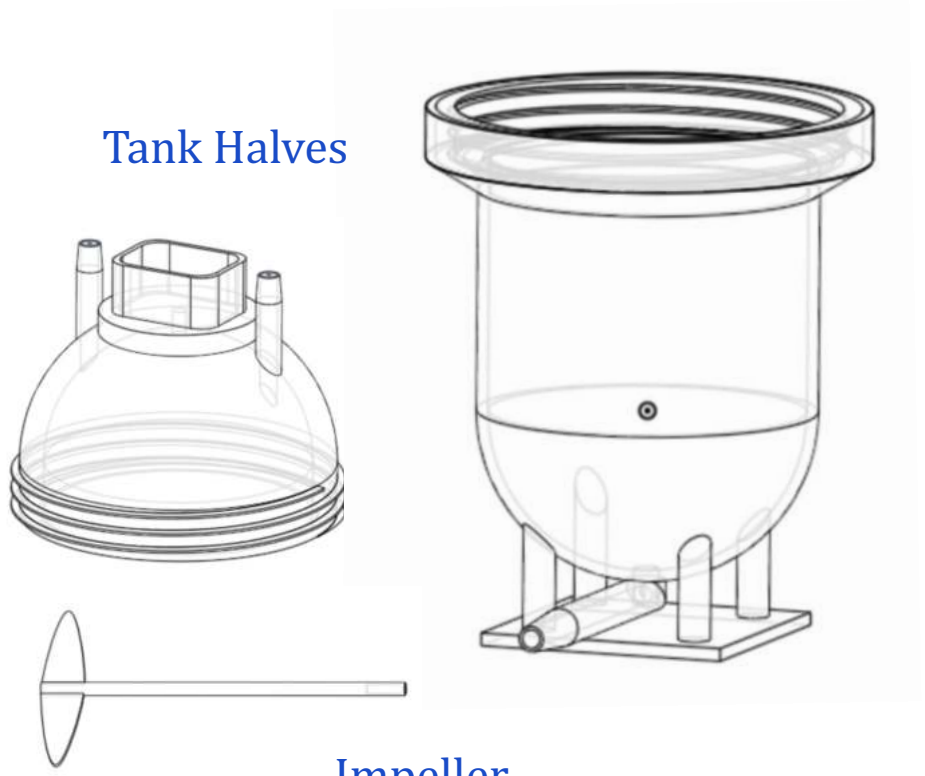
Colorimetric Reactions

★

Potassium Thiocyanate
+
Iron Chloride Ferric
⟶ Thiocyanate

Potassium Ferrocyanide
+
Ferric Ammonium Sulfate
⟶ Ferrocyanide

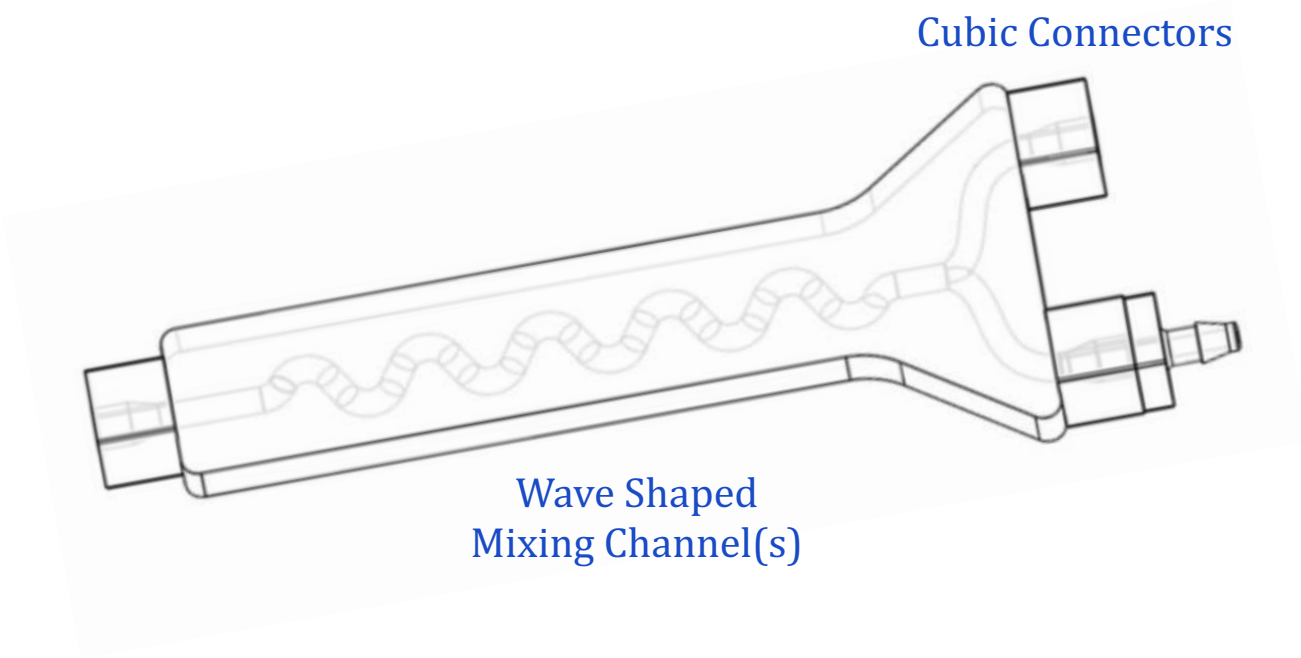
Continuous Stirred-Tank Reactor (CSTR)



CSTR CAD Design

CSTR Prototype

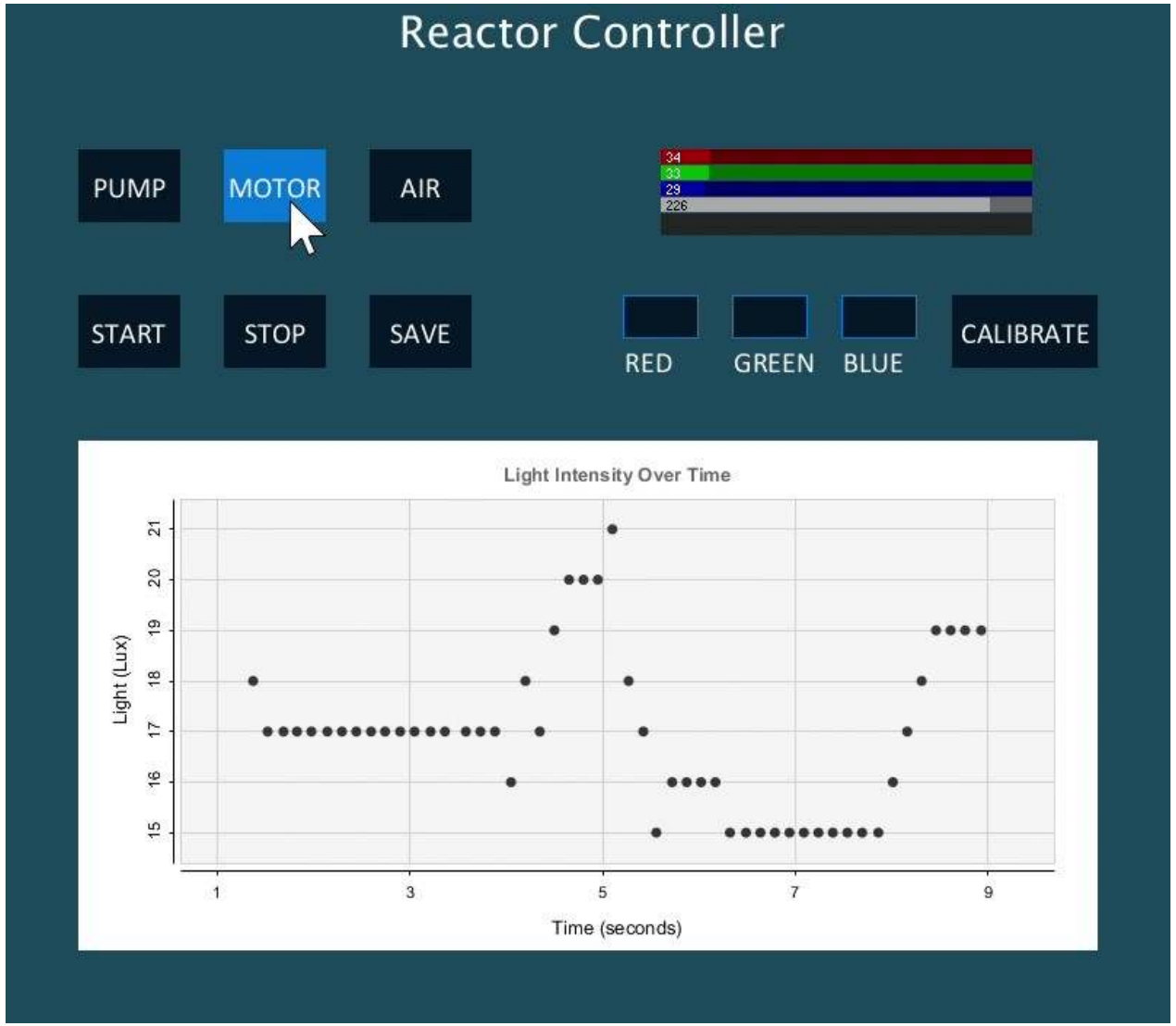
Flow Bed Reactor



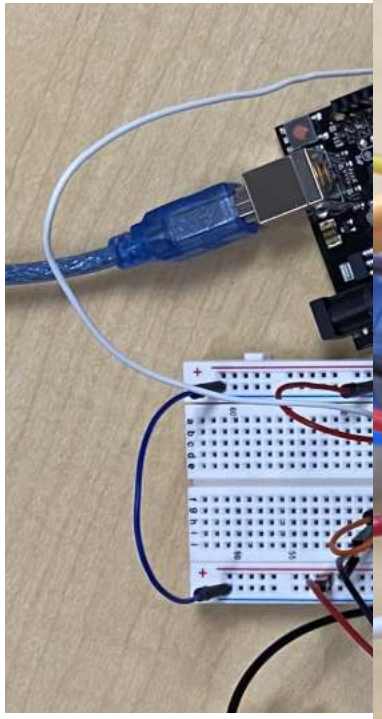
Flow Bed Reactor CAD Design

Flow Bed Prototype

Graphical User Interface (GUI)



PCB Development



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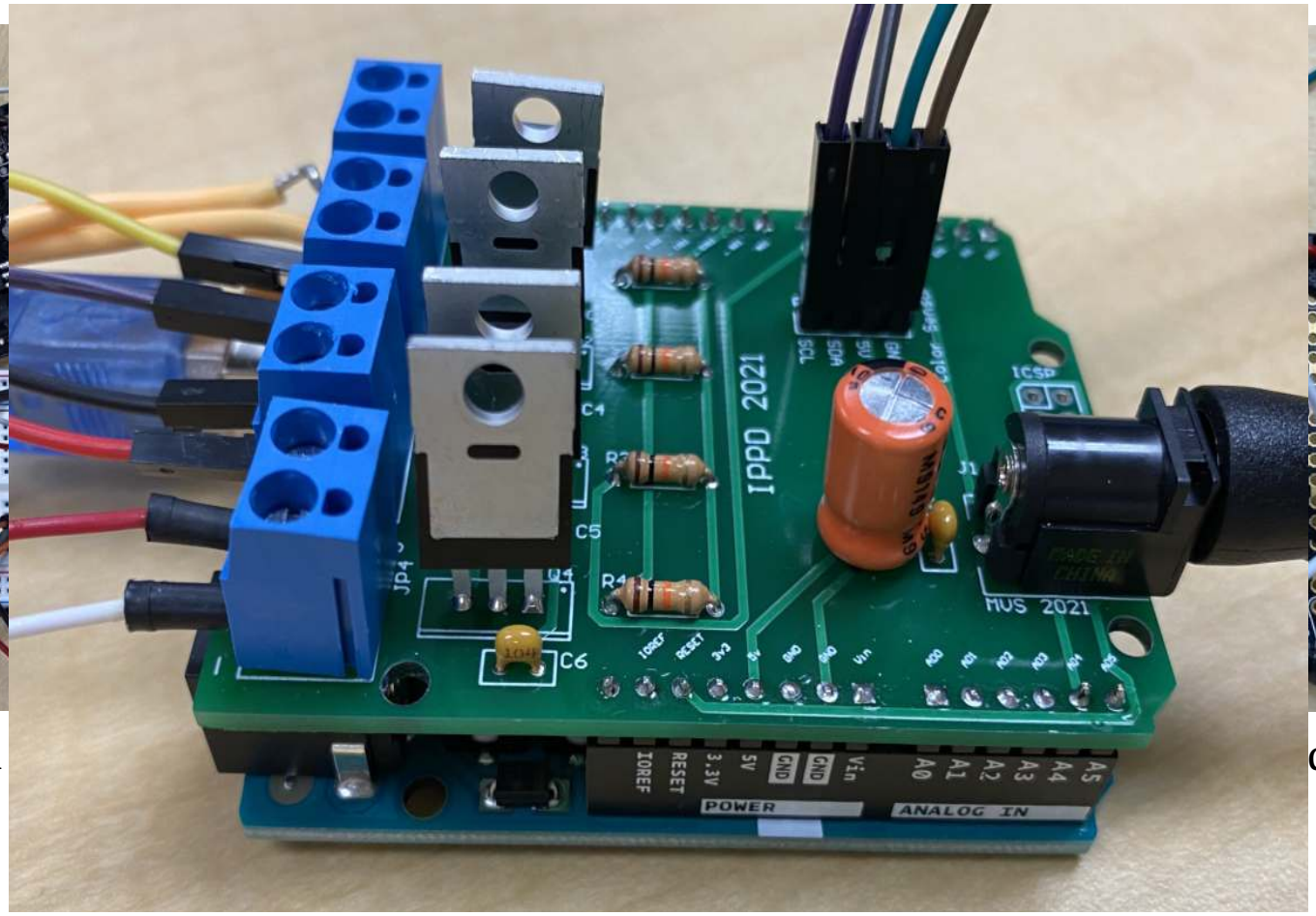
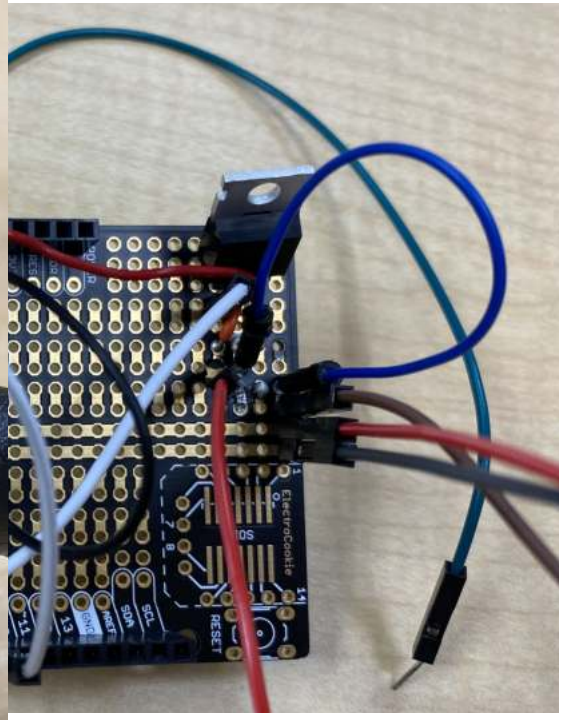
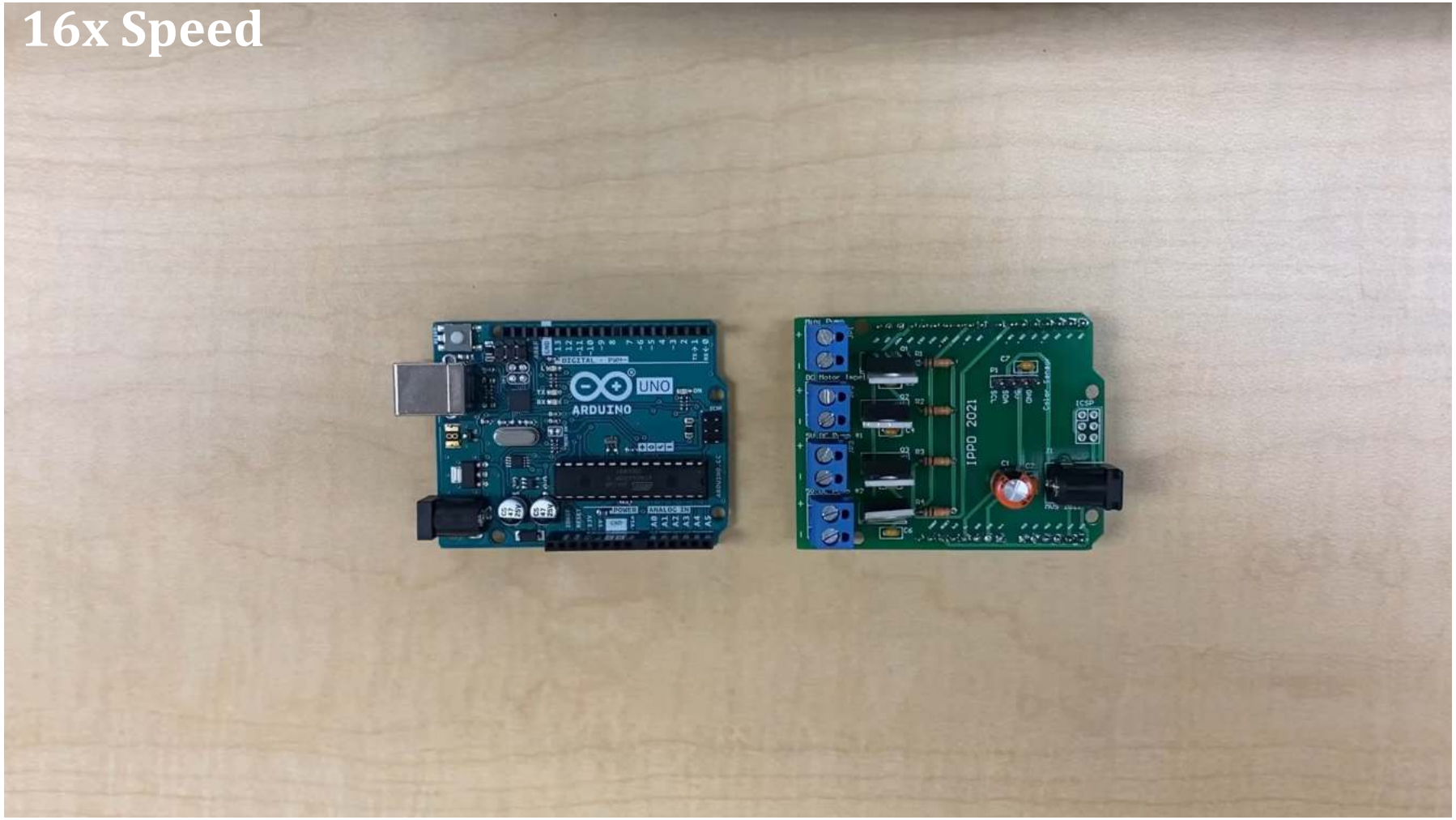


PCB Prototype

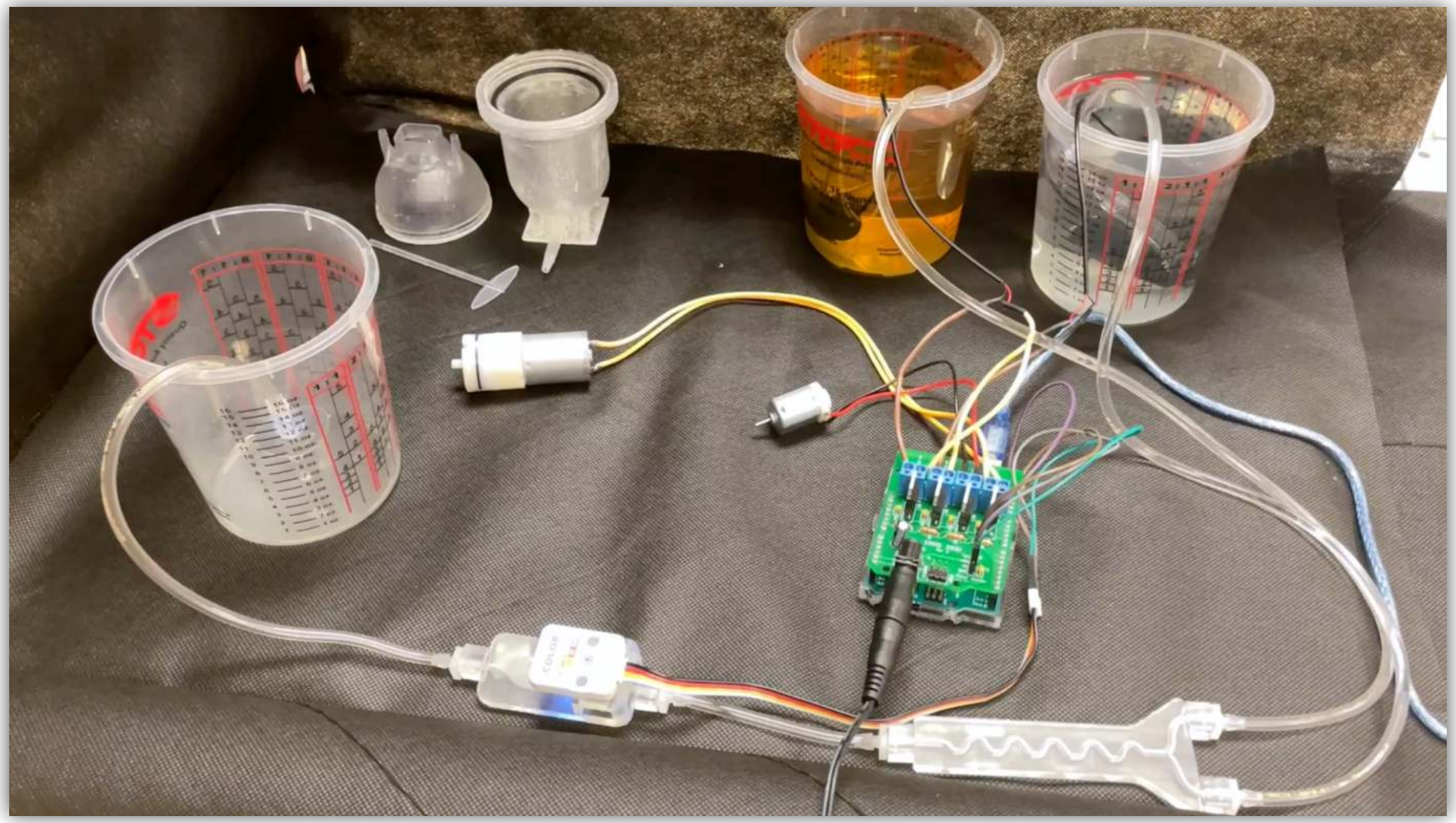


d Prototype

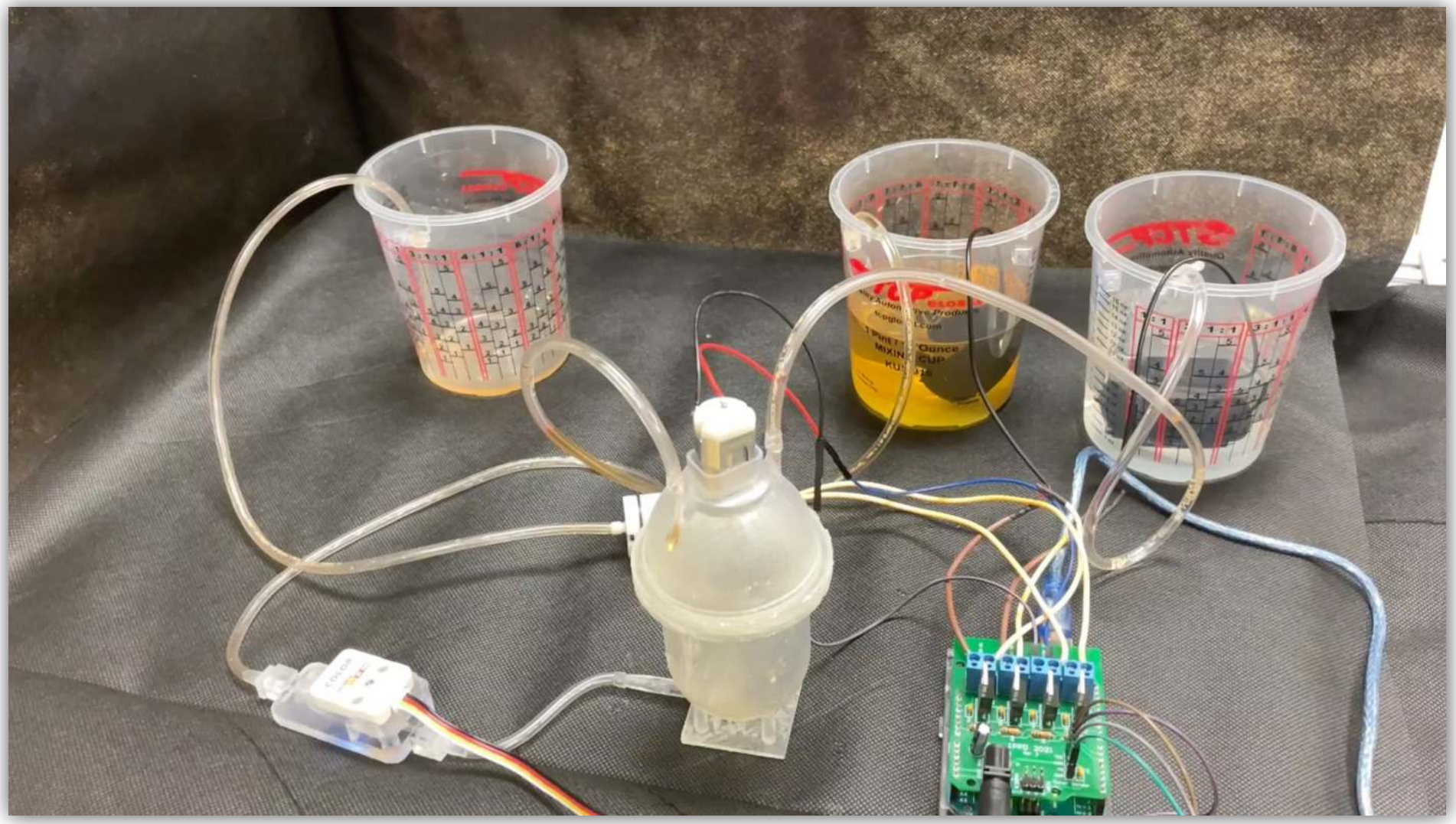
PCB Assembly



Flow Bed System



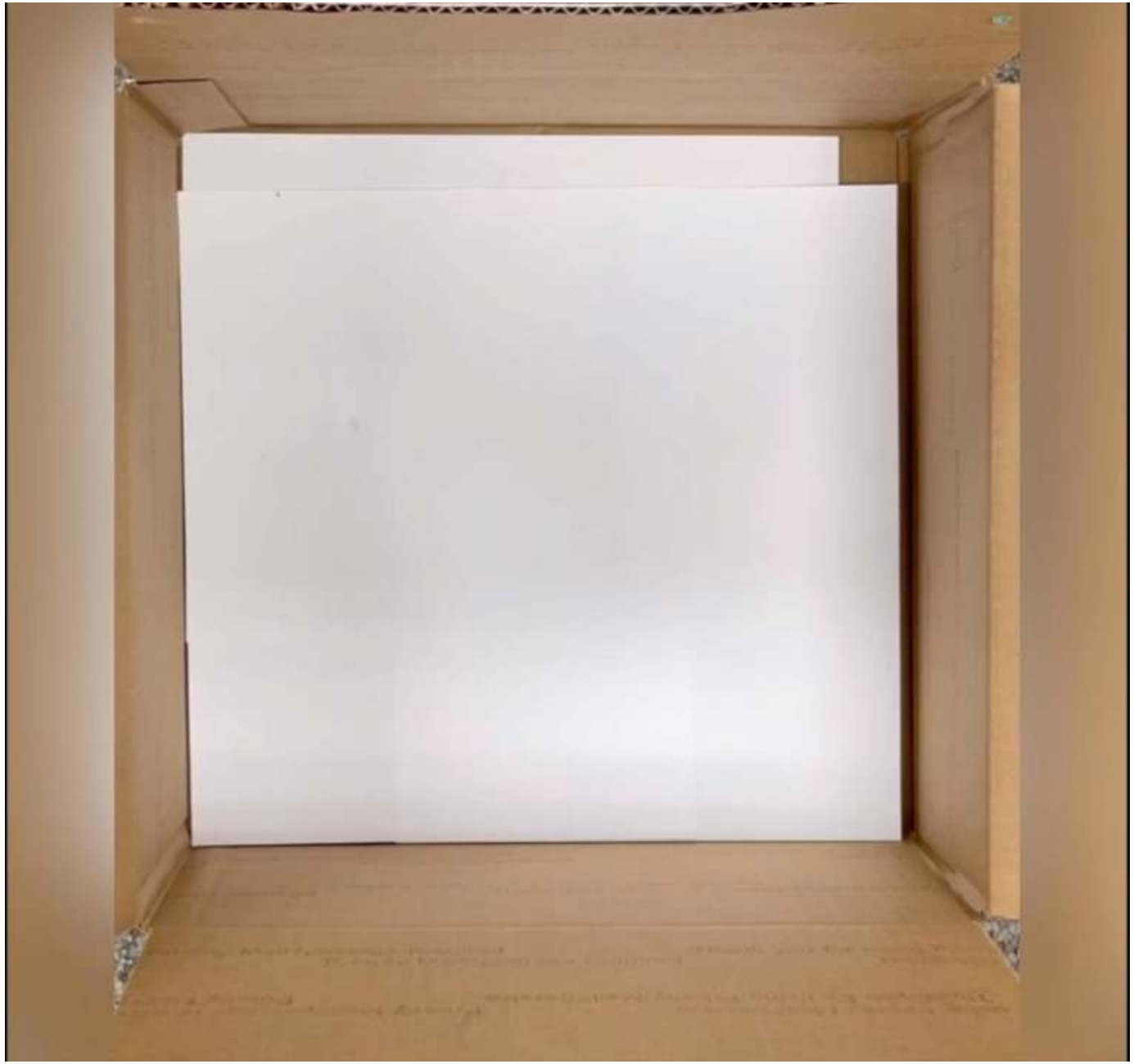
CSTR System



Kit Component Box

- Arduino + Jumper Wires
- Printed Circuit Board(PCB)
- User Manual
- Gloves
- Containers
- Chemicals
- Measuring Spoons
- Colorimetric Sensor
- 3 Pumps
- Tubing
- CSTR and Flow Bed Reactor
- Terminal Screwdriver
- AC Adapter
- Product Container

Size: 12”(L) x 12”(W) x 6”(H)

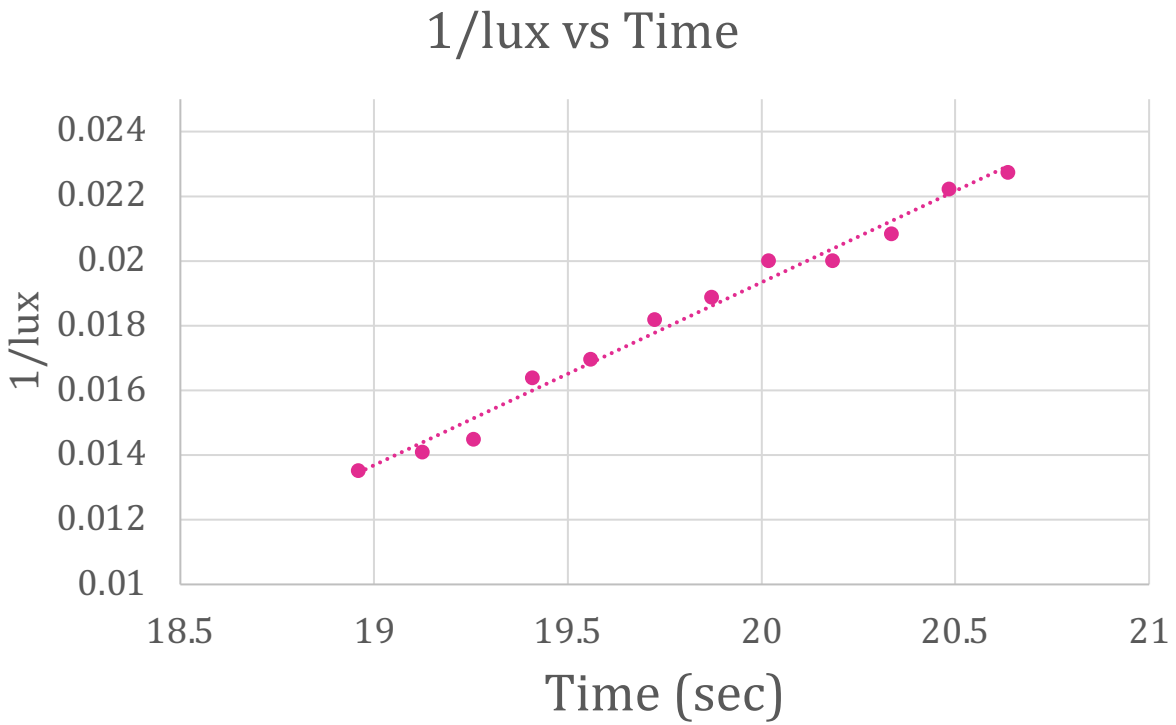


Kit Testing

No.	Test Type	Objective(s)	Status
1	Functionality	• Determine if each component works properly, and the rate/extent of reaction matches a traditionally done reaction	• **PASSED**
2	Drop & Shock	• Determine if the product is tough enough to withstand a sudden shock or a drop.	• **PASSED**
3	Accelerated Life Cycle	• Determine how many reactions can be completed with the reactor before any issues occur	• **PASSED**
4	User Testing	• Invite students to assemble the kit to determine accessibility	• **COMPLETED**

Kit Testing (Cont'd)

Concentration Selection



Rate of Reaction Calculation

Kit Testing (User Feedback)

12

Total Participants

CHE and CS students;
CHE professors;
Coach; Liaison

31 min

Average Assembly Time

Assembly times range from 20min to 1hr

58%

Had Prior Experience

Experience from using Unit Ops Lab kits

66%

Instruction Manual Satisfaction

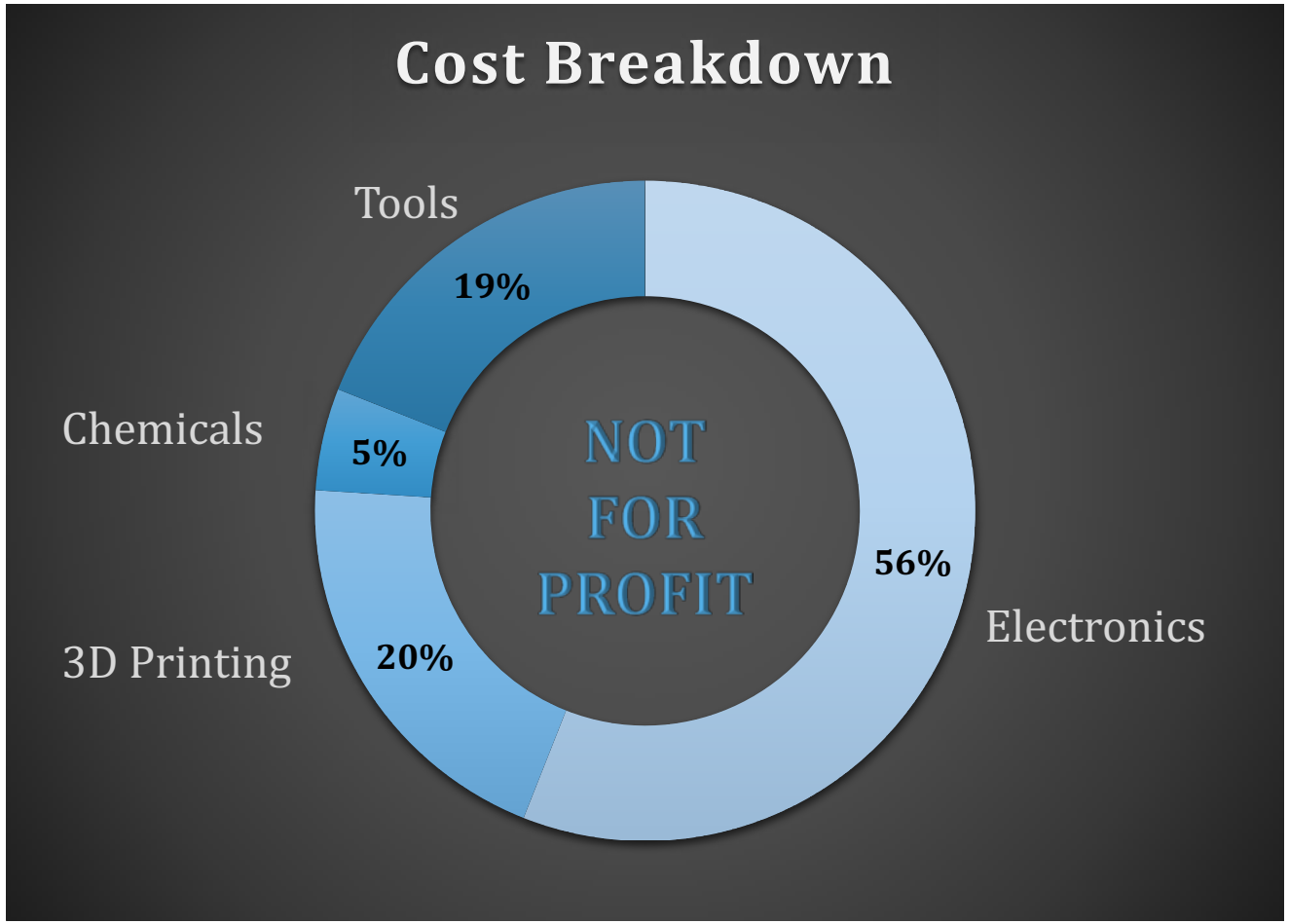
Feedback have been taken into consideration

90%

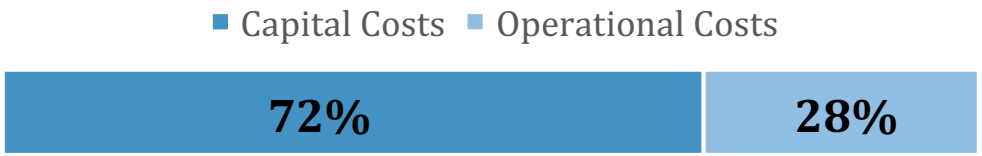
Instructional Video Satisfaction

Very positive feedback for video demos

Business Case



Kit Investment Breakdown



Subsystem	Cost
Electronics	$55.82
Reactor Components	$20.08
Chemicals	$4.30
Tools	$18.68
Total Cost	**$98.88**

Moving Forward…

Modularity

Open Source

More Reactions

Acknowledgements

Dr. Philip Jackson
University of Florida
Assistant Engineer of the Department of Engineering Education

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University of Florida
Chair of the Department of Chemical Engineering

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Electrical and Computer Engineering Professor

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Director of Integrated Product and Process Design

Integrated Product and Process Design Staff
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Q&A