Microscope Cell Culture Incubator

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Client: Dr. John Puccinelli
Date: 10/15/2021

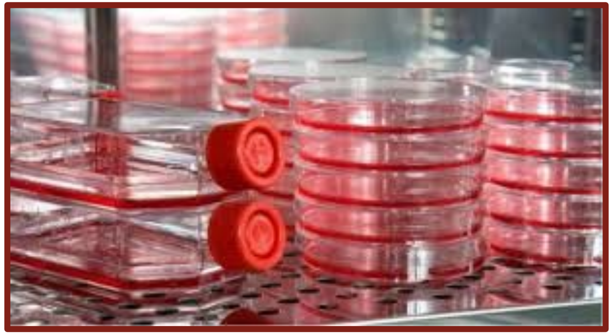


Figure 1: Cell Culture Plates [1]

Background Information

- **Cell Cultures**
  - Lab method for the use of studying cell biology, replicating disease mechanisms, and investigating drug compounds [2]
  - Use both primary, transformed, and self-renewing cells
- **Incubators**
  - Replicate cells' natural conditions in order for optimal growth
    - Natural Cell Environment - 37°C, pH = 7.2-7.4, 95% humidity [3]
  - 2 Types:
    1. Water-Jacketed
    2. Direct Heat
  - Cost: $500-$40,000 [4]

Problem Statement

- **Purpose*:*** Develop a low cost cell culture incubation chamber that is compatible with an inverted microscope and capable of live cell imaging.

- Current commercially available systems
  - Sometimes result in evaporation from low volume cultures
  - Expensive
  - Too large
  - Enclose the entire microscope

Figure 2: Cell Culture Procedure [5]

PDS Summary

Performance requirements:

- Compatible with an inverted microscope
- Maintain an internal environment of 37℃, 5% CO_2, and 95-100% humidity

Safety:

- Biosafety Level 1 Standards [6]

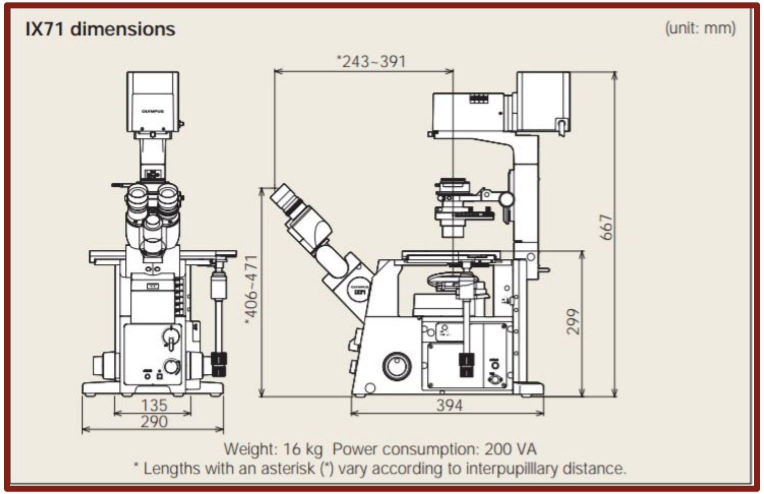


Figure 3: Measurements of Inverted Microscope [7]

Accuracy and Reliability:

- Temperature of 37℃ ± 0.5℃, humidity of >95%, and CO_2 levels of 5% ± 0.1%
- Maintain internal environment for at least 1 week

PDS Summary cont.

Size:

- Incubator < 310x300 mm with a thickness < 32.40 mm

Materials:

- Transparent top and bottom surfaces

Target Production Cost:

- < $100

Competition:

- Previous BME 200/300 design projects
- ThermoFisher NuAire, and New Brunswick [4]
- Portable Live-cell Imaging Box ~ $400 materials

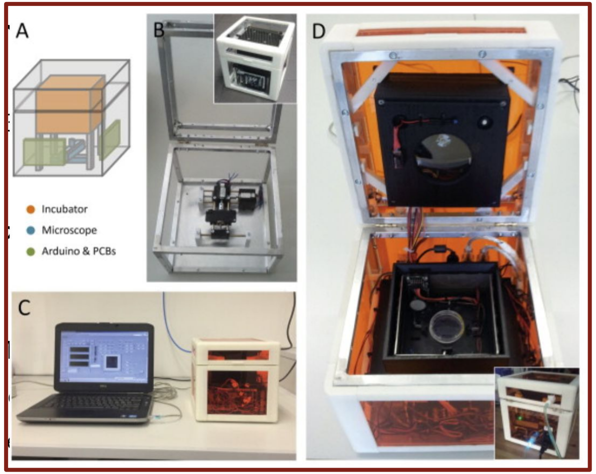


Figure 4: Portable Live-Cell Imaging Platform [8]

Figure 5: Thermo Fisher Incubator [9]

Preliminary Design #1

Past Project Refurbished

Strengths:

- Streamlined production
- Previous internal condition testing
- Compatible with inverted microscope

Weaknesses:

- Not cost-effective
- Materials need improvement
- Non-reliable sensors

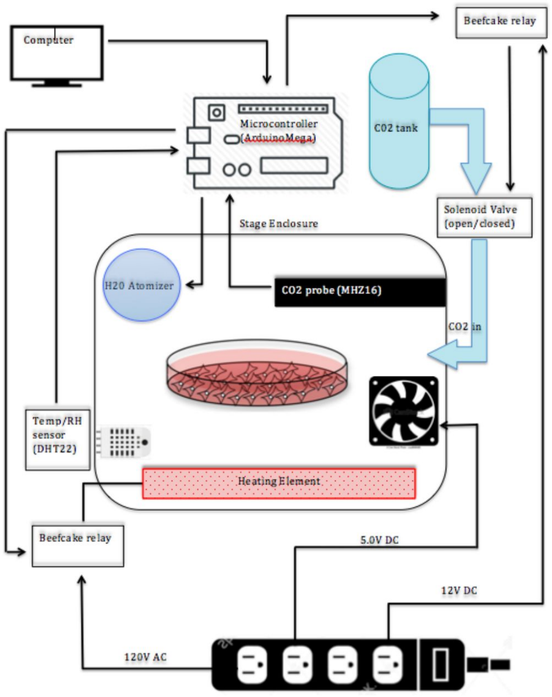


Figure 6: Past Project Schematic

Preliminary Design #2

Heated Water Pump Incubator

Strengths:

- More reliable system for desired materials
- Microscope compatibility
- Arduino sensor compatibility
- Lowest Cost

Weaknesses:

- Measuring internal environment

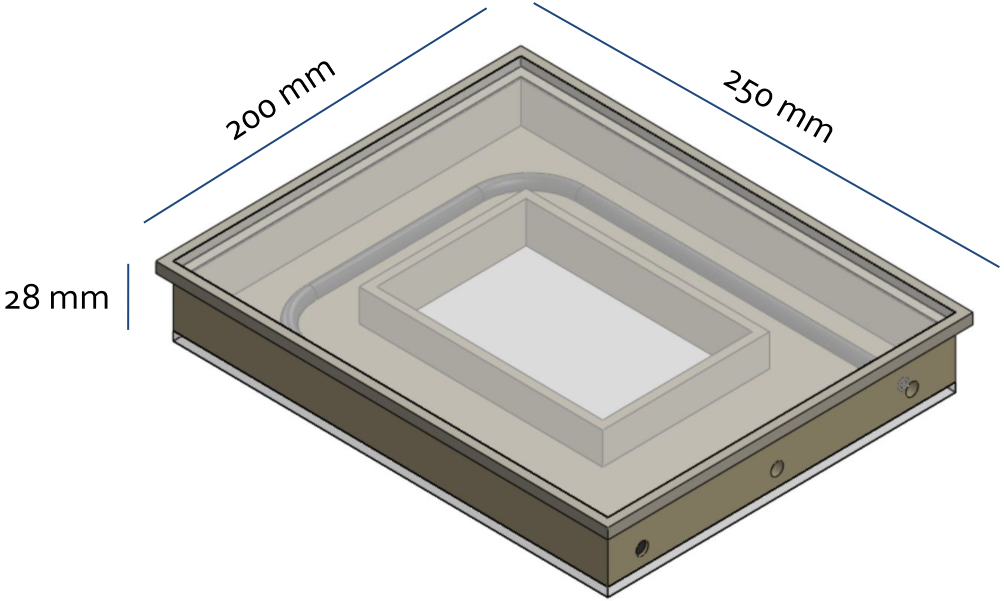


Figure 7: Heated Water Pump Incubator

Table #1: Specific Measurements of Heated Water Pump Incubator

Item NO.	Item Description	Dimensions (mm)	QTY.
1	Top glass plate	250 x 200 x 5	1
2	Sealed glass plate holder	260 x 210 x 6	1
3	Metal tube for water	d = 7.16	1
4	Outer box of incubator	250 x 200 x 28	1
5	Inner box of incubator to hold cell plate	140 x 96 x 18	1
6	Lower glass plate	250 x 200 x 5	1

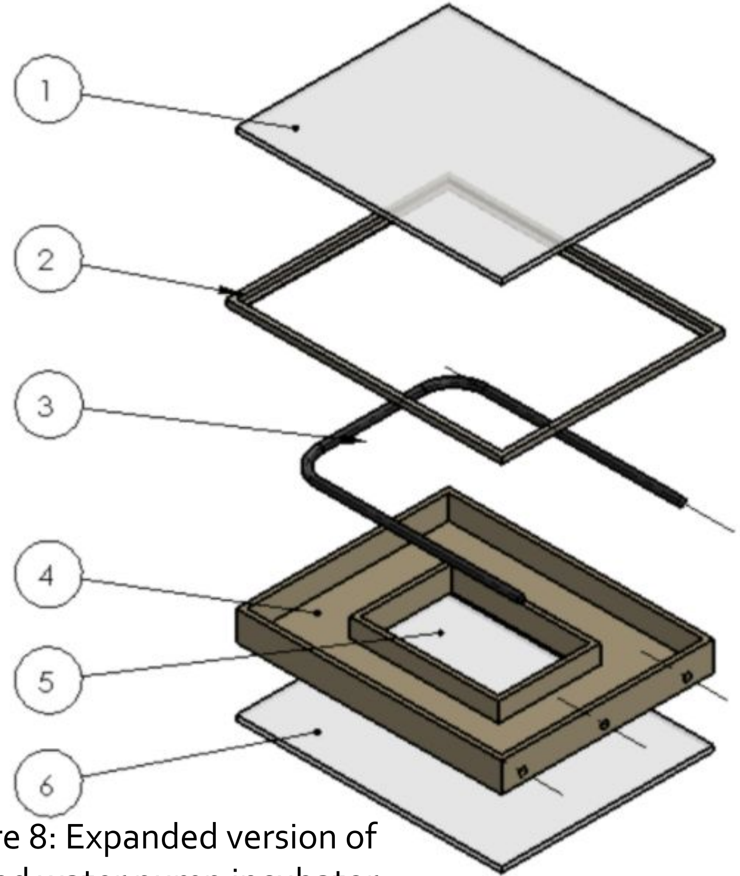


Figure 8: Expanded version of heated water pump incubator

Preliminary Design #3

Shelving Incubator

Strengths:

- Compatible with inverted microscope
- Safe design; not harmful to user

Weaknesses:

- Maintain accurate internal conditions
- Lack of internal visualization
- Ergonomics
- Shelf-life
- Cost

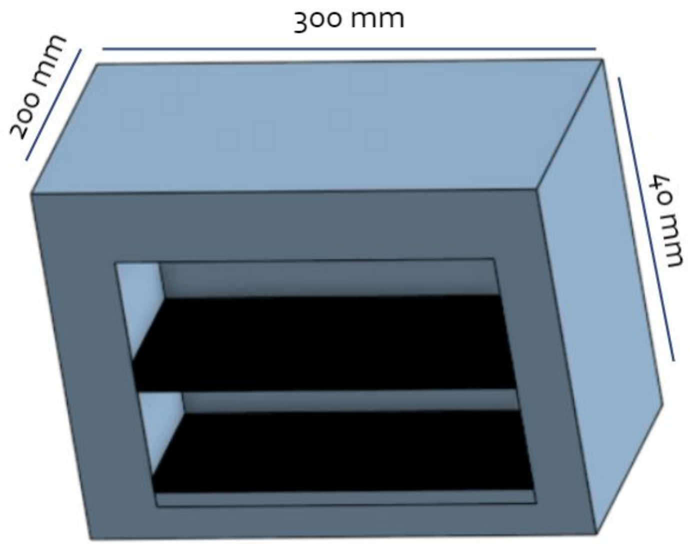


Figure 9: Shelving Incubator

[6] [7]

Design Matrix

- Internal Environment: 37°C, 5% CO_2, and 95-100% humidity
- Microscope compatibility: product < 310x300x32.40mm
- Accuracy and Reliability
- Ergonomics
- Cost: <$100
- Life in service: up to one week
- Safety

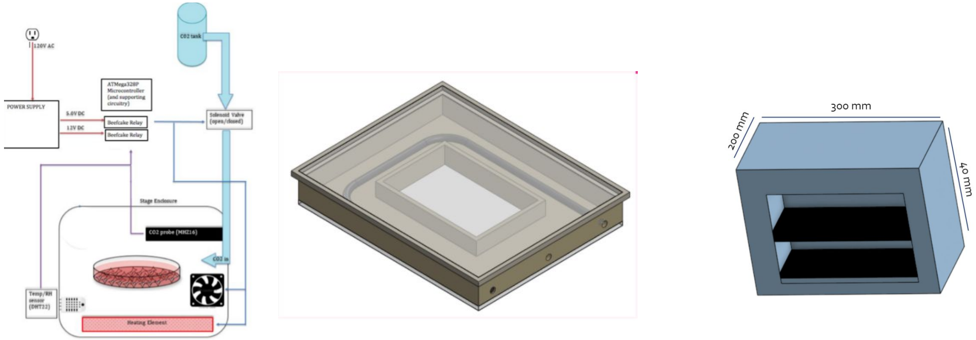
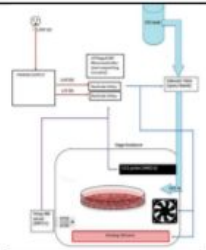
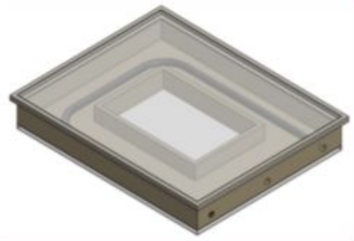
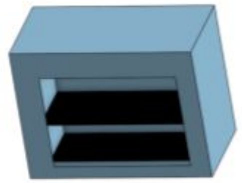


Figure 10: Design Ideas

Design Matrix







			Past Project Refurbished		Heated Water Pump Incubator		Shelving Incubator	
Rank	Criteria	Weight	Score (10 max)	Weighted Score	Score (10 max)	Weighted Score	Score (10 max)	Weighted Score
1	Internal Environment	25	9	23	7	18	5	13
2	Microscope Compatibility	20	10	20	10	20	10	20
3	Accuracy and Reliability	20	7	14	8	16	4	8
4	Ergonomics	15	5	8	8	12	4	6
5	Cost	10	2	2	4	4	3	3
6	Life in Service	5	10	5	10	5	10	5
7	Safety	5	10	5	10	5	10	5
	Sum	**100**	**Sum**	**76**	**Sum**	**80**	**Sum**	**60**

Future Work

1. Order materials
2. 3D Print SolidWorks Design
3. Start working on Arduino code for the sensors
4. Create test protocols for each design component

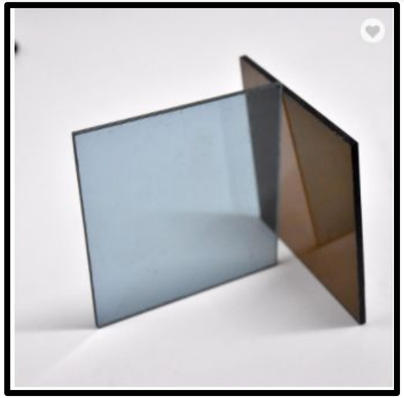


Figure 11: Polycarbonate Roofing Glass [10]

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Figure 12: UW MakerSpace Logo [11]

Upcoming Project Goals

Purchase Materials
Friday, Oct. 22nd

Testing Materials
Monday, Oct. 25th

Begin Prototyping
Friday, Oct. 29nd

Testing Prototype
Friday, Nov. 19th

Final Deliverables
Wednesday, Dec. 15th

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11. *UW MakerSpace*. .

Questions ?