



Neonatal Incubator

Team Members: Noah Daugherty,
Andrés Rodriguez, Elisa Schrader,
Alyssa Beyler, Malvika Upadhyaya

May 1st, 2020

Team Members



Noah Daugherty
Electrical Engineer



Andres Rodriguez
Computer Engineer



Elisa Schrader
Biomedical Engineer



Alyssa Beyler
Mechanical Engineer



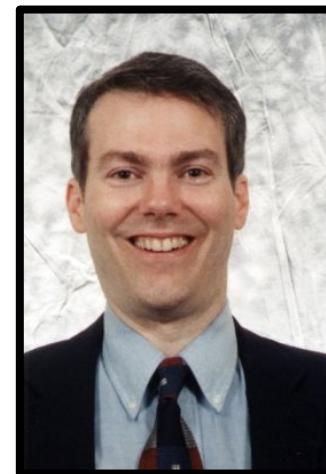
Malvika Upadhyaya
Mechanical Engineer

Main Team Advisors/ Contacts



Dr. William Okyere-Frempong
Medical Doctor from Ghana
Main Project Contact

Dr. William W. Smith
Senior Academic Professional
Project Advisor



Content

1. Introduction of Members - Quick intro
2. Introduction of Project - How it came to be
3. Initial Research - State of the Art
4. Sources of Information
5. Final project proposal
6. Designing the Incubator
 - The Initial Design
 - Prototyping
 - The New Design
 - The Hood
 - The Mattress Tray
 - The Base
 - The Heating System
 - The Monitoring System
7. Final documentation
8. Future Design Considerations
9. Moving Forward

Introduction of Project



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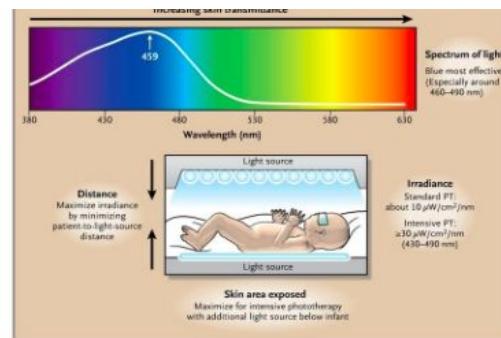
Background:

In Ghana, it is challenging to maintain and procure funds to purchase commercially available incubators and blue light therapy equipment most of which is produced outside the country.

Introduction of Project

Concept:

- Provide and demonstrate a prototype neonatal incubator incorporating blue light therapy
- Design must be manufacturable in Ghana and should be cheaper than the available commercial options
- Prompted by Dr. Okyere-Frempong, Medical Superintendent of ~200 employee hospital in the Ghana Capital
- Design should provide essential functions of a neonatal incubator and should also be transportable for use in rural regions of Ghana
- Design must be locally maintainable, and materials and components should be locally sourceable



www.nejm.org/na101/home/literatum/publisher/mms/journals/content/nejm/2008/nejm_2008.358.issue-9/nejmct0708376/production/images/img_medium/nejmct0708376_f3.jpeg

Initial Research - State of the Art



A



B



C

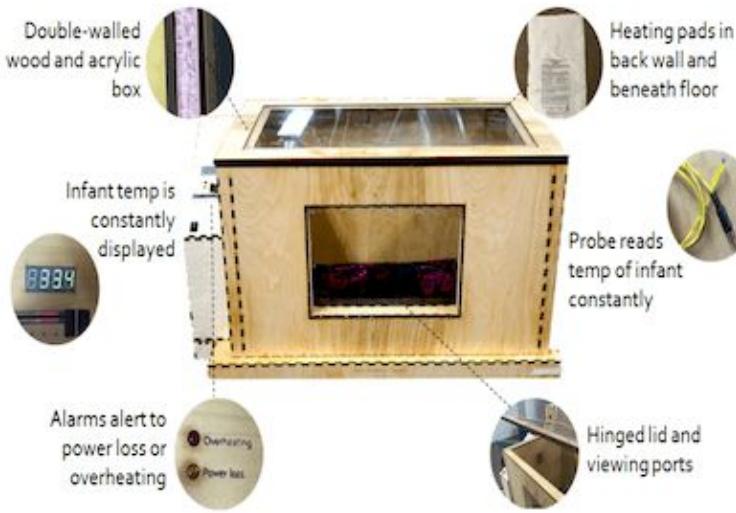
Average Cost:

A: GE Giraffe: \$2,500 - \$13,952.00

B: Dräger Caleo(used): \$3,400 - \$5,500

C: Dräger Isolette: \$2,950 - \$3895

Initial Research - State of the Art Low cost incubators



Sources of Information

James Stubbs

Medical Device Company Executive & Investor
Professor - Ga Tech Biomedical Engineering

Matthew H. Merves, MD

Assistant Professor of Pediatrics
Division of Neonatology Emory University
School of Medicine

Irma Raquel Tabares, MD

Pediatrician Neonatologist
PROCAREN UCI-NEONATAL
Caldas, Antioquia, Colombia

Matthew Khoory

m0m Incubators

Co-founder

Theophilus Ofori

Biomedical Engineer
Korle-Bu Teaching Hospital, Accraa

Alfred Selorm Betepe

Fabricator
Seloart Group

Masego Gilbert, MD

Humphrey Fellow
Botswana

Sana Saleem, MPH

Humphrey Fellow
Maldives

Mexan Mapouka, MD

Humphrey Fellow
Central African Republic

Susan Zachariah, MD

Ghana Pediatrician Specialist
Korle-Bu Teaching Hospital, Accra

Admore Jokwiwo, MD

CEO Humphrey Fellow
Zimbabwe

Nana Yaa Owusu, MD

Specialist Obstetrician Gynecologist
Ghana

William Obeng, MD

Consultant Paediatrician
Ghana

Main Takeaways

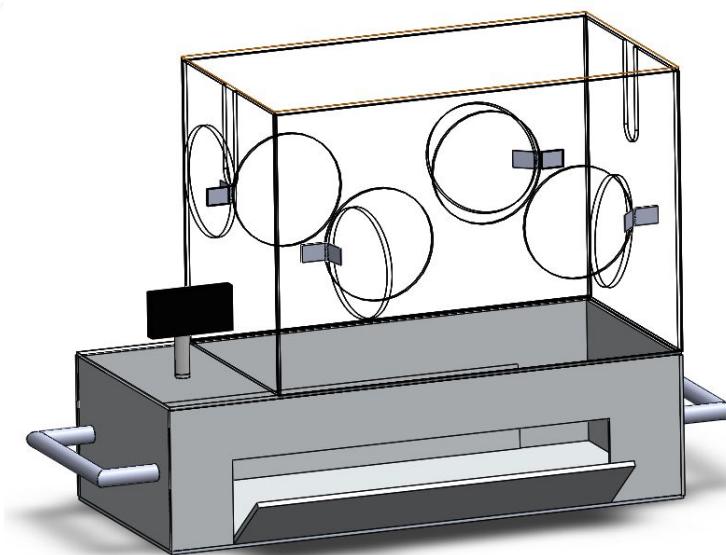
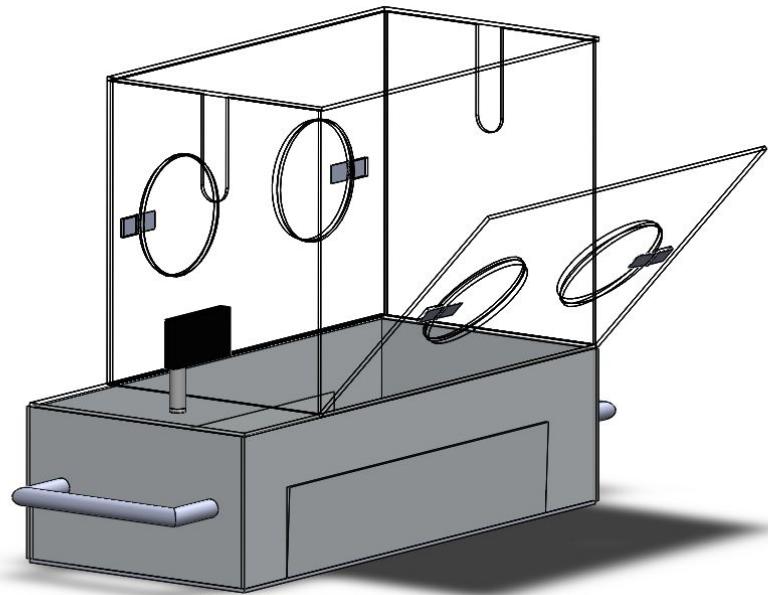
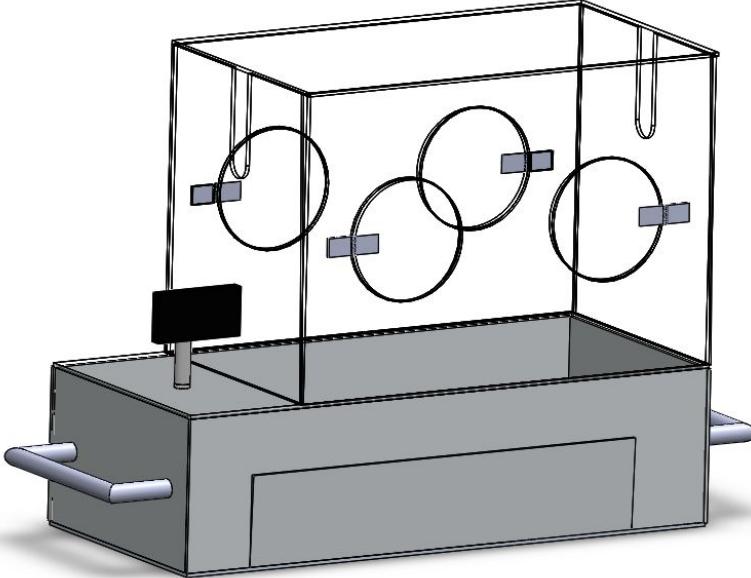
- The main necessity of an incubator is as a source of thermoregulation.
- Humidity is a plus but not entirely necessary.
- Quick access to the baby is essential
- The incubator is divided into the head side and foot side for sterilization purposes.
- Important considerations for devices in Ghana
 - Power outages can be as long as 6 hours long
 - Transportation compatible
- Fabrication options available in Ghana
 - Laser cutters
 - Vacuum Forming
 - Metal Bending

Final Project Proposal

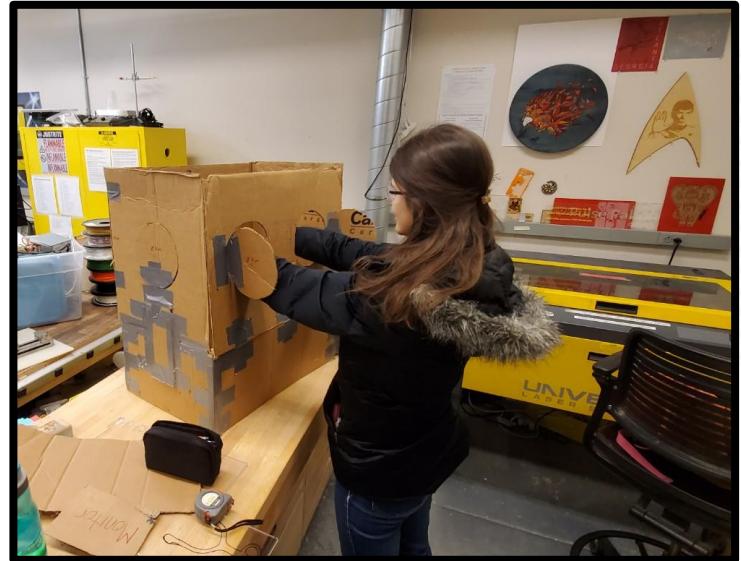
We will design and construct a neonatal incubator that is appropriate for travel in a vehicle. Its main purpose will be the thermoregulation of the patient and the monitoring of the patient's basic vital signs. It will be manufacturable with the local resources available in Ghana.

1 - Absolutely Necessary	2- Extras	3- Completely new
<ul style="list-style-type: none">- Sensors:<ul style="list-style-type: none">- Temperature- Humidity- HR- O2 Saturation- Mechanical Capacity:<ul style="list-style-type: none">- Capacity to be on a stand- Hand access to baby- User interaction<ul style="list-style-type: none">- Instructions Manual- User interface- Calibration system- Electrical Requirements<ul style="list-style-type: none">- O2 Filter- Motor Powered Fan- Exhaust Fan- General Illumination	<ul style="list-style-type: none">- Electrical Requirements<ul style="list-style-type: none">- Backup Battery- Interchangeable Power Supply- Redundancy + Maintainable Electrical Components- Mechanical Capacity<ul style="list-style-type: none">- Inclination- Detachable Hood- Sensors<ul style="list-style-type: none">- Apnea- Weight	<ul style="list-style-type: none">- Dual Chamber- Heat/UV Sterilization- Blue Light Incorporation- Cabinet space- BP Sensor

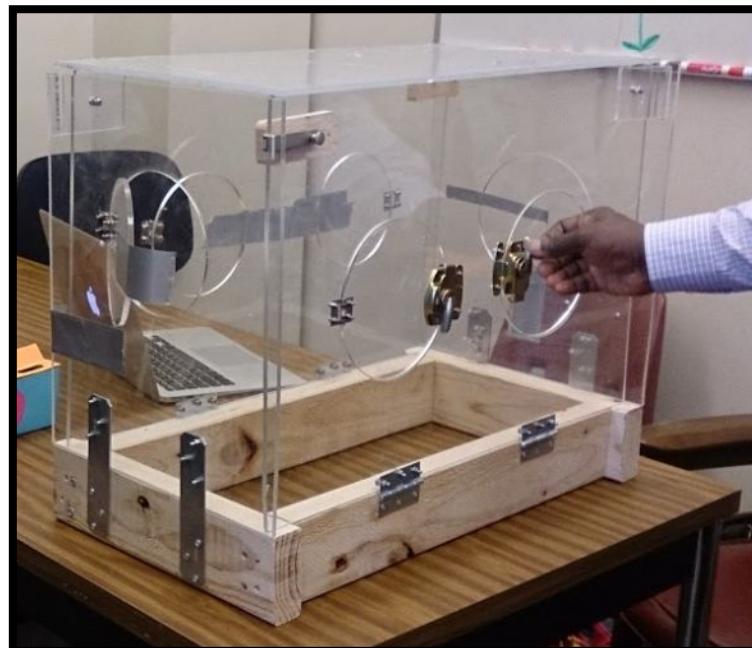
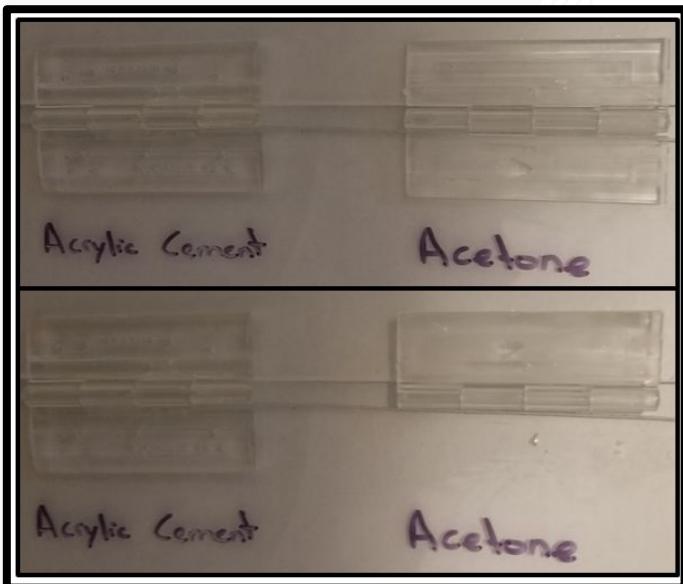
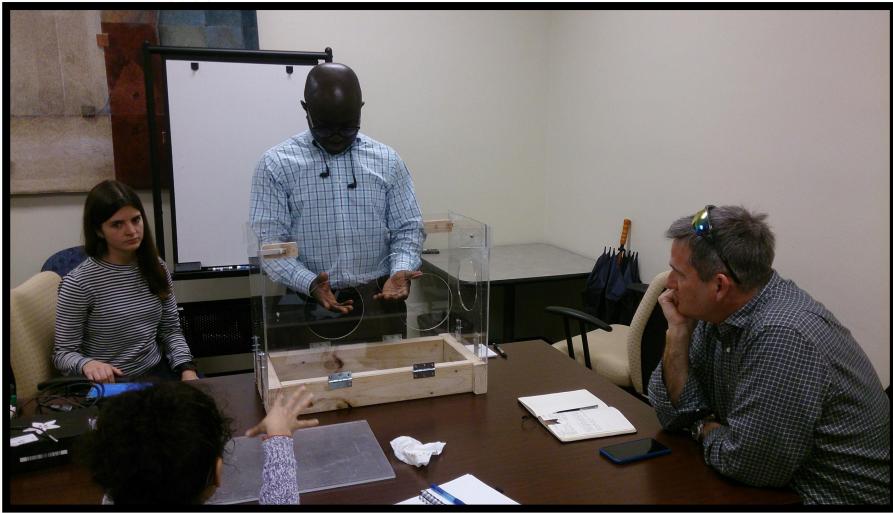
Initial Design



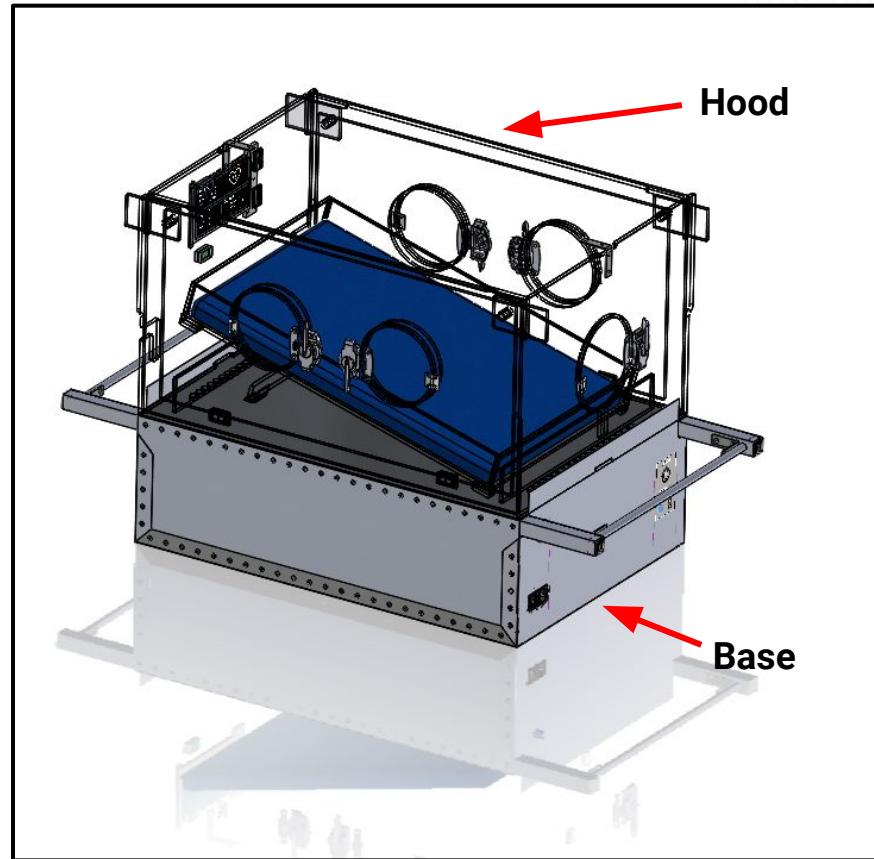
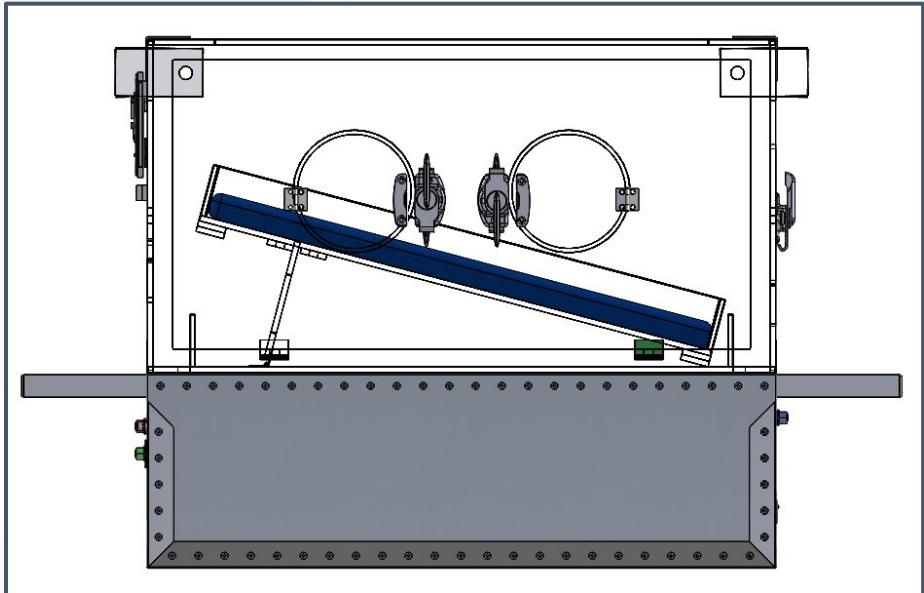
Prototyping - Cardboard



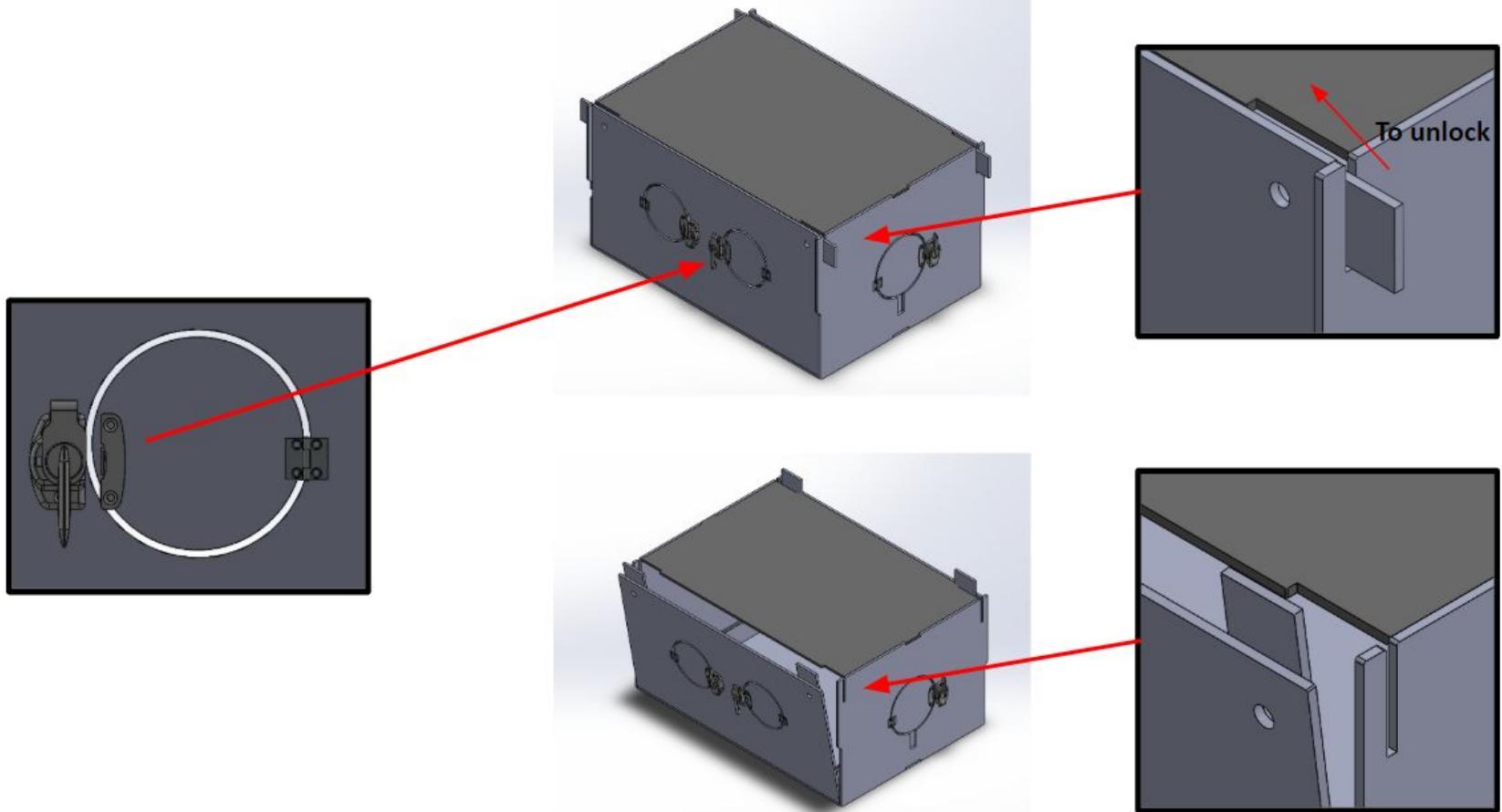
Prototyping - Feedback



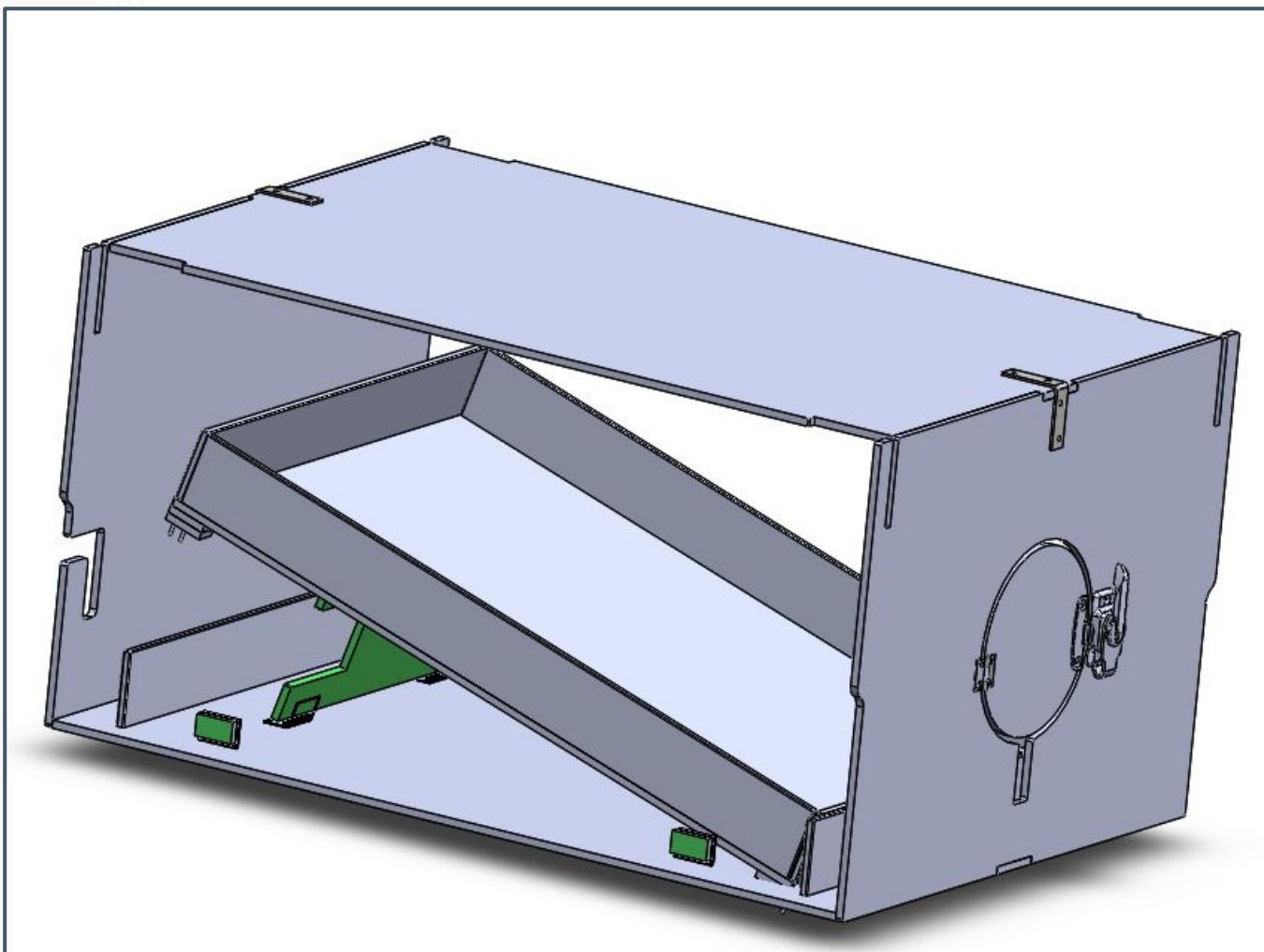
New Design



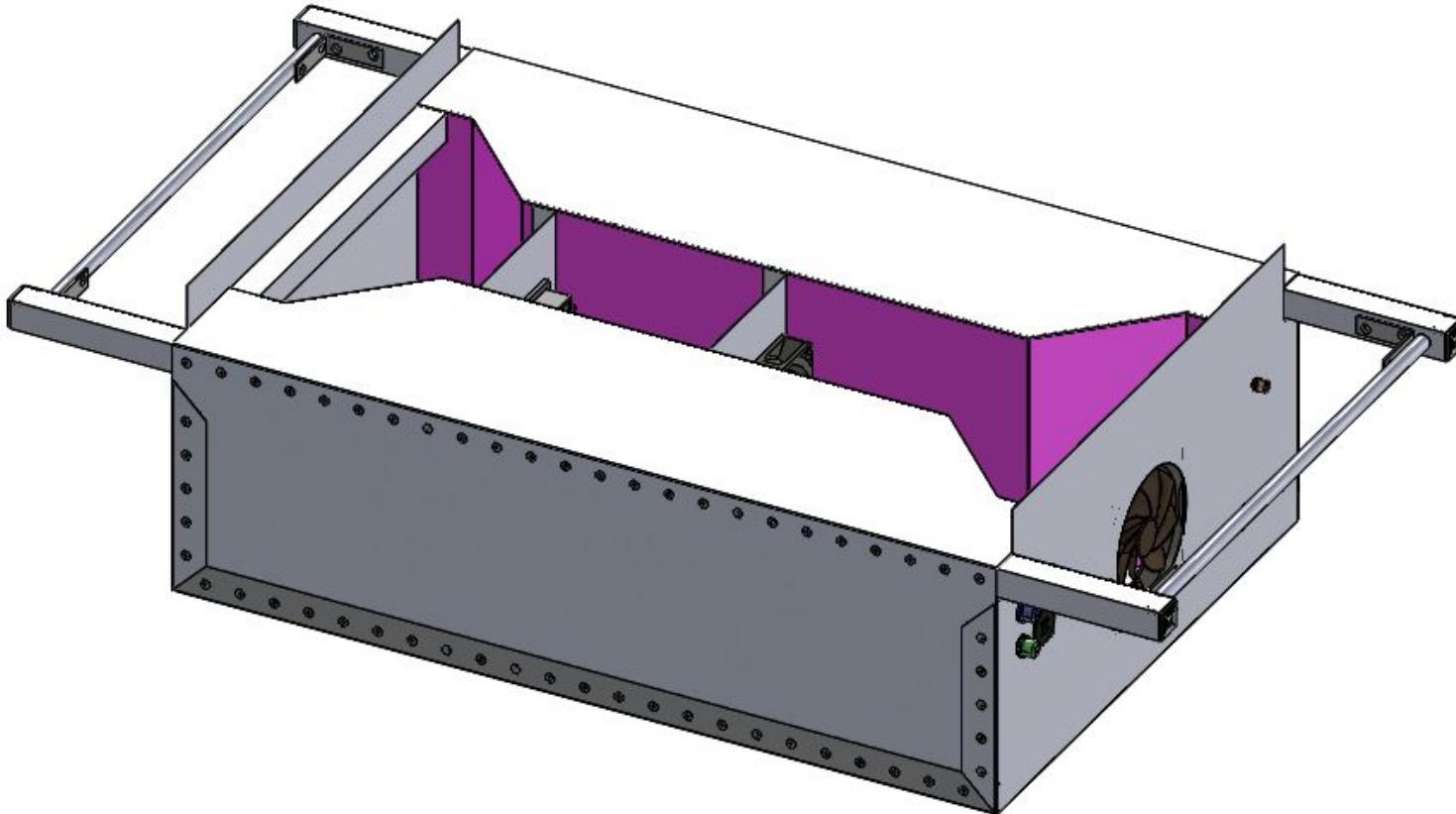
The Hood



The Mattress Tray



The Base

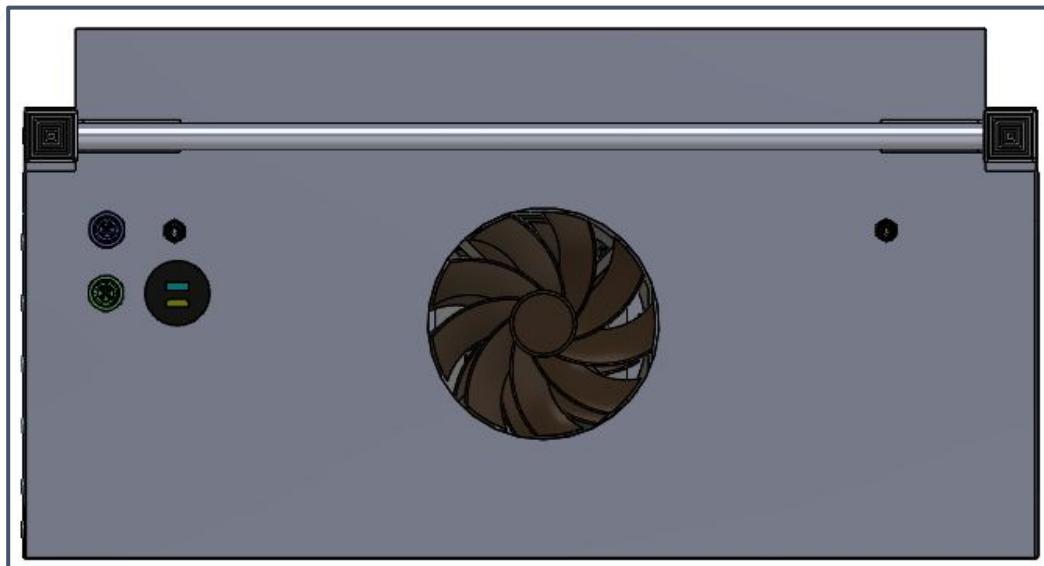


The Base Sides



Foot Side

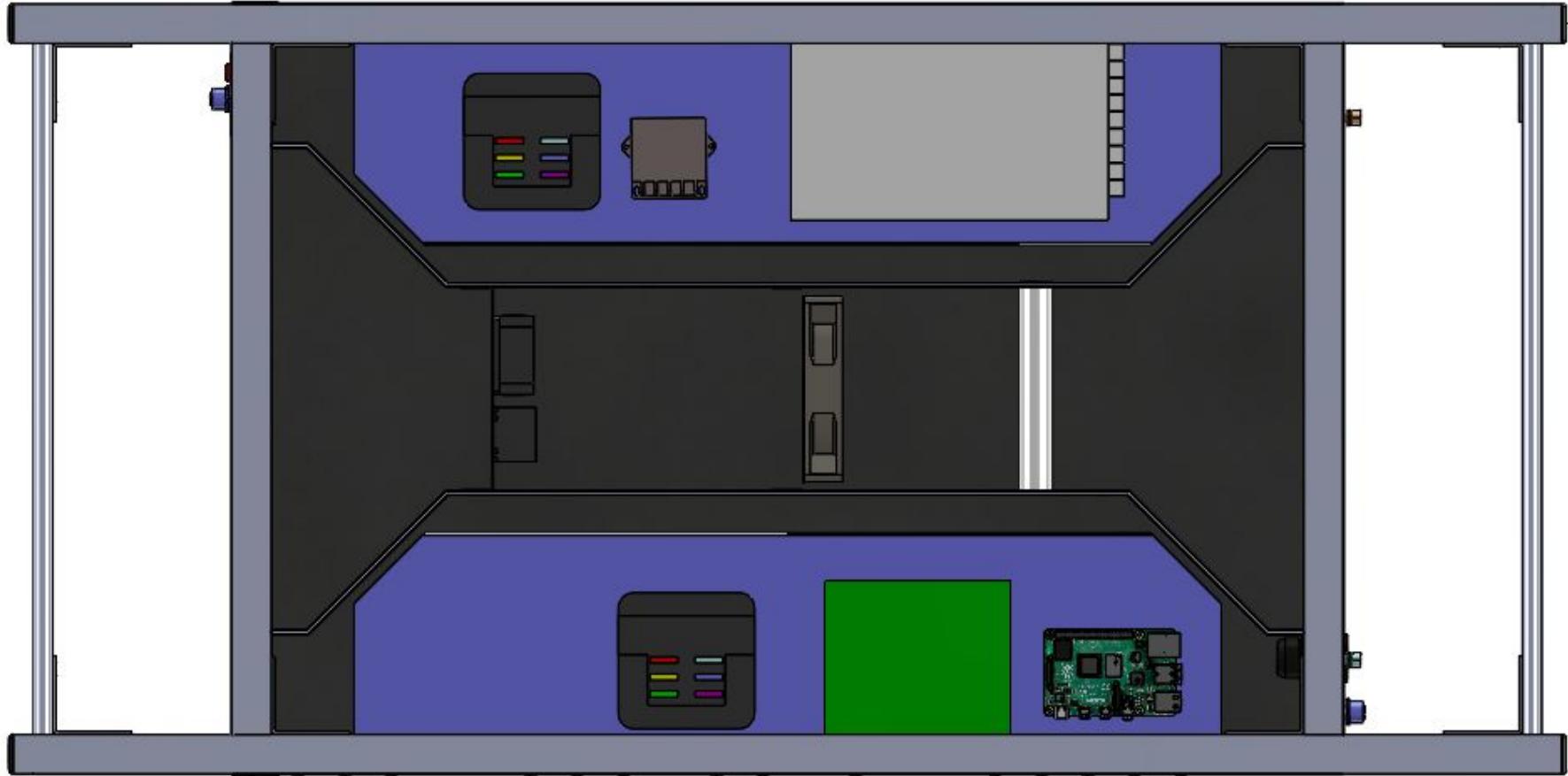
Head Side



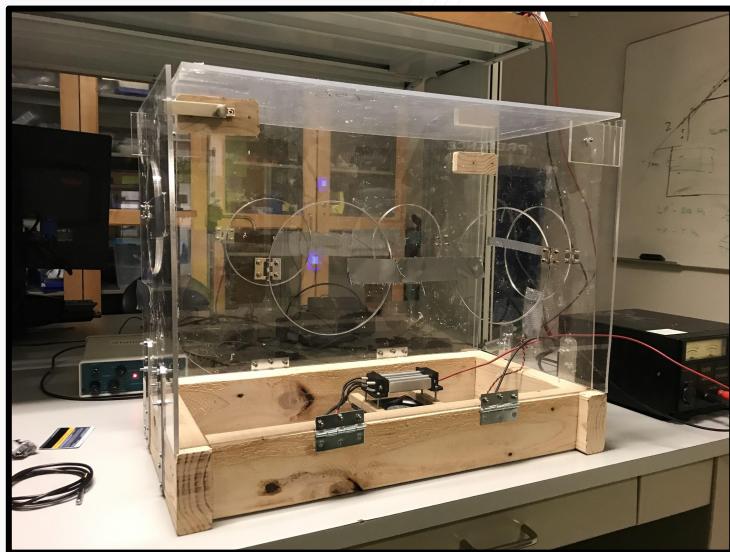
The Base Top View



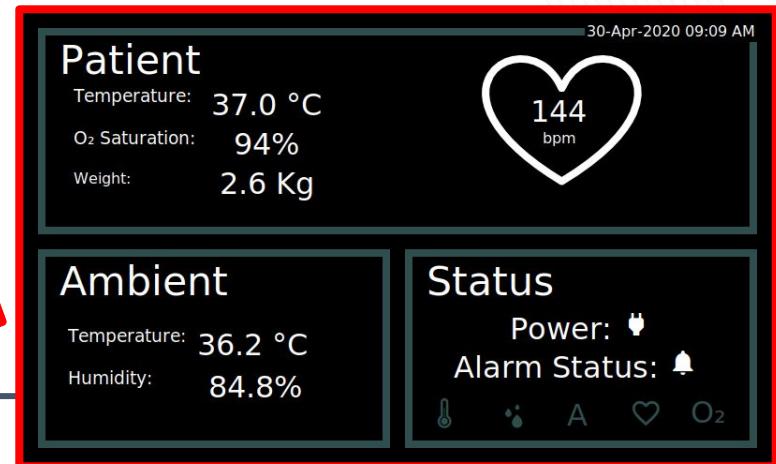
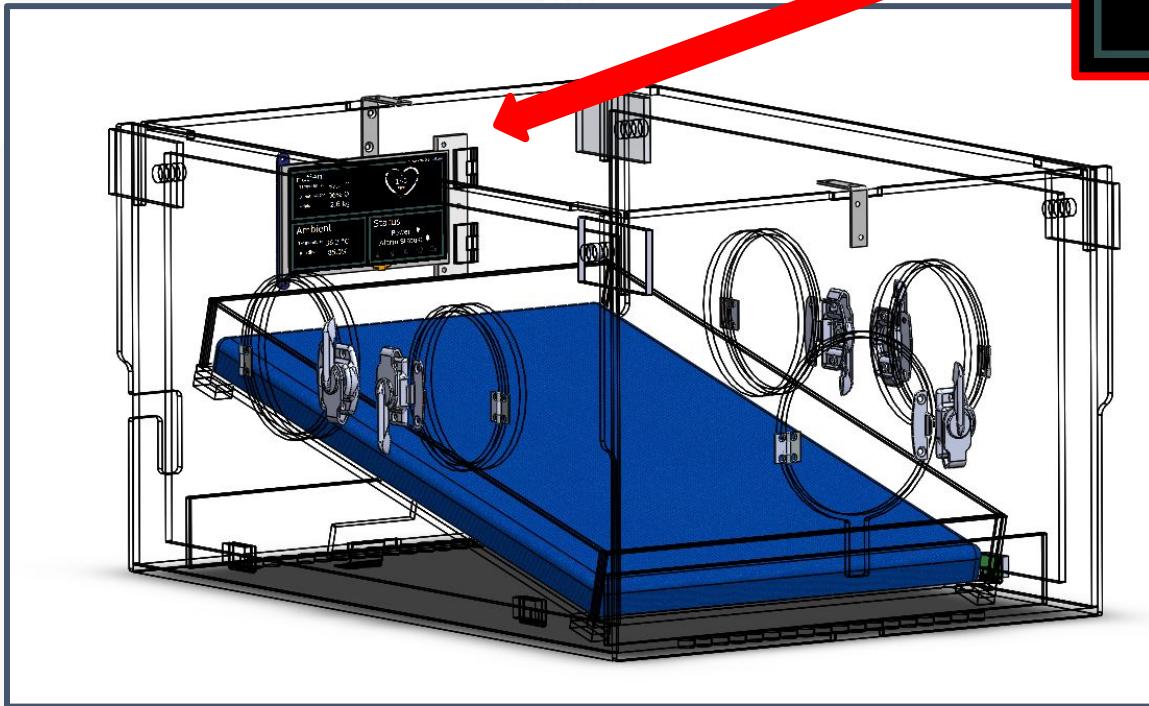
The Base Top View Inside



The Electrical System

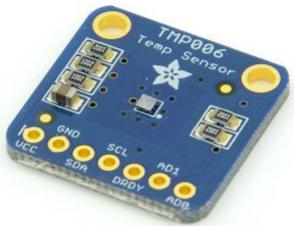


The Monitoring System

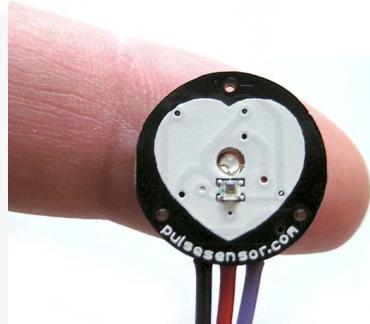


The Monitoring System

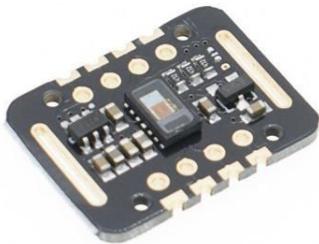
- The (Patient) Sensors -



Temperature



Heart Rate



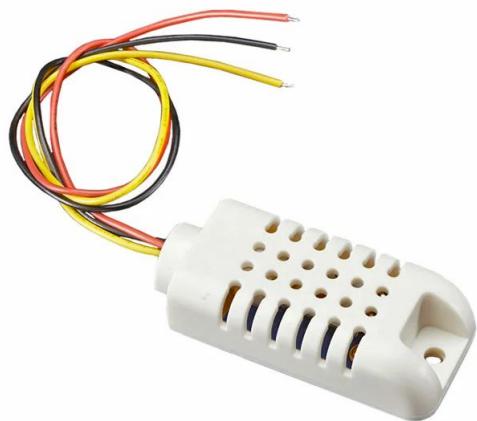
Oxygen Saturation

The Monitoring System

- The (Environment) Sensors -

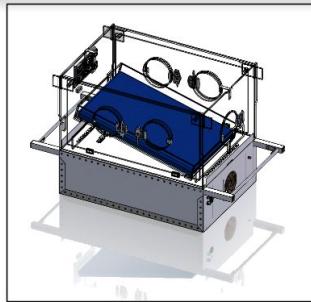


Temperature



Humidity

Final Documentation

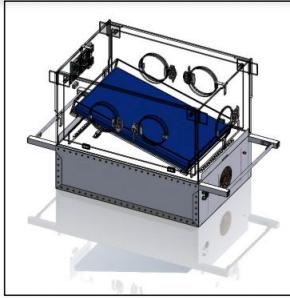


BLUE LIGHT INCUBATOR PROTOTYPE
BLUE ANGELS
Manufacturing Instructions

GT SENIOR DESIGN SPRING 2020

plate slot

1



BLUE LIGHT INCUBATOR PROTOTYPE
BLUE ANGELS
User Manual

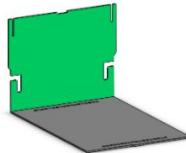
GT SENIOR DESIGN SPRING 2020

Temperature: 37.2 °C ①
② Saturation: 96% O₂
Weight: 2.6 kg ③
145 bpm ④

The top box on the monitor is where the patient's vital signs can be found.

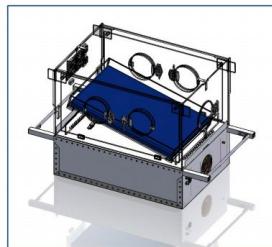
- ① This is the patient's body temperature
- ② This is the patient's oxygen saturation level.
- ③ This is the weight of the patient
- ④ This is the live heart rate of the patient.

Ask for real image



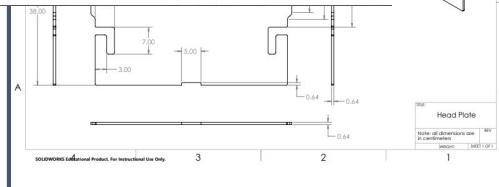
* Not Approved For Human Use

Hood S



BLUE LIGHT INCUBATOR PROTOTYPE
BLUE ANGELS
Engineering Drawings

GT SENIOR DESIGN SPRING 2020



Future Design Considerations

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Future Design Considerations

- Fully incorporating the Load cells to measure the weight of the baby (design and code have been developed but integration is needed)
- Choosing a specific air filter for the intake fan (there is space for it just haven't chosen a specific one)
- Illumination is accounted for in the wiring but doesn't have a specific mounting system yet.

Moving Forward



Dr. William Okyere Frempong



**Thank you to
everyone who
contributed to this
project!**



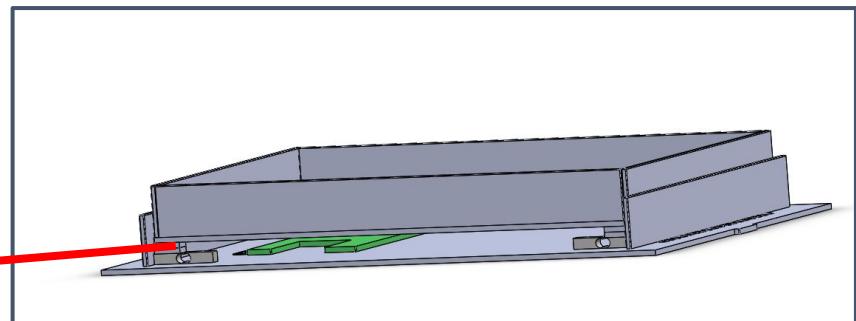
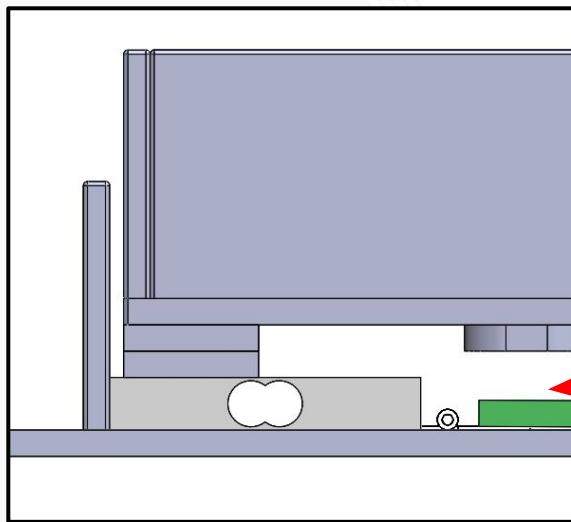
Supplementary Slides

Team Members: Noah Daugherty,
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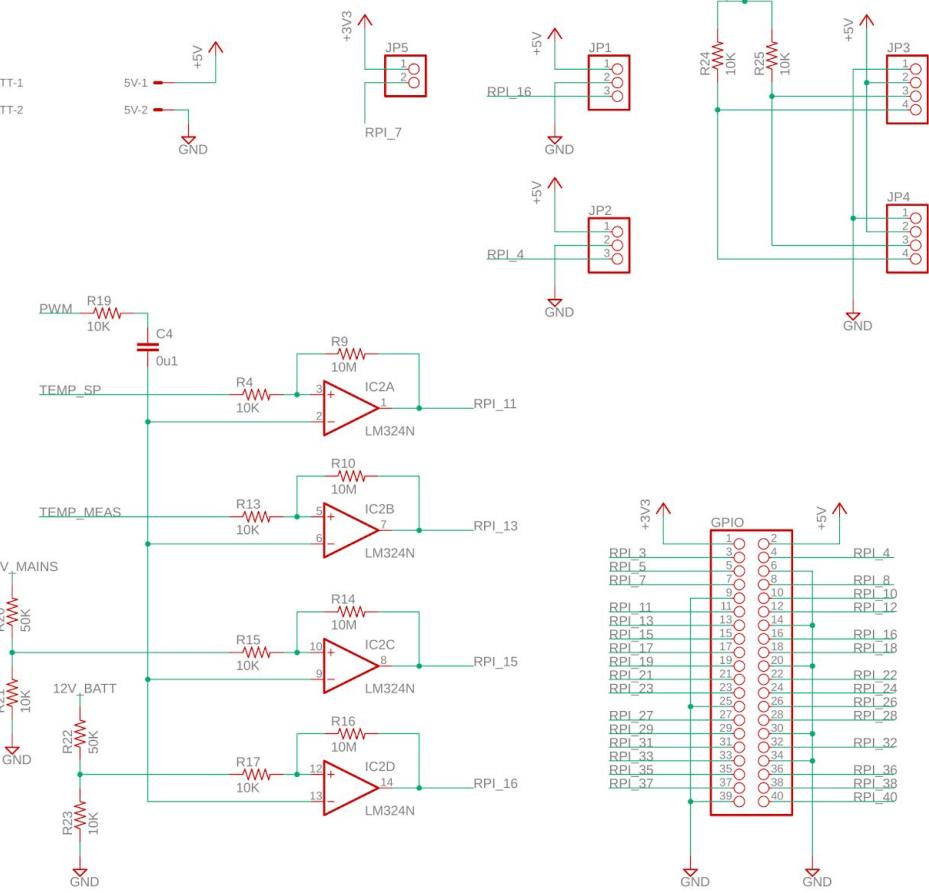
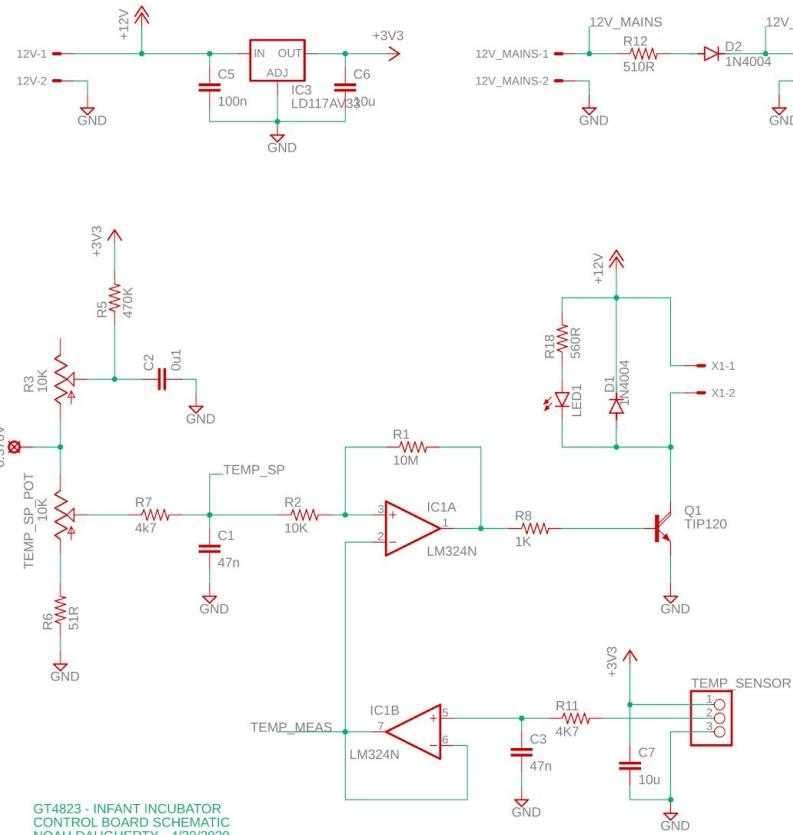
May 1st, 2020

Supplementary Slides

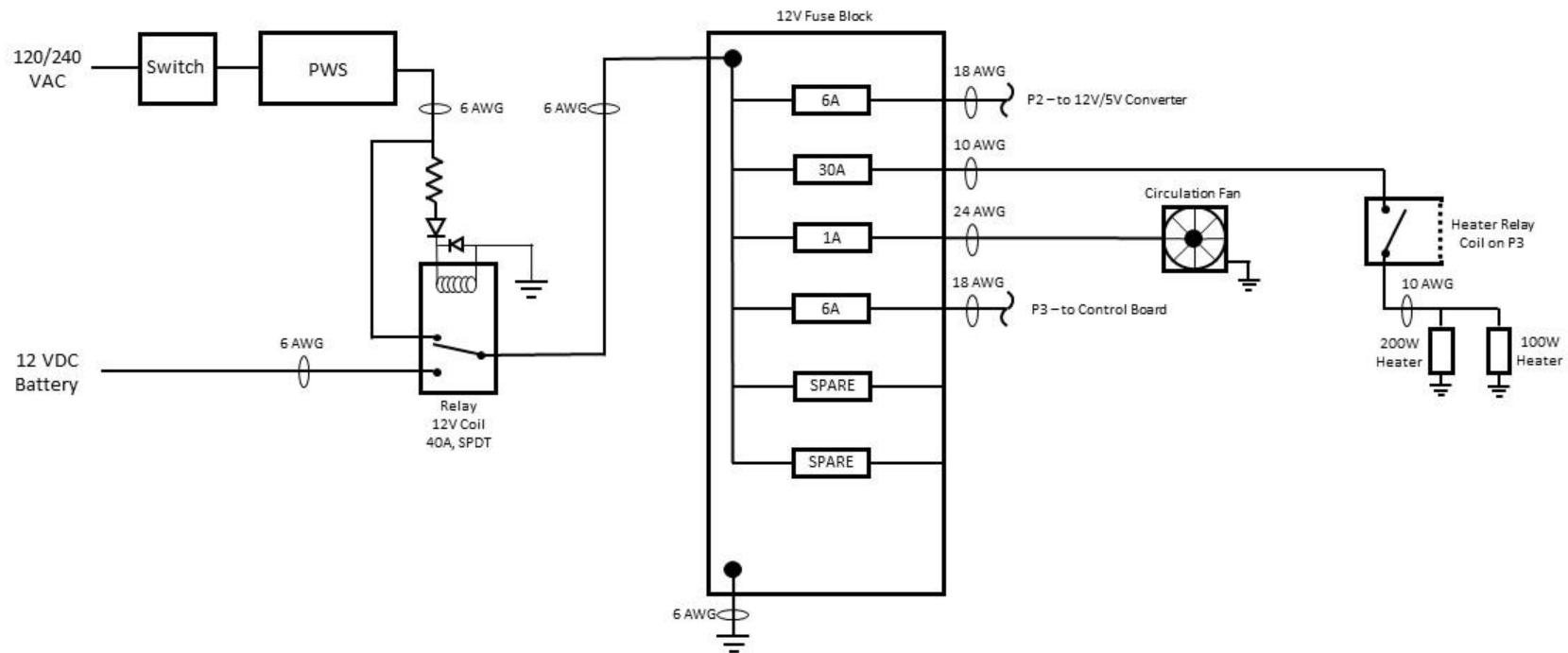
Weight Sensor Design



Control Board Schematic



12V Power Distribution

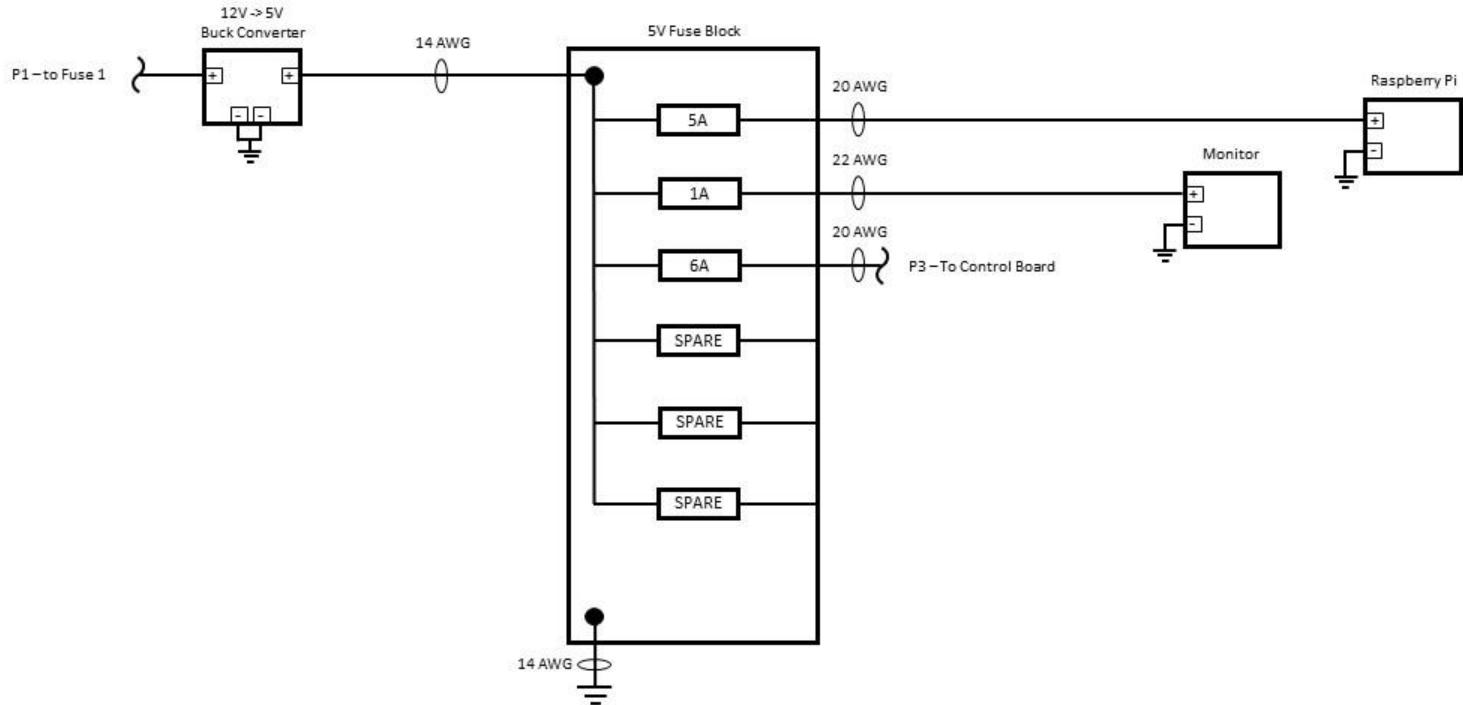


GT4823 – Infant Incubator

12V Power Distribution

Designer: Noah Daugherty | Date: 4/12/2020

5V Power Distribution



GT4823 – Infant Incubator

5V Power Distribution

Designer: Noah Daugherty | Date: 4/12/2020

Vitals Monitor

30-Apr-2020 09:09 AM

Patient

Temperature: 37.0 °C

O₂ Saturation: 94%

Weight: 2.6 Kg

 144 bpm

Ambient

Temperature: 36.2 °C

Humidity: 84.8%

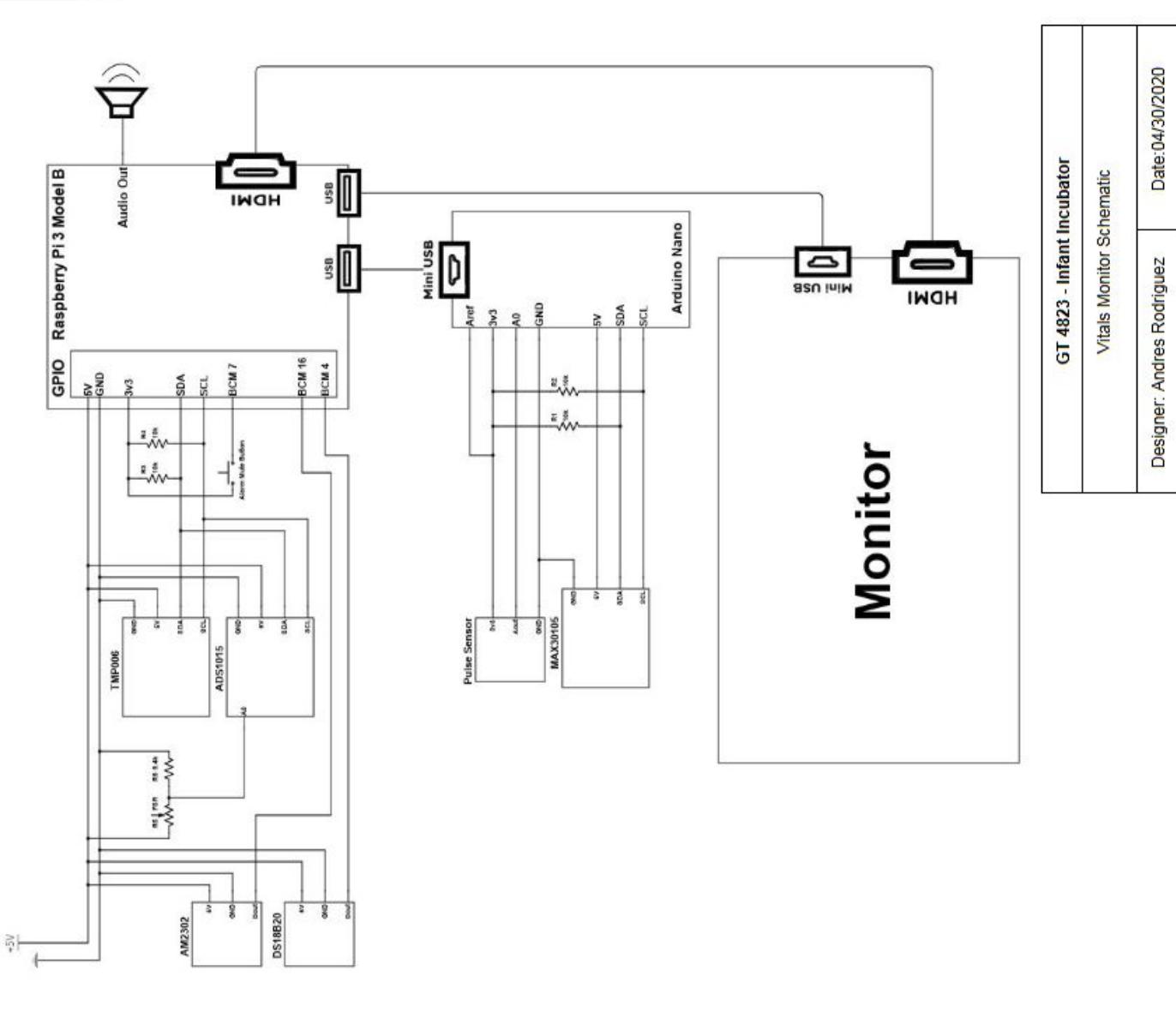
Status

Power: 

Alarm Status: 

Vitals Monitor Schematic



Operator Interface

