Smart Integration of Climate Chamber Operations

Team 508

Design Review 6

March 26, 2019

Team Introductions

Cassie Roby
Lead Engineer

Danny Carlos
Design and
Software Engineer

Daniel Lane
Lead Design
Engineer

Kyle Barber
Project Manager

Sara Steele
Systems
Engineer

Sara Steele

Sponsor

Vinayak Hegde, Danfoss Turbocor Compressors Inc.

Background: Energy efficient technologies

Advisor

Neda Yaghoobian, Ph.D.
College of Engineering

Background: Computational fluid dynamics

Sara Steele

Objective

To design a smart integration network and an observation system with remote accessibility for climate chamber tests.

Sara Steele

Project Background

Danfoss climate chambers experience random power failures during testing and test engineers are unaware until visiting the test site. User must manually collect data with USB drive.

Sara Steele

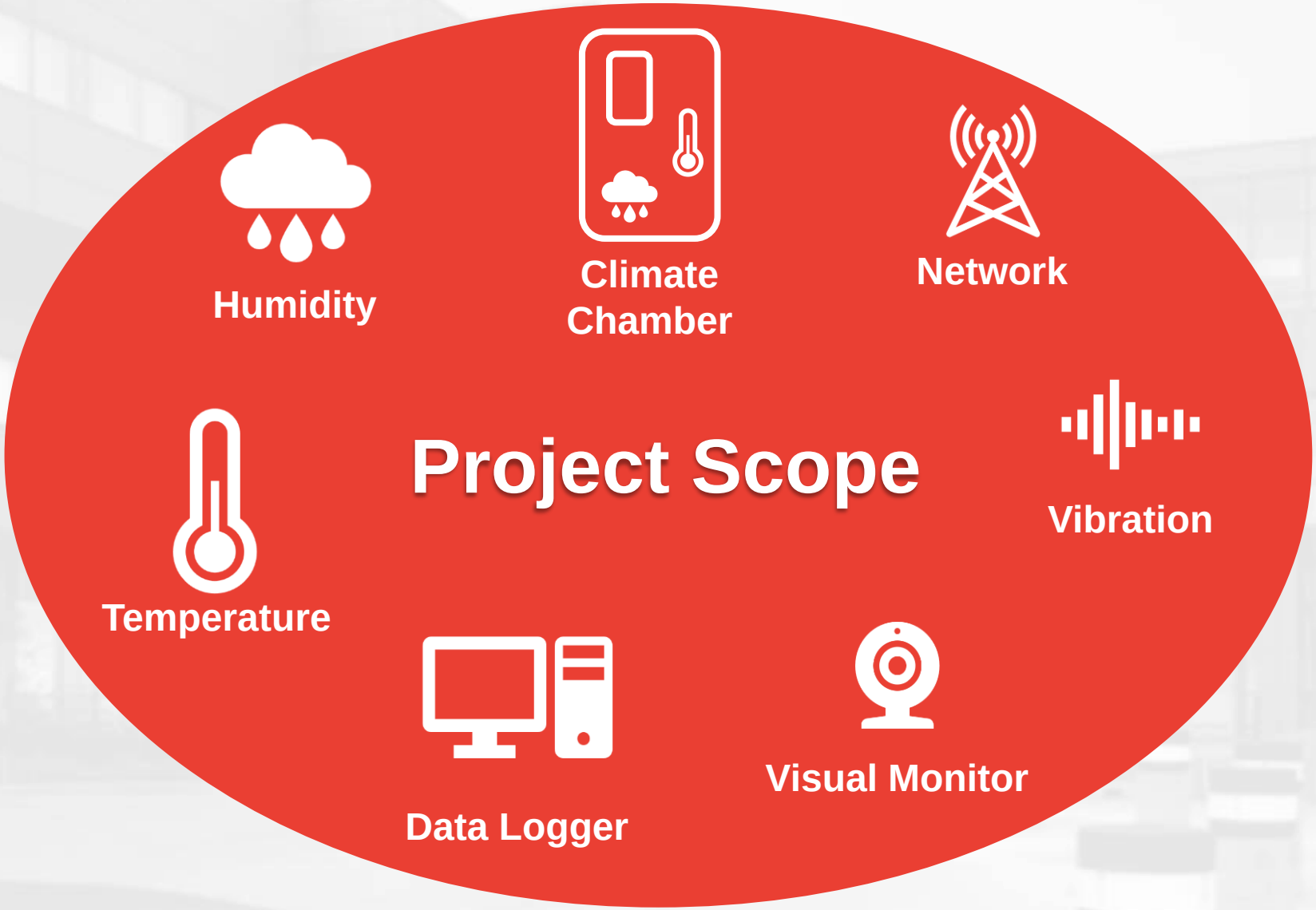
Project Outline

- To connect the Danfoss climate chambers and dataloggers to the accessible network
- To design and build a small scale prototype to demonstrate the software used to view the video footage of the climate chambers
- To research a camera that will withstand the environment in the chambers or design a possible insulation system

Sara Steele

Scope & Functional Decomposition

Next Presenter: Kyle Barber


Humidity
Climate Chamber
Network
Project Scope
Temperature
Vibration
Data Logger
Visual Monitor

Kyle Barber

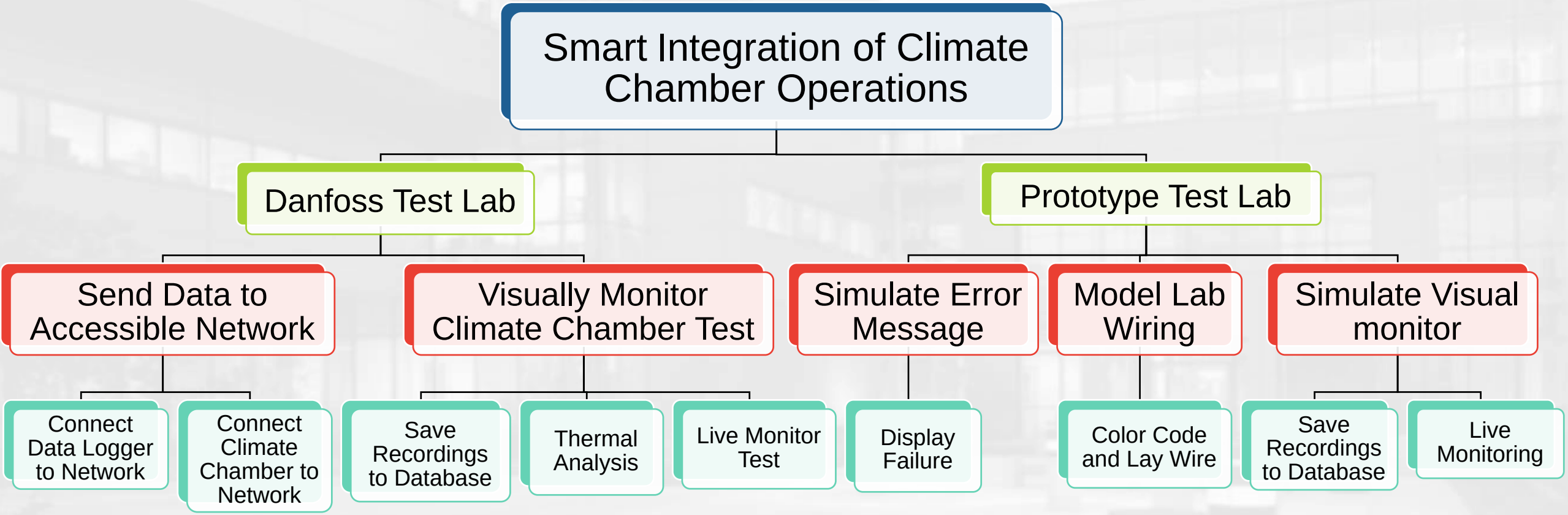
Customer Needs

In order of importance:

1. To remotely transport data from climate chamber to user computer
2. Prototype of laboratory floor plan including microcomputer, camera, and tablet
3. Real time visual footage monitoring and recording of the test
4. Prototype is not to exceed $4500

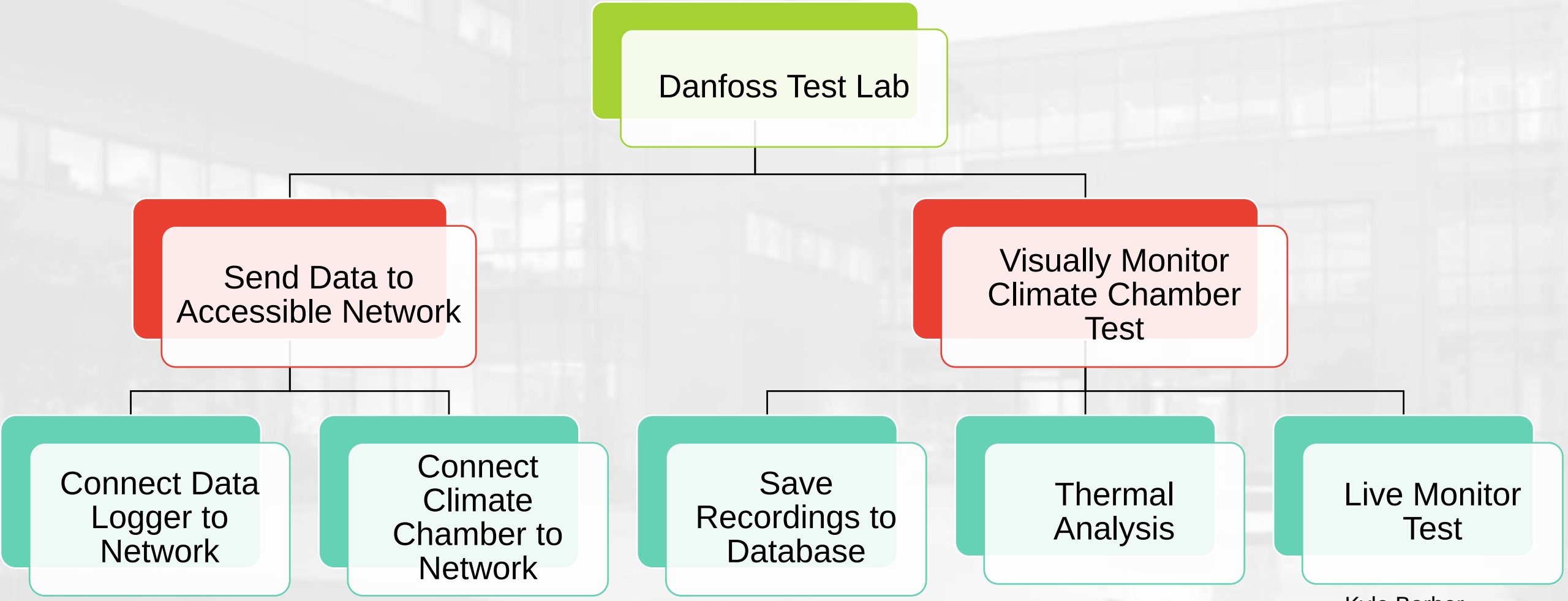
Kyle Barber

Functional Decomposition



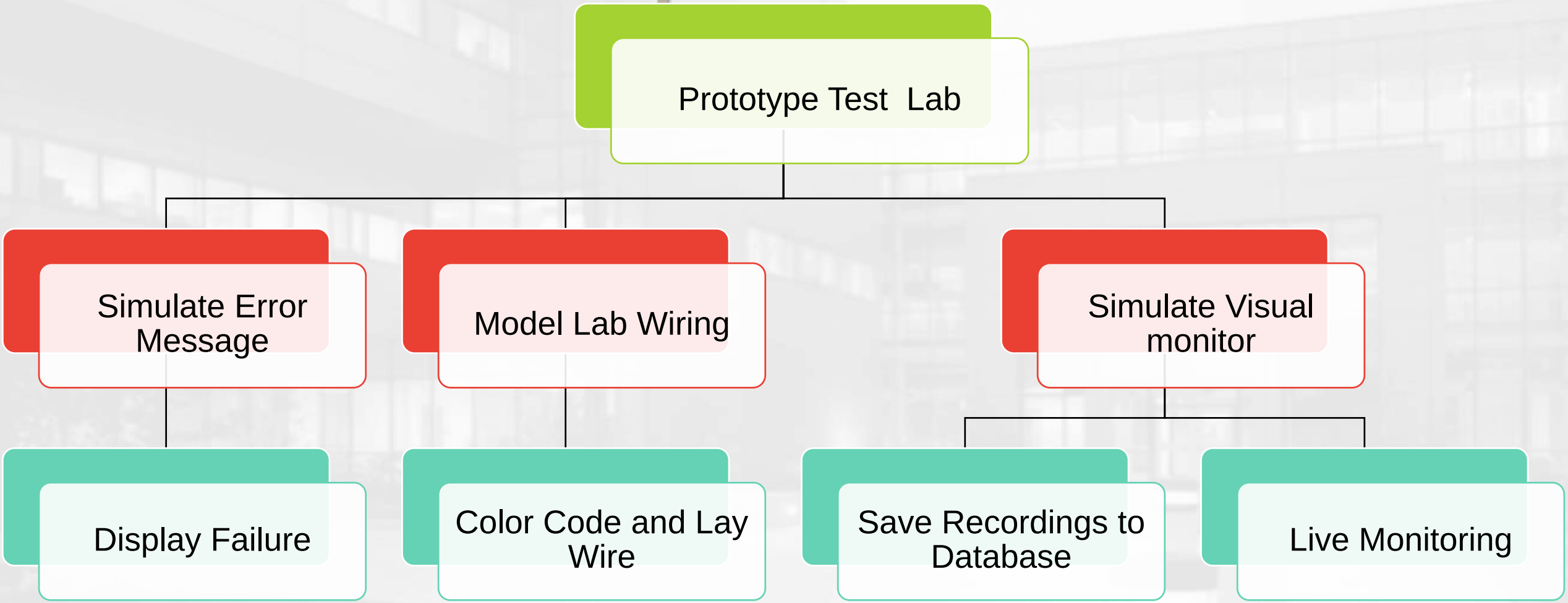
Kyle Barber

Functional Decomposition



Kyle Barber

Functional Decomposition



Kyle Barber

Previous Work

- CAD select prototype parts
- 3D print select prototype parts
- Researched software to run cameras
- Researched climate chamber and data logger connections
- Received all parts
- Begun building prototype

Current Work

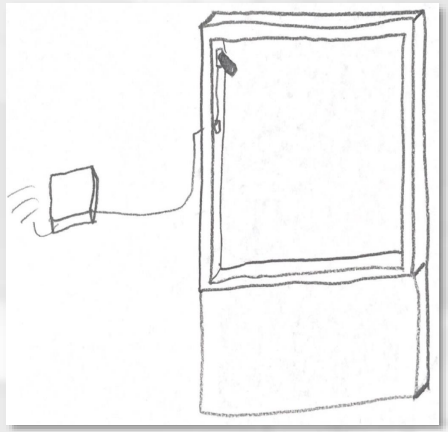
- Insulation and camera thermal analysis
- Manufacturing remaining parts
- Finish building prototype

Kyle Barber

Conceptual Design

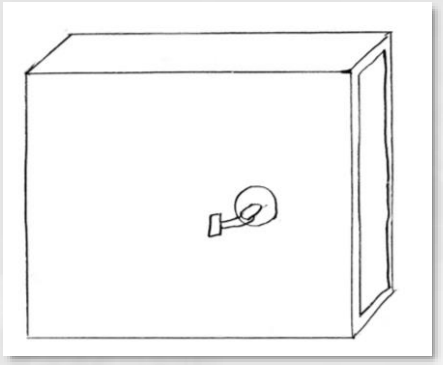
Next Presenter: Cassie Roby

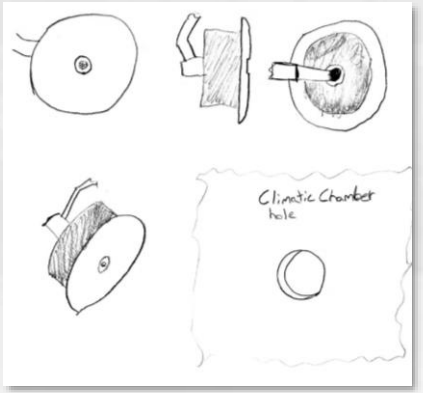
Concept Generation



1

- One corner adhesive mounted camera
- Insulation around camera
- Scaled prototype of lab
- Live stream and recording
- Existing DL350 Series data logger
- Internet connection through Ethernet cable



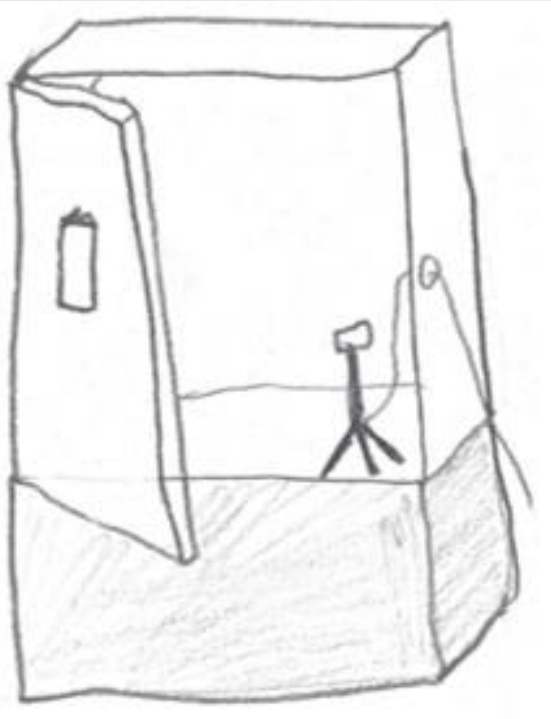


2

- One outside mounted camera (side)
- Scaled prototype of lab
- Live stream and recording
- Existing DL350 data logger
- Internet connection through Ethernet cable

Cassie Roby

Concept Generation

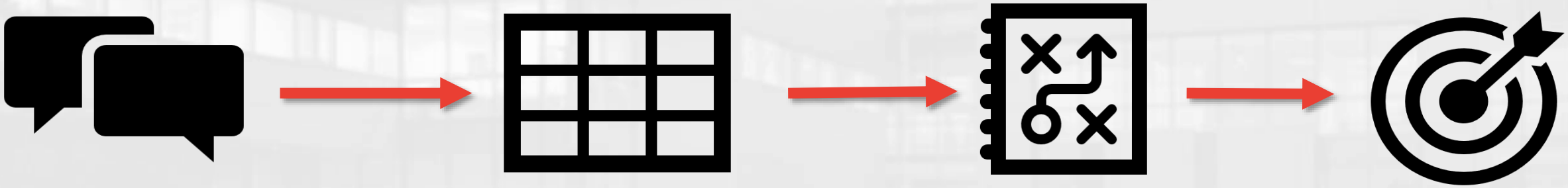


6

- One camera mounted on stand on chamber floor
- Insulation around camera
- Scaled prototype of lab
- Live stream and recording
- Existing DL350 data logger
- Internet connection through Ethernet Cable

Cassie Roby

Concept Selection



Criteria Comparison Matrix

Normalized Criteria Comparison Matrix

Final Matrix

Concept Selected

Cassie Roby

Analytic Hierarchy Process

Final Matrix

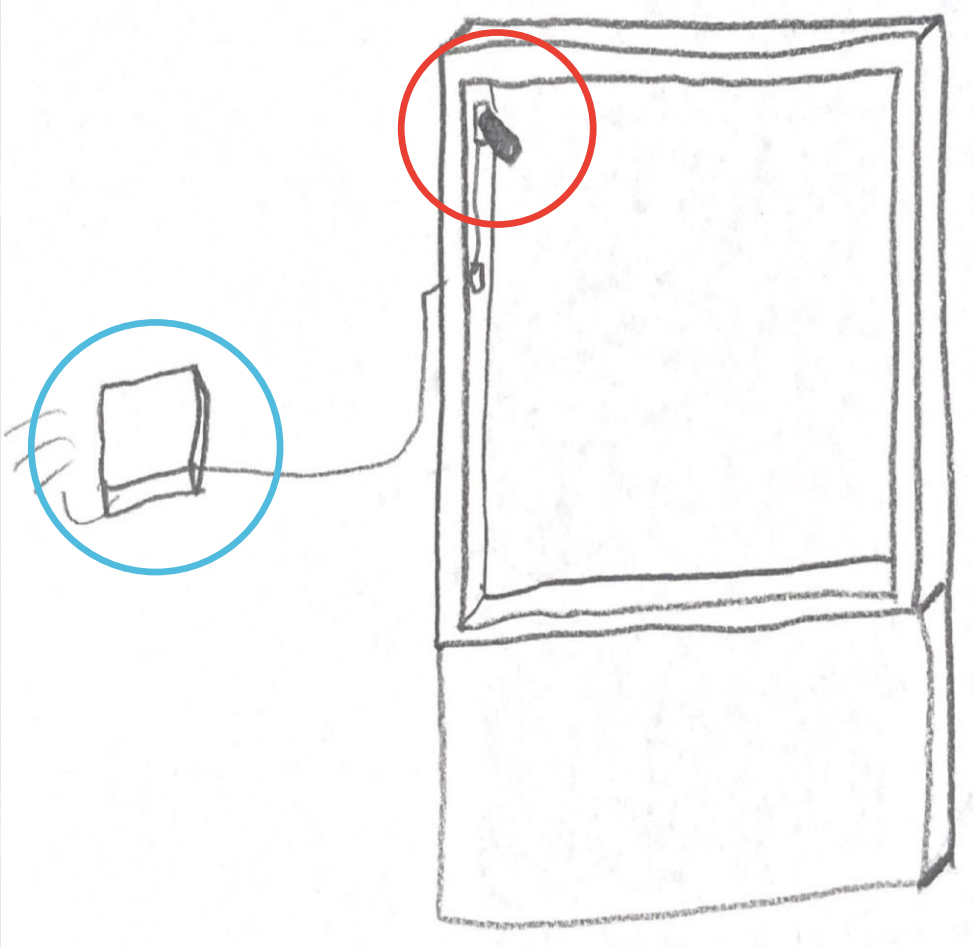
	Concept 1	Concept 2	Concept 6
Cost	0.48	0.11	0.41
Area View	0.29	0.30	0.14
Temperature	0.16	0.50	0.19
Frames Per Second	0.19	0.25	0.16
Max Size	0.21	0.66	0.10
Weight	0.24	0.10	0.62
Relative Humidity	0.07	0.50	0.18
Sum	0.28	0.35	0.26

$$Alternative\ Value = [Final\ Matrix]^{T} .* \{P_i\}$$

	Alternative Value
Concept 1	0.321
Concept 2	0.407
Concept 6	0.217

Cassie Roby

Concept 1



- One corner adhesive mounted camera
- Insulation around camera
- Scaled prototype of lab
- Digital video recorder
- Live stream video
- Data logger connected to internet via Ethernet cable

Cassie Roby

Danfoss Climatic Chamber Endurance Tests

How long are you running climate tests?

- "The chamber operates continuously, 24/7."

How long are you staying at each temperature?

- "It depends on the test. Sometime minutes, sometimes many days, and sometimes months."

How many cycles are conducted for each test?

- "It depends on the test. Thousands of cycles."

How long does each cycle take?

- "It depends on test and soaking plan. Each cycle normally takes one to two hours based on the temperature selection."

Answered by our sponsor, Vinayak Hegde.

Cassie Roby

Camera Research

$ 6,056.01

Custom soft shut off available

-40ºC to 140ºC

Larson Electronics
Outdoor Security Camera

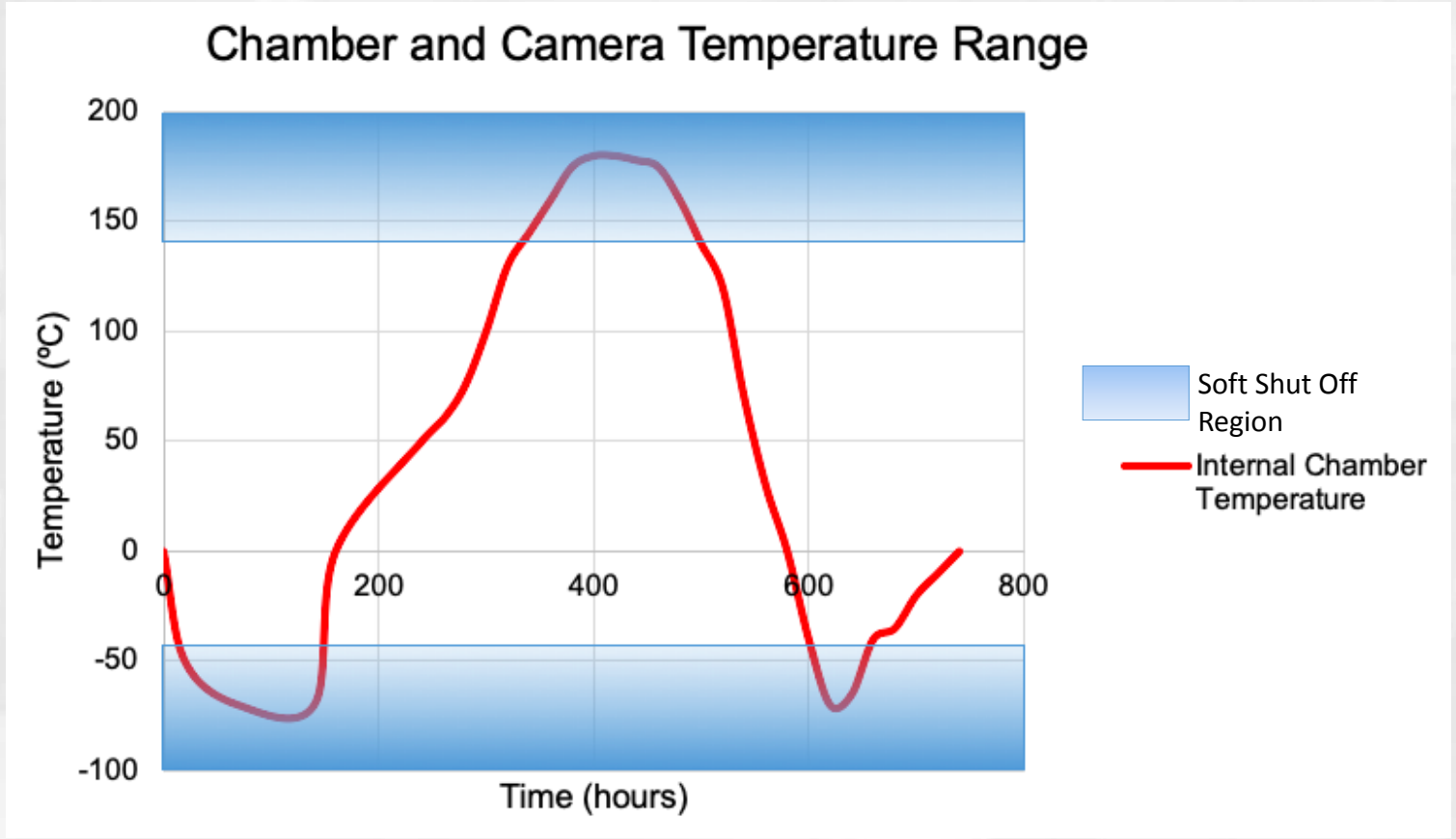
Internal Fog Prevention Heater

Target Temperature Range:
-73ºC to 180ºC

Cassie Roby

Camera Shut Off Regions

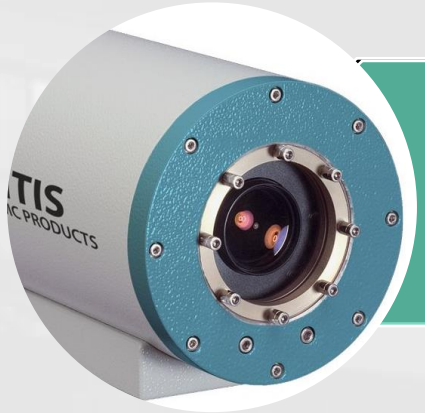
Soft shut off – the camera will temporarily go into a sleep mode while extreme temperatures are present.



Cassie Roby

Thermal Analysis – Insulation

Insulation works by slowing conductive heat flow and, to a lesser extent, convective heat flow.



Static Material Insulation:

Will not work unless the camera is removed from chamber after a pre-determined amount of time.

Liquid Nitrogen insulation:

Must have liquid Nitrogen readily available

Liquid at -196ºC boils at 27ºC

A chamber at 180ºC will boil off all liquid Nitrogen before it reaches the camera

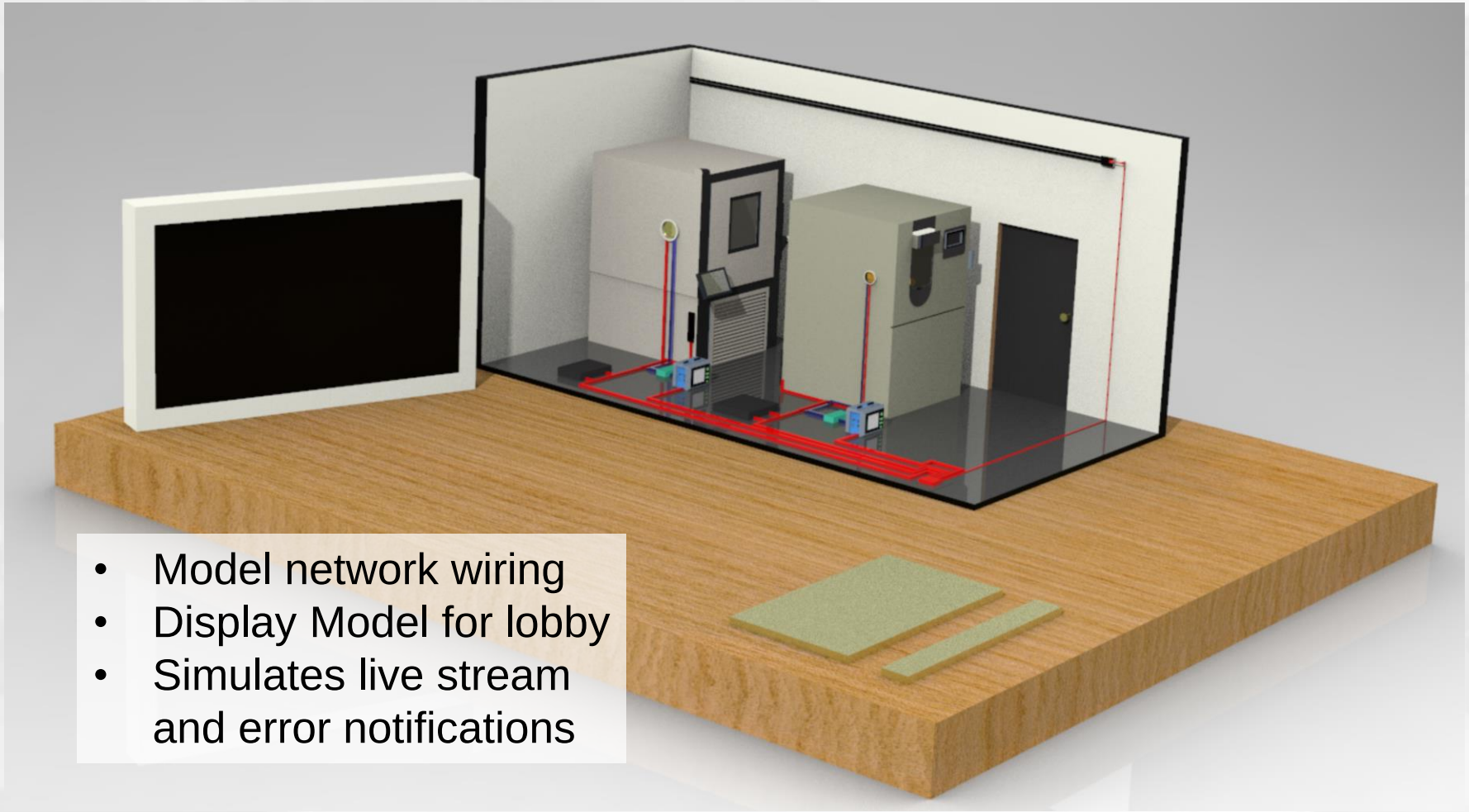
Currently not enough room at access point for large enough tubes

Cassie Roby

Prototype Detailed Design

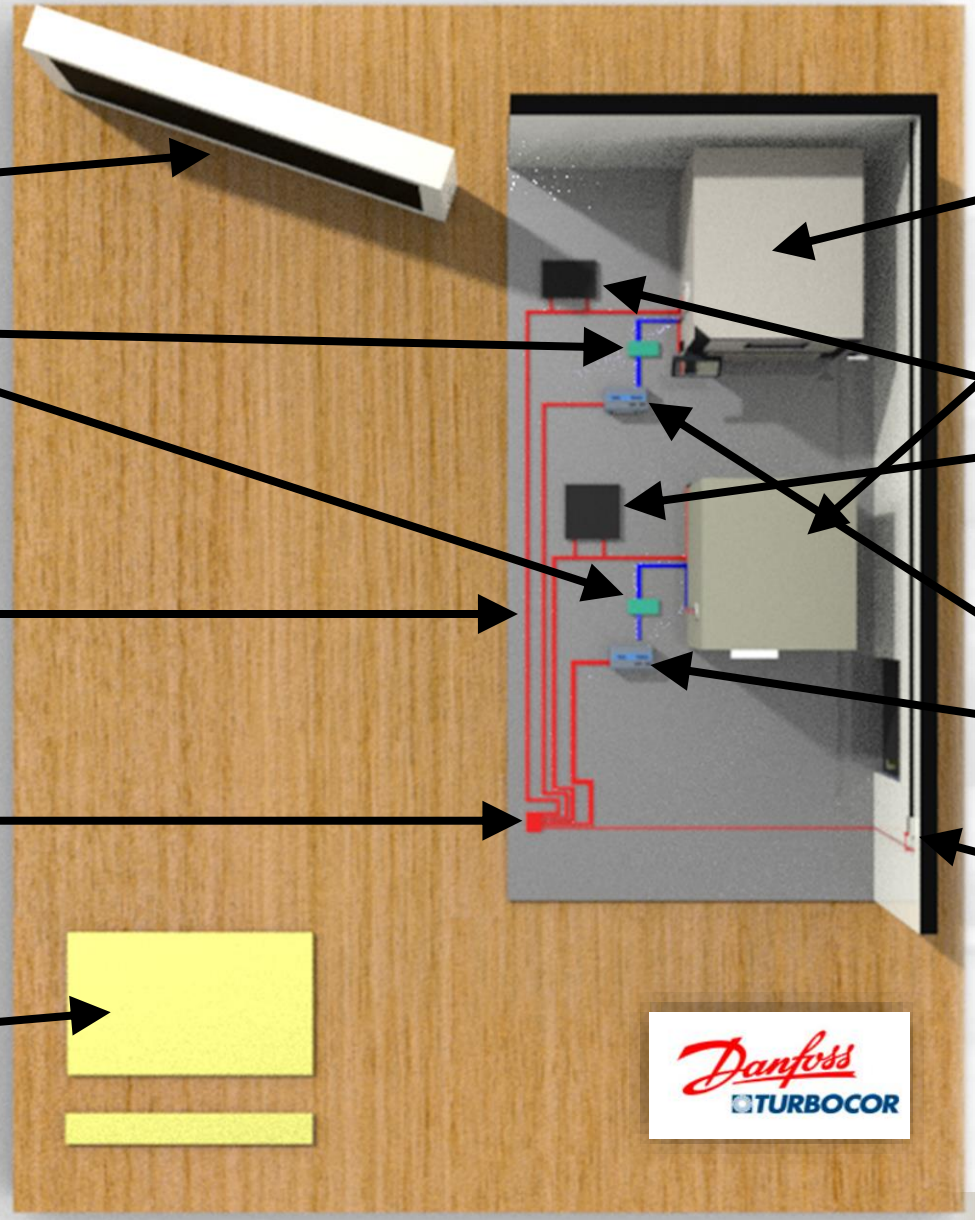
Next Presenter: Daniel Lane

Prototype CAD



- Model network wiring
- Display Model for lobby
- Simulates live stream and error notifications

Daniel Lane

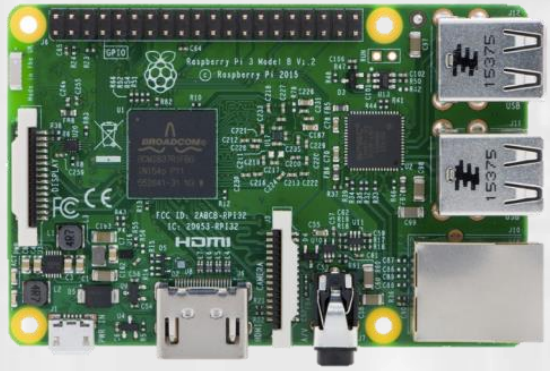

Tablet Display
Channels and
Thermal Couples
Ethernet cables
7-Way Ethernet Splitter
Information Panel
Climate Chambers
Digital Video Recorder
Data Loggers
Server Access Point
Danfoss
TURBOCOR

Daniel Lane

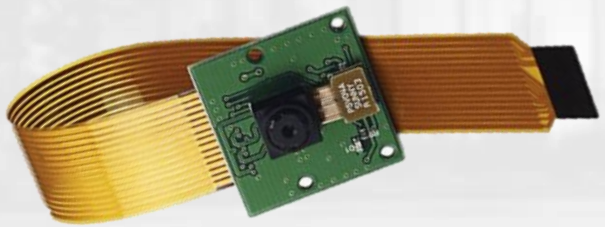
Prototype Networking

Android Tablet

Error Simulation



Raspberry Pi



Camera

Danfoss Router

Wire Connections
Wireless Connections

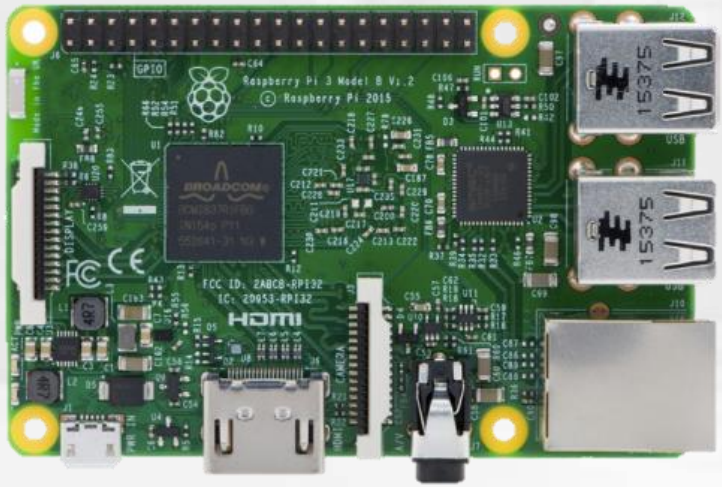
Daniel Lane

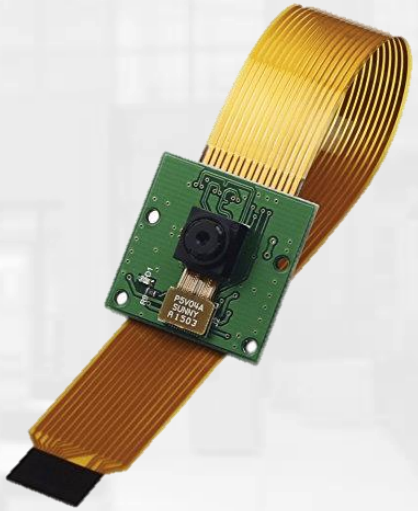
Software

MotionEye

- Surveillance software
- Compatible with any camera
- Live steam video
- Detect motion
- Save video for future use

MotionEye



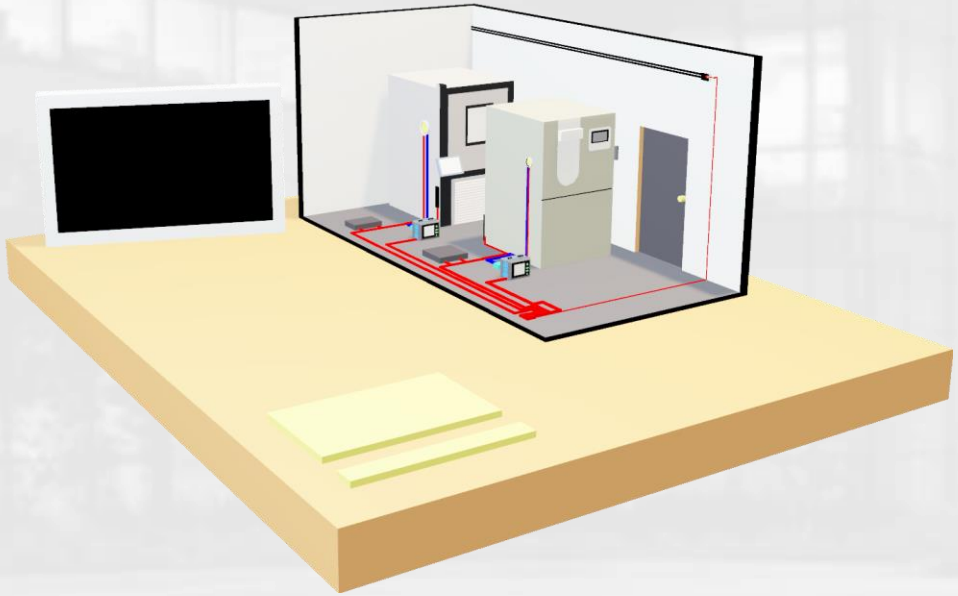


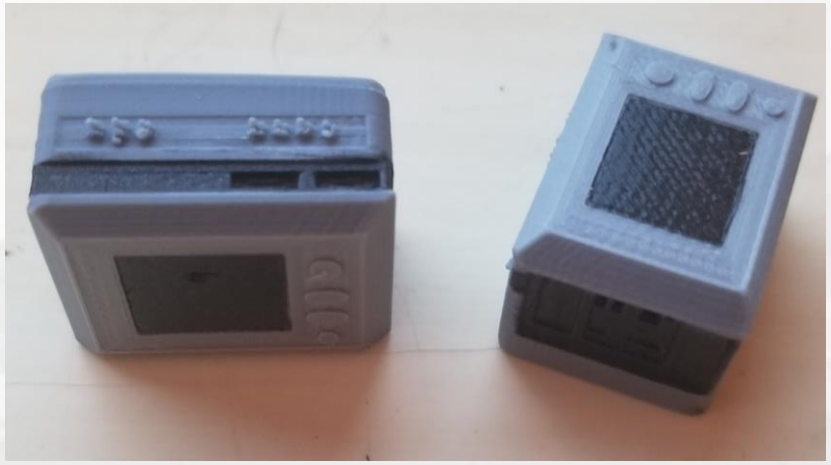
Daniel Lane

Embodiment Design

Next Presenter: Danny Carlos

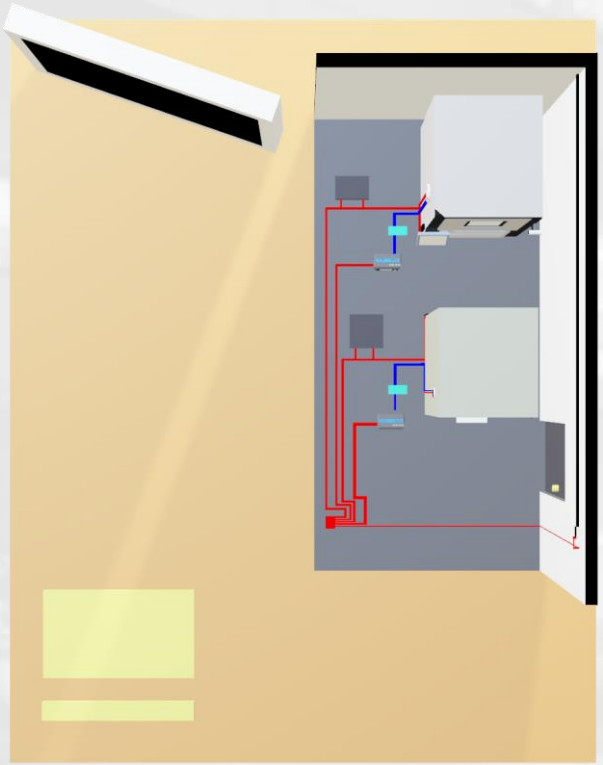
Manufacturing

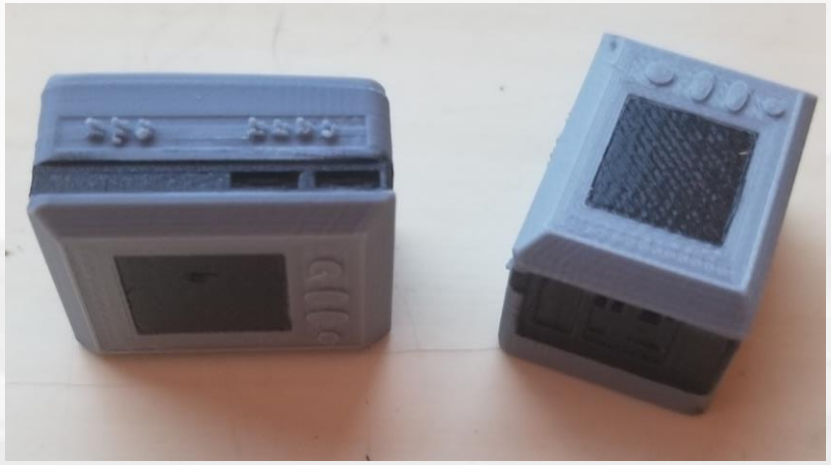




Danny Carlos

Manufacturing



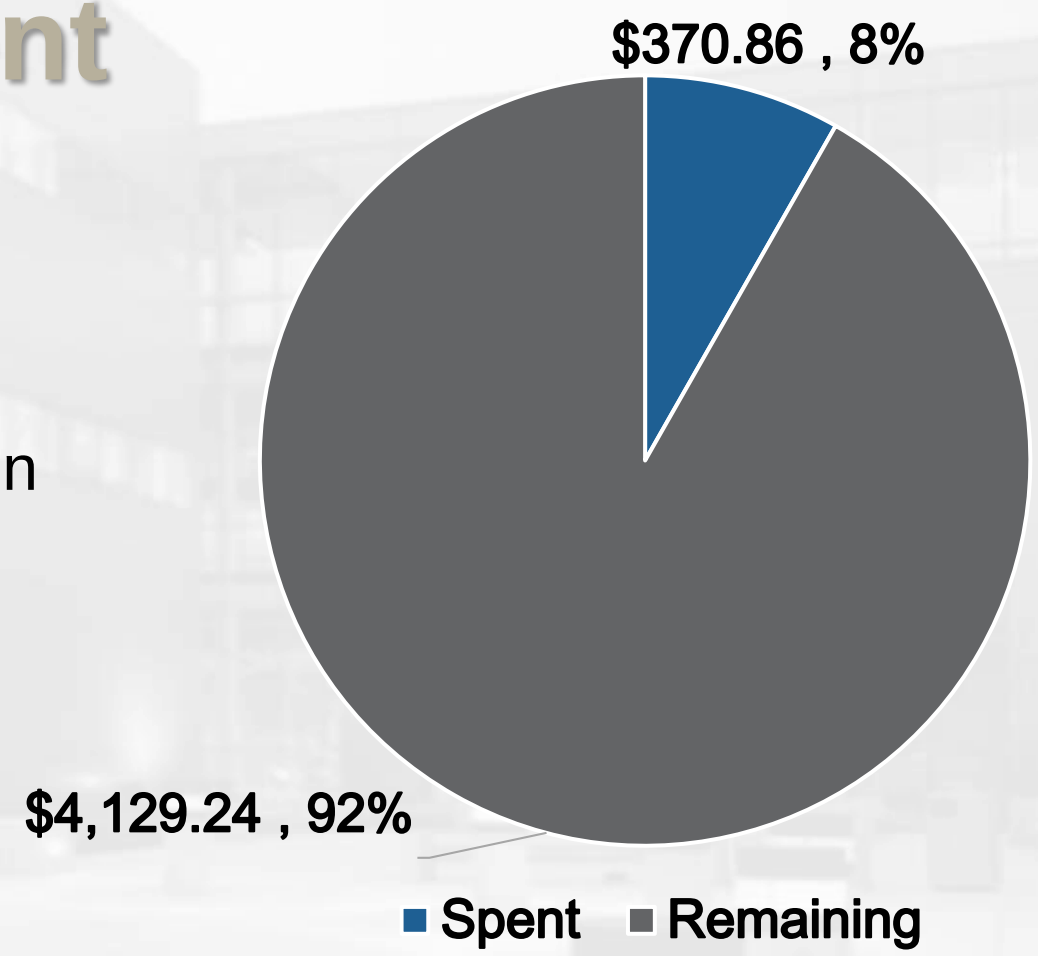


Danny Carlos

Project Management

We were able to reduce costs by:

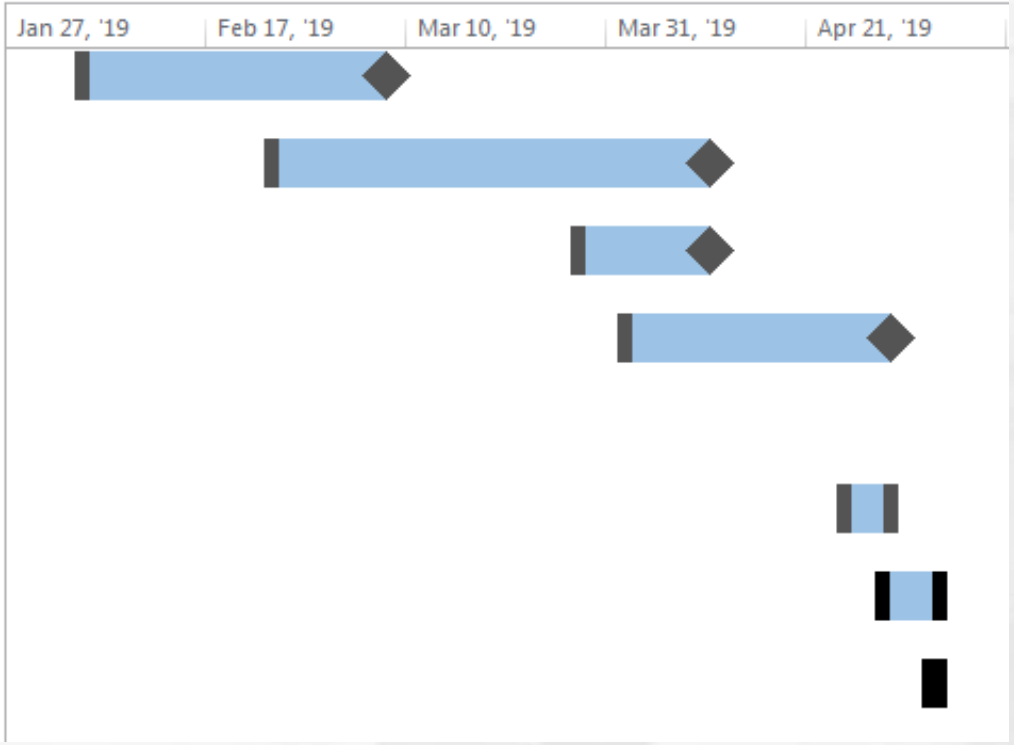
- 3D printing at the Innovation Hub
- Utilizing tools from the senior design room
- Choosing a limited function tablet



Danny Carlos

Moving Forward

Task Name
Receive all parts
Complete prototype build
Prototype testing complete
Prototype documentation, connection proposal, and operation manual
Engineering Design Day
Finals Week
Graduation



Danny Carlos

Key Take Away

1. Two part project: Danfoss test lab and prototype test lab.
2. Waiting on Larson Electronics to give a quote on camera modifications.
3. Assemble prototype electronics and hardware.

Danny Carlos

References

Cincinnati Sub-Zero.Enviromental.(2017).Environmental Chamber Controller: User Manual. Sharonville, OH.GENTHERM

Thermotron.(2009).Environmental Chamber: Instruction Manual.Holland,MI.Thermotron

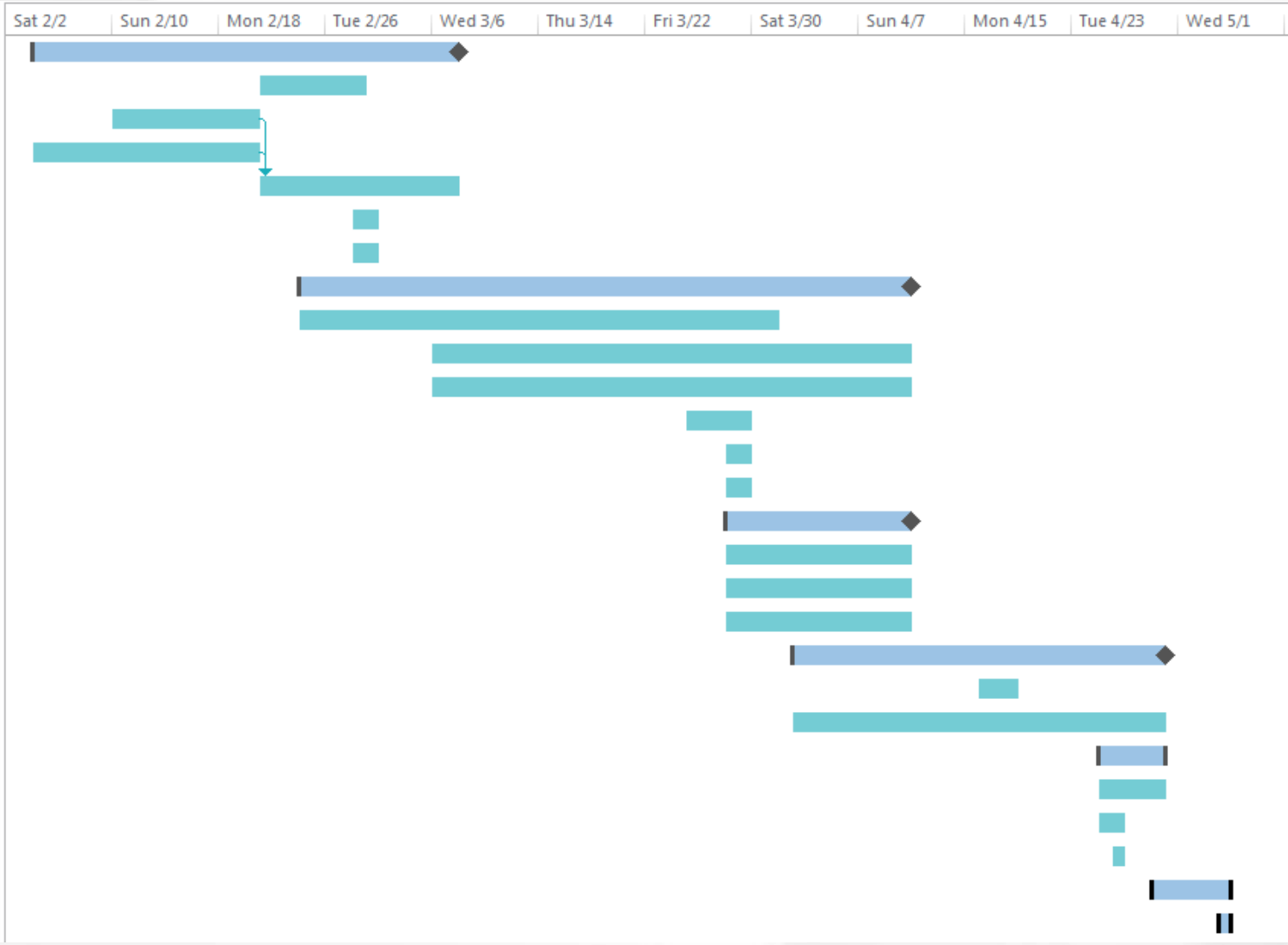
Multi-channel Data Logger LR8400, LR8401, LR8402. (n.d.). Retrieved from https://www.hioki.com/en/products/detail/?product_key=5613

Coley, P. (n.d.). Old V-Model Diagram. Retrieved October 03, 2018, from https://www.coleyconsulting.co.uk/old-v-model.htm

Questions

Backup Slides

Task Name
Receive all parts
Begin Spring Presentation 2
Cut base for prototype and 3D print components
Program microcomputers for prototype
Assemble prototype
Reading review 2
Advisor meeting 2
Complete prototype build
Test and modify
Create design report
Create Operation manual and connection proposal
create mini poster
Reading Review 3
Advisor Meeting 3
Prototype testing complete
Create final project poster and presentation
Edit prototype documentation
Edit connection proposal and operation manual
Prototype documentation, connection proposal, and operation manual complete
Prepare for final presentation
Begin studying for finals
Engineering Design Day
Study for finals
Reading Review 4
Advising Meeting with Dr. McConomy
Finals Week
Graduation



Camera Links

https://www.jmcanty.com/product/high-temperature-surveillance-camera/

https://www.larsonelectronics.com/p-150537-.aspx?keyword=&gclid=EAIaIQobChMI2fnb65ui3gIVQ0OGCh2zUwnOEAkYBiABEgIJh_D_BwE

Hardware

- Three different types of hardware being integrated
- All network connection will be via Ethernet cable
- An IP address will be required to enable connectivity

DL350 Data Logger

Cincinnati Sub Zero Climate Chamber

Thermatron-800 Climate Chamber

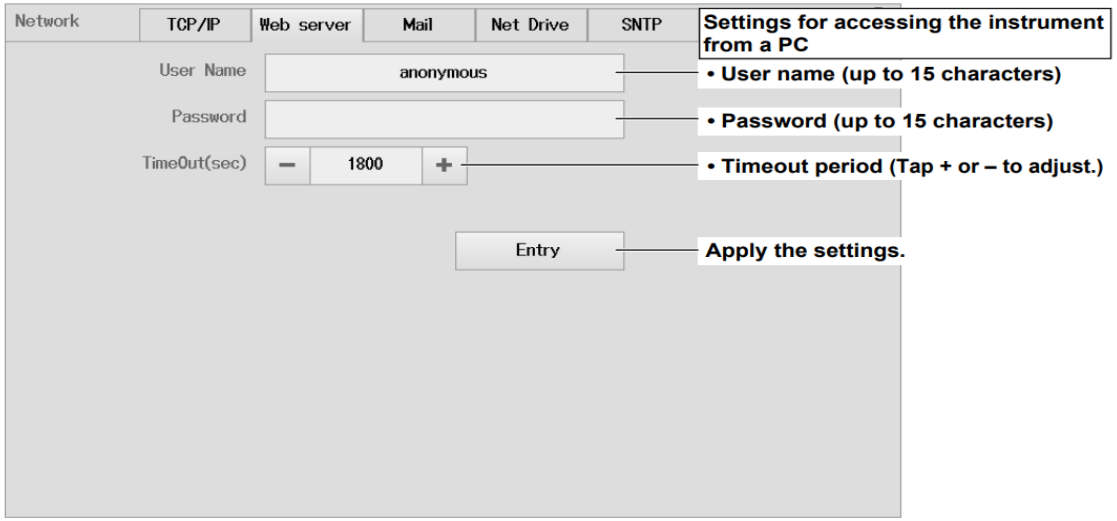
DL 350 Data Logger (Web Server)

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring the Web Server (Web Server)

2. Tap the **Web Server** tab.
3. Tap each item. Use the input box to set the items.



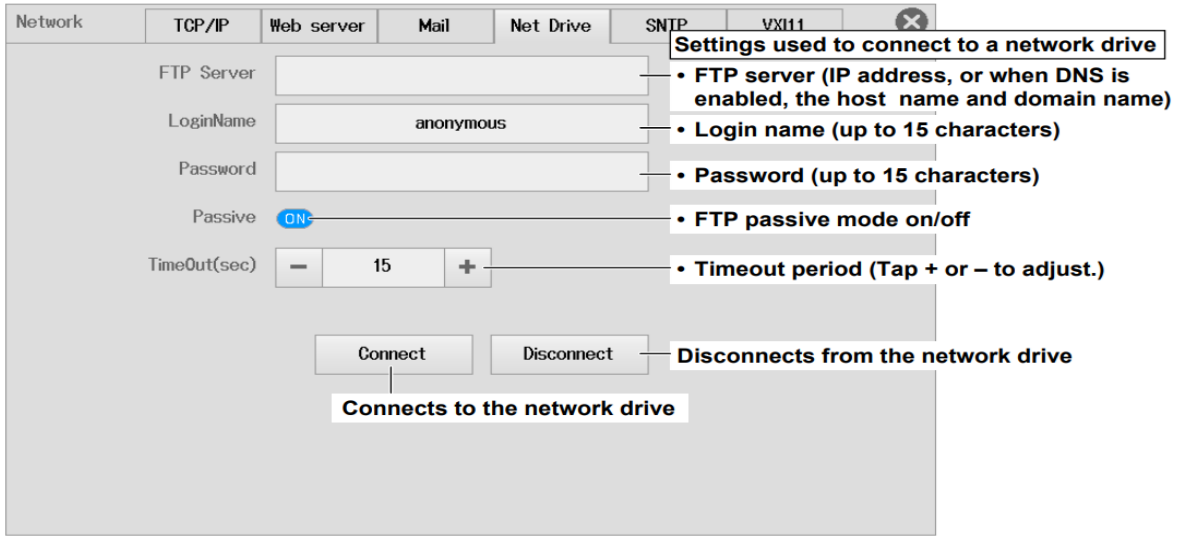
DL 350 Data Logger (Network Drive)

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring a Network Drive and Connecting to It (Net Drive)

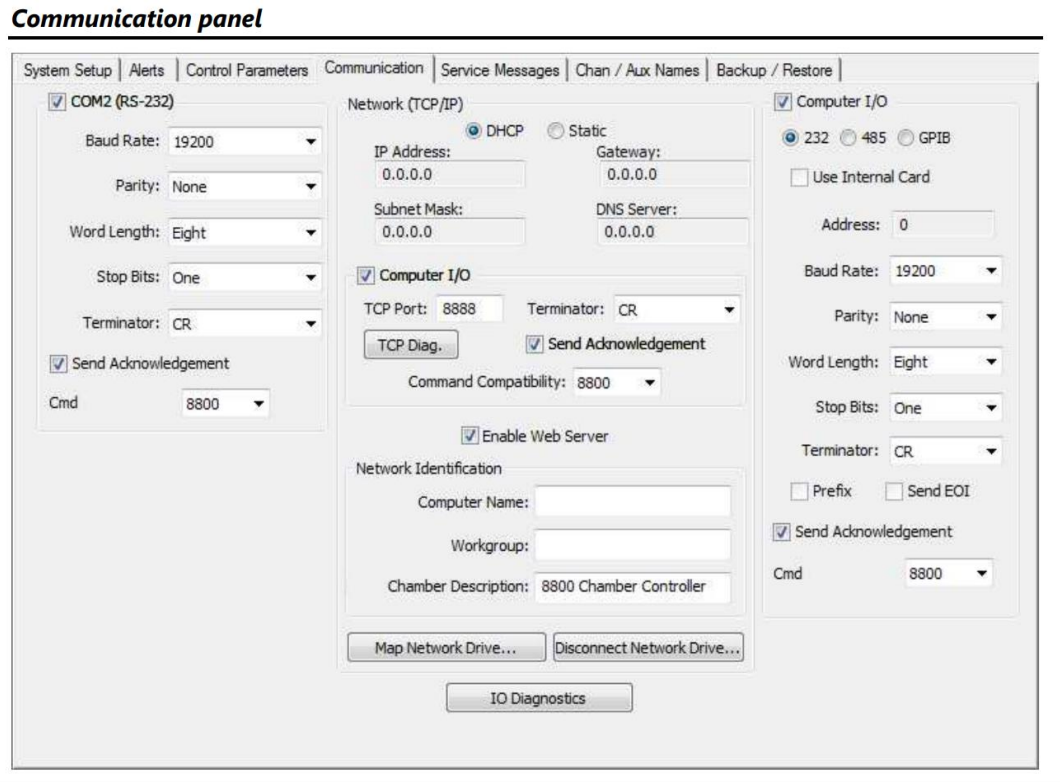
2. Tap the **Net Drive** tab.
3. Tap each item. Use the displayed input box to set the items.



Cincinnati Sub-Zero Climate Chamber

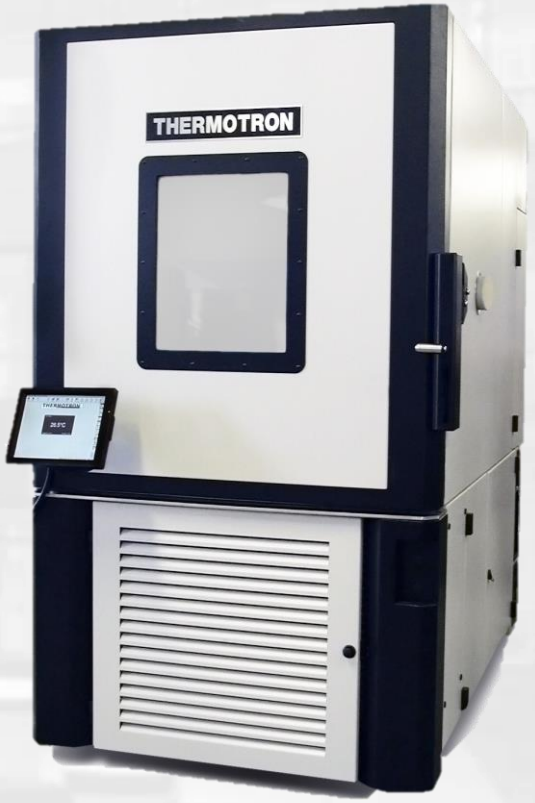
- Virtual network computing (VNC) accessible with free software download
- Enter the IP address of the chamber

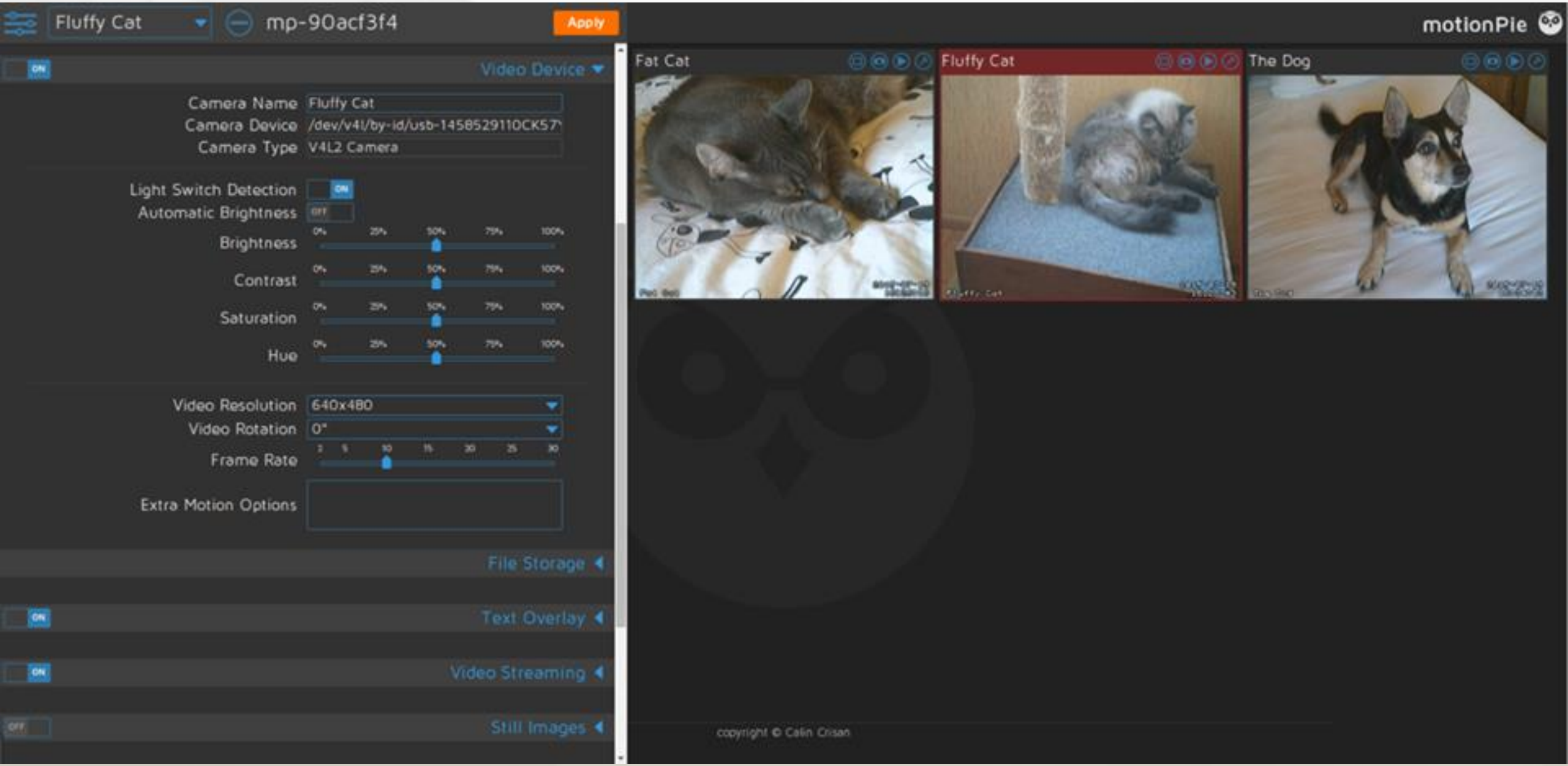
Thermatron Climate Chamber

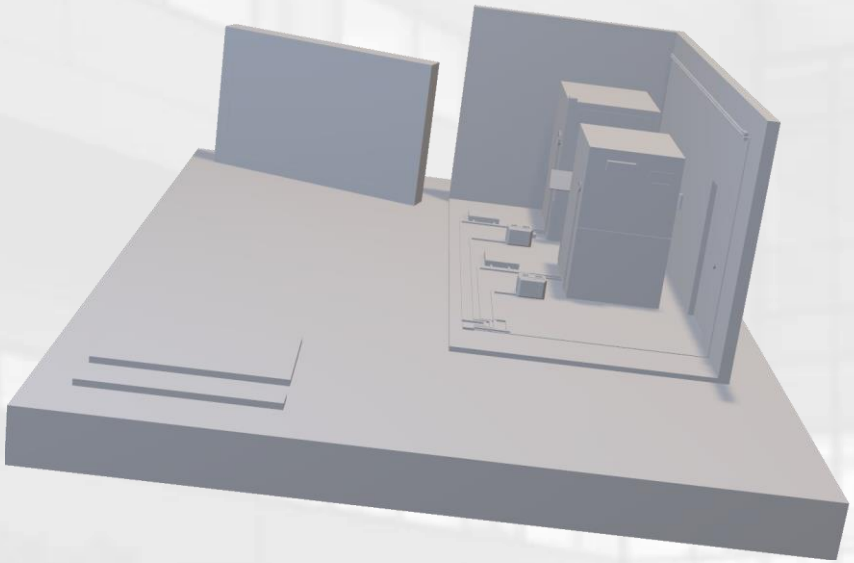


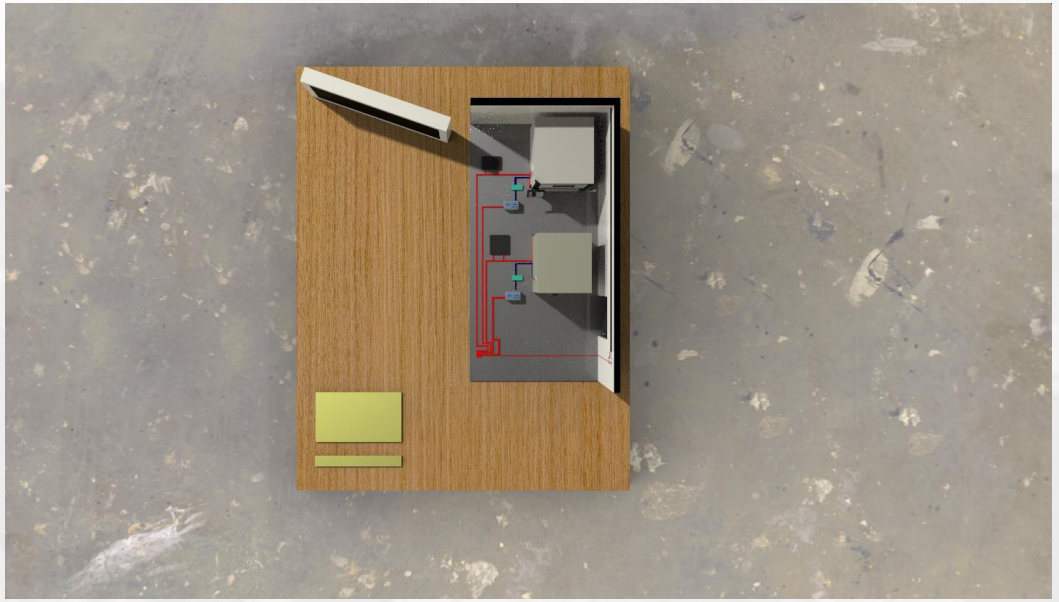
Webserver

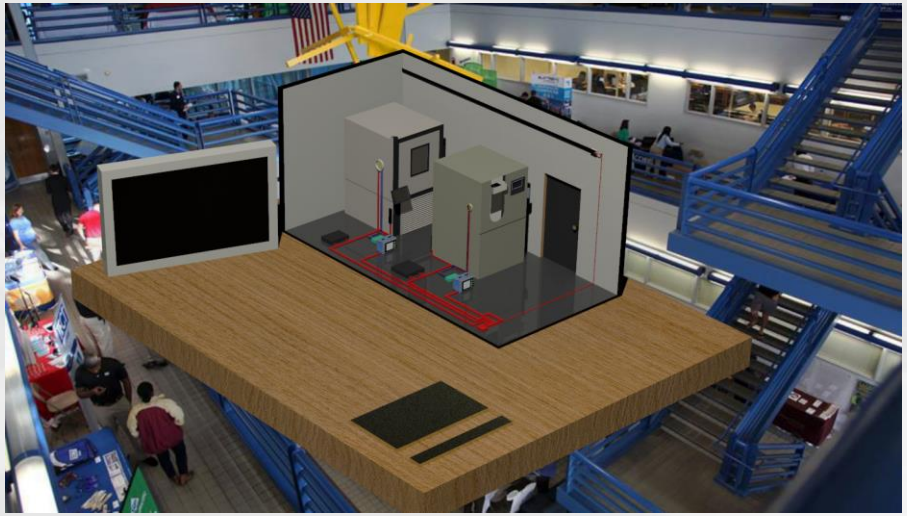
- Select setup
- Select the communication panel

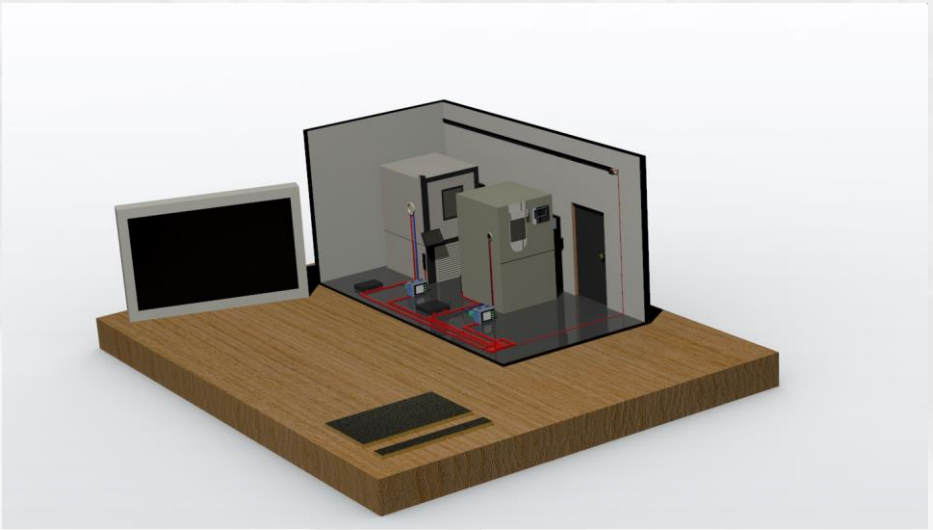



Fluffy Cat
mp-90acf3f4
Apply
motionPie
Video Device
Camera Name
Fluffy Cat
Camera Device
/dev/v4l/by-id/usb-1458529110CK57
Camera Type
V4L2 Camera
Light Switch Detection
Automatic Brightness
Brightness
Contrast
Saturation
Hue
Video Resolution
640x480
Video Rotation
0°
Frame Rate
Extra Motion Options
File Storage
Text Overlay
Video Streaming
Still Images
Fat Cat
Fluffy Cat
The Dog
copyright © Calin Crisan









Thermal Equations

Conduction

$$Q = -kA\frac{dT}{dx}$$

K: thermal conductivity (W/mK)
A: Area (m^2)

Convection

$$Q = h_c A(T_{surface} - T_{fluid\ (air)})$$

h_c= Heat transfer coefficient (W/m^2K)
A: Area (m^2)

Radiation

$$Q = \sigma T^4$$

σ = Stefan-Boltzman Constant (5.6703x10^{-8} W/m^2K^4)
T: Absolute Temperature (K)

Epoxy Adhesive

Permatex Cold Weld Bonding Compound

- -81ºC
- 195ºC
- Shear Strength 3000Psi