Smart Integration of Climate Chamber Operations

Team 508

Design Review 5

February 19, 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

Kyle Barber

Sponsor

Vinayak Hegde, Danfoss Turbocor Compressors Inc.

Background: Energy efficient technologies

Advisor

Neda Yaghoobian, Ph.D.
College of Engineering

Background: Computational fluid dynamics

Kyle Barber

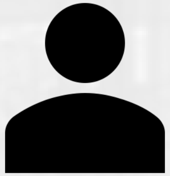
Objective

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

Kyle Barber

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.



Kyle Barber

Project Summary

- 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

Kyle Barber

Project Scope

- Humidity
- Climate Chamber
- Network
- Vibration
- Visual Monitor
- Data Logger
- Temperature

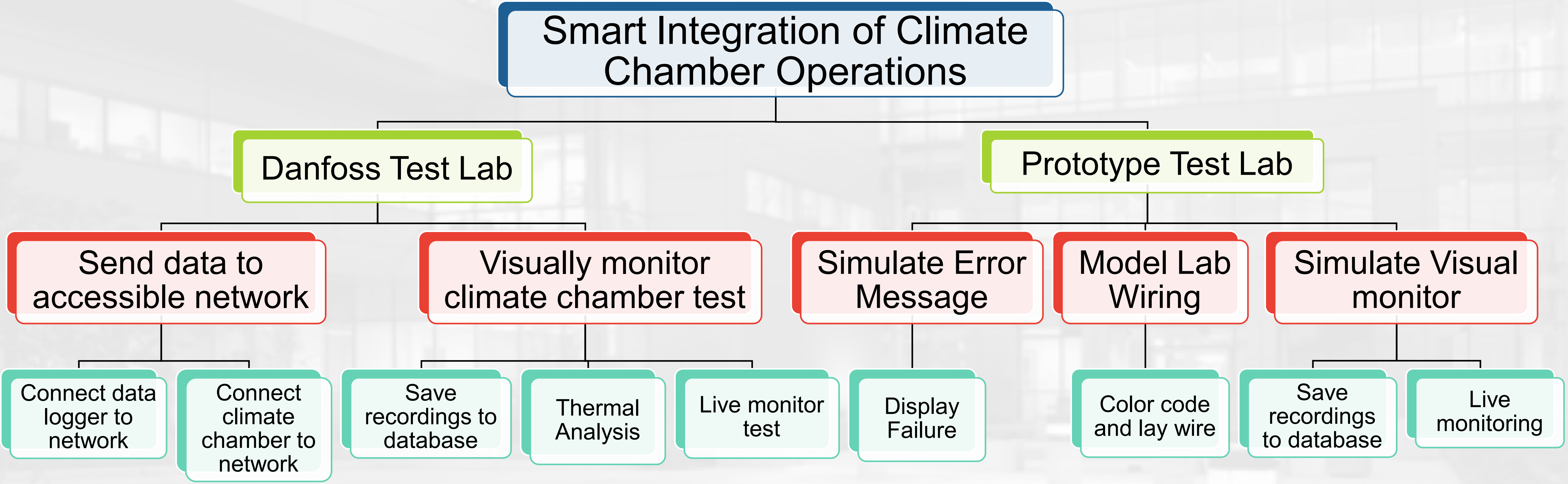
Kyle Barber

Customer Needs

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

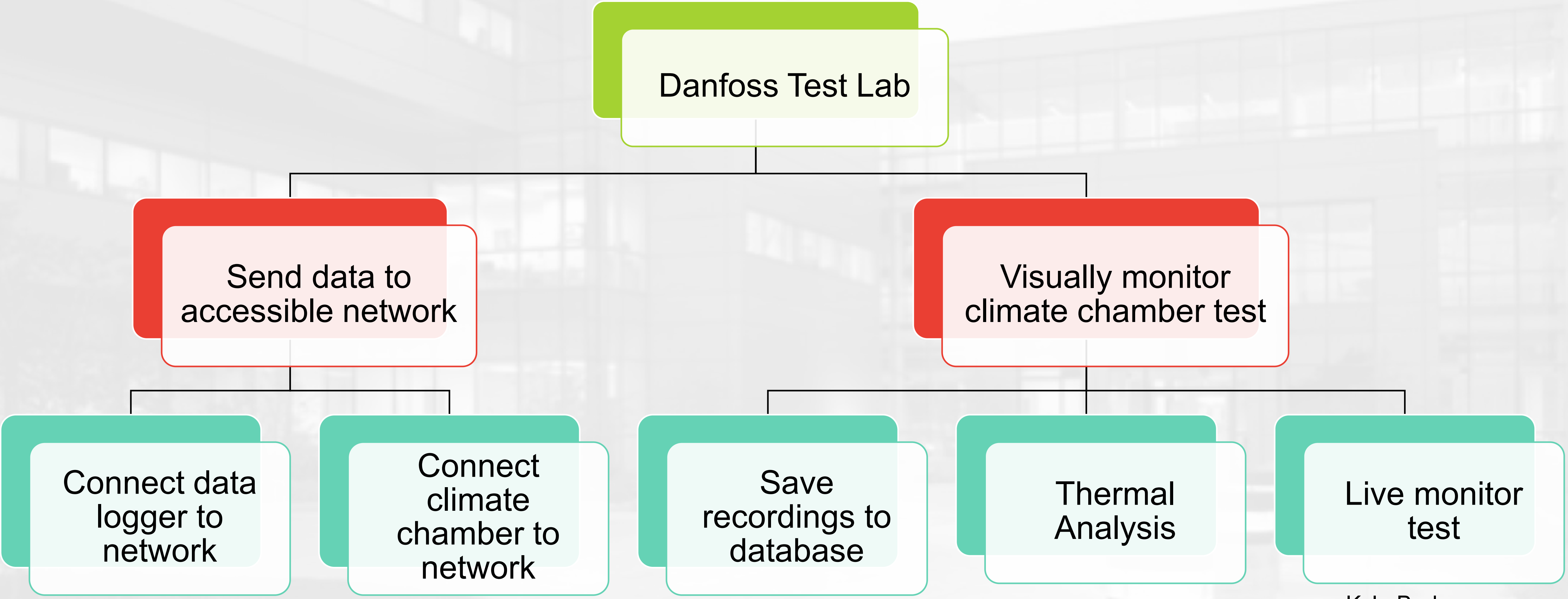
Kyle Barber

Functional Decomposition



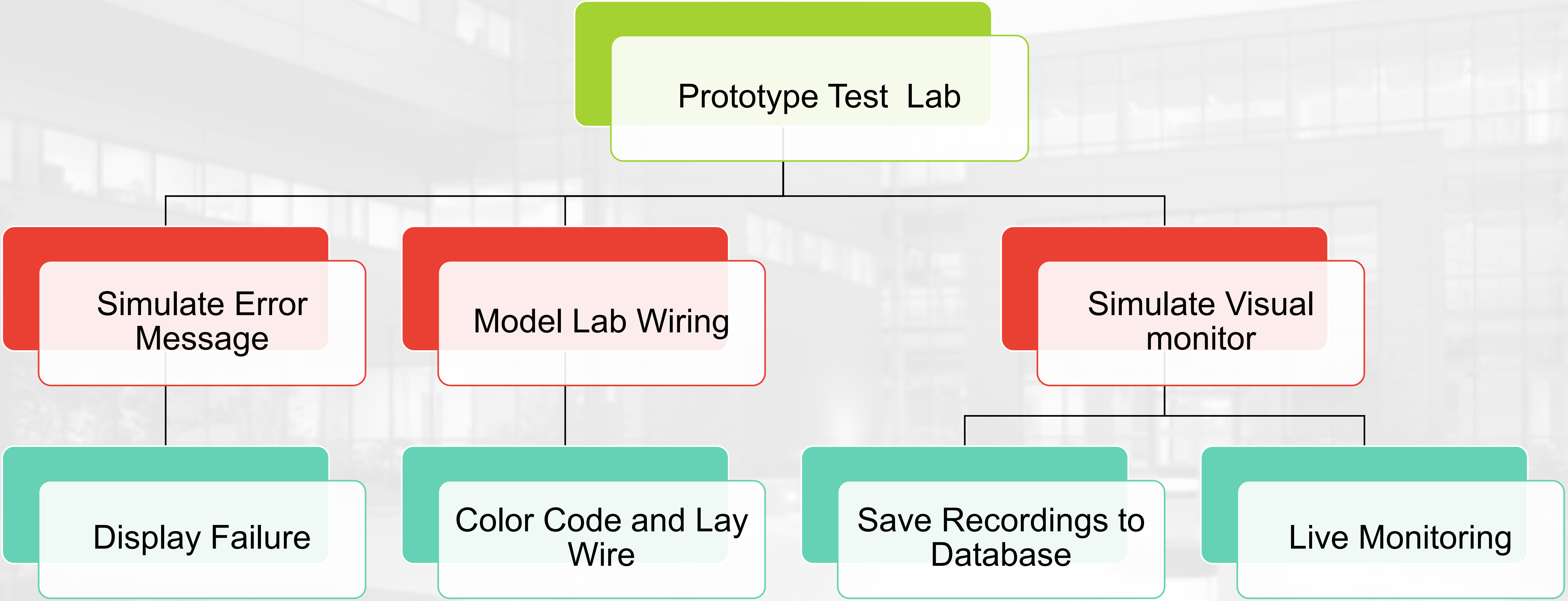
Kyle Barber

Functional Decomposition



Kyle Barber

Functional Decomposition



Kyle Barber

Previous Work

- Spring project plan and Gantt chart
- Bill of Materials for prototype approved
- CAD all prototype parts
- 3D print all prototype parts
- Researched software to run cameras
- Researched how to connect climate chambers and data loggers to servers

Current Work

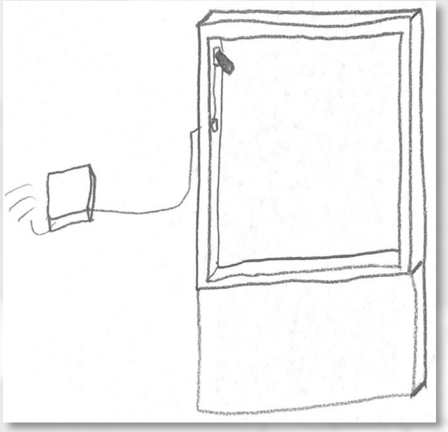
- Insulation and camera thermal analysis
- Unexpected delays in shipping acrylic casing

Kyle Barber

Conceptual Design

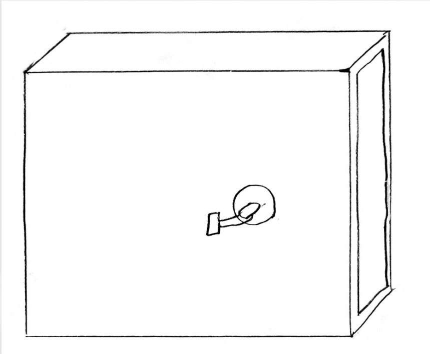
Next Presenter: Cassie Roby

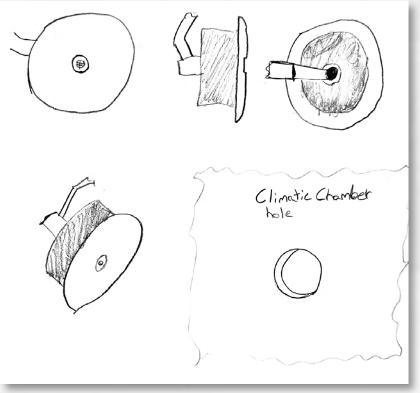
Concept Generation



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



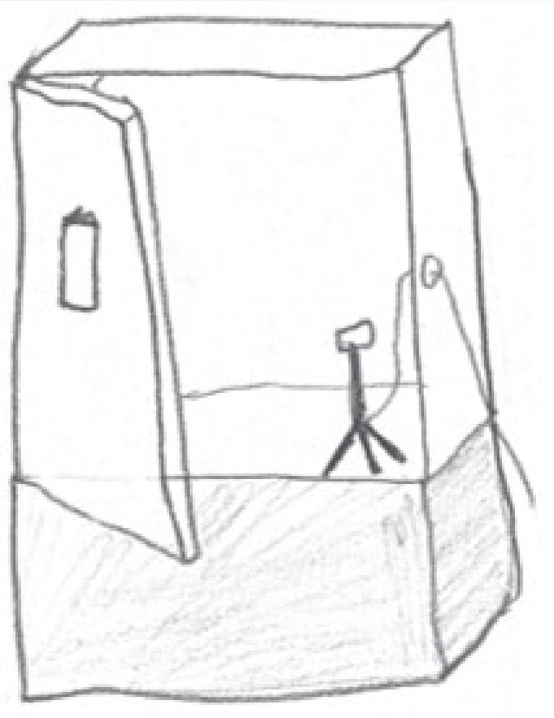


2

- 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

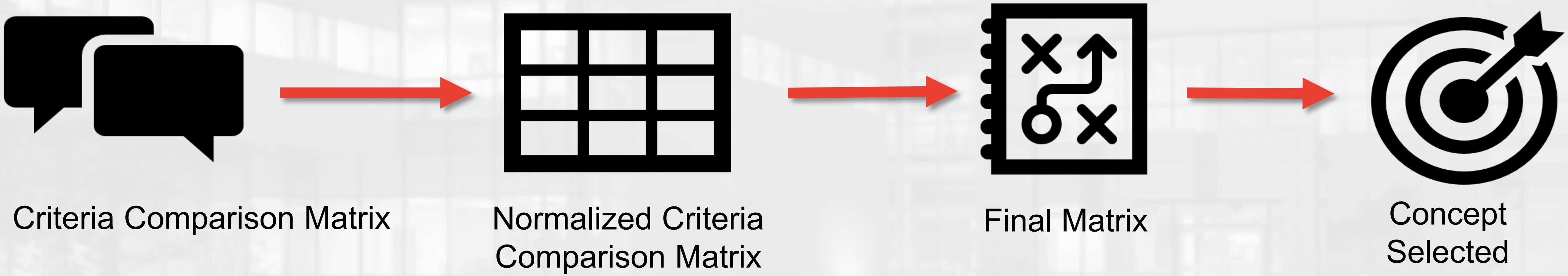


6

- 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



Cassie Roby

Analytic Hierarchy Process

Final Matrix

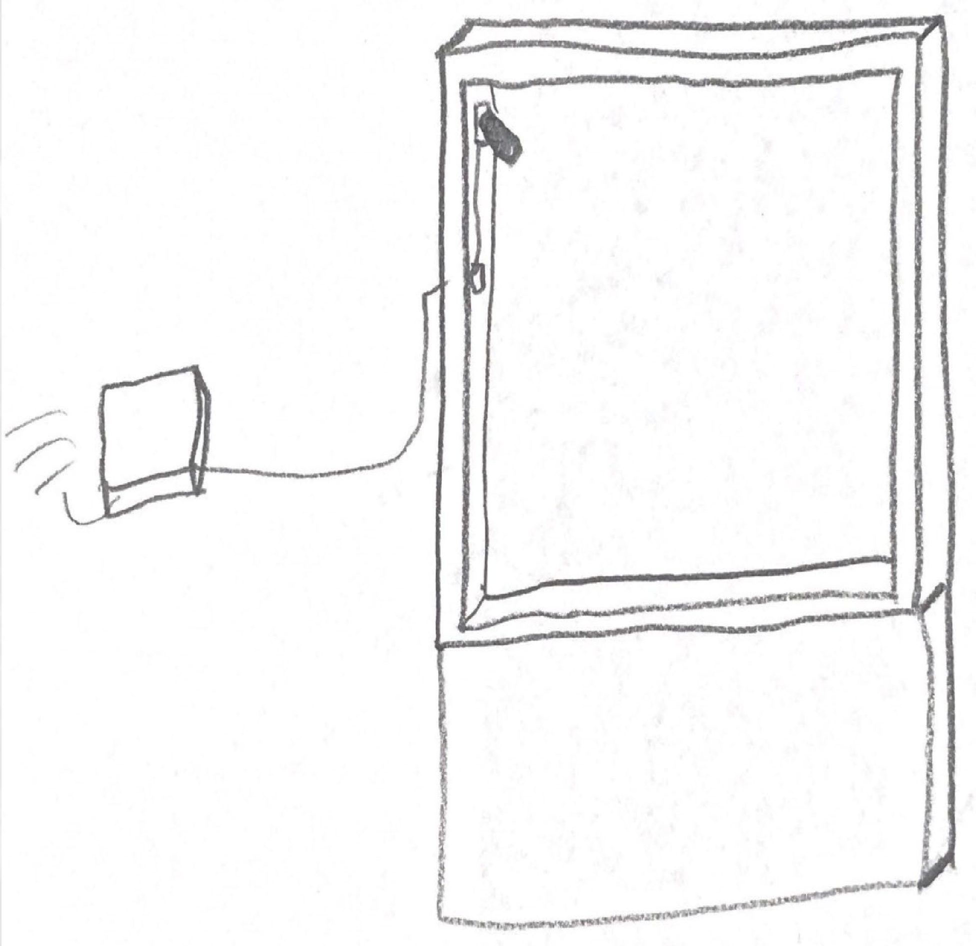
	Concept 1	Concept 2	Concept 6
Cost	0.48	0.11	0.41
Area View	0.29	0.30	0.14
Temperature	0.16	0.50	0.19
Frames Per Second	0.19	0.25	0.16
Max Size	0.21	0.66	0.10
Weight	0.24	0.10	0.62
Relative Humidity	0.07	0.50	0.18
Sum	0.28	0.35	0.26

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

	Alternative Value
Concept 1	0.321
Concept 2	0.407
Concept 6	0.217

Cassie Roby

Concept 1



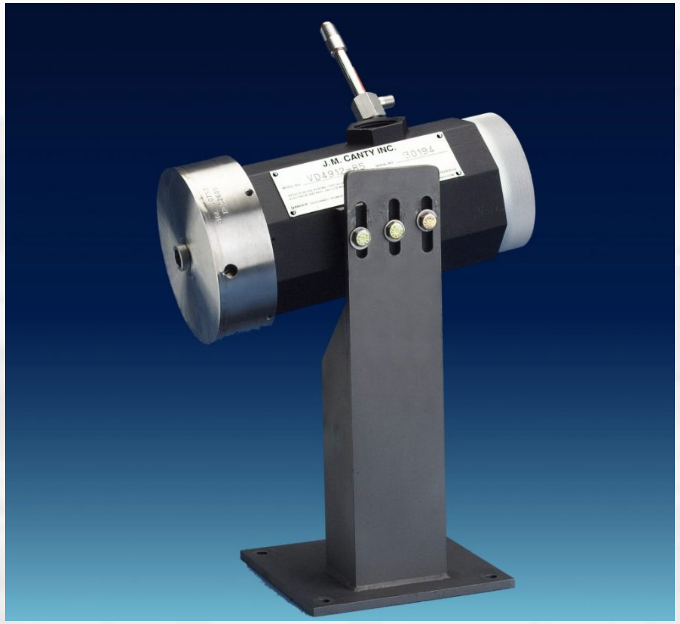
- One corner adhesive mounted camera
- Insulation around camera
- Scaled prototype of lab
- The camera will be live streamed and save recordings
- Data accessible by connecting existing DL350 to the internet via Ethernet cable

Cassie Roby

Camera Research

Larson Electronics Outdoor Security Camera

- $ 6,056.01
- Hot: 140ºC
- Cold: -40ºC



Canty High Temperature Surveillance Camera

- $ Waiting on response
- Hot: 1371ºC
- Cold: -10ºC

Cassie Roby

Thermal Analysis

Larson Electronics Temperature Difference

- Cold -33ºC
- Hot +40ºC

Canty Camera Temperature Difference

- Cold -63ºC
- Hot +1191ºC

Target Temperatures
-73ºC to 180ºC

Cassie Roby

Thermal Analysis – Heat Transfer

Conduction

- Camera mounted to chamber wall
- Will need small mounting area to reduce conduction in both hot and cold conditions

Convection

- Camera will experience convection as air in the chamber circulates
- The upper corners of the chamber will experience the hottest air. Good for cold condition, but not for hot condition.

Radiation

- Subsystems tested inside the chamber give off heat
- Can be reduced through multi-layer insulation, but will need to be increased during cold conditions.

Cassie Roby

Thermal Analysis – Insulation

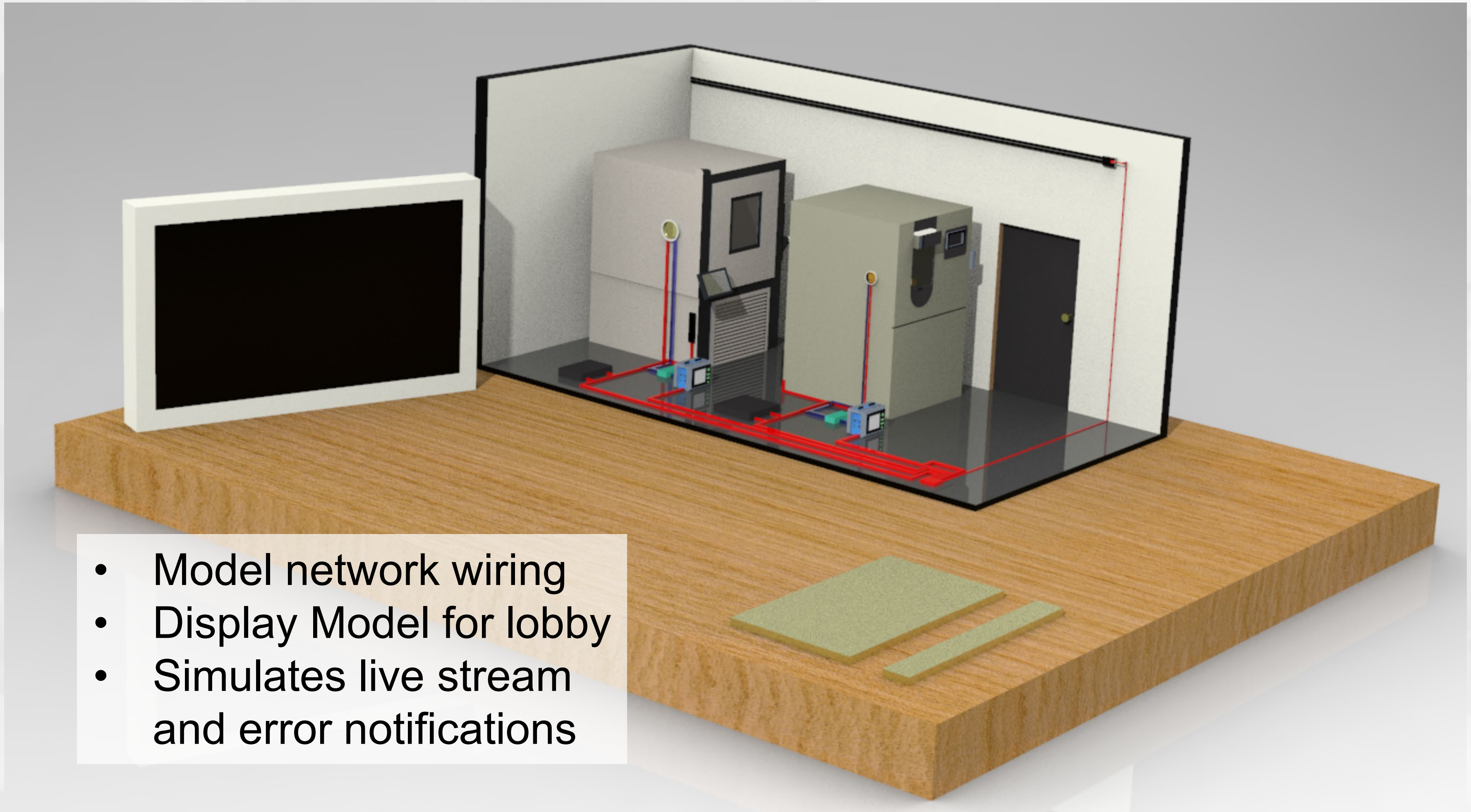
- Works by slowing conductive heat flow and - to a lesser extent - convective heat flow
- At steady state temperatures for long periods of time insulation will fail as all the insulating material becomes the same temperature as the chamber
- Static material insulation will not work unless the camera is removed from chamber after a pre-determined amount of time
- Hot/cold liquid insulation option
    - Must have hot/cold water readily available
    - Needs tubes run into the chamber, up the chamber wall, and around the camera
    - Currently not enough room outside chamber

Cassie Roby

Embodiment Design

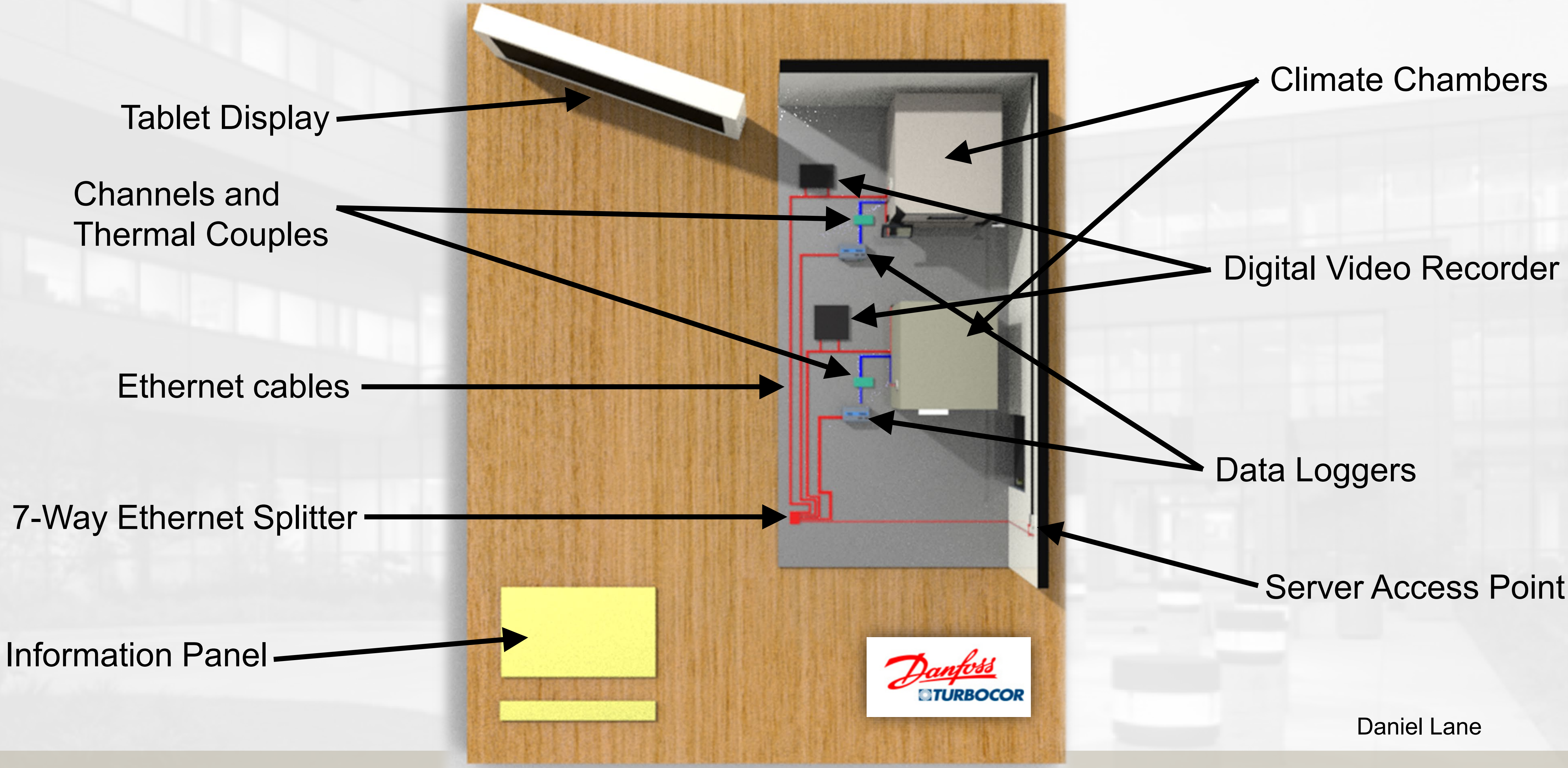
Next Presenter: Daniel Lane

Prototype CAD



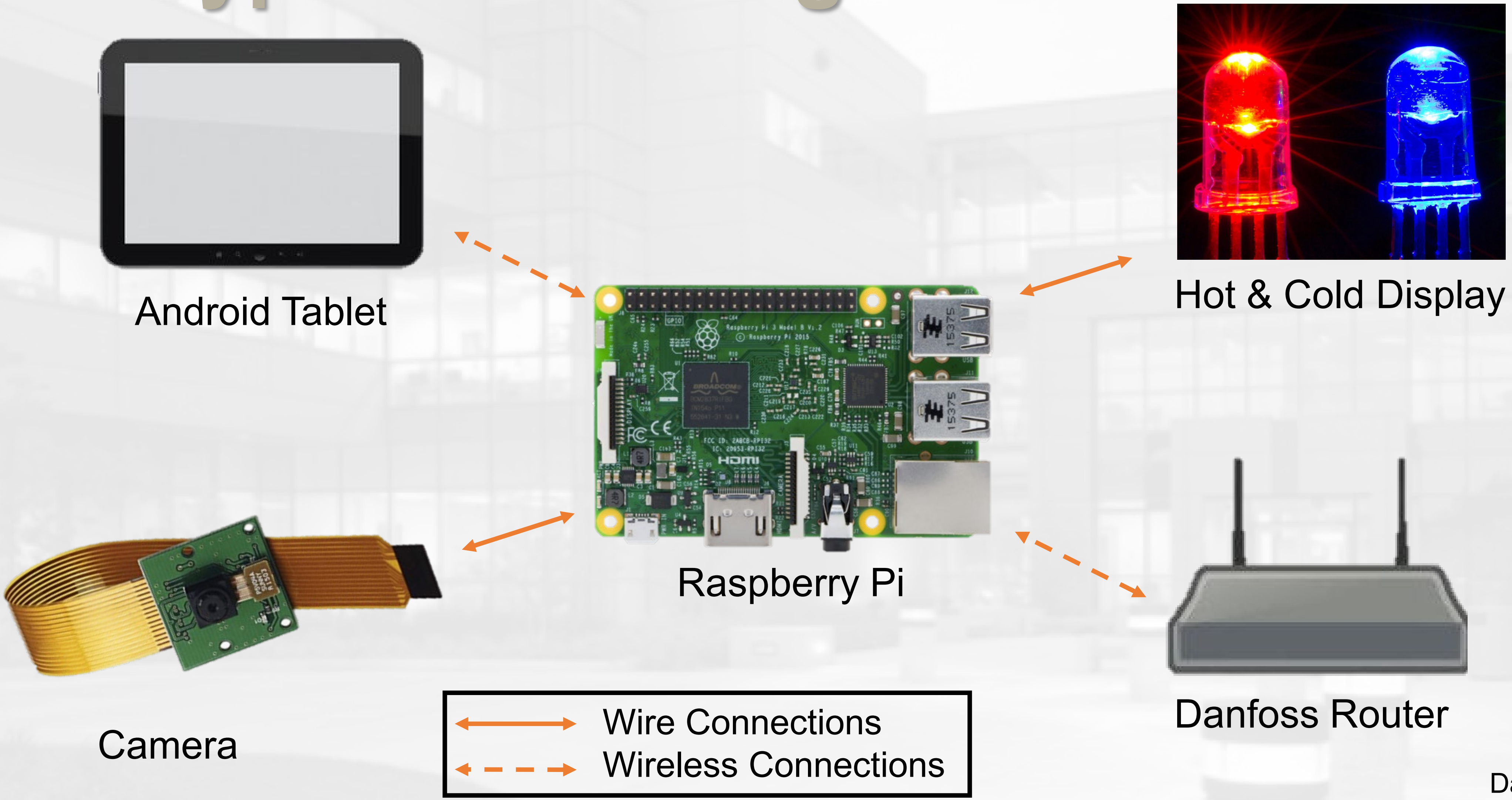
- Model network wiring
- Display Model for lobby
- Simulates live stream and error notifications

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



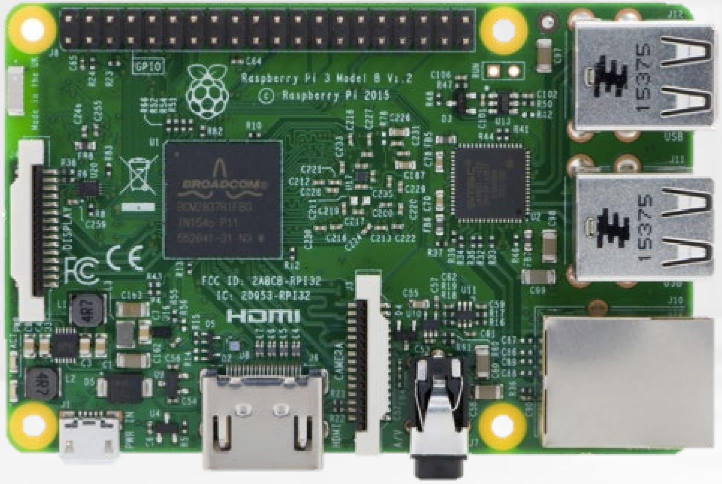
Daniel Lane

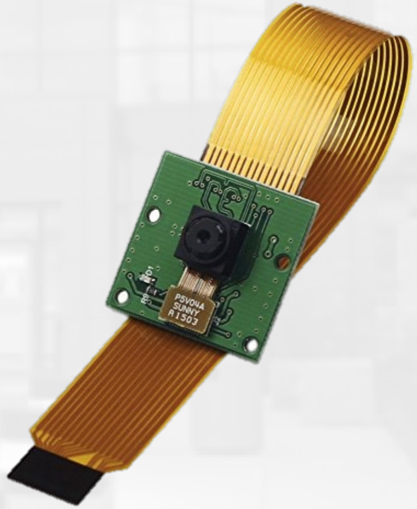
Software

MotionEye

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

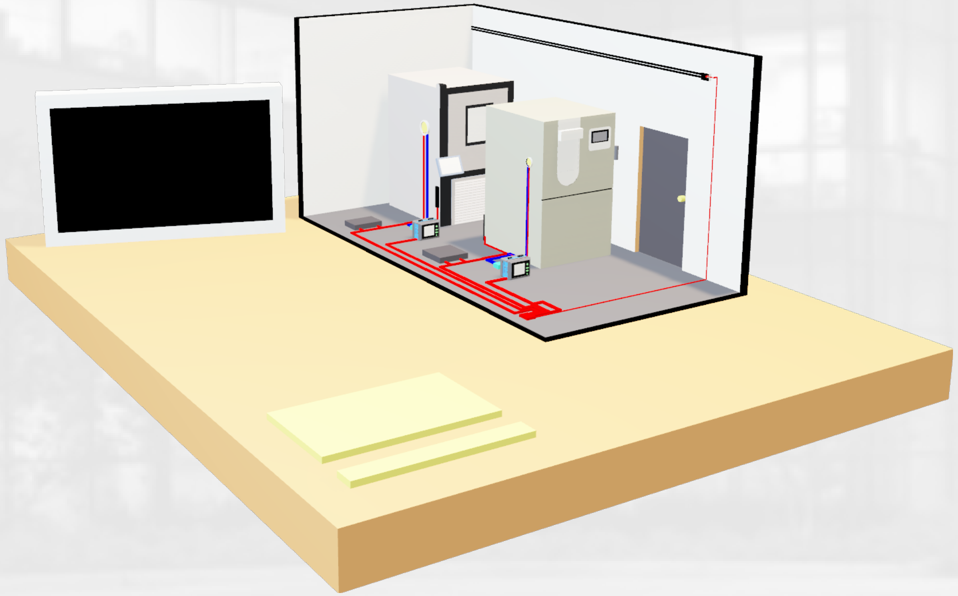
MotionEye

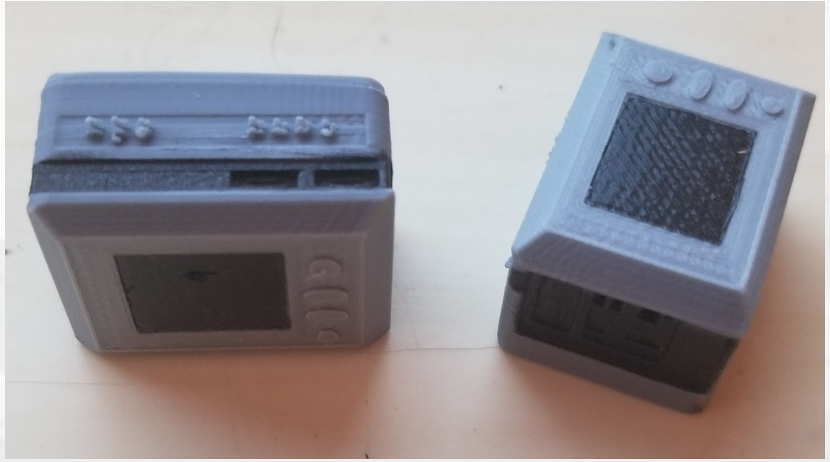




Daniel Lane

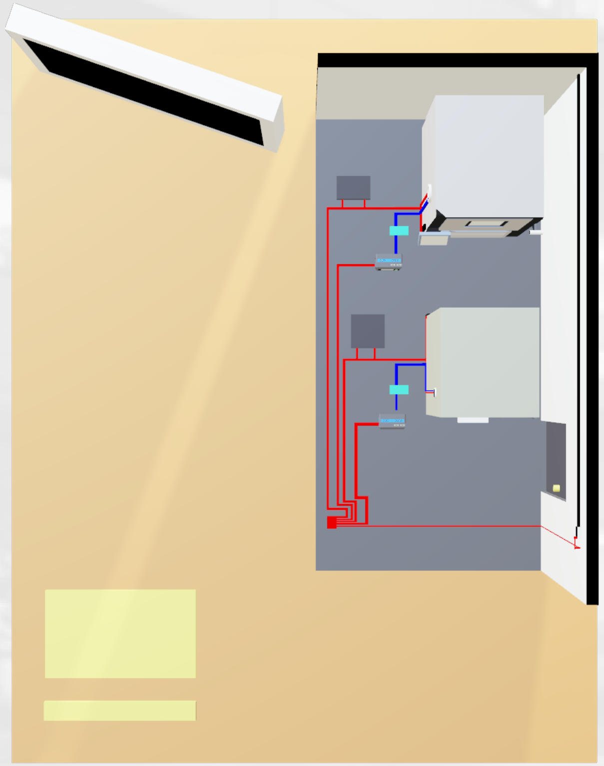
Manufacturing

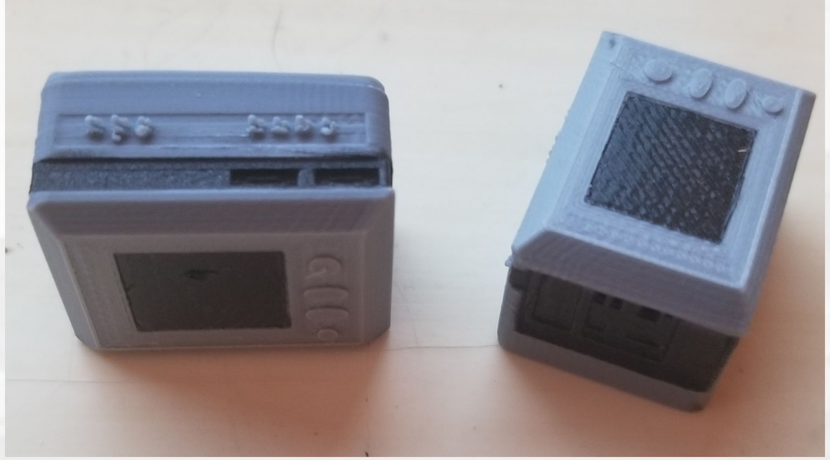




Daniel Lane

Manufacturing



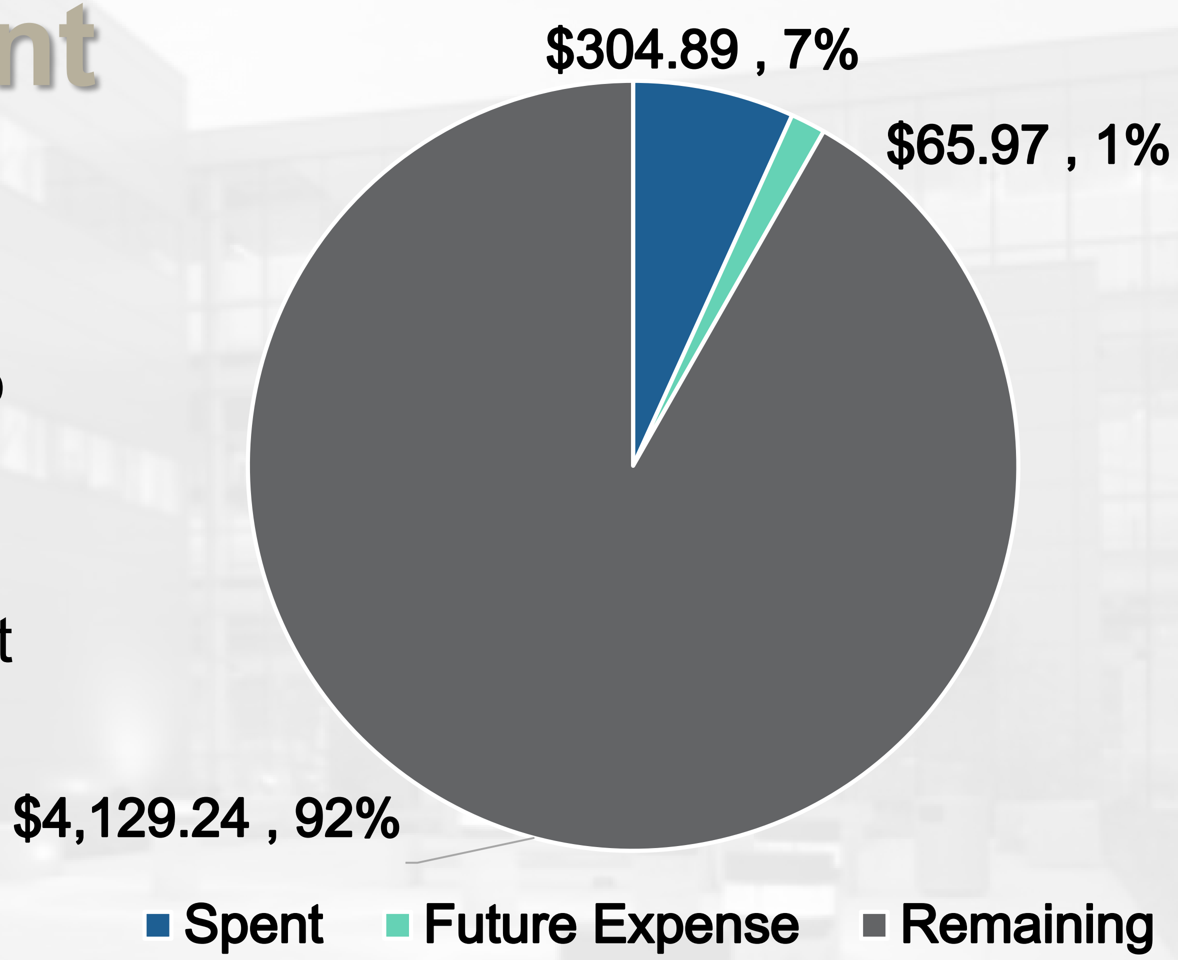


Daniel Lane

Project Management

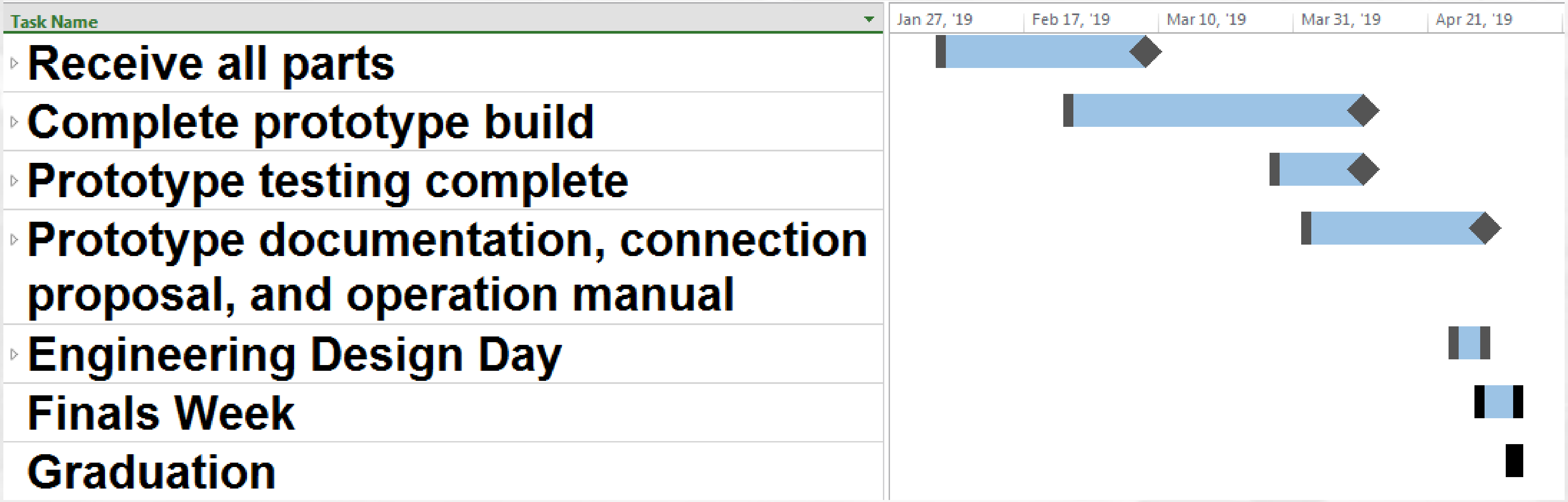
We were able to reduce costs by:

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



Daniel Lane

Moving Forward



Daniel Lane

Key Take Away

1. Two part project: Danfoss test lab and prototype test lab.
2. Currently developing thermal analysis for a suitable camera and possible insulation unit.
3. Waiting for the second part order to arrive from shipment.

Daniel Lane

References

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

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

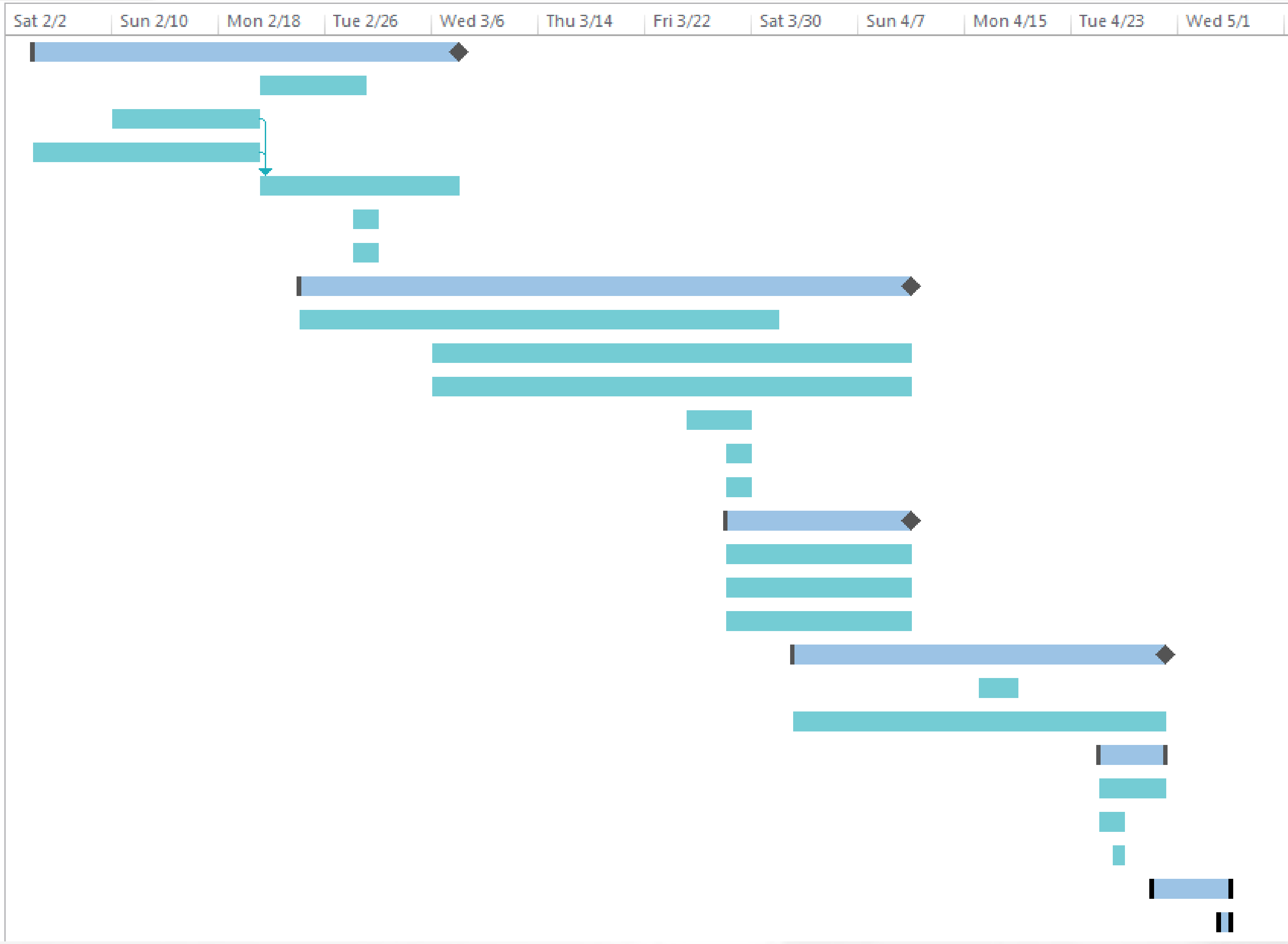
Multi-channel Data Logger LR8400, LR8401, LR8402. (n.d.). Retrieved from https://www.hioki.com/en/products/detail/?product_key=5613

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)

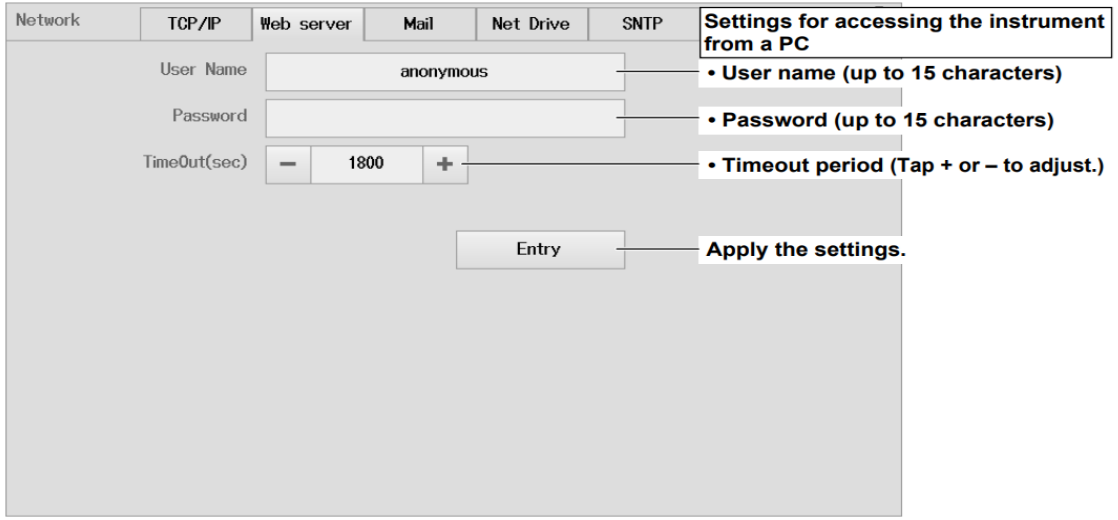
Utility Network Menu

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.



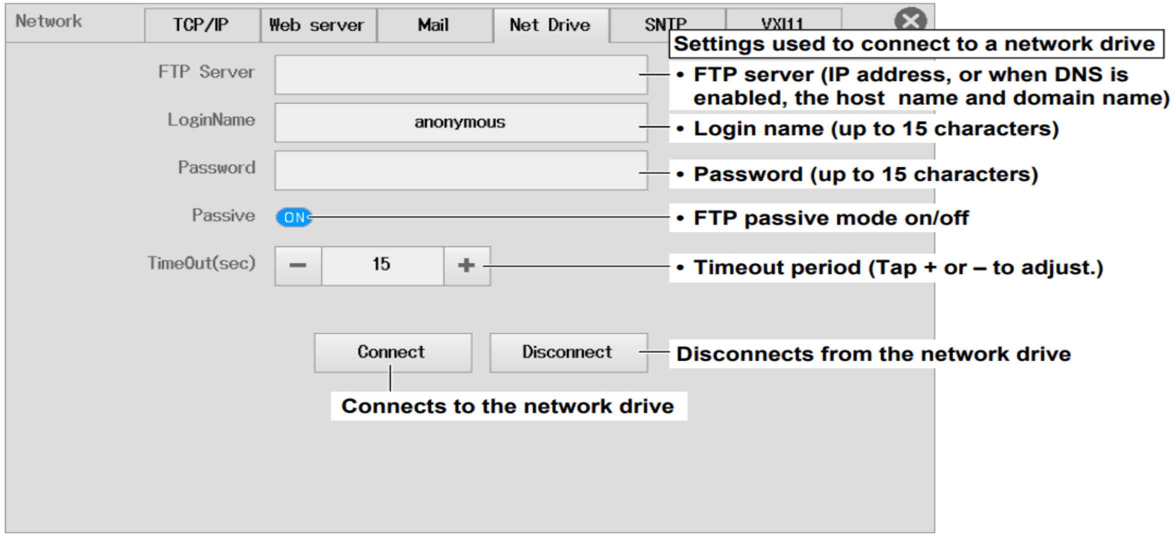
DL 350 Data Logger (Network Drive)

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)

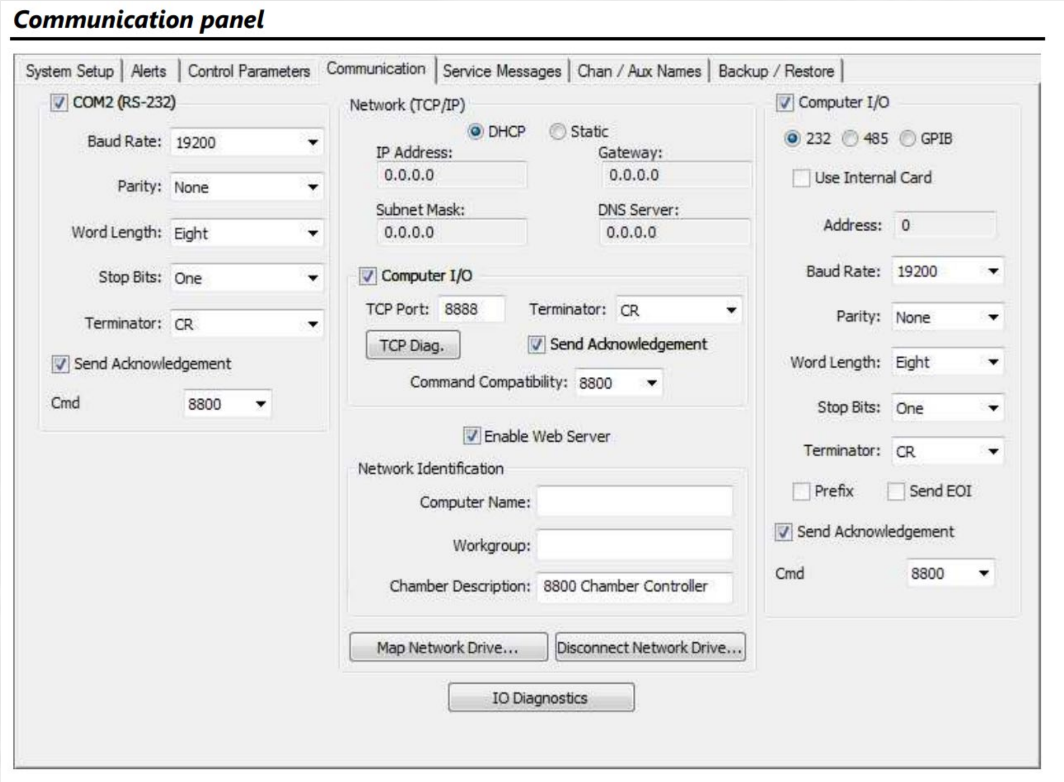
2. Tap the **Net Drive** tab.
3. Tap each item. Use the displayed input box to set the items.



Cincinnati Sub-Zero Climate Chamber

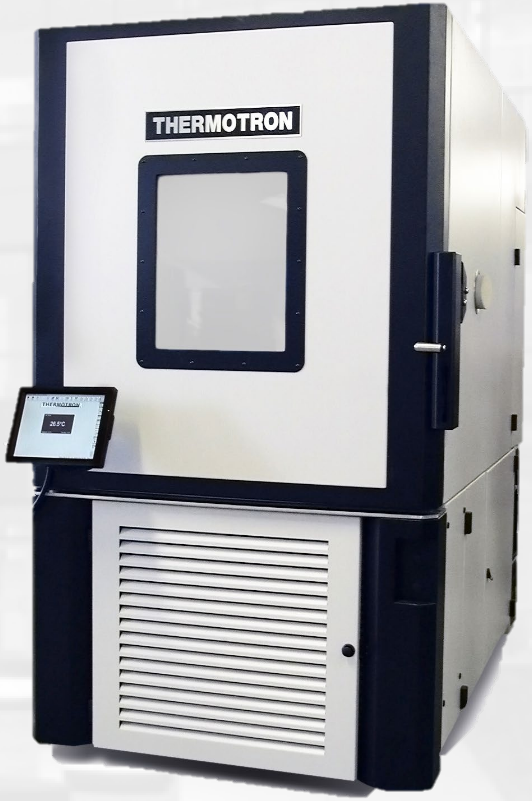
- Virtual network computing (VNC) accessible with free software download
- Enter the IP address of the chamber

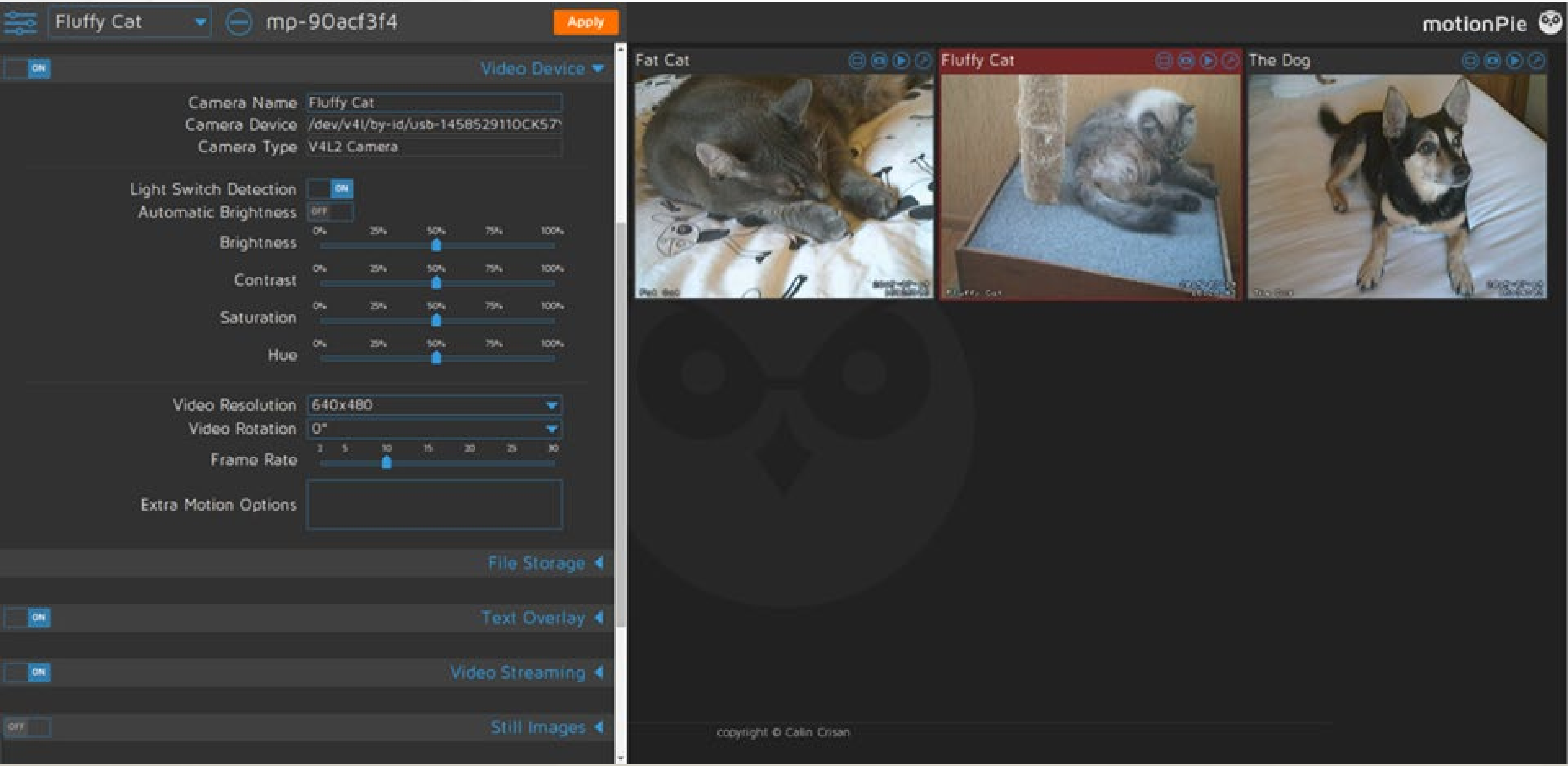
Thermatron Climate Chamber



Webserver

- Select setup
- Select the communication panel




Fluffy Cat
mp-90acf3f4
Apply
motionPie
ON
Video Device
Camera Name
Fluffy Cat
Camera Device
/dev/v4l/by-id/usb-1458529110CK57
Camera Type
V4L2 Camera
Light Switch Detection
ON
Automatic Brightness
OFF
Brightness
Contrast
Saturation
Hue
0%
25%
50%
75%
100%
Video Resolution
640x480
Video Rotation
0°
Frame Rate
2
5
10
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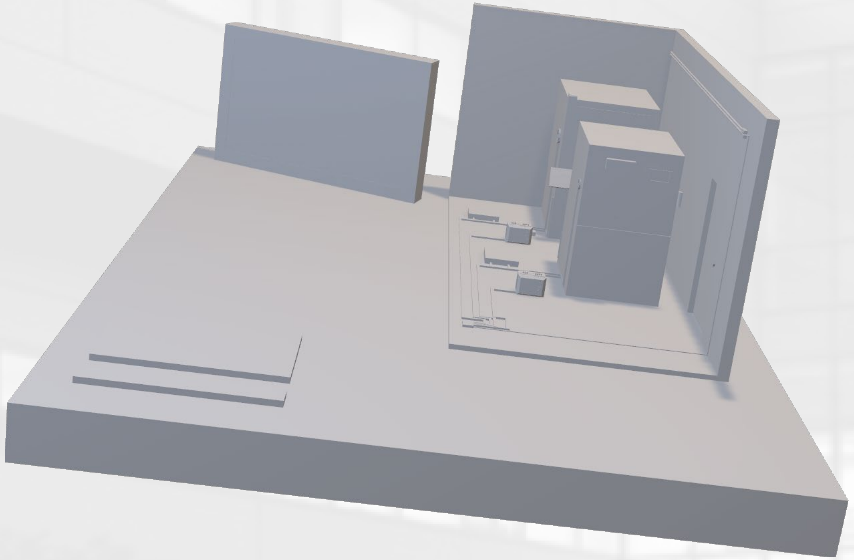
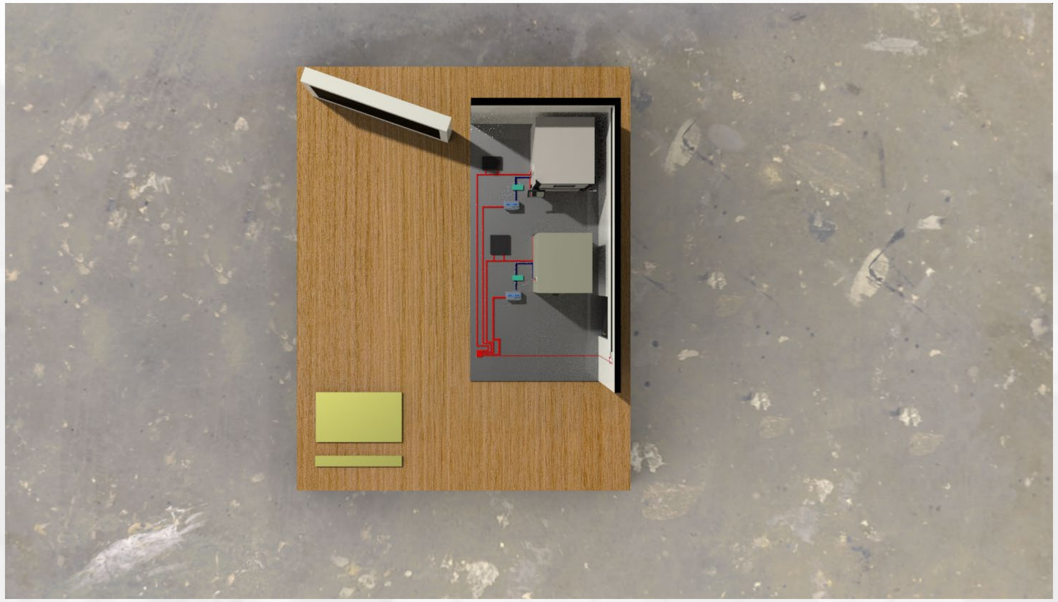
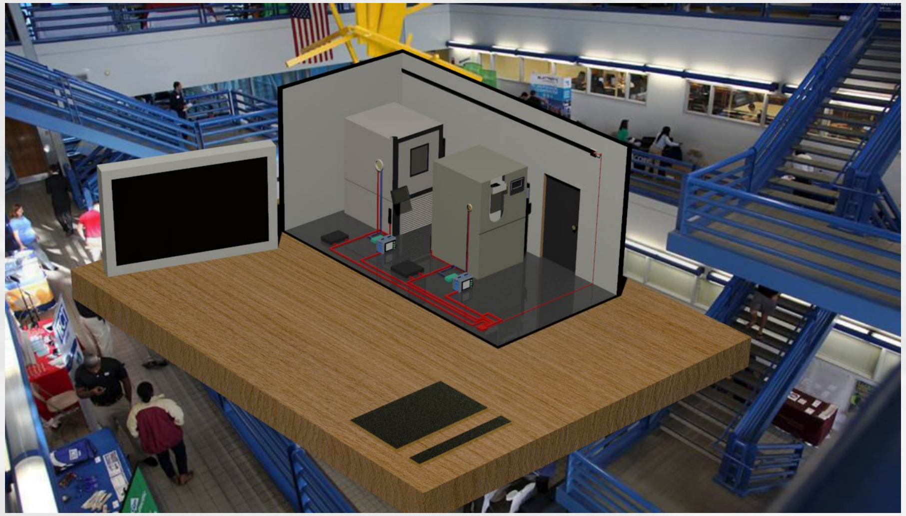
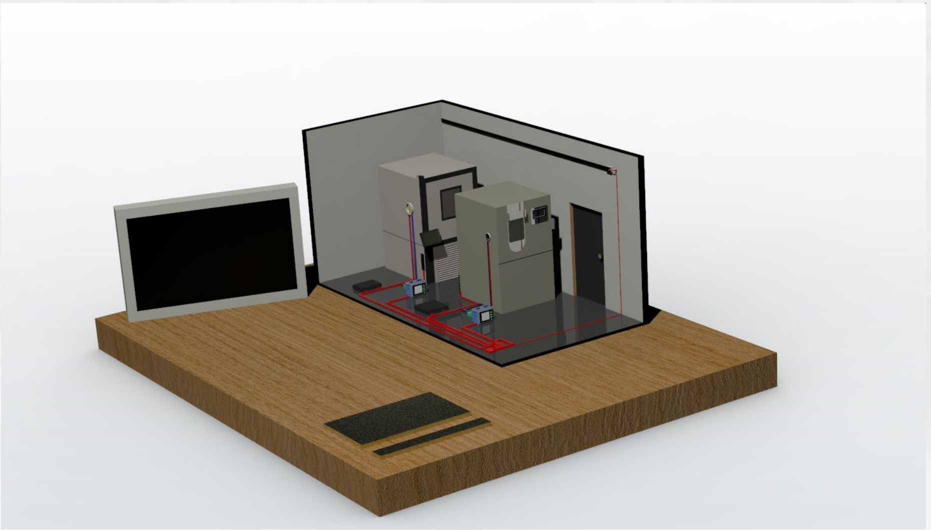
30
Extra Motion Options
File Storage
Text Overlay
Video Streaming
Still Images
Fat Cat
Fluffy Cat
The Dog
copyright © Calin Crisan

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

$$Q = \sigma T^4$$

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