

Temperature Sensitive Medication Storage During Natural Disaster

Team Introductions



Zoe Dillehay
Systems Integration
Engineer



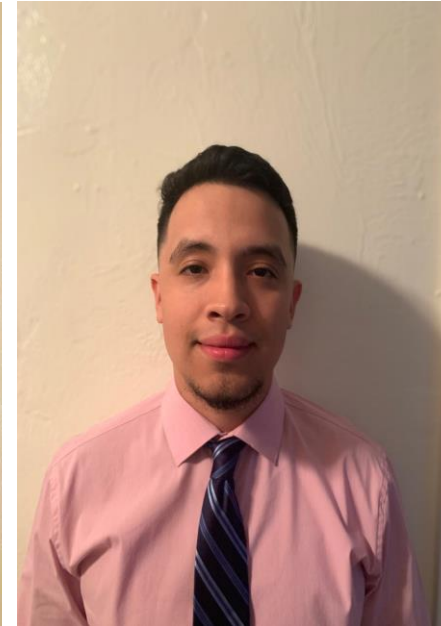
Travis Amaral
Project Manager &
Research Engineer



Nick Georgevich
Design Engineer



Keon Glass
Entrepreneurial Leader
& Research Engineer

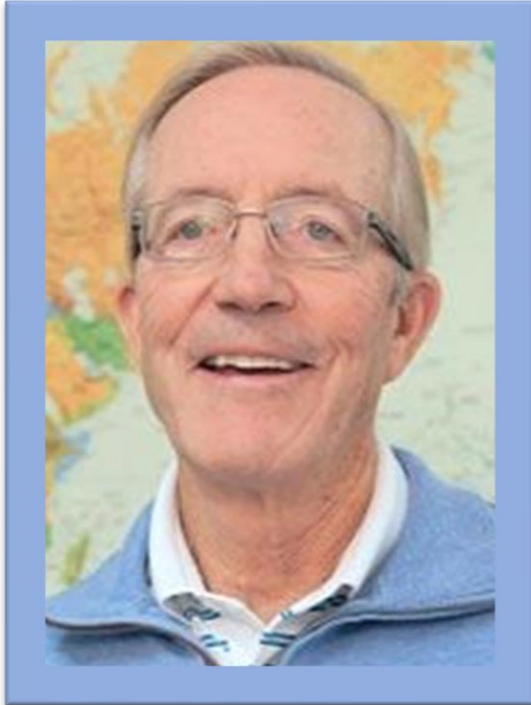


Diego Mendoza
Electrical Engineer



Andrew Sayers
Quality Control
Engineer

Sponsors



Dr. Michael Devine

- Entrepreneur in Residence and an Adjunct Professor at FAMU-FSU College of Engineering
- Ph.D. in Mechanical Engineering (Operations Research)



FAMU-FSU
College of Engineering



Advisor

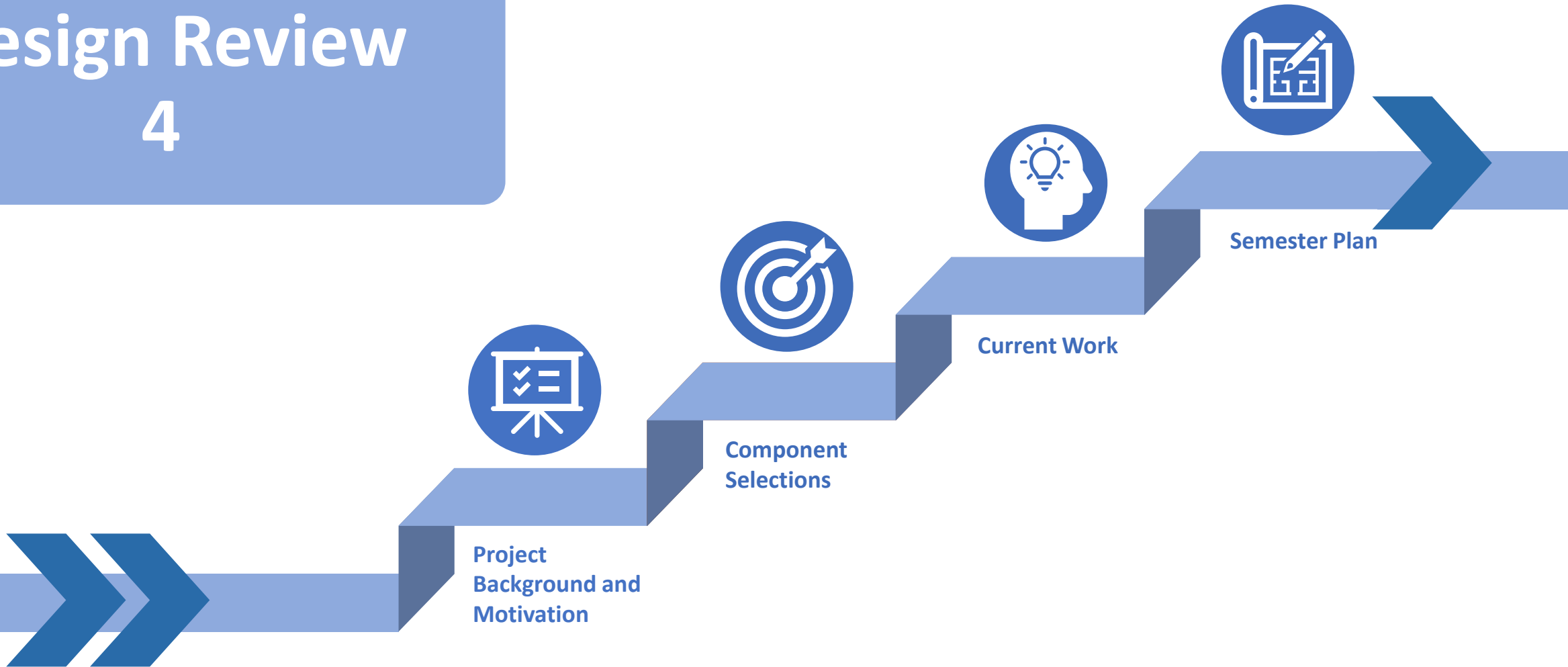


Dr. Shayne McConomy

- Teaching instructor at FAMU-FSU College of Engineering
- Ph.D. in Automotive Engineering

Design Review

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Objective



Our objective is to develop a device that stores and maintains the quality of temperature sensitive medication in the event of a natural disaster that causes mass power outages

Background and Motivation



During large scale natural disasters, diabetes related deaths skyrocket



One University of South Florida study suggests increase of elderly diabetes related deaths up to 40% ^[1]



Insulin requires temperatures between 2°C and 8°C (35°F and 46°F)

[1] Quast, T., et al. (2019). Long-Term Effects of Disasters on Seniors With Diabetes: Evidence From Hurricanes Katrina and Rita.

Primary Goals

Length of
Operation



Adequate
Cooling



Portability



Securing
Content

Targets and Metrics

TARGET

METRIC

Maintain appropriate temperature for 14 days



Conduct 14-day test using attached power system

Temperature maintained between 2°C to 8°C



Read temperature using thermocouple

Accommodate a 30-day supply of insulin



Successfully fit 3 insulin vials/pens

No broken vials or pens

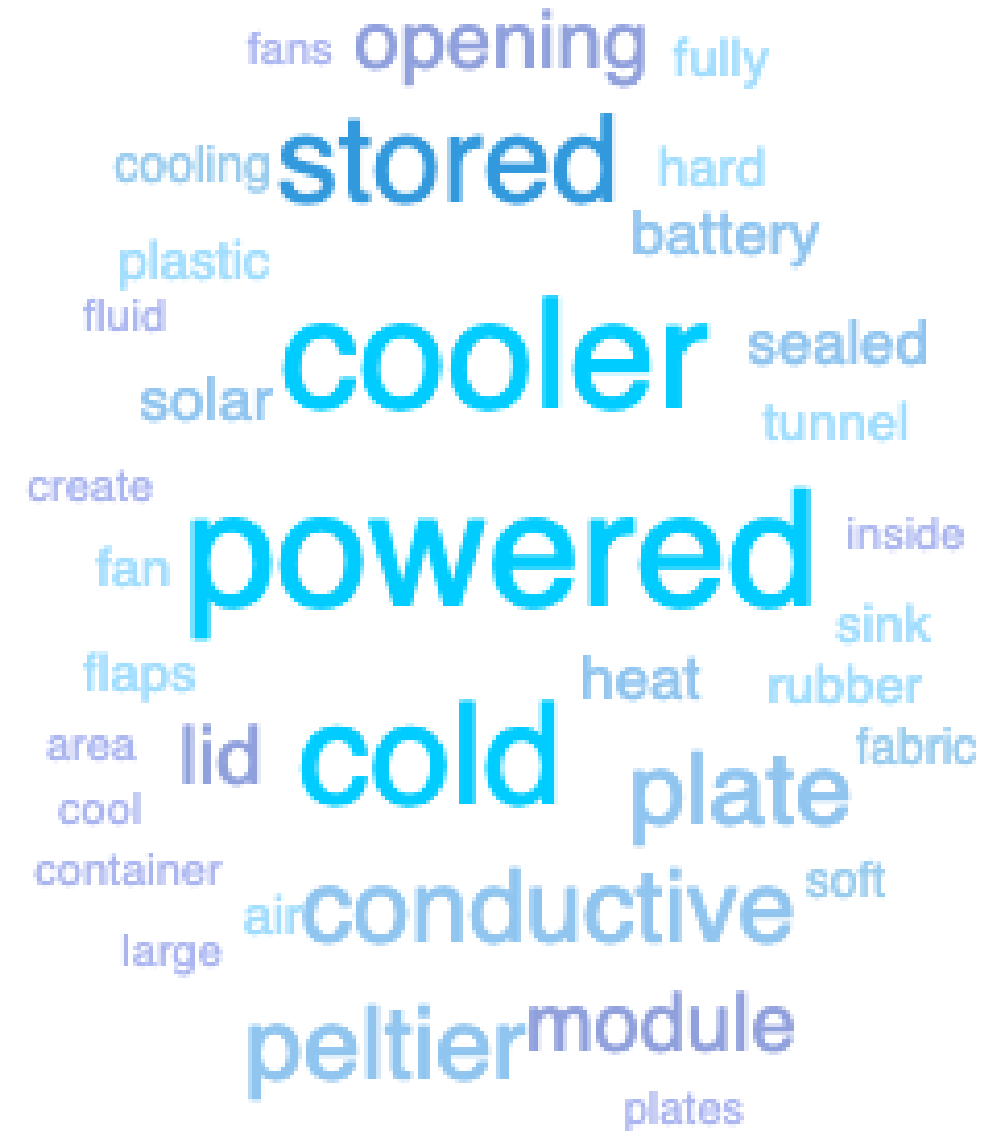


Ensure all pens/vials are intact throughout testing

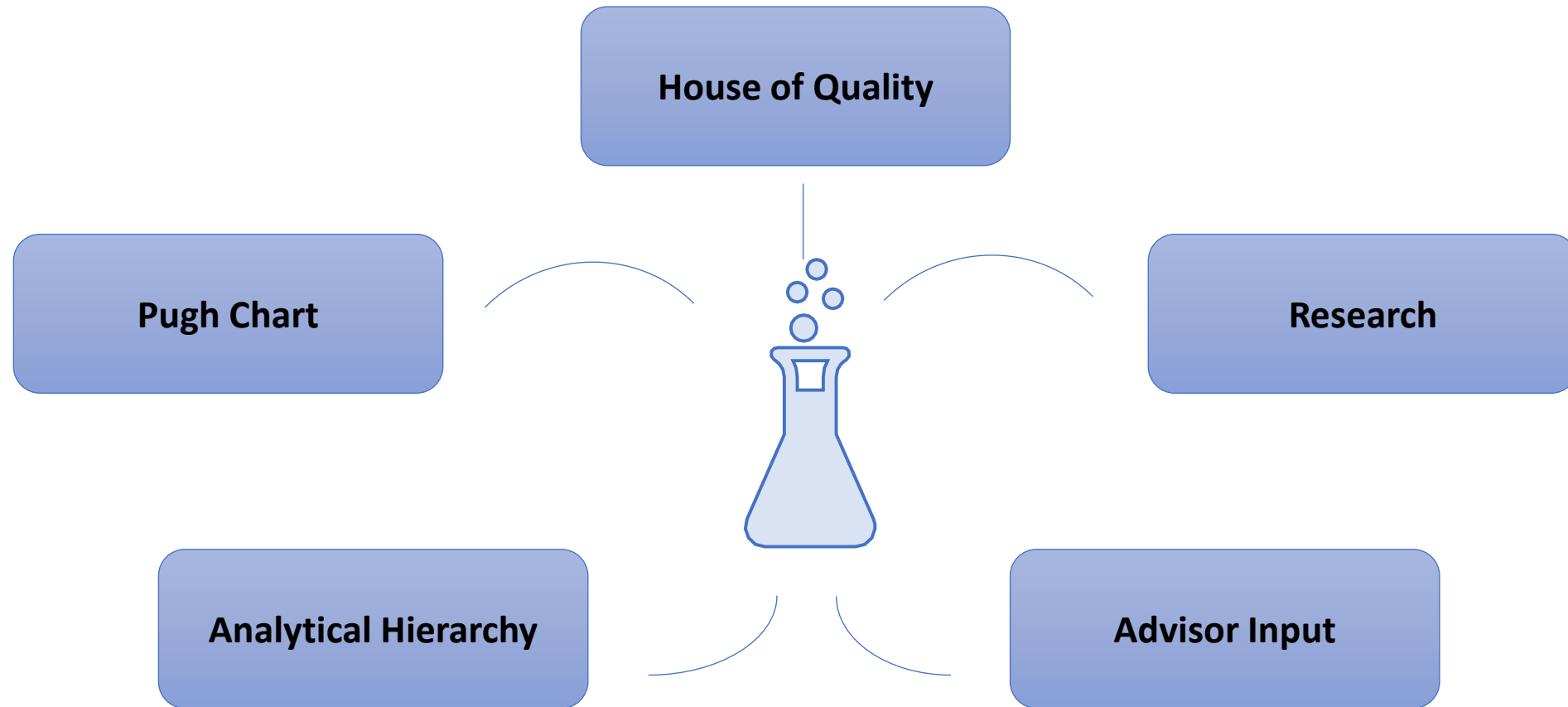


Concept Generation

- 1) Bottom mounted conductive Peltier plate
- 2) Side mounted conductive Peltier plate
- 3) Conductive Tunnel System
- 4) Conductive liquid heat exchanger
- 5) Side mounted convective Peltier plate
- 6) Alternating liquid compressor with Peltier plate
- 7) Aluminum mesh conductive Peltier plate
- 8) Mechanically powered thermoelectric cooler



Concept Selection



Final Concept Selected

1 Protective Fan Ventilation Gate

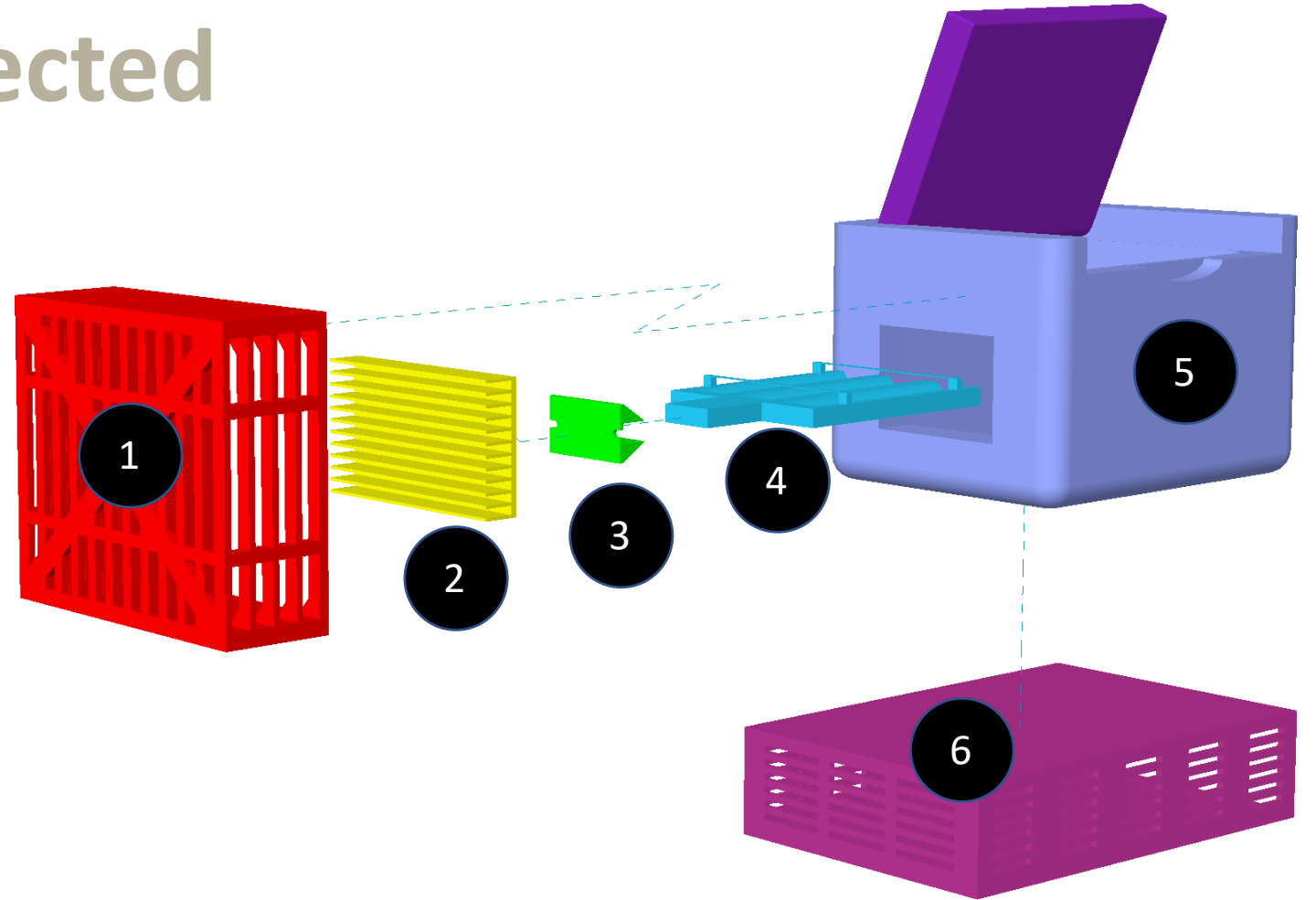
2 Thermoelectric Cooling Module with Peltier Plate

3 Cold Plate Adapter

4 Grooved Cold Plate with Elastic Bands

5 Cooler w/ Added Insulation and Seals

6 Battery Compartment



Preliminary Testing

Possible changes:

- Temperature gradient along cold plate
- Potential for rearranging placement or addition of TEC module
- Heat given off from the batteries



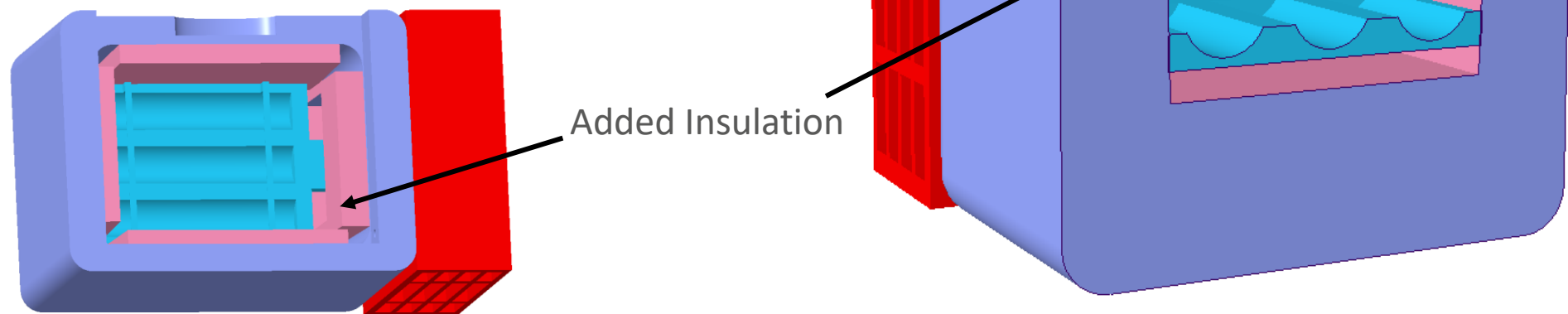
Container



- 5 Quart FlipLid™ Cooler
- Durable (hard plastic)
- Lightweight (weight: 0.75 kilograms)
- Easy to handle
- Easily contains added insulation and cooling plate (volume: 560 in³)
- Sufficient storage space for 3 vials/pens of medicine
- Inexpensive

Insulation

- Combination of spray foam insulation and solid board insulation
- Board insulation will create shell inside the cooler with foam insulation to fill in gaps



Solar Panel

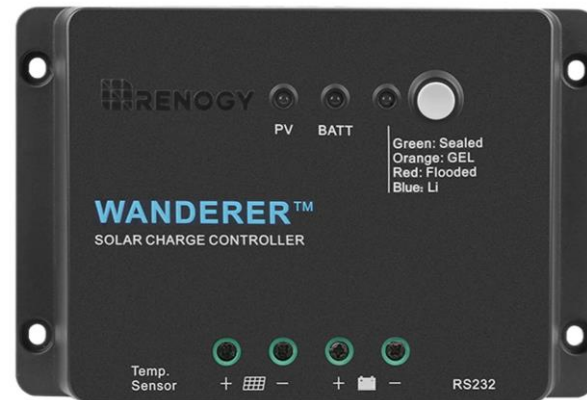
- Rockpals 60W Foldable Solar Panel
- Foldable/Portable
- Relatively lightweight (weight: 9 lbs)
- Reliable source of energy production
- May need solar charge controller depending on battery



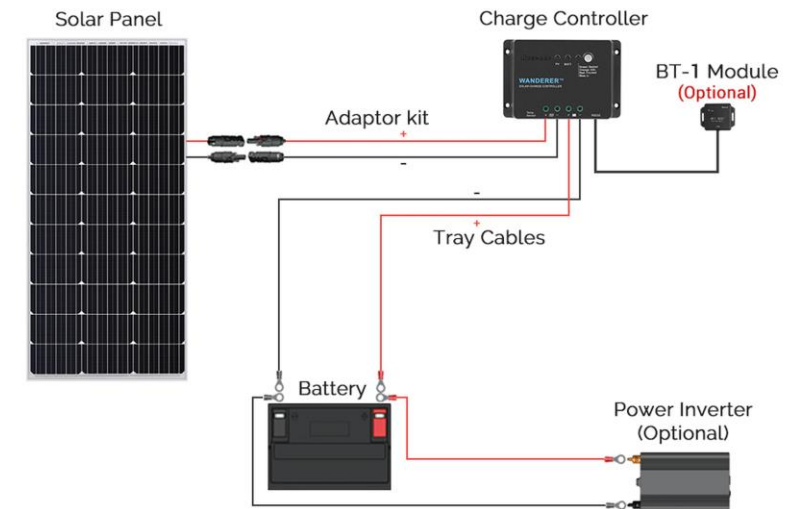
Solar Charge Controller

WANDERER LI 30A PWM CHARGE CONTROLLER

- Increases battery life and improves system performance
- Optimized 12V system

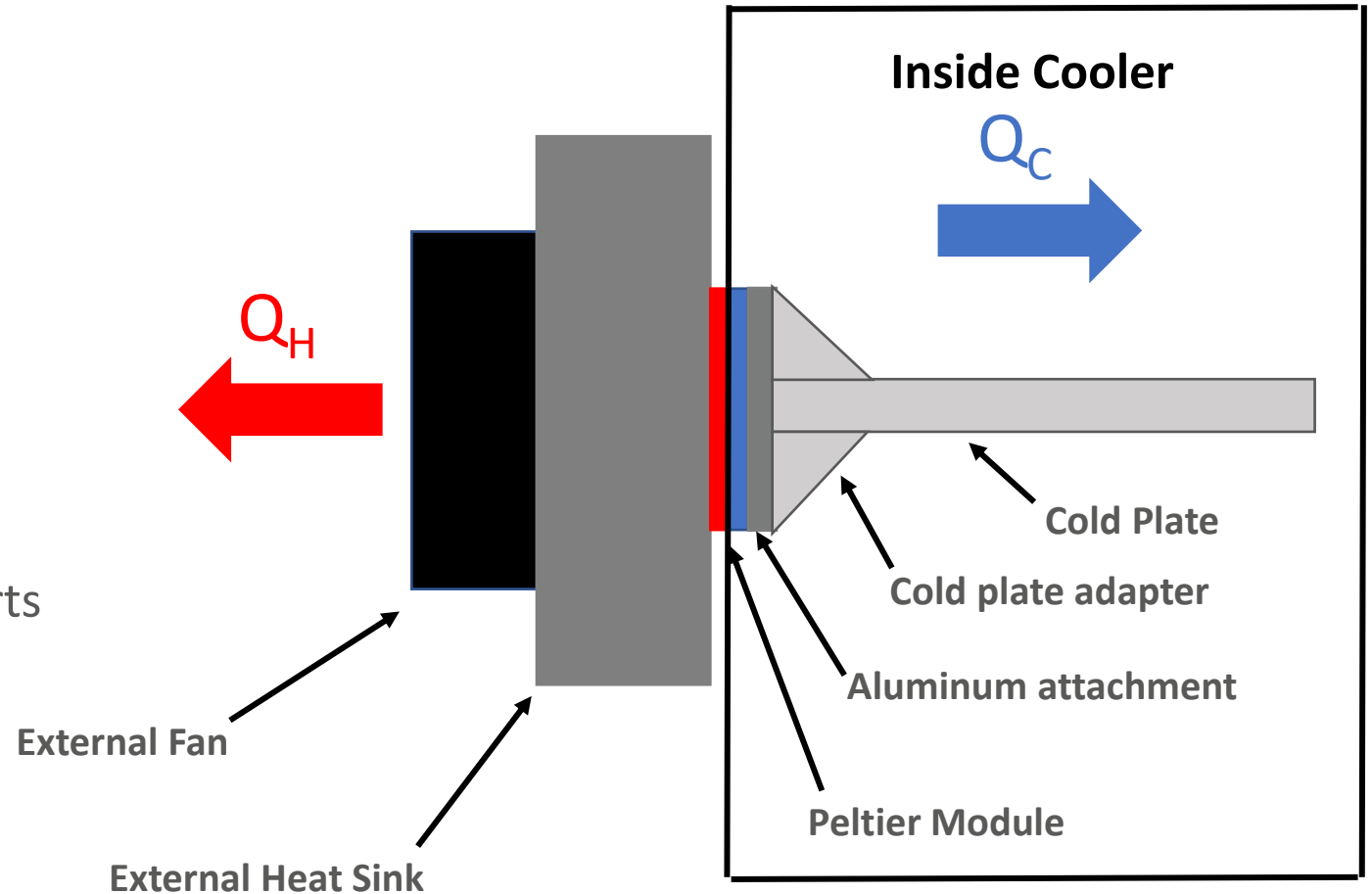


SETUP DIAGRAM

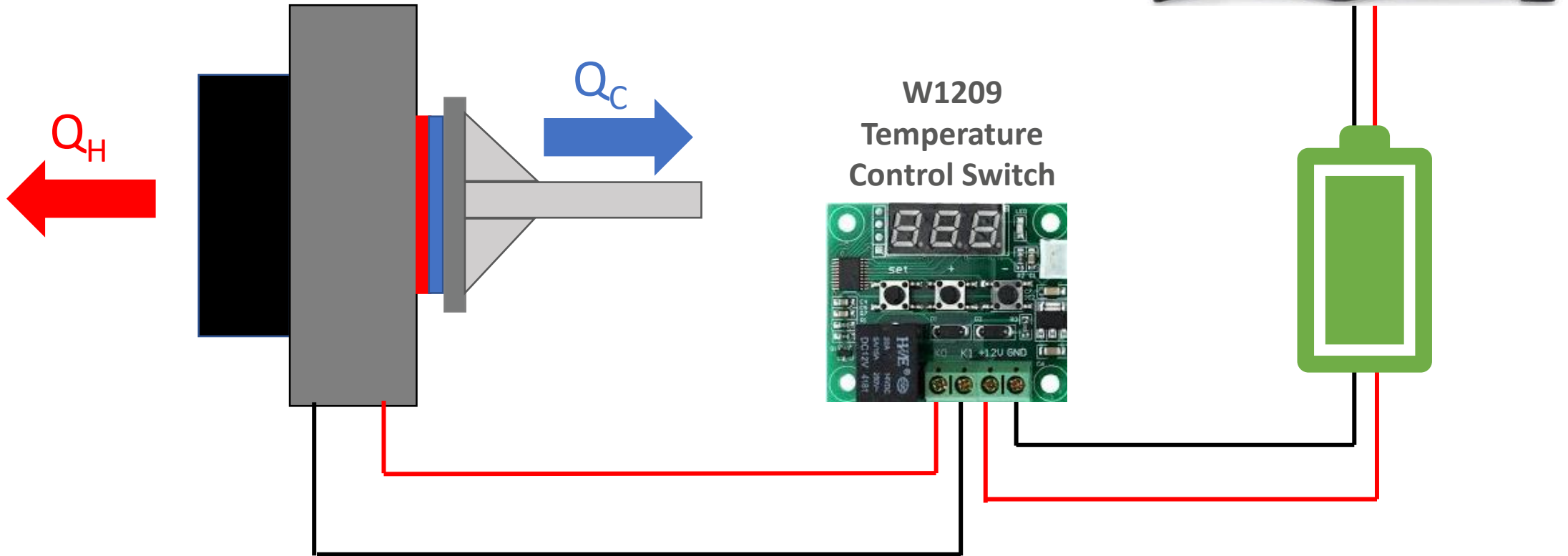


Thermoelectric Cooler

- Existing TEC module
- Proven to function well for this purpose
- Use of existing cold plate and cold plate adapter
- If not sufficient, order/fabricate new parts



Temperature Control



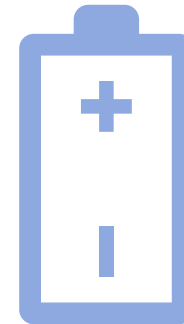
Current Progress



Method of Securing
Medication



Second Seal for Lid



Battery and Placement

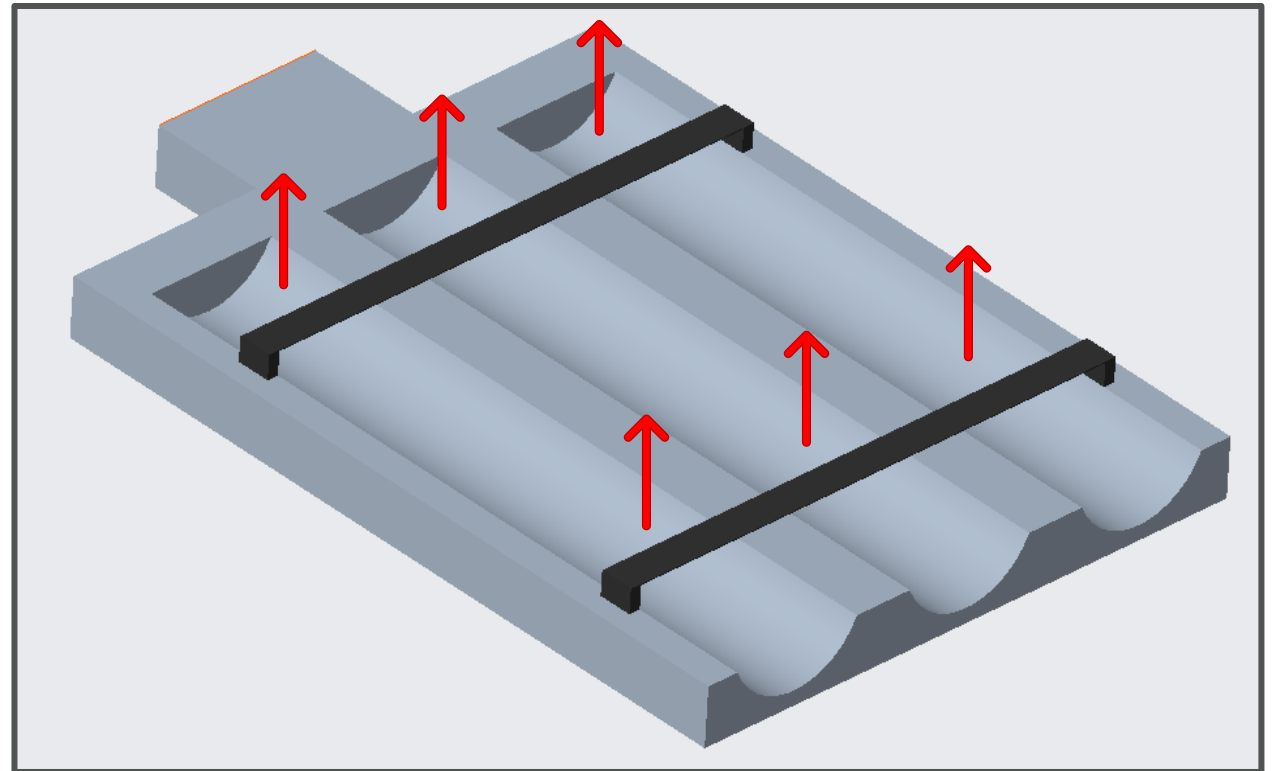
Securing Mechanism: Elastic Bands

PROS

- Insert/extract motions are similar
- Simple design

CONS

- Possible brittle failure in cold temperatures
- All pens and vials would need to be of similar diameter



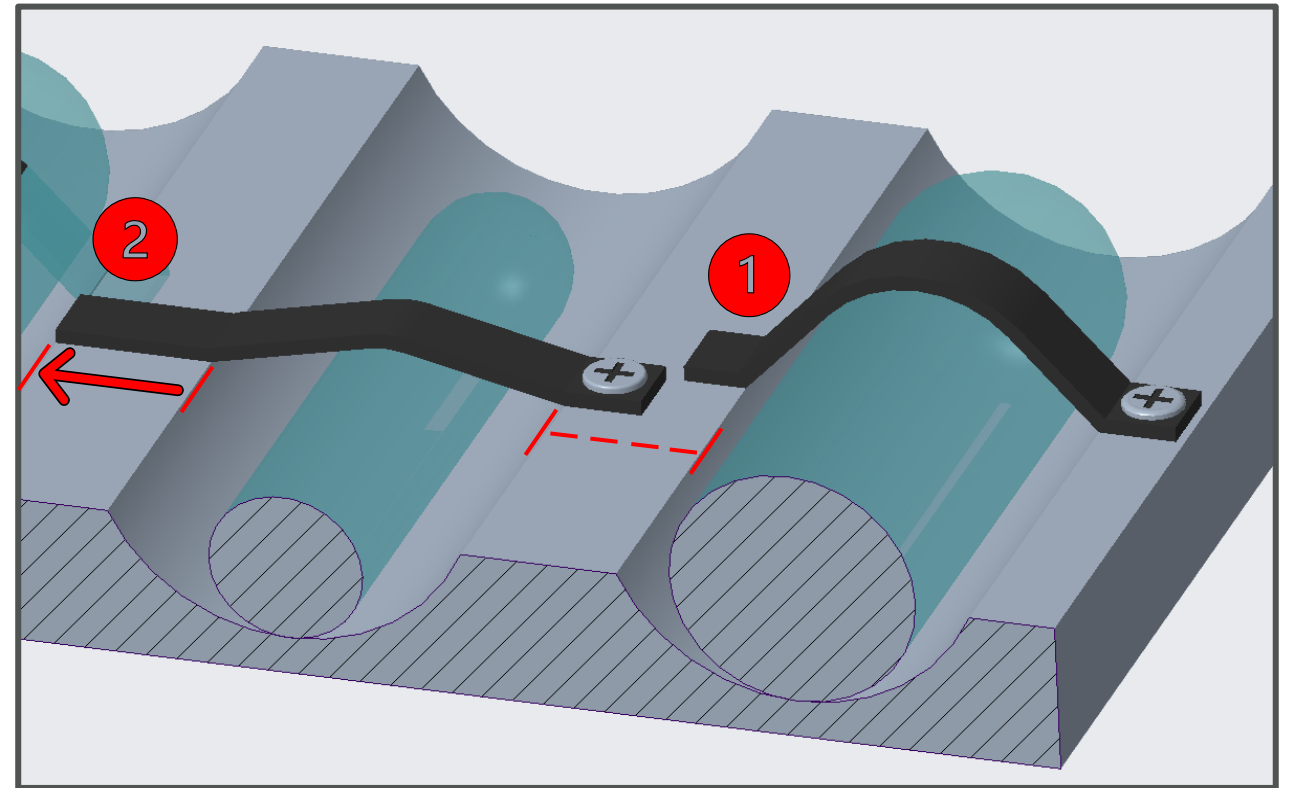
Securing Mechanism: Magnetic Straps

PROS

- Strong enough to hold medication, weak enough to pull with ease
- Accommodates pen diameters ranging 10-20 mm

CONS

- Potential difficulty resecuring straps
- Aluminum cooling plate would require additional magnetic inserts/attachments



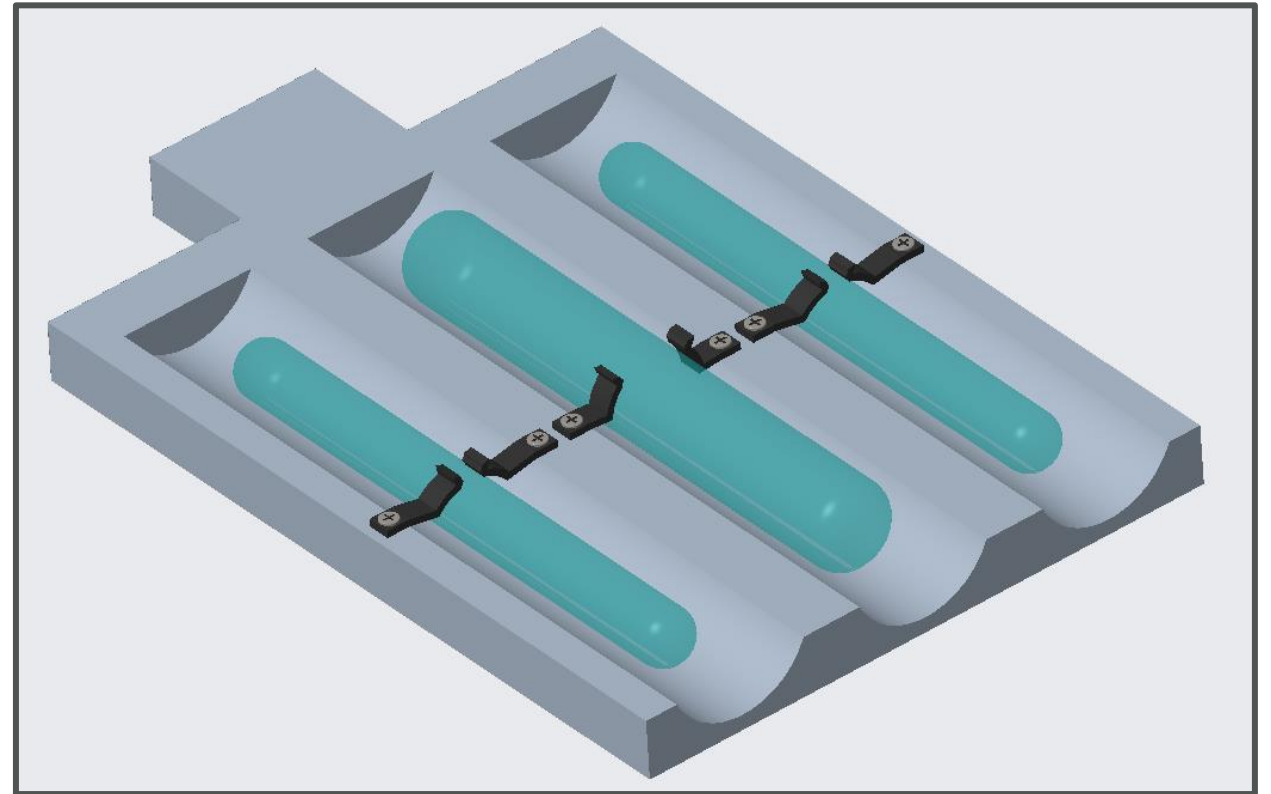
Securing Mechanism: Clasps

PROS

- Plastic clasps fitted with inner layer of foam for protection
- Simplest insert/extract motions

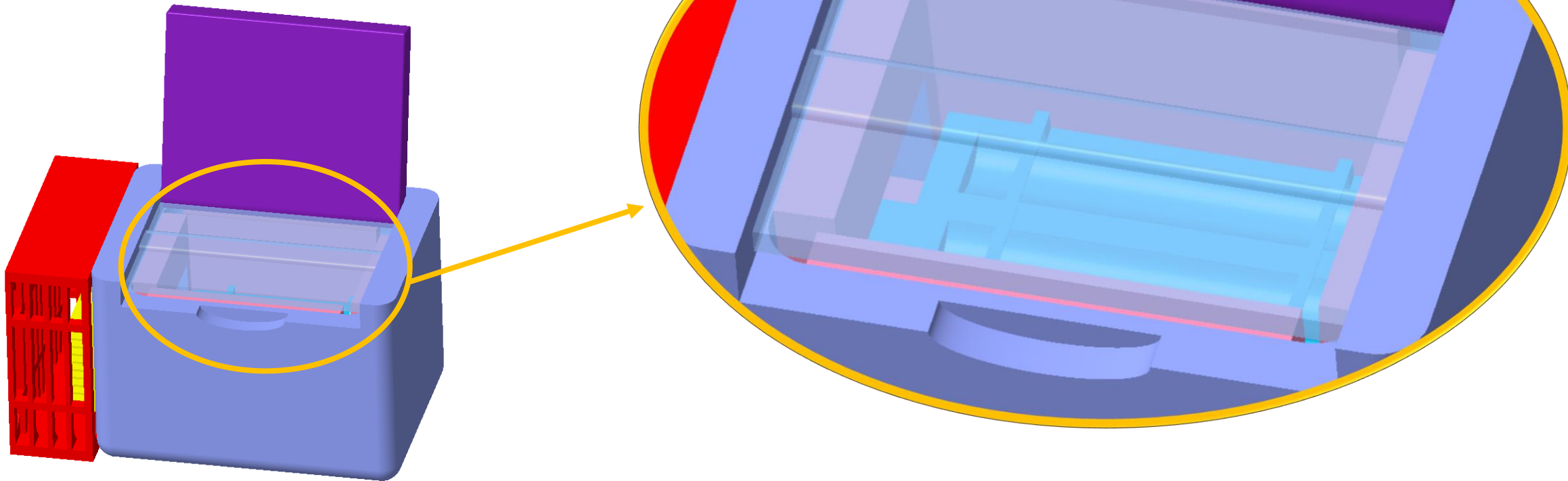
CONS

- Potential for brittle failure due to cold and fatigue
- Difficulty sizing clasps properly



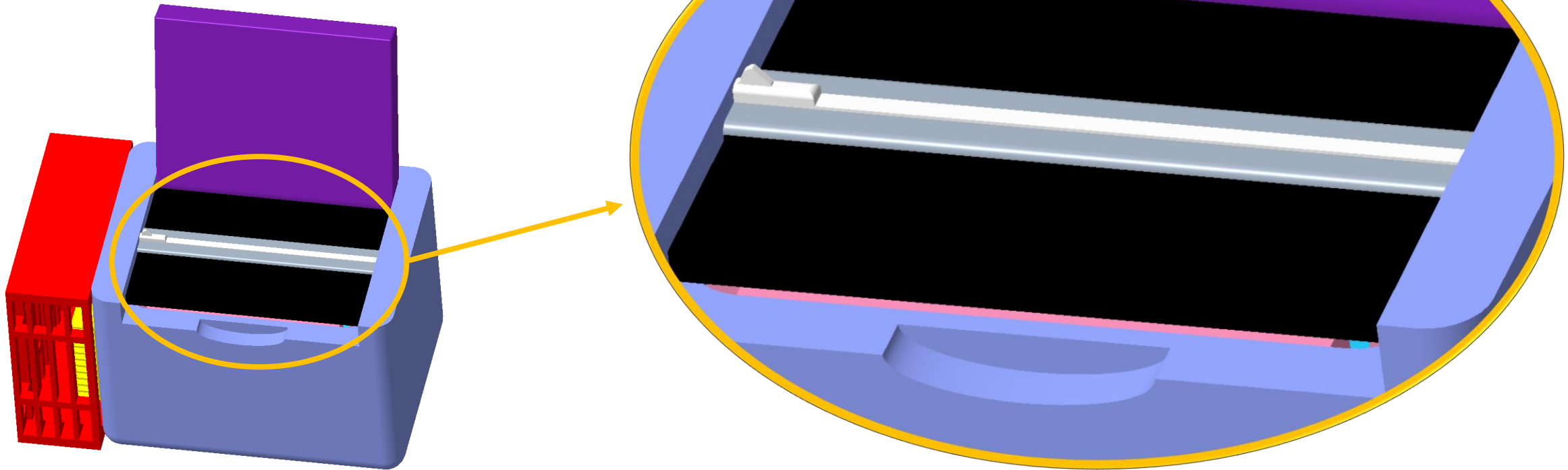
Second Seal Idea 1

- Clear Vinyl overlapping from both sides
- Allows user to see inside



Second Seal Idea 2

- Rubber with zipper in the middle
- Seals cold air better but cannot see inside

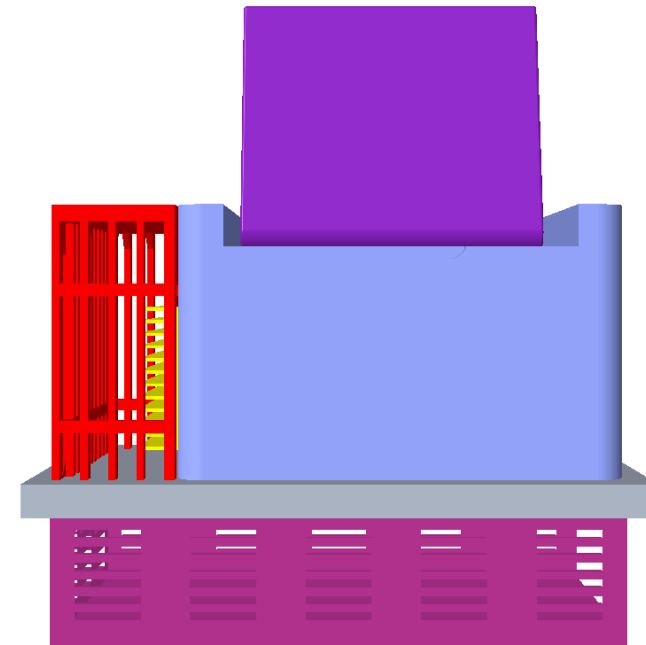
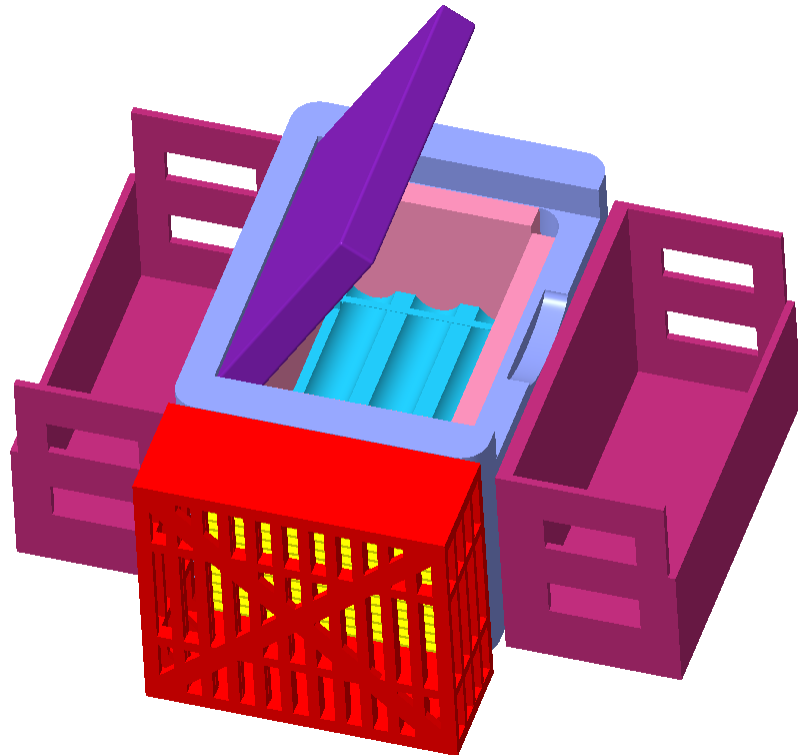


Batteries

- TalentCell Lithium Battery – 12V/ 11000 mAh
 - Would require a solar charger
 - Small enough to be packaged with cooler
- Jackery Explorer 240 Portable Power Station
 - Doesn't require solar charger
 - Much larger, cannot be packaged with cooler



Battery Placement Ideas



DESIGN TIMELINE

February
2021 SPRING

