The “Cool” Group

Presents

A Joint Production By:

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The Thermoelectric Cooler

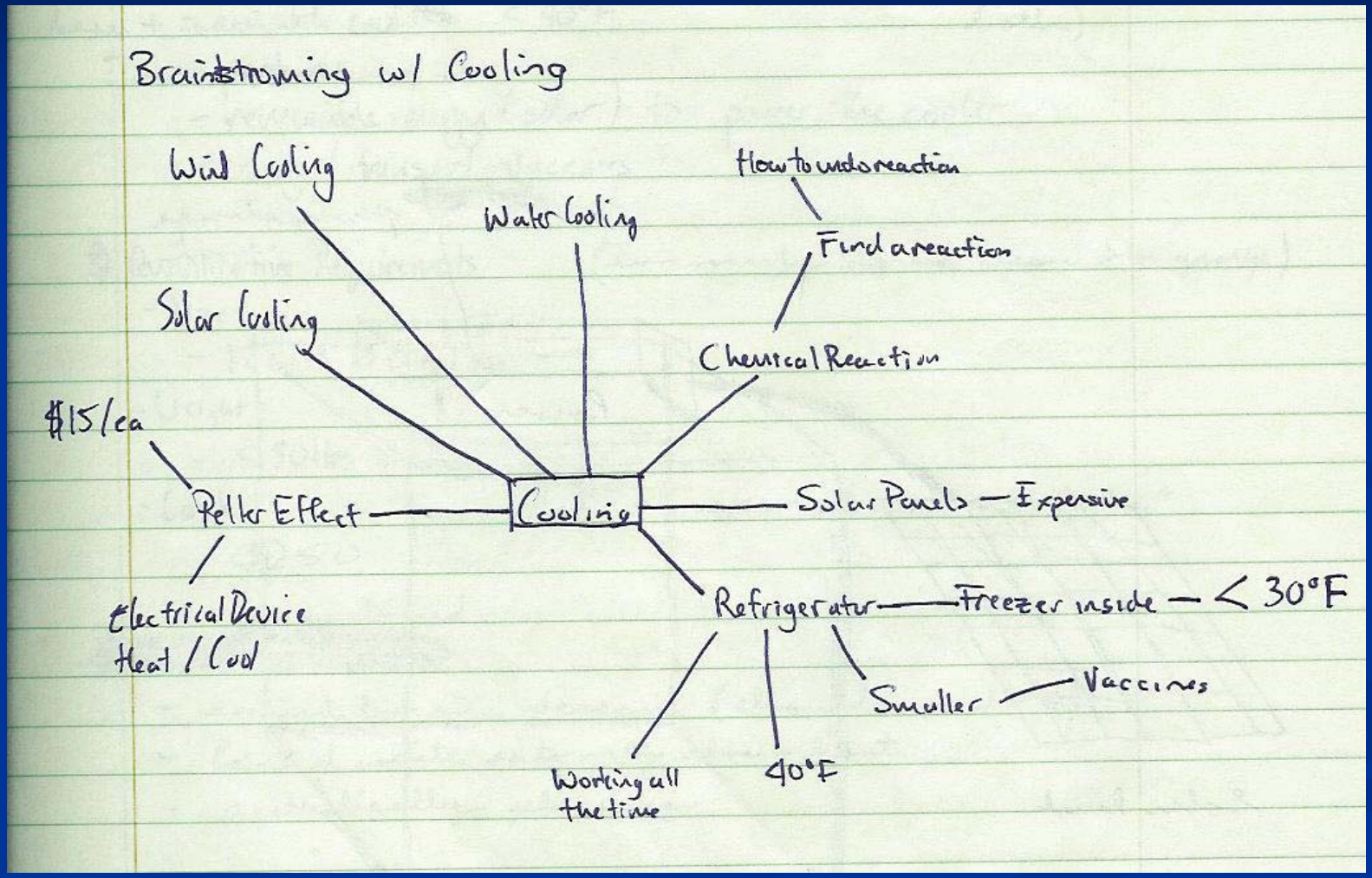
The Beginning

- Design Project Problem Statement
  - Appropriate and Sustainable Technology
  - Must be applied to help developing communities
  - Needs to be functional, efficient, durable, appropriate, reliable, affordable, attractive, and satisfy the needs of the community it serves

Initial Idea

- Refrigerating with Renewable Energy
  - Cooling Powered By:
    - Sun
    - Wind
    - Water
    - Chemical
  - Recycled Refrigerator
  - Thermoelectric Modules
  - Chemical Cold Packs
  - Absorption Cooling
- Could be used to store vaccines or other perishable items in developing communities

Brainstorming

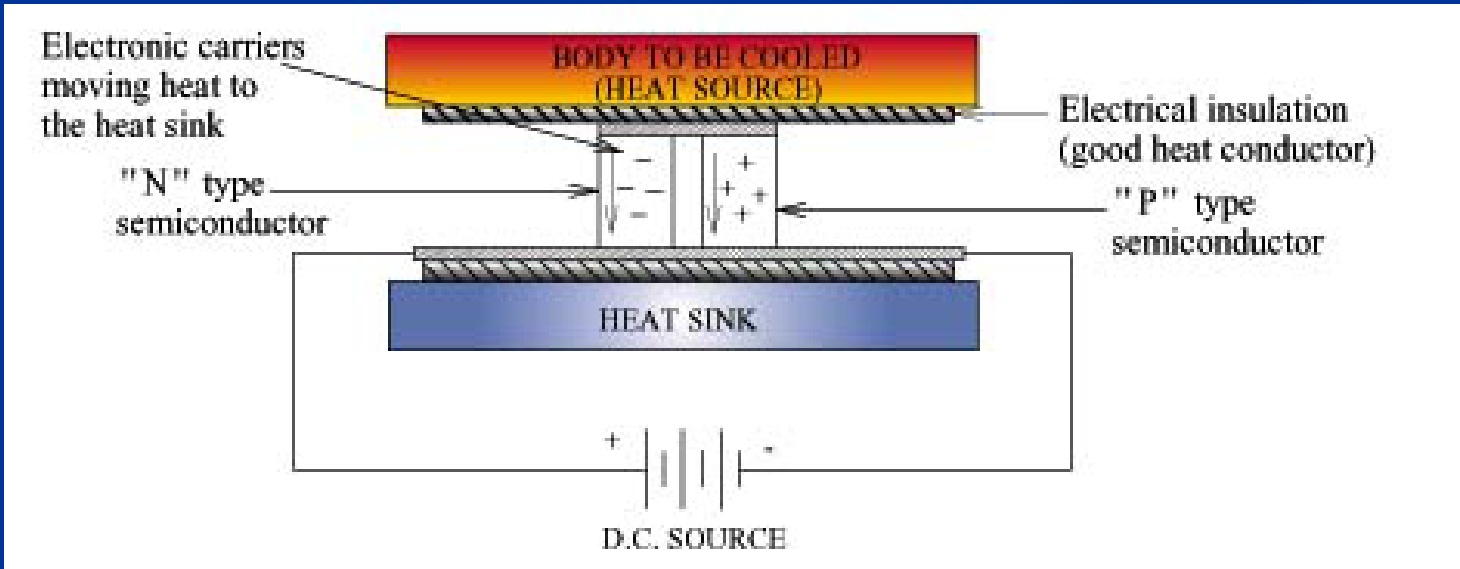


Choosing a Design

- Decided to pursue cooling using the Peltier Effect
  - Left the option to integrate solar panels into our project to provide renewable energy
- Decided against:
  - Wind, Water, Chemical
    - Availability, difficult to test, irreversible reactions
  - Recycled Refrigerator
    - Availability, size

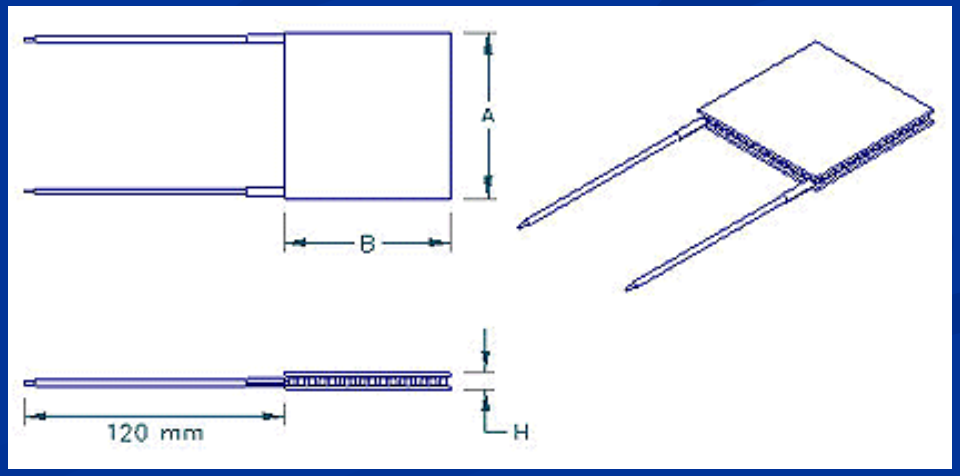
The Peltier Effect

- Cooling with Electricity
  - Electrical current runs through two different types of metals creating a temperature difference
  - This temperature difference cools the box



Thermoelectric Modules

- Thermoelectric Modules
  - Use the Peltier Effect to create a hot and cold side
  - These modules are what power the refrigerator

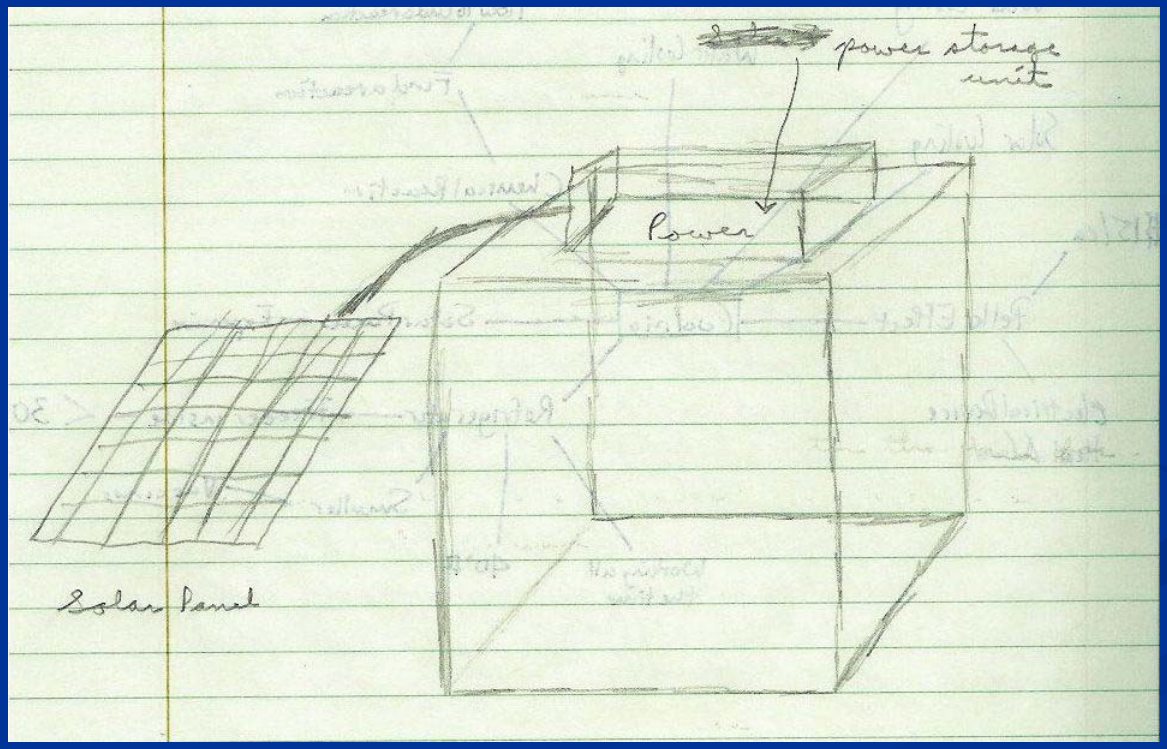


The Refrigeration Box

- Initially thought to use an old refrigerator
  - Recycled refrigerators are hard to come by
- Researched materials to build a box
  - Polyethylene
    - Insulator
    - Easy to work with
    - Could make our own dimensions

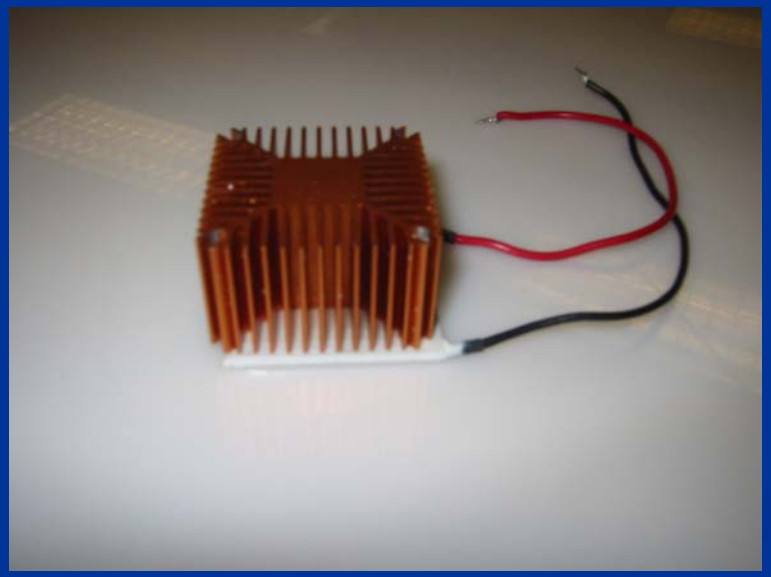
Initial Design

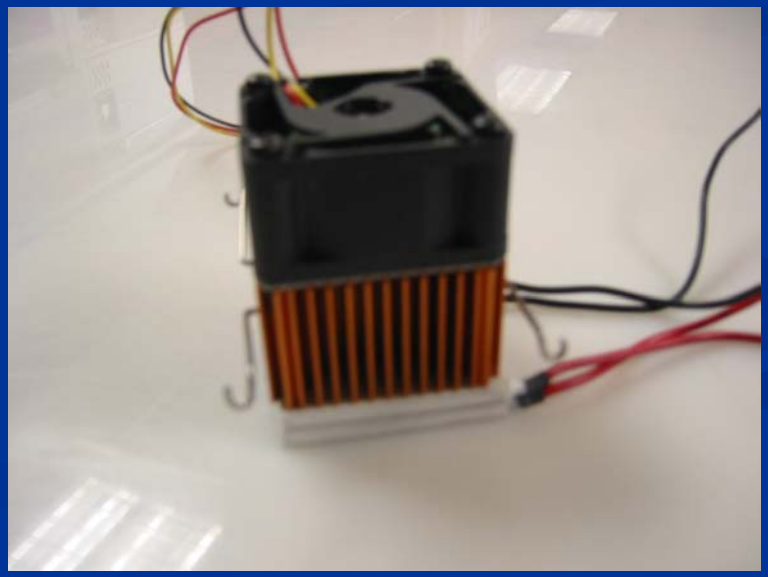
- Small box with Thermoelectric Modules on top powered by a solar panel



Initial Testing

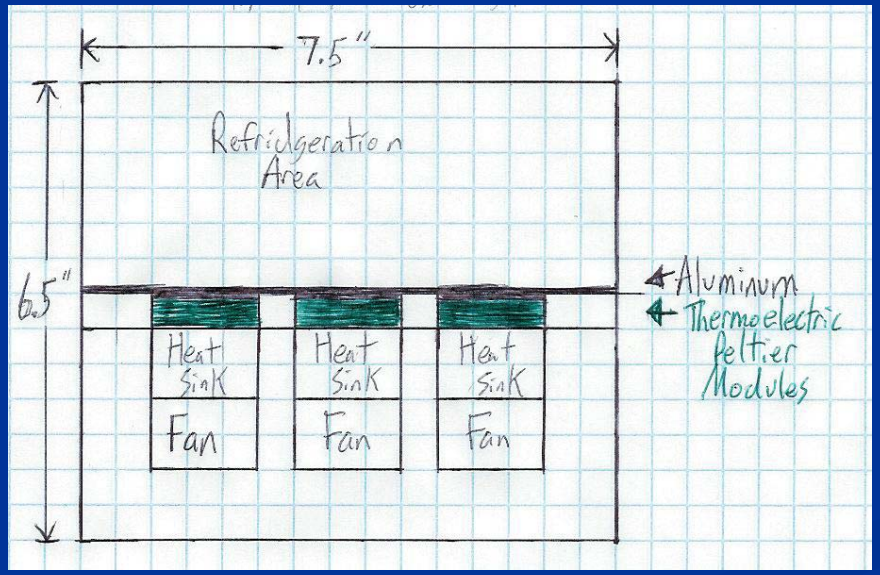
- Our Thermoelectric modules:
  - Overheated quickly
  - Performed better when stacked
  - Needed larger fans

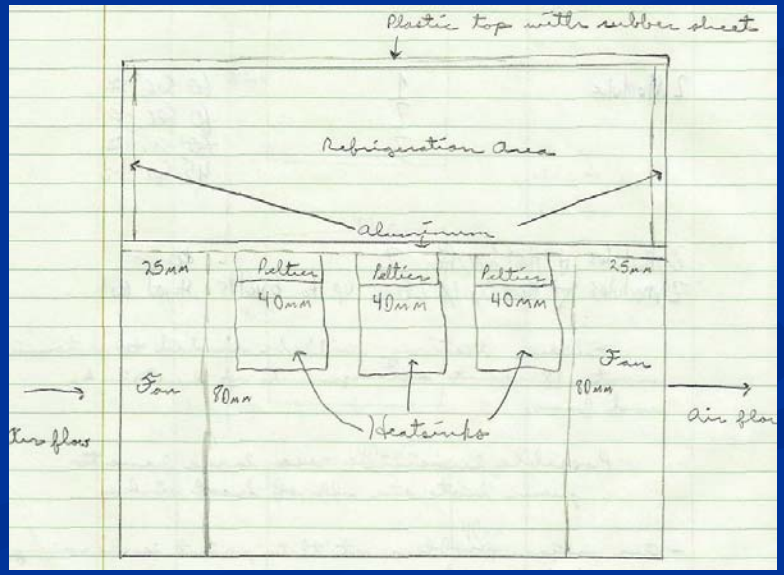




Design Improvements

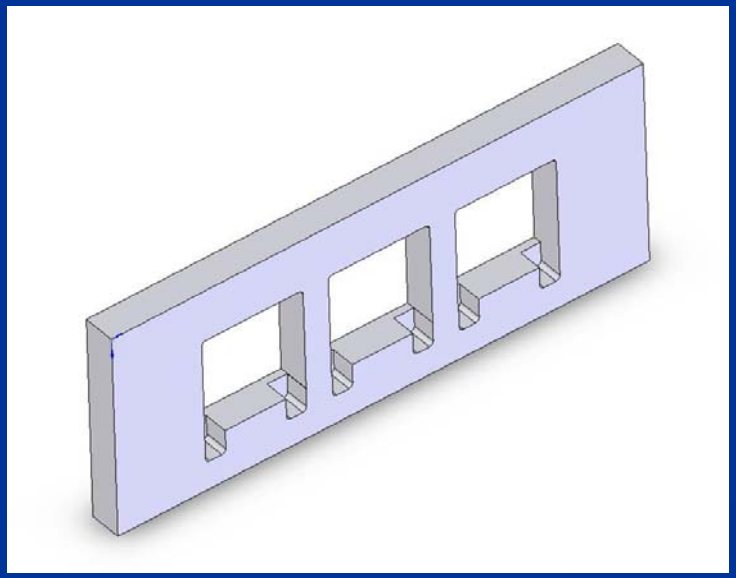
- Refrigeration compartment would be atop the Thermoelectric modules while fans would cool the heat sinks.





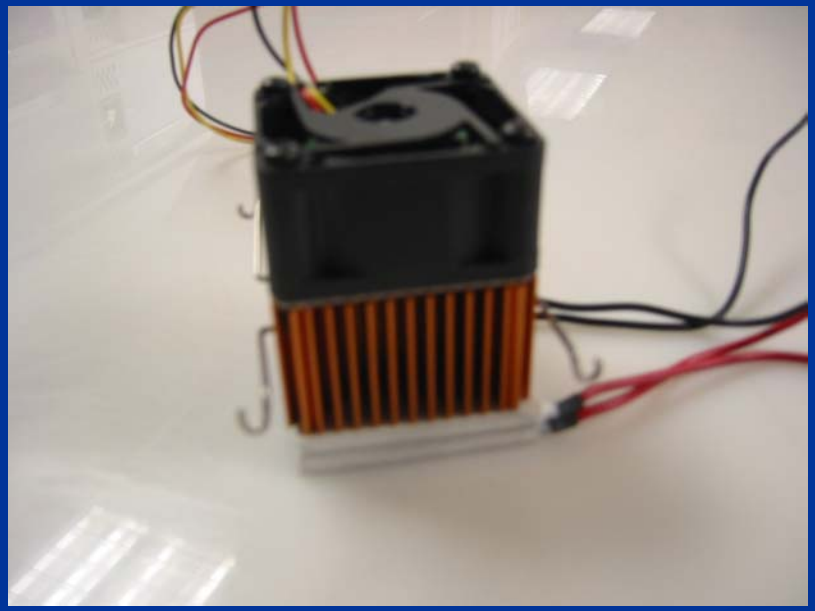
Design Improvements

- Shelf would separate refrigerated area from hot exhaust
  - Modules would sit inside machined holes
  - Insulate hot from cold and cold from hot



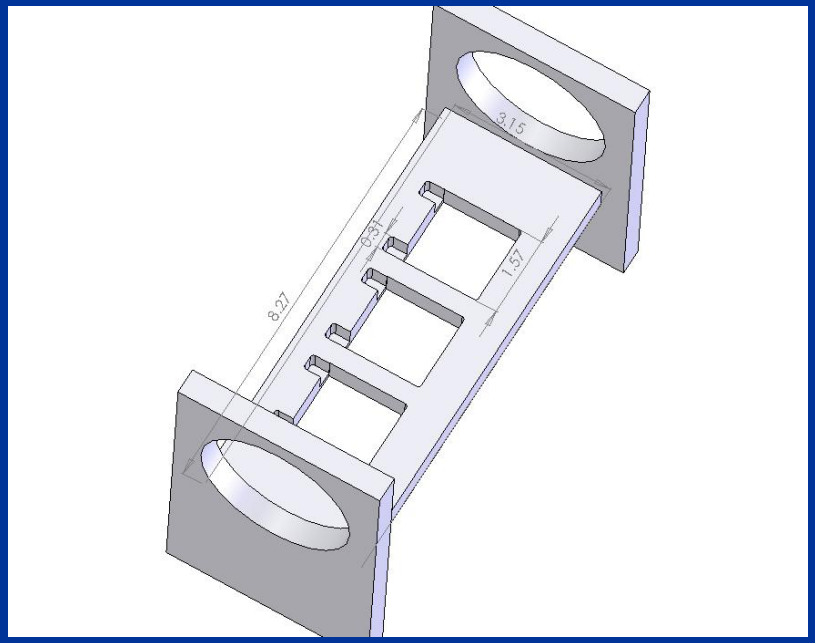
Design Improvements

- Larger fans were ordered to cool heat sinks
  - Small fans were not powerful enough



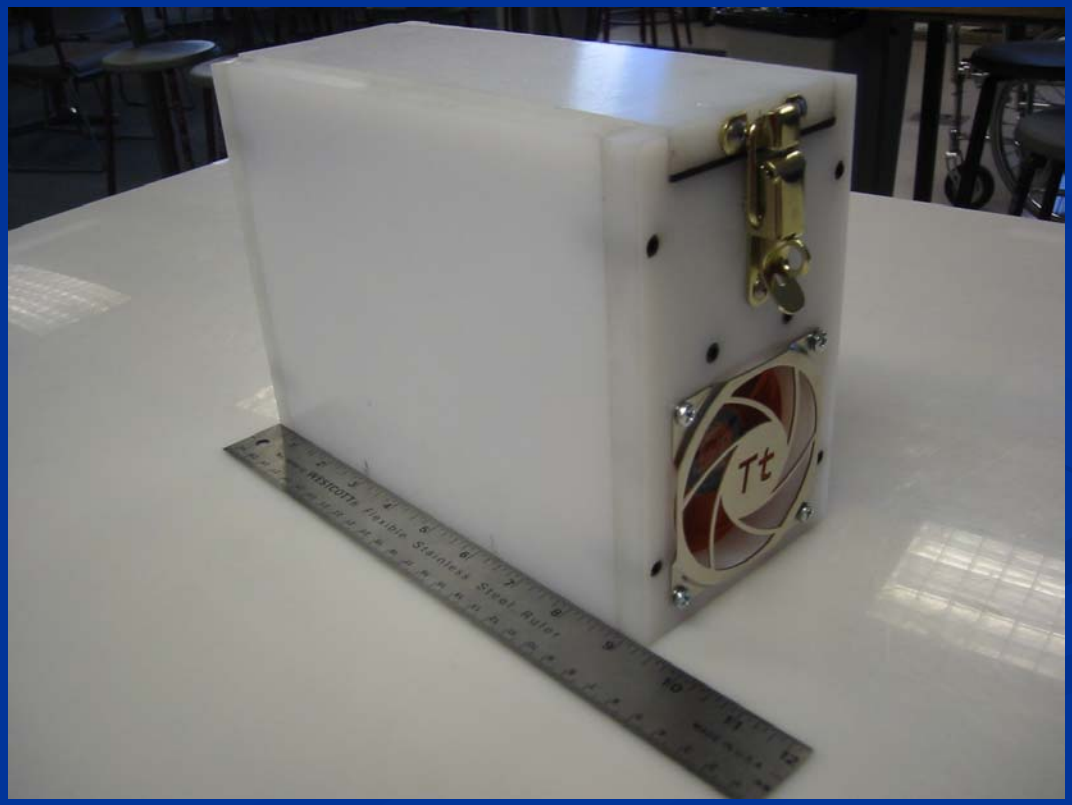
Design Improvements

- Air would be blown by twin fans across the heat sinks removing excess heat



Construction

- After much trial and error, the box was pieced together



Inside

- An Aluminum sheet was added to the bottom of the box to evenly distribute the cold

Top

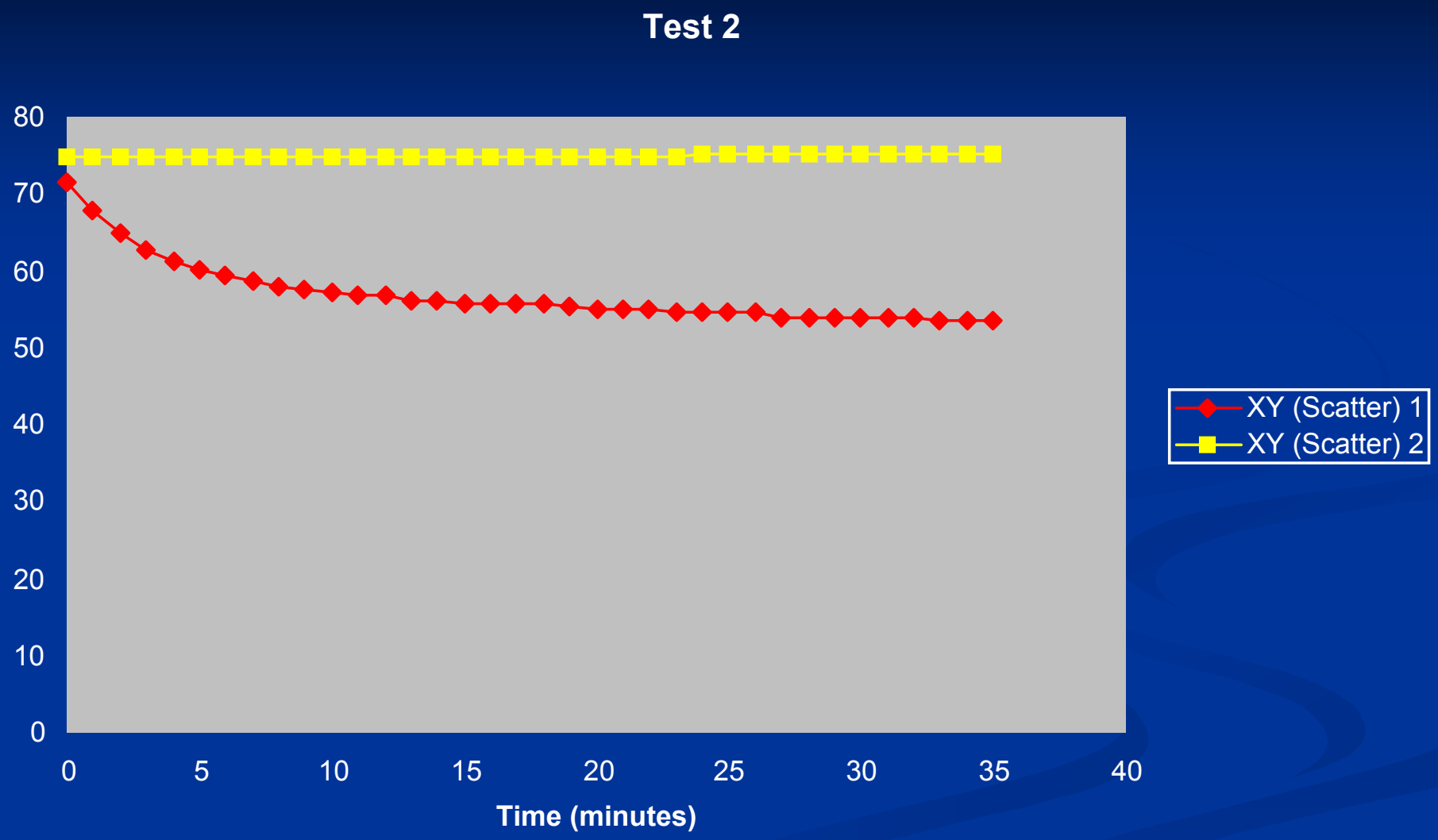
- To make the refrigerated compartment airtight a rubber seal was added to the top along with a clasp to complete the box

Completed Box

- Final Dimensions:
  - 4 (1/4)” x 6 (7/8)” x 9 (3/8)”
- Cost:
  - $125
  - Includes plastic, thermoelectric modules, heat sinks, fans, aluminum, wiring, rubber, latch, hinge, and screws

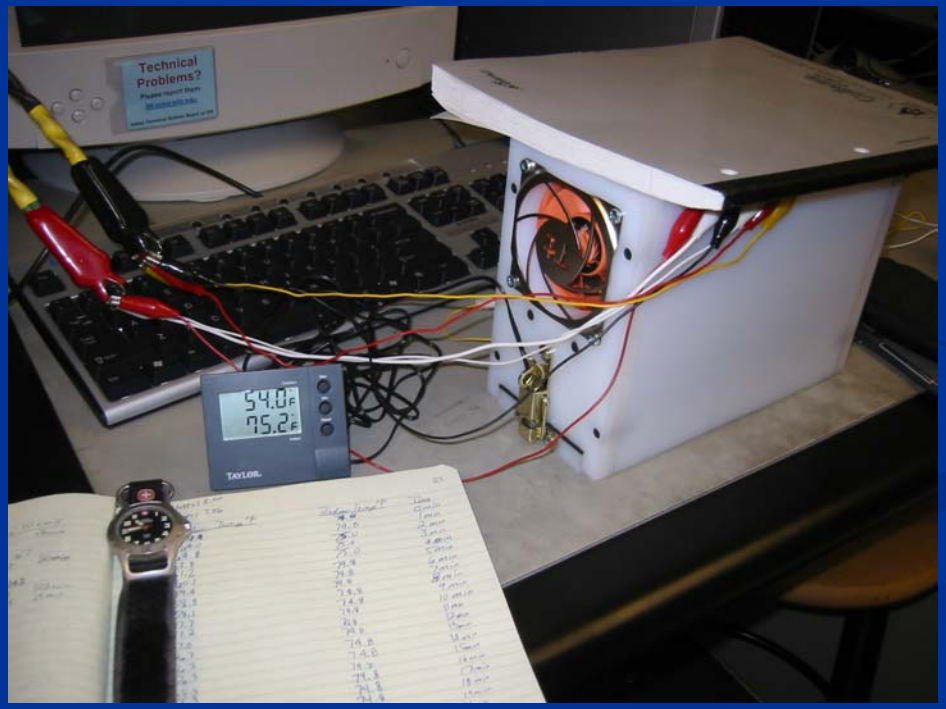
Testing

- To test our refrigerator we hooked it up to a DC power supply as if it would be run off batteries
- Using 3 Volts and 7.5 Amps our refrigerator reduced the inner temperature from 75.0 °F to 53.4°F in approximately 30 minutes, a difference of 21.6°F


Test 2
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
Time (minutes)
XY (Scatter) 1
XY (Scatter) 2

Test Evaluation

- Excited with a 21.6 °F drop in temperature
  - Modules are rated up to 30°F drops
  - Only our first prototype



Future Improvements

- Better Insulation
  - Two walls, insulation between
- More Modules
  - Have modules covering a greater surface area of the refrigeration box
- Line the inner walls with aluminum
  - Spread the cold from the bottom of the box up and around the sides

Renewable Energy

- Although we regret not having more time to explore the possibilities of solar power, this would not be a difficult transition as the modules draw a minimal amount of electricity

- Room for future improvement

Real World Application

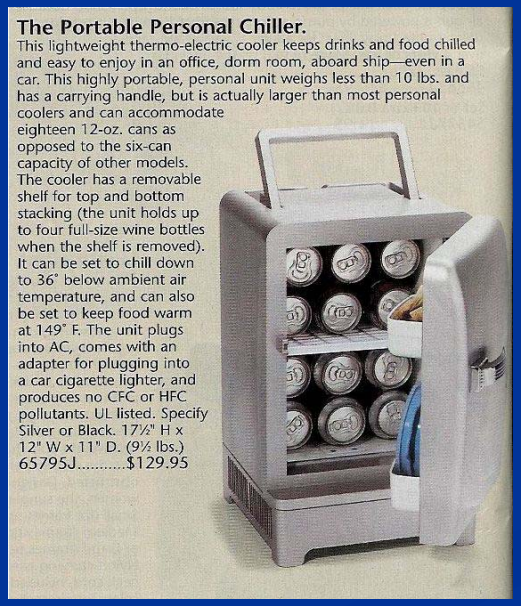
- Appropriate
  - Demand for vaccine storage in developing communities
  - Way to store other perishable items in remote locations
- Sustainable
  - No real moving parts to break or wear
  - Thermoelectric Modules have a life expectancy of 200,000 hours

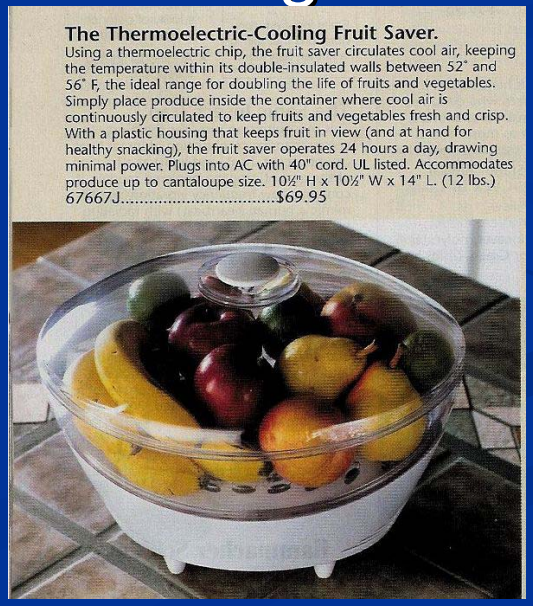
Real World Impact

- The Thermoelectric Refrigerator could have a very large impact in the real world
  - Provide a way to vaccinate a very large population of people who live in developing communities around the world
  - Save the lives of the thousands of people that could now receive vaccinations

Competition

- Vaccine Refrigeration
  - No current products
- Refrigeration for everyday use
  - Refreshments and fruit storage





Conclusion

- Team Success
  - Team bonded and worked together to achieve our goals
  - Learned the ins and outs of the Design Loop
  - Learned invaluable manufacturing skills
  - Created a prototype that successfully fulfills the project objectives and that we are proud of

Questions?