Sno2Go

Team 1

Our Team: Snow Big Deal

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Problem Statement

In the backcountry, there is rarely access to clean, drinkable water — threatening **severe dehydration**. It is difficult for an individual to carry sufficient water, due to weight and sheer volume.

Cold weather increases risk of dehydration

- Increased metabolism
- Dry air
- Frozen water sources

Dehydration can result in issues as severe as:

- Seizures
- Hypovolemic shock
- Death

User & Purchaser

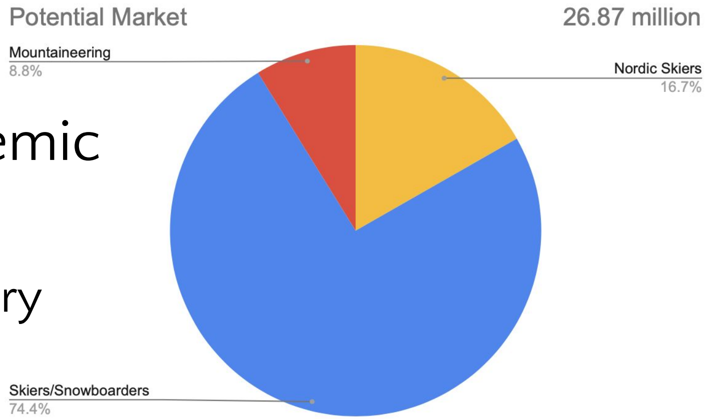
User & Purchaser

User: winter sports athlete

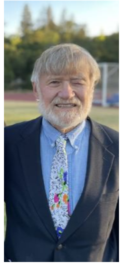
Purchaser: winter sports athlete or outdoor guides

Backcountry skiing increased during pandemic

- Of established skiers:
  - **81%** noticed **more** people in the backcountry
  - **27%** reported **increasing** their own use



Interviewing Potential Users



- **18/19** nordic skiers interviewed **displayed interest** in our product

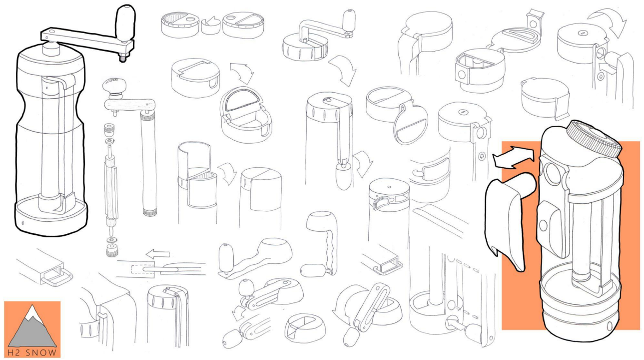
"I would love to have something like that,
let me know if you guys end up finishing the product"
-potential customer Don Yansen

- **3 random users** were able to **safely operate** our product after our instructions, and said it was easy to use

State of the Art

H2 SNOW

Pros	Cons
No batteries required	Takes manual labor
Simple to use	User must stop to melt the snow
	Energy inefficient
	Non-insulated bottle



Specifications

Our 8 Specifications

Safety

The user should not experience any injuries or illness from the product

- Including filter and no toxic materials

Energy Usage

Enough power for multiple uses must be provided within one charge of the batteries

- Total battery voltage under 9 V

Volume

The bottle must provide sufficient amounts of water while being the size of a standard bottle

- 1 L of snow

Time

The bottle must provide water at frequent intervals, providing multiple portions within one charge

- Produce 500 mL within an hour

Durability

The bottle must survive cold temperatures and being dropped from a moderate height

- Survive 1 m fall and -10 ℃

Weight

The bottle must be as easy to carry as large volumes of water

- Weight ~ 1 kg

Cost

The bottle must be affordable to potential users

- Under $100

Materials

The bottle should be made from mainly recyclable materials

- 50% recycled materials

Energy Requirement for Melting Snow

Specific heat $C_p = 2090$ J/kg°C

Enthalpy of fusion $H = 333$ J/g

$Q_1 = mH$ = (104.6 g)(333 J/g) = 34,832 J

$Q_2 = mC_p\Delta T$ = (104.6 g)(2090 J/kg°C)(2.9°C)(10^{-3} kg/g) = 634 J

$Q_{total} = Q_1 + Q_2$ = 34,832 + 634 = **35,466 J**

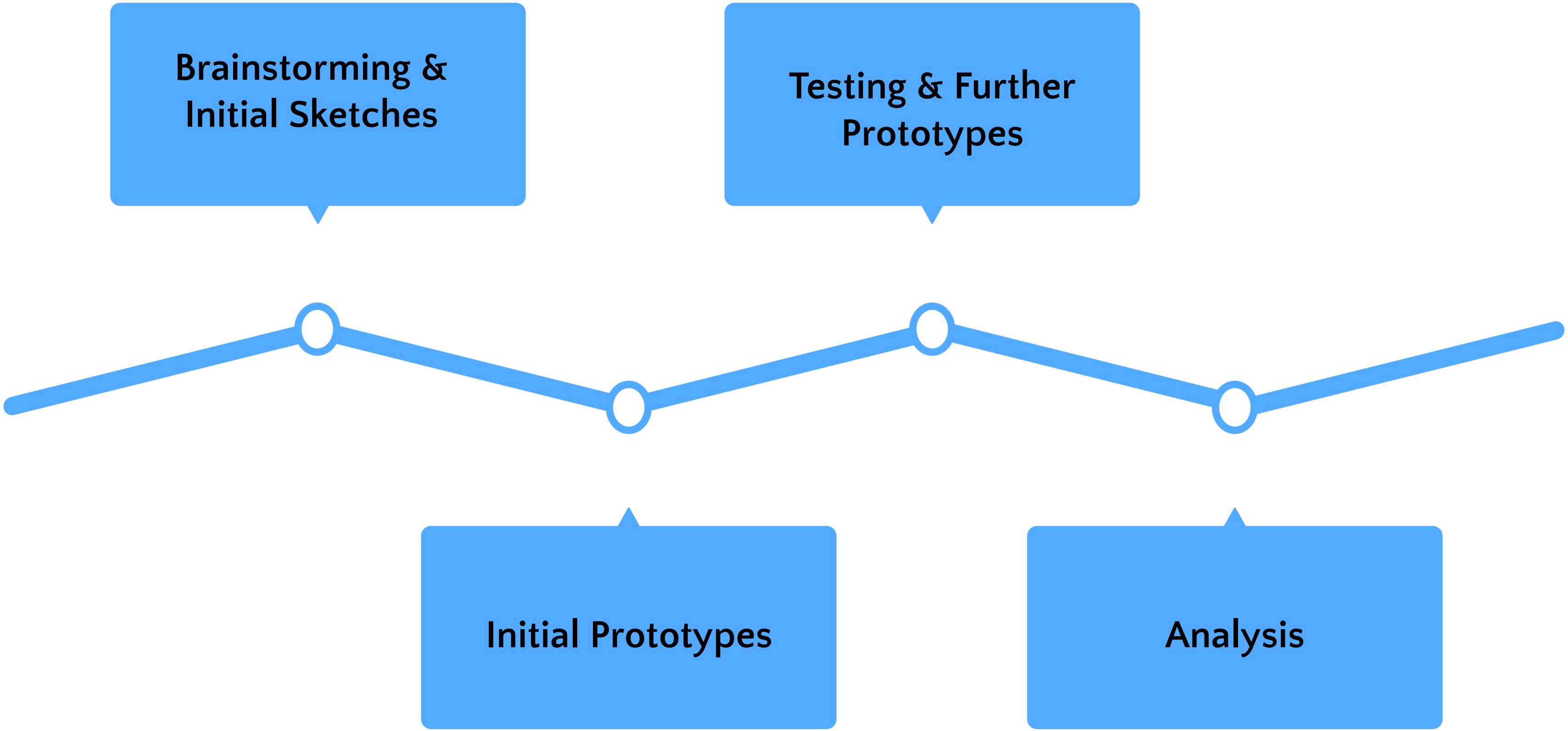
For 104.6 g of snow

Corresponding Power

To melt in under 30 minutes (1800 seconds):

$$P = Q/t \quad = (35{,}466\ \text{J})/(1800\ \text{s}) = 19.70\ \text{W}$$

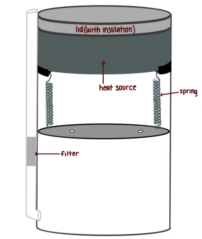
Testing and Design Process


Brainstorming & Initial Sketches
Testing & Further Prototypes
Initial Prototypes
Analysis

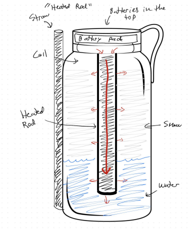
Areas of Research and Exploration

- Circuitry
- Thermodynamics
- Materials

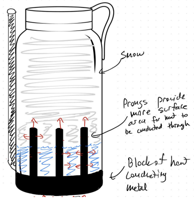
Initial Designs and Sketches



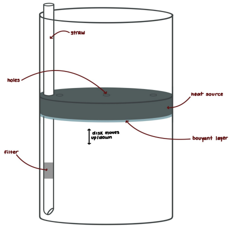
Spring compression



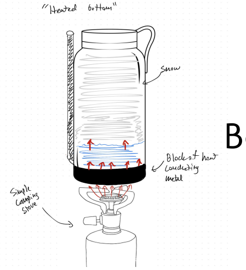
Heated rod



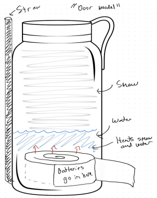
Heated prongs



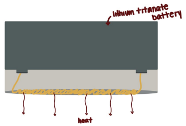
Floating heater



Bottom heating



Fuel compartment



Heated lid

Initial Prototypes

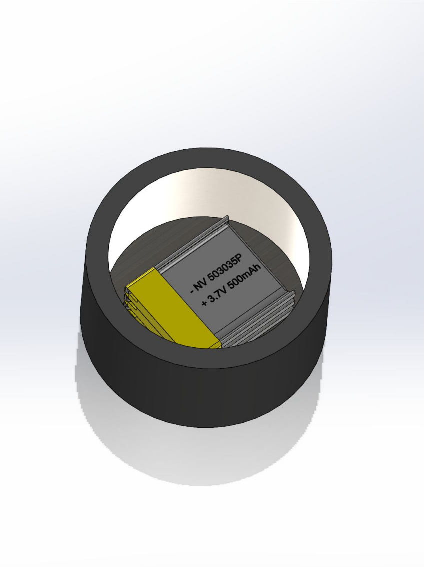
Spring compression

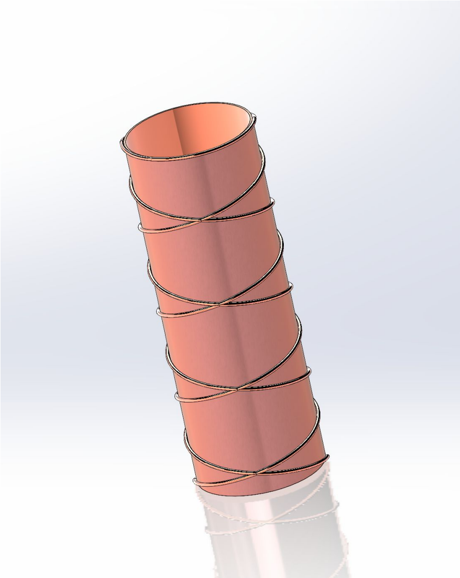
Bottom-heating stove attachment

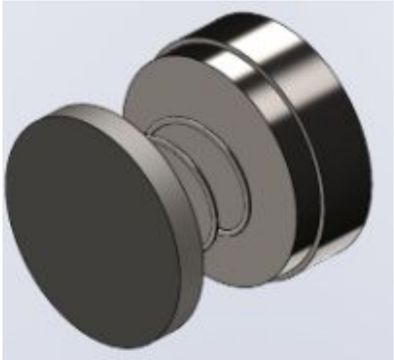
Fuel chamber

Wire-wrapped inner shell

design combining wire heating and spring compression







Testing: Wires

- TAPEGO tape to avoid short circuits
- Nichrome wires
- Electromagnetic induction

Limitation: inability to direct heat radiation

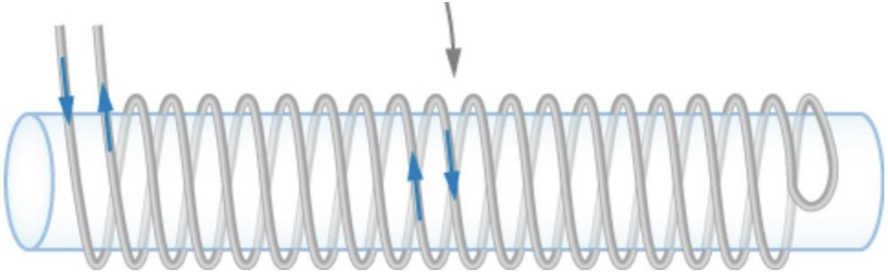
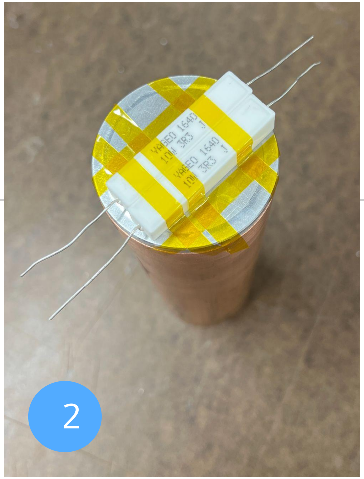
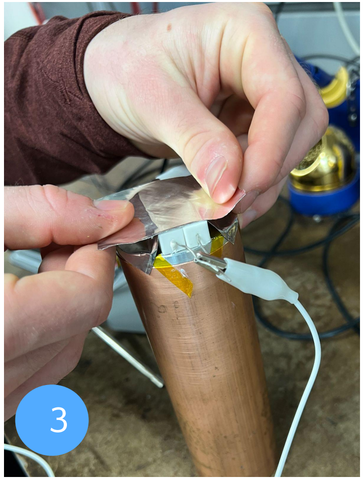


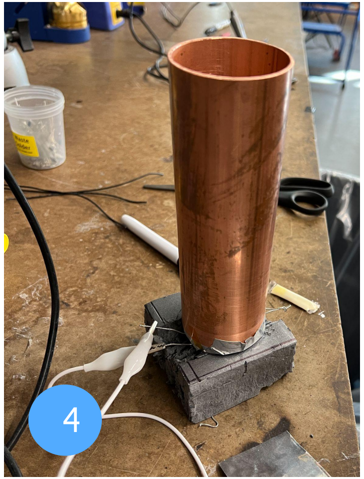
Figure 14.3 The heating coils of an electric clothes dryer can be counter-wound so that their magnetic fields cancel one another, greatly reducing the mutual inductance with the case of the dryer.

Testing: Resistors

1. "Cement" resistors: electric wire wound around heat resistant ceramic
2. Heat transfer grease
3. Aluminum tape insulation
4. Foam insulation







Series and Parallel Configurations

$$R_P = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_{N-1}} + \frac{1}{R_N} \right)^{-1} = \left(\sum_{i=1}^{N} \frac{1}{R_i} \right)^{-1}.$$

$$R_S = R_1 + R_2 + R_3 + \cdots + R_{N-1} + R_N = \sum_{i=1}^{N} R_i.$$

Testing: Power Output

Current (I) = 2.71 A

R_{total} = 2.7 Ω.

Power Dissipated = I^2R

Power generated:

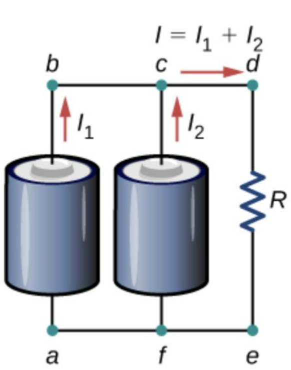
19.83 Watts

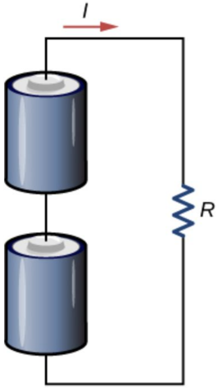
Testing: Batteries

Power: $P = IV = 20.05W$

Our system: V=7.4 V in parallel

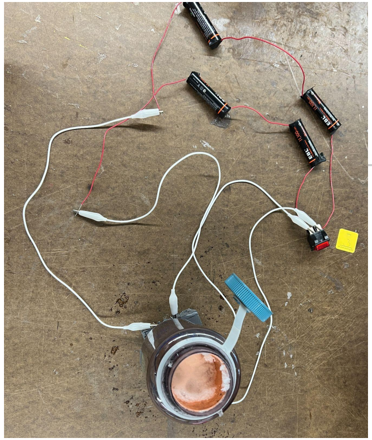
(calculated voltage of 8.06V)

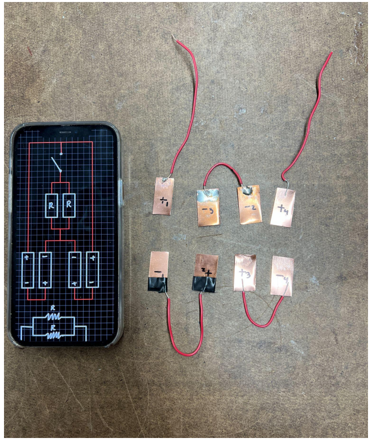


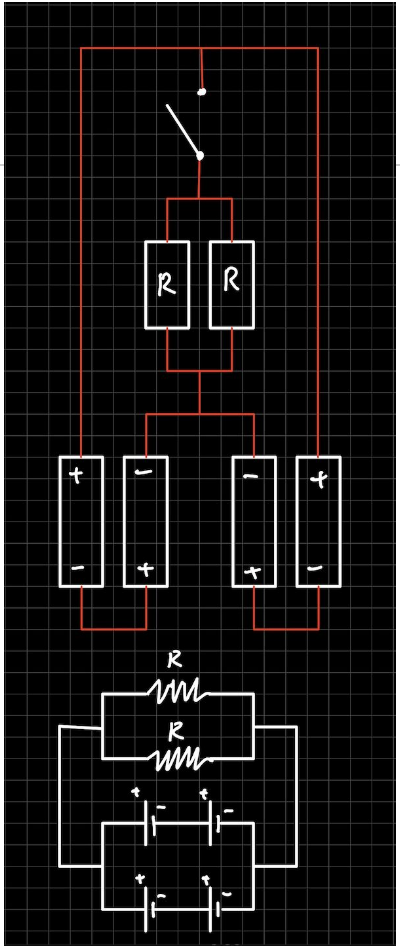


Circuit Configuration

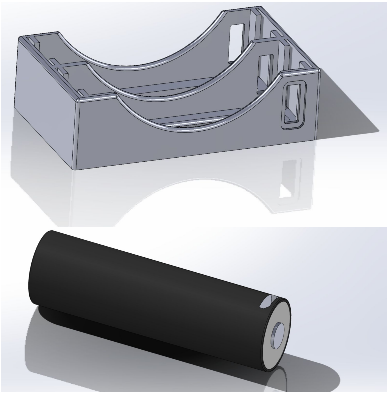
- Two parallel batteries pairs at 7.4V
- Resistors in parallel (2.7 Ω)
- Switch to control circuit



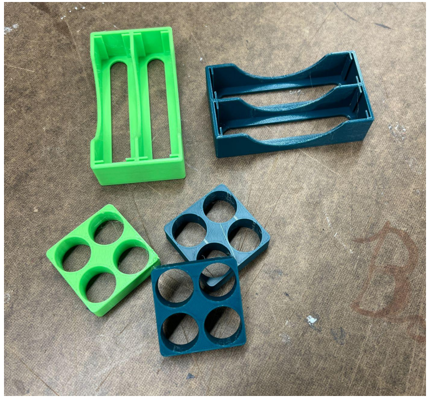




Custom Battery Holders

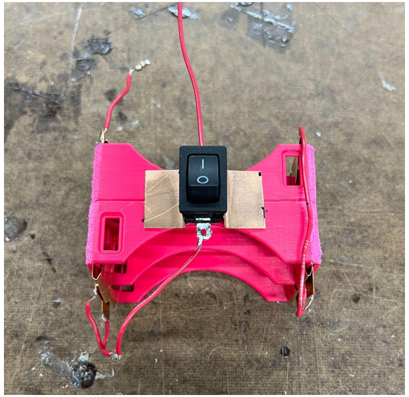


Research & CAD modeling



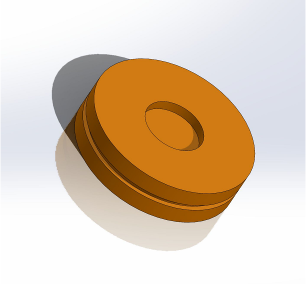
Printed 3 Design Iterations

Built battery terminal plates



Added switch and wiring

Custom cap and spring



CAD modeling of disk

Milling and cutting

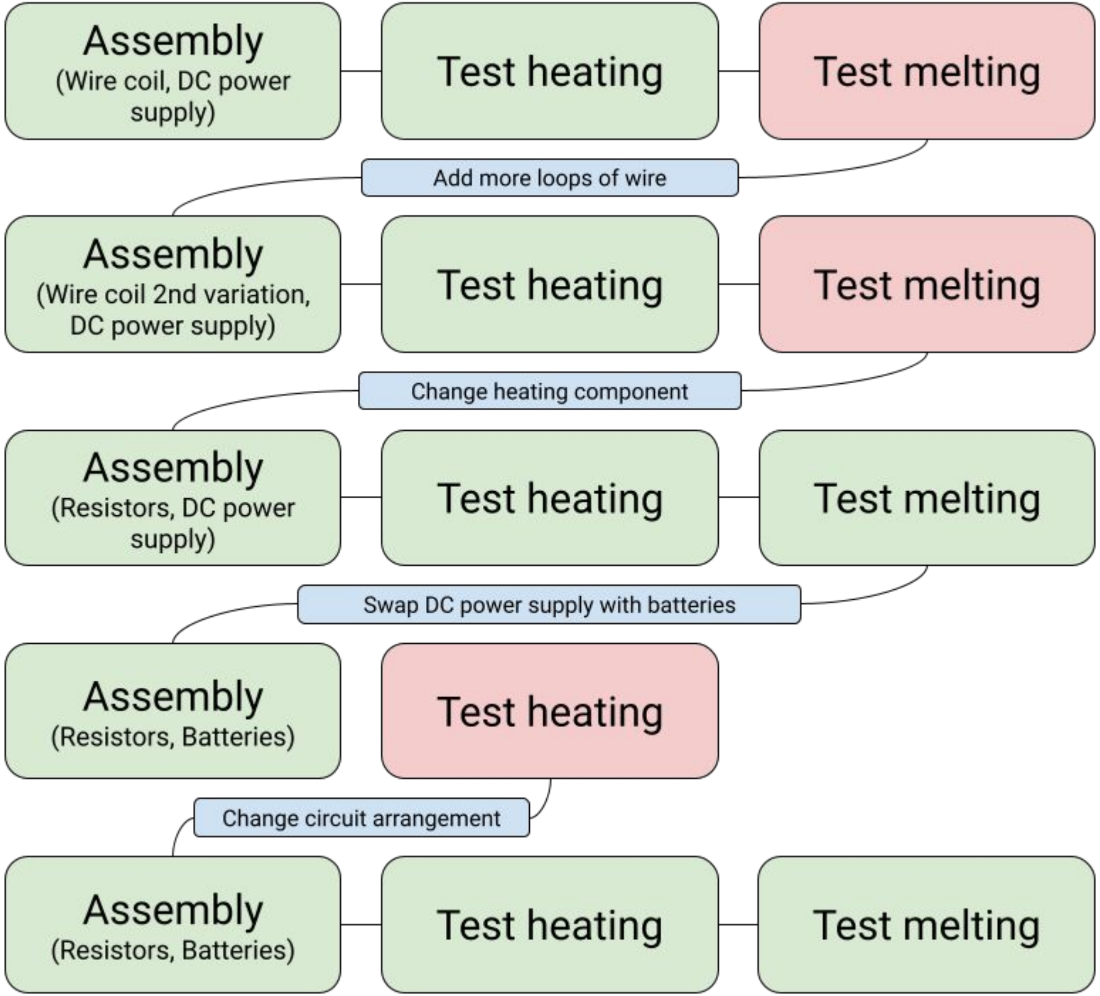
Assembly

+

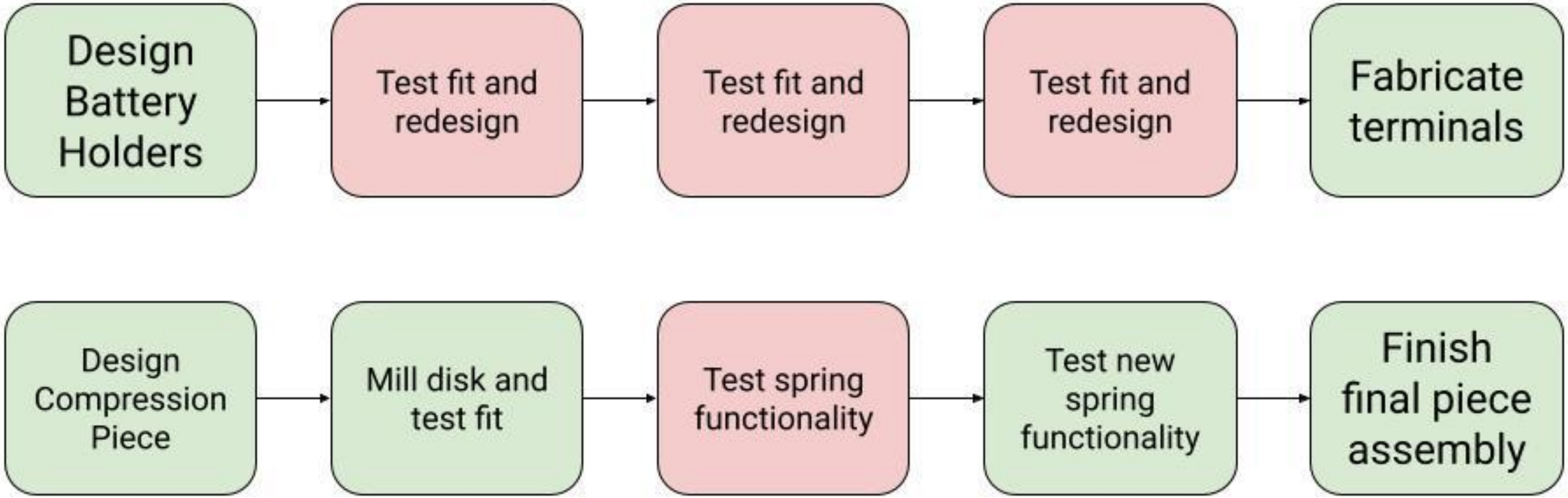
CAD modeling of new lid

Assembly

Major Design Steps:



Other
Design Processes:



Final Prototype


28
24
16

Final Prototype Specifications

Safety: Safe to handle and drink the water through straw

Energy Usage: 3.8 uses per full charge

Time: 34 Minutes, 54 Seconds

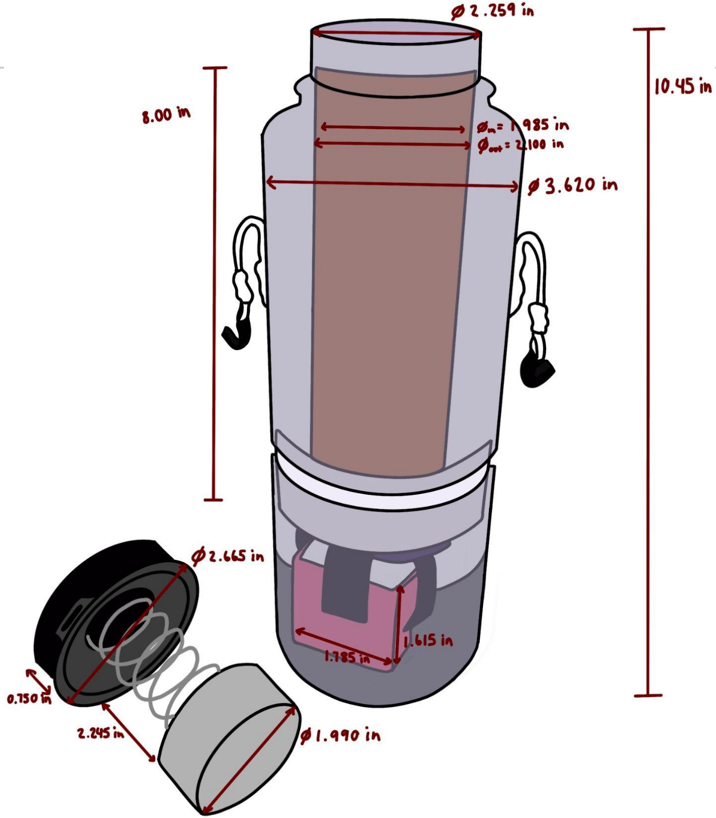
Volume: 105 mL water (105g snow).

Weight: 1.161 kg

Cost: 16.75$

Durability: Functions in as low as -8℃

Materials: Tritan plastic shell, copper snow container, li-ion batteries, acrylic compression, and aluminum heat sink



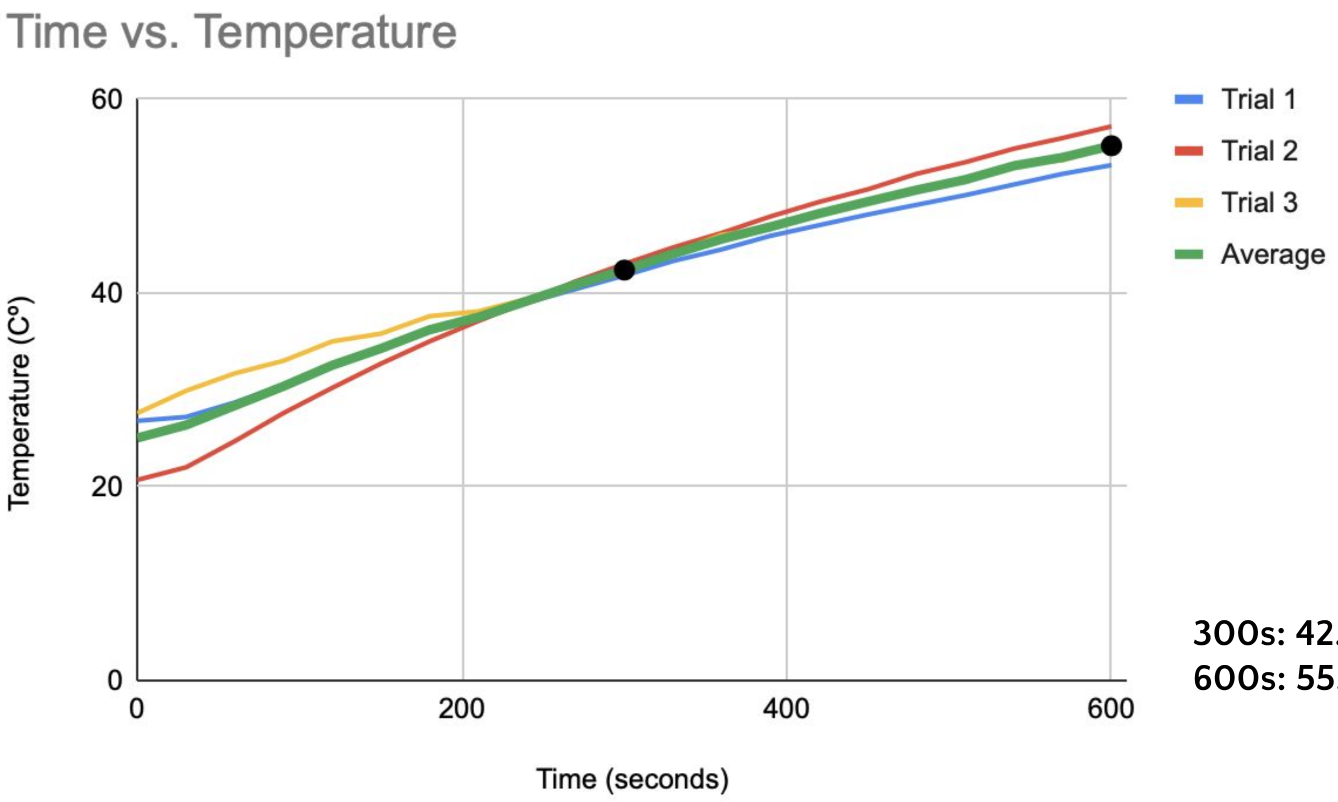
Calculated Efficiency

- Power — $P = IV =$ ***19.83W***
- Energy — $E =$ ***35.5kJ***
- Time — $t = E/P = 1789s$ or **29 minutes, 49 seconds**
- Current — $I = 2.71\ A$; Battery Storage, $S = 6Ah$
- Circuit runtime — $t = 7970s$ or **2 hours, 13 minutes**
- Water yield — $V = 466mL$

But Does it *Actually* Melt Snow??

Yes!

Final Prototype Test Results



300s: 42.4 C°
600s: 55.2 C°

Capacity: 105g of snow

- Produces 105 mL of snow

5 Minutes of Preheating

- Reaches an average temperature of 42.4 C°

Average Melt Time: 34.9 minutes

- 3.8 melts within one charge of the batteries

Ethics, Risks, & Sustainability

Lithium ion batteries: not providing own charger, going to put warning in package

Open wiring: could be dangerous

3D printed materials are not sustainable

Impact Scores

Part	Impact Score	Impact Score (with injection molding)
Cap and Battery Containers	8.06	0.0936
Nalgene Shell	0.1924	0.1924
PVC Pipe	0.096291	0.096291
Copper Pipe	0.8526	0.8526
Batteries	5.72	5.72
Acrylic	0.2128	0.10944
Wires and Copper Plates	0.5	0.5
Electric resistors	0.08464	0.08464
Total	15.718731	7.648971

51.3% decrease

Economics & Business Plan

Fixed Costs

Rent (Factory)	$18,000
Leasing Equipment	$5,000
Heat	$2,000
Electricity	$1,500
Advertising	$5,000
Manufacturing	$30,000
Insurance	$2,500
Legal	$2,000
Salary	$40,000 (x4)
Total	$226,000

$18,834 monthly

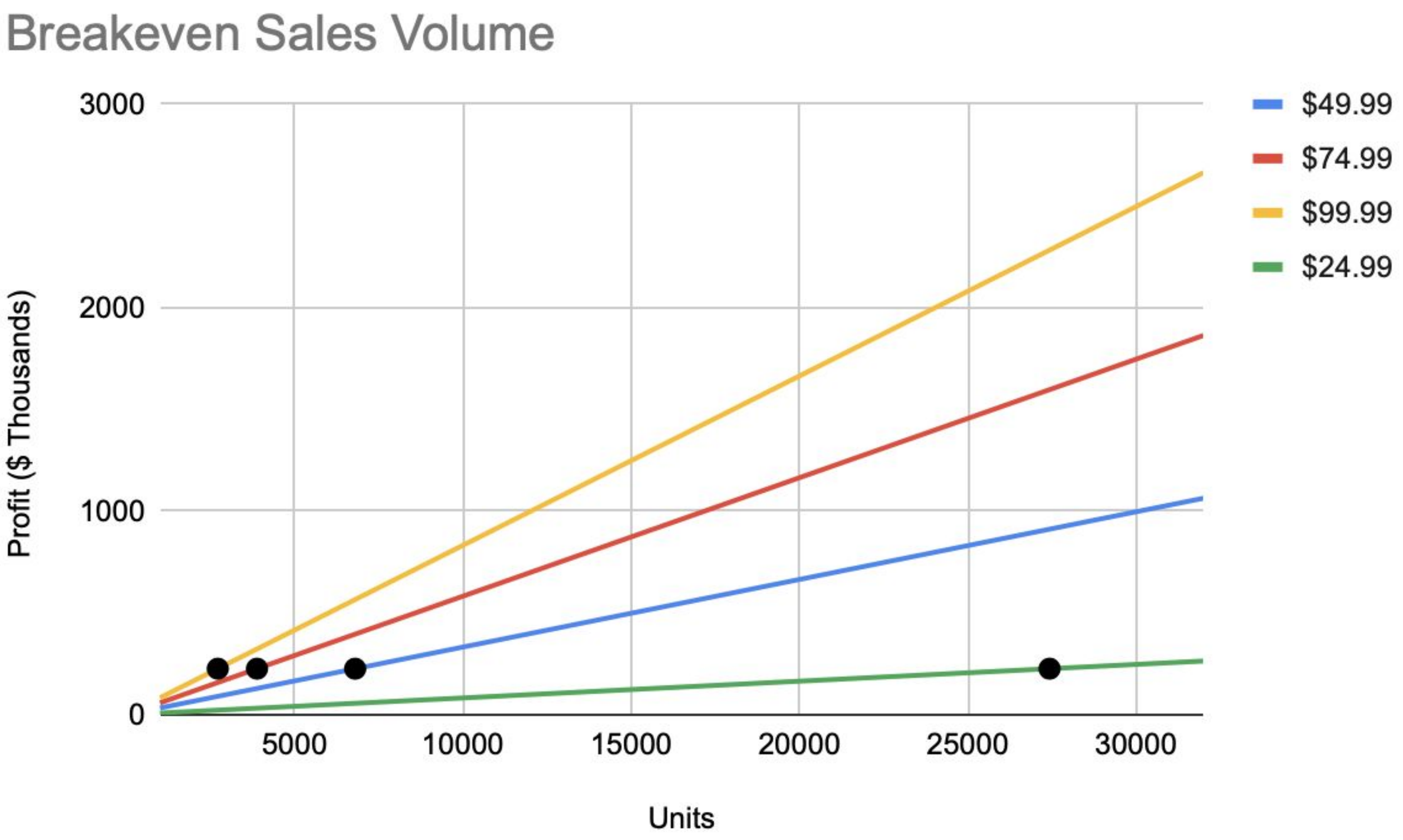
Variable Costs

Item	**Cost**
Water bottle shell	2 * $1.38 = **$2.76**
Copper piping	0.392 kg * $6.50/kg = **$2.55**
Batteries	4 * $2.60/battery = **$10.4**
Resistors	2 * $0.07/piece = **$0.14**
Switch	**$0.30**/piece
Wiring	0.3 m * $0.20/meter = **$0.60**
Total	**$16.75** / bottle

Breakeven Sales Volume

Cost (per bottle)	16.75
Total Market Size	26,870,000 (from market research)

Price per Board	Profit per Board	**Breakeven Volume**	Percent of Market
$24.99	8.24	27,428	0.102%
$49.99	33.25	6,797	0.025%
$74.99	58.24	3,881	0.014%
$99.99	83.24	2,716	0.010%


Breakeven Sales Volume
3000
2000
1000
0
Profit ($ Thousands)
5000
10000
15000
20000
25000
30000
Units
$49.99
$74.99
$99.99
$24.99


Cumulative Profit
Price: $74.99
Profit ($ Thousands)
400
300
200
100
0
-100
0
10
20
30
Months

Business Canvas

Key Partners

Individuals

Outdoor Equipment Retail Stores

Ski Shops

Key Activities

Production

Marketing

Sales

Key Resources

Materials
- Resistors
- Copper Pipe

Labor

Value Propositions

Provides a compact, sustainable way to have continuous access to water in backcountry environments.

Customer Relationship

Surveys

Free repairs if damaged.

Free initial set of batteries.

Channels

Retail Stores

Online

Ski Resorts

Customer Segments

Backcountry Skiers (4.5 million)

Skiers and Snowboarders (20+ million)

Campers and Hikers (50+ million)

Cost Structure

Manufacturing
Shipping
Marketing
R & D

Revenue Streams

Sales

Revenue from selling utility or design patent

Funding

Personal Funding

Kickstarter Campaign

Exit Opportunities

Seeking complete buyout or royalty deal

In 2016, consumer products conglomerate Helen of Troy swooped in, acquiring Hydro Flask for about $210 million.

Standard royalties range from 2-5%

Conclusion

Limitations

Small Volume

Slow Heating

Non Eco-Friendly Materials

Precarious Cap Fastening System

Future Design Plans

Sustainable Materials: injection molding & aluminum shell

Increase volume: 3 inch diameter water container

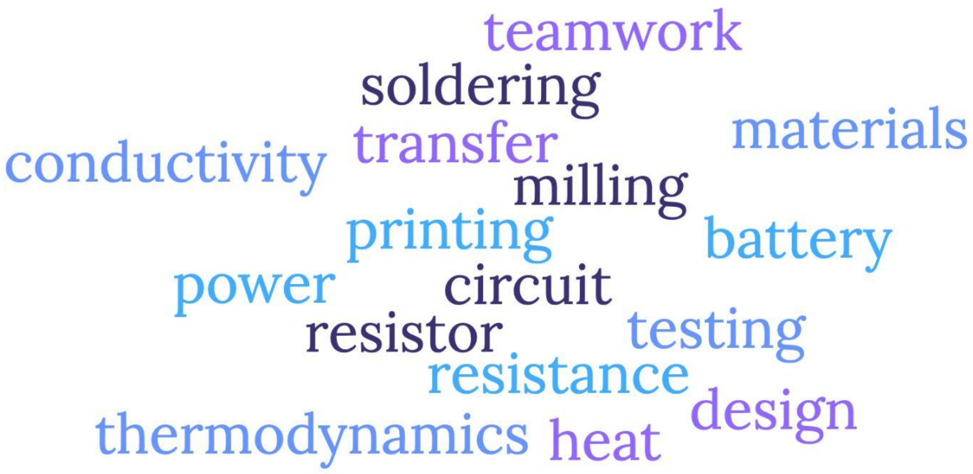
Increase speed and longevity: add batteries and resistors

Integrate charging capability

With these design plans, we recommend that DCEF should pursue future development

Based on continued success in testing, we will consider patenting our design

Skills we learned



Acknowledgements

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