40 Quart Cooler Design

Senior Design Project

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Overview

- Needs Identification
- Goal & Scope
- Constraints
- Engineering Process
  - Latch Design
  - Hull Design
  - Testing
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- Simulation
- Final Design
  - Latch
  - Assembly
- Cost Analysis
- Project Conclusions
- References and Acknowledgements

Needs Identification

- Mold quality
- Durability
- Ice retention
  - Latches
  - Gasket
- Widened range of function

Goal & Scope

Goal:

Develop a cooler with an internal volume of 40 quarts that offers reliability and performance. The final product must meet the highest standards in the industry while maintaining a manufacturer's suggested retail price (MSRP) of no more than $199.99

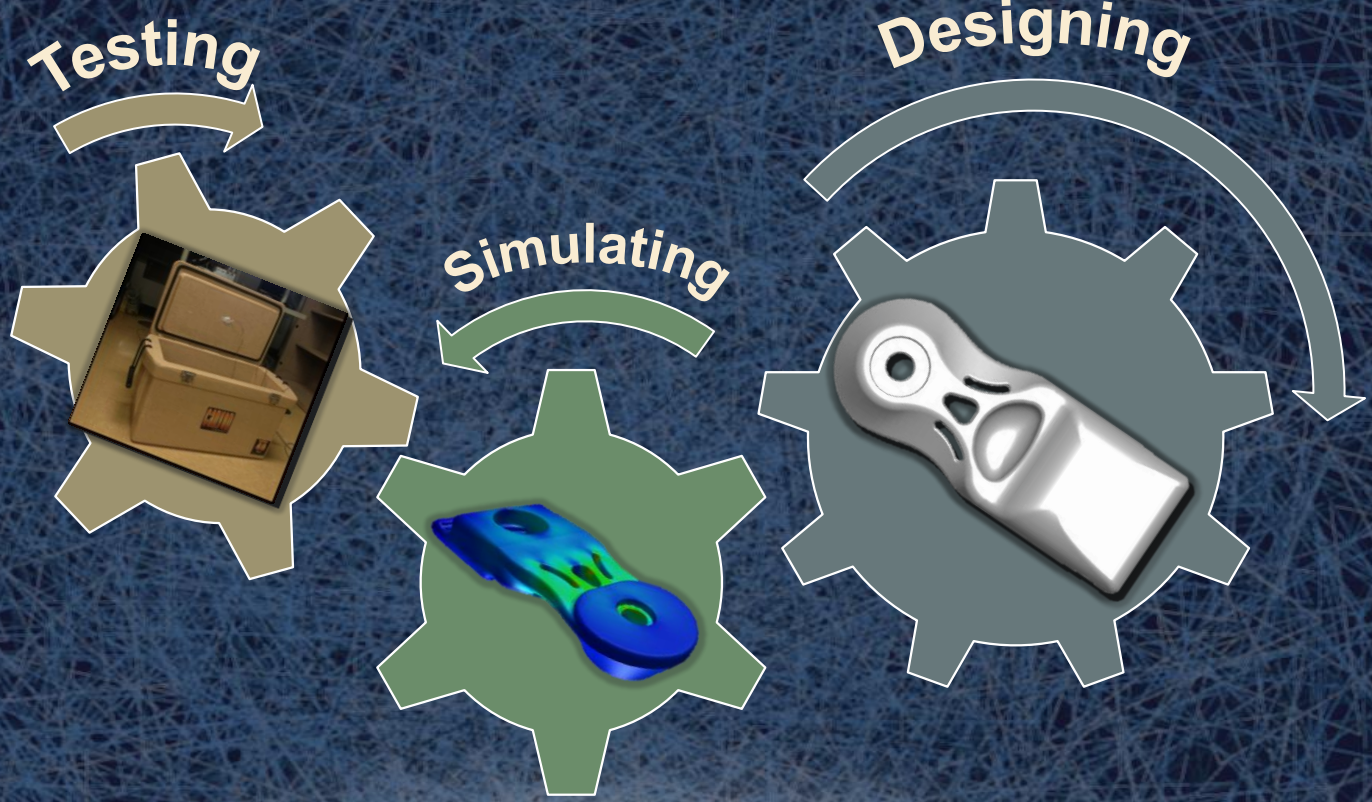
Scope:

- Rotational & Injection molds are costly to prototype
  - CAD focused project
  - Produced affordable prototypes
  - Temperature testing
  - Computer simulations

Constraints

- **Cost**
  - MSRP of no more than $ 199.99
- **Geometry**
  - Internal volume of 40 quarts
  - Nest into existing coolers
  - Dimensioned for common goods
- **Weight**
  - Maximum dead weight of 20 lbs.
  - Includes weight assist features
- **Durability**
  - Resist warping
  - Impermeable to debris and water
- **Function**
  - Improved ice retention
  - Offer integrated features

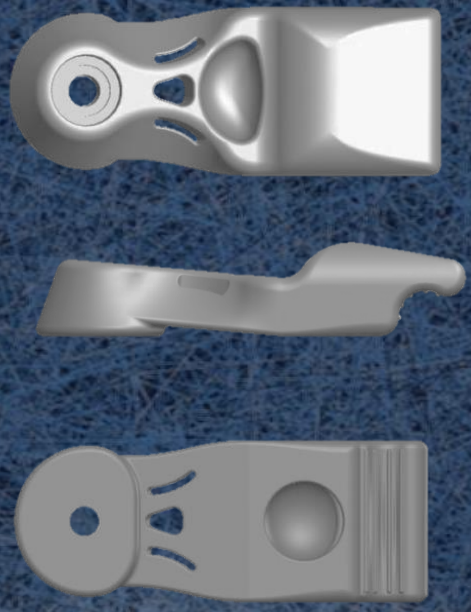
Engineering Process



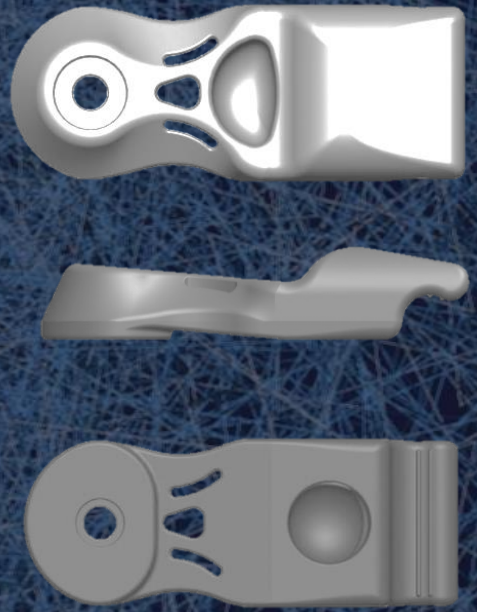
Engineering Process · Latch

1st Iteration

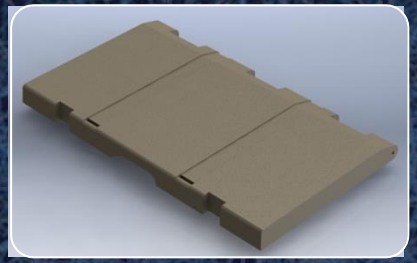
2nd Iteration

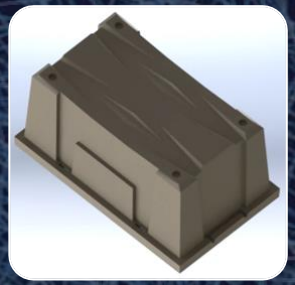


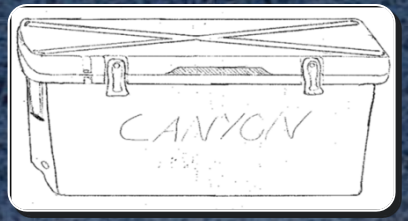
3rd Iteration



Engineering Process

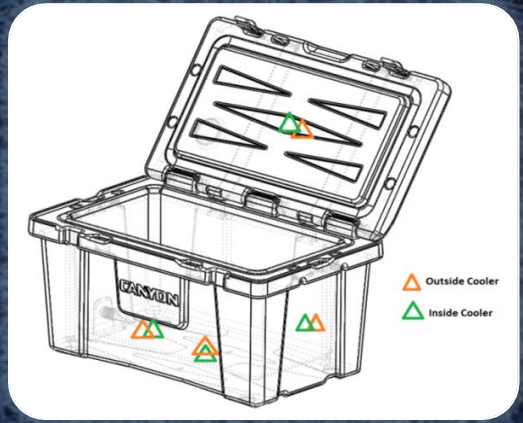




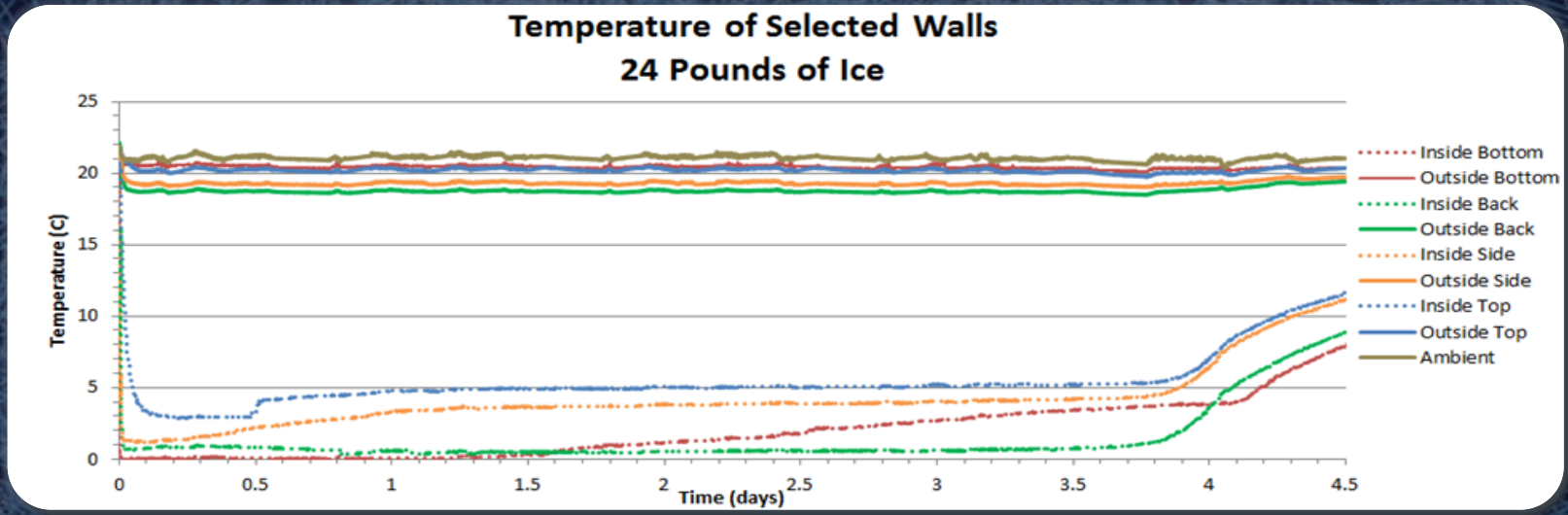


Engineering Process · Testing

- 8 T-type thermocouples
- Placed on top, bottom, back, and side walls, both inside and outside
- National Instruments 9213 DAQ
- 3 experiments performed
- 3rd and final test produced best results



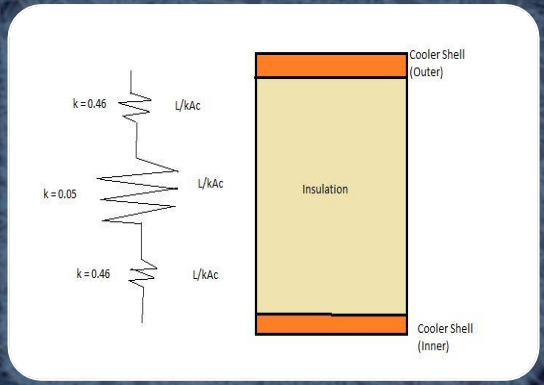
Engineering Process · Testing

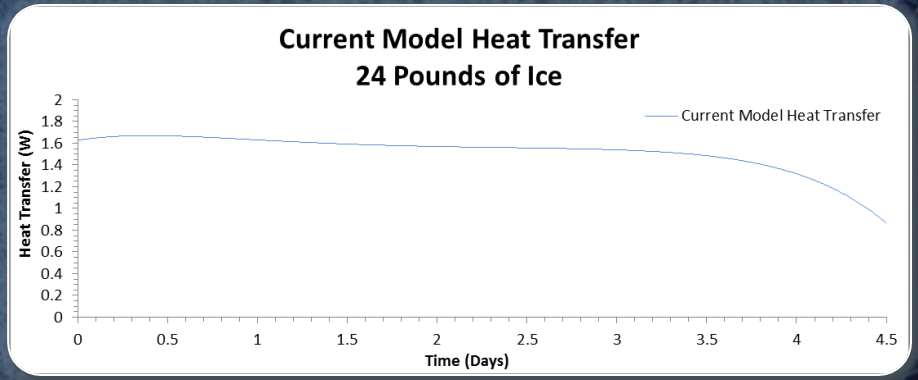


- Experiment started at ambient conditions
- Ice added shortly after start of test
- Sharp decrease in internal temperatures
- Internal temperatures increased on fourth day after the ice had melted

Engineering Process · Results

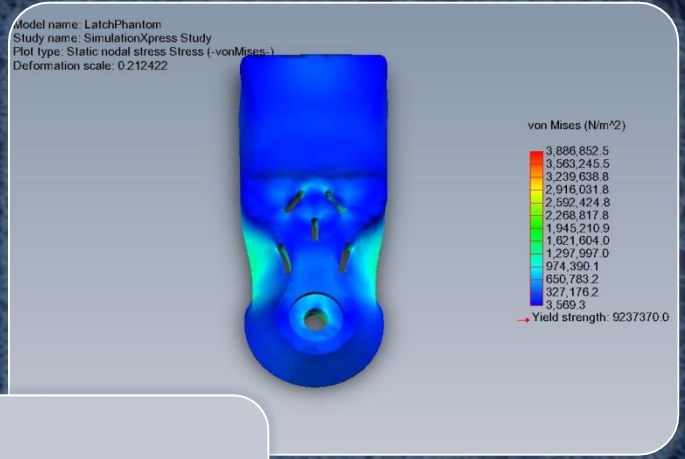
- 1-D heat plane wall
- Boundary conditions from experimental data
- Thermal resistance circuit
- Comparison of thermal resistances
- Integration reveals total heat gain of 0.15 W

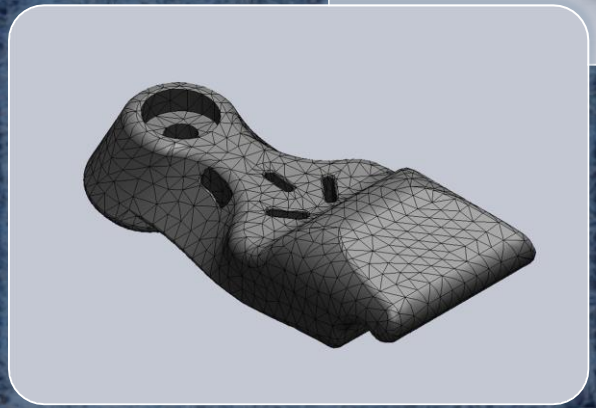




Engineering Process · Simulation

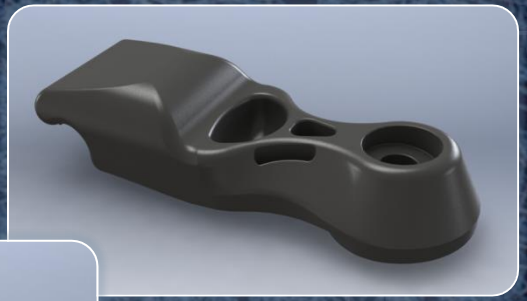
- Stress map generation
- Accounted for mesh dependency
- Multiple configurations
- Function information
- Form and fit by RAPID prototyping

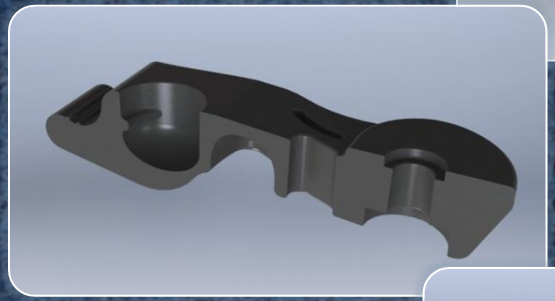


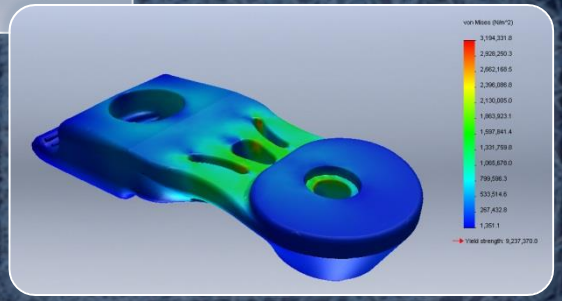


Final Design · Latch

- EPDM rubber (40-50 shore)
  - Weather resistant
  - Consistent performance
  - Rough finish
  - Resists high stress
  - Allows for functional stretching
- Ergonomic
- High latching force
- Backwards compatible





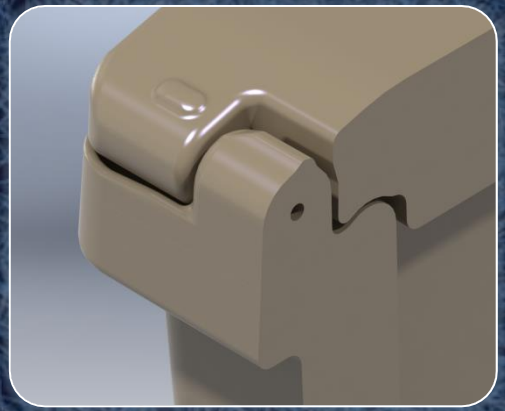


Final Design · Latch

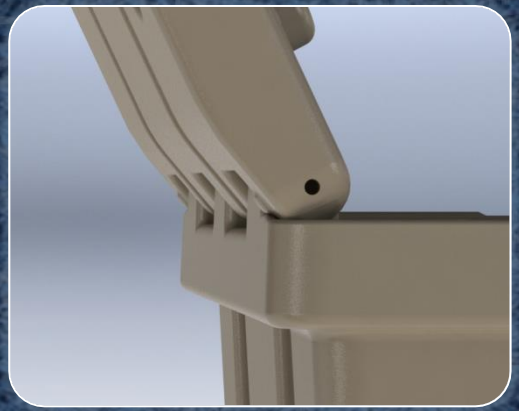
- SolidWorks Assembly
- Four part files
  - Lid
  - Body
  - Two Latches
- Blueprints for rotational and injection molding

Final Design · Hinge

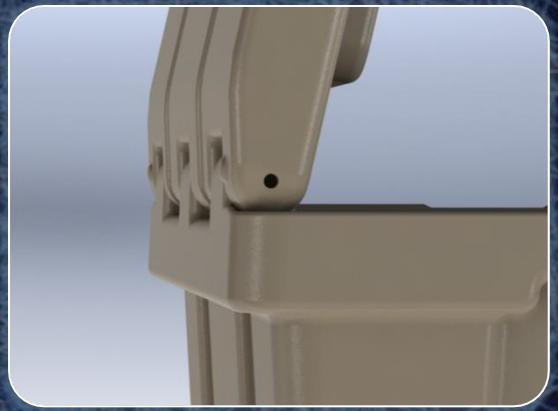
Hinge Section View



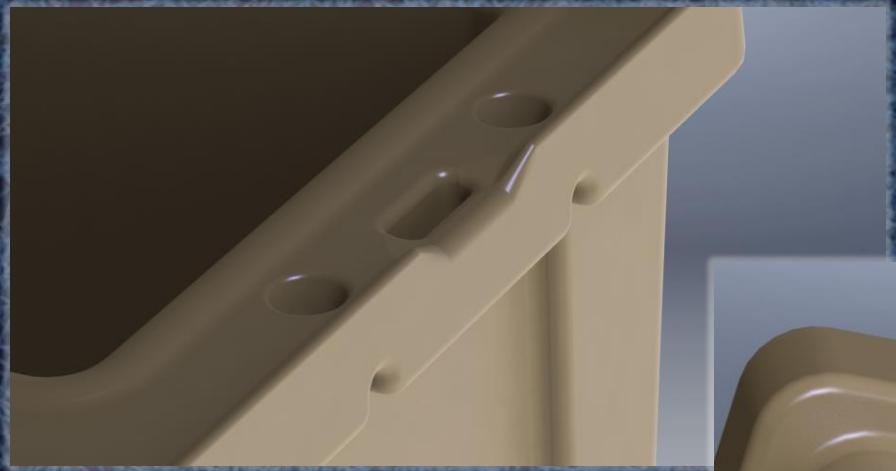
Primary Open Position

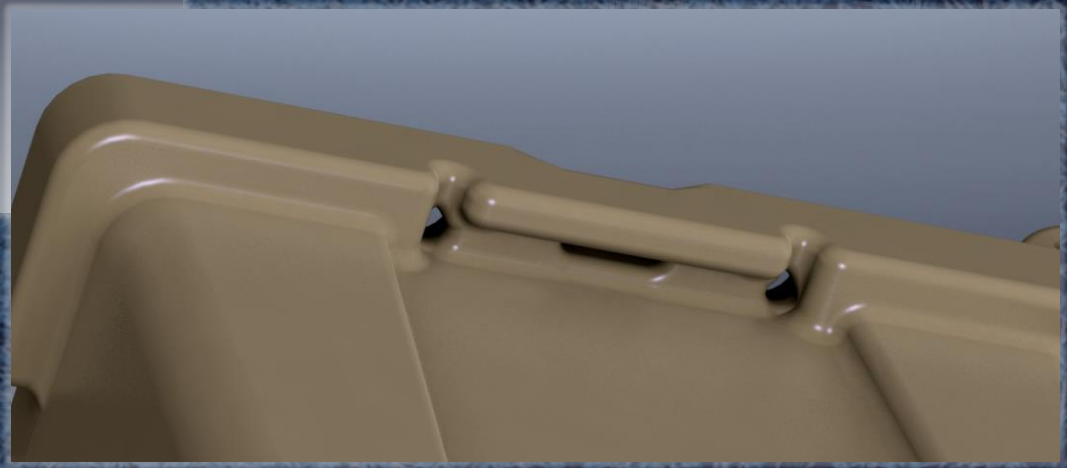


Secondary Open Position



Final Design · Lip Features





Final Design · Hinge

- Four holes function as feet inserts and PE foam injection ports
- Rubber feet offer consistent grip
- Warp prevention
- Movable when tilted
- Minimizes heat transfer

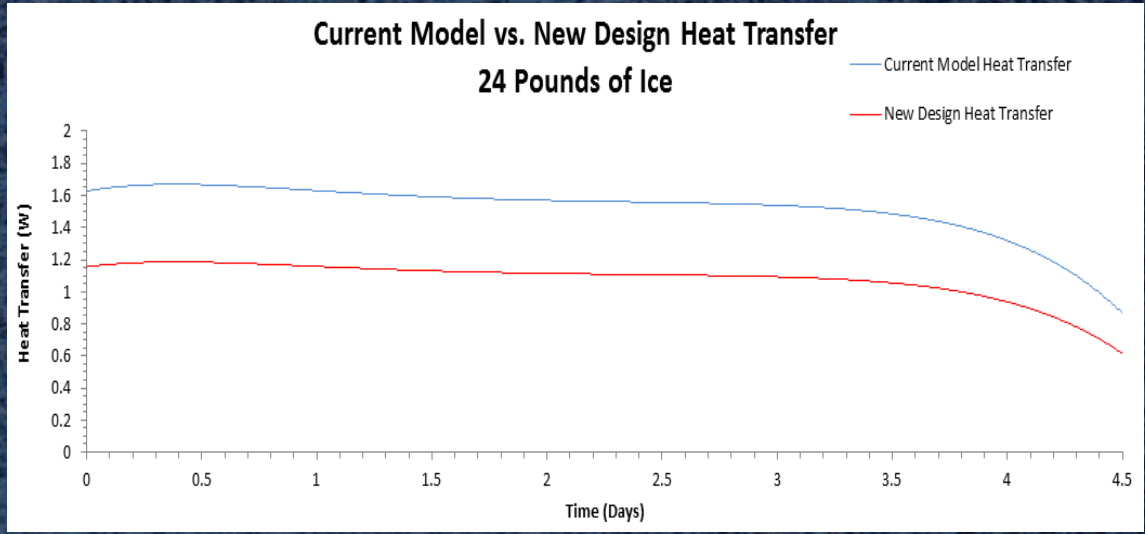
Final Design · Virtual Tour

Cost Analysis

Material	Unit Cost ($)	Quantity	Total Cost ($)	Notes
Plastic handle	0.98	2	1.96	Dynamic handle component
¼ in. diameter nylon rope	0.13 per ft.	4 ft.	0.52	Dynamic handle component
Drain plug	1.45	1	1.45	
3/16 in. Trifold aluminum rivet	0.14	2	0.28	Latch component
Nylon shoulder washers	0.02	2	0.04	Latch component (WS-0402-0201-0354)
Insulating PVC gasket	4.77 for 35 ft.	6 ft.	0.82	¼ in. x ¾ in. (PVC-PSA-1)
Plastic latch knob	0.25	2	0.5	Latch component
Flat head screws	0.09	2	0.18	Latch component
Rubber foot	0.85	4	3.38	
¼ in. Diameter steel hinge pin	3.45	26 in.	3.45	
HDPE plastic	TBA	17.9 lbs.	TBA	Cooler hull, lid & body
Polyurethane foam	TBA	2.26 lbs.	TBA	Insulation, lid & body
EPDM rubber	TBA	0.07 lbs.	TBA	Latch
		Component Cost	**12.58**	
		Target Cost	**66.70**	
		Manufacturing Budget	**54.12**	

Performance Verification

- Heat transfer improvement
- Boundary conditions from experimental data
- Comparison of thermal resistances
- Improvement of 29%
- Integration reveals average heat gain of 0.11 W (compared to 0.15 from previous model)



Conclusion

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REFERENCES & ACKNOWLEDGMENTS

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QUESTIONS?