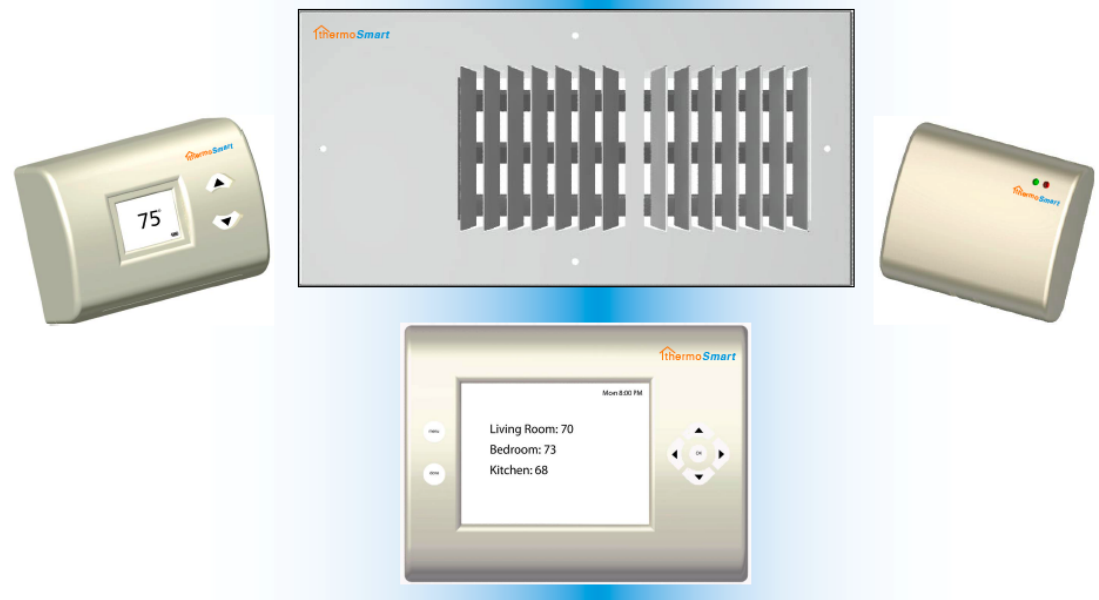




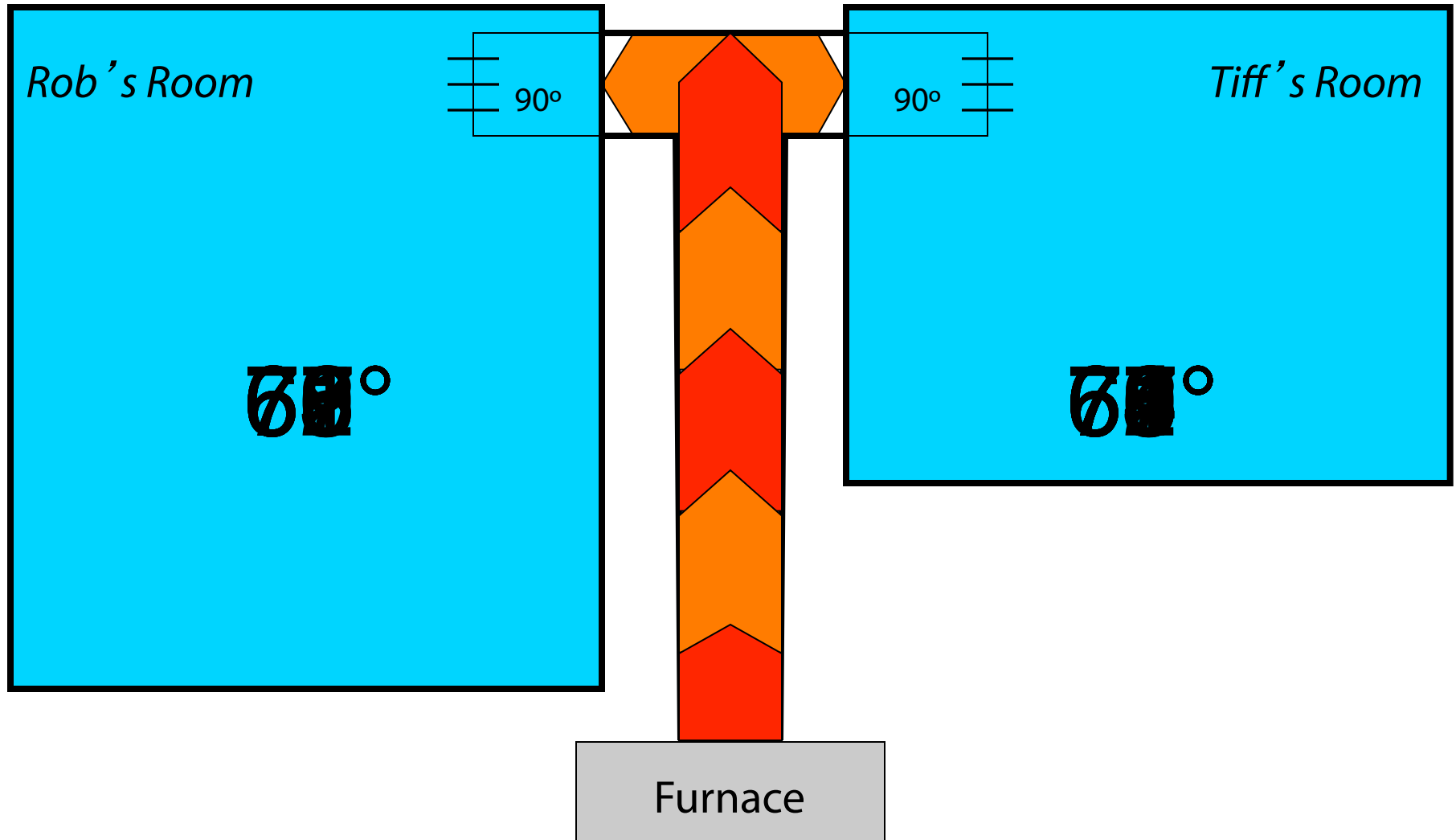
2.009 Product Engineering Process
Orange Team
December 8, 2008

Product Overview

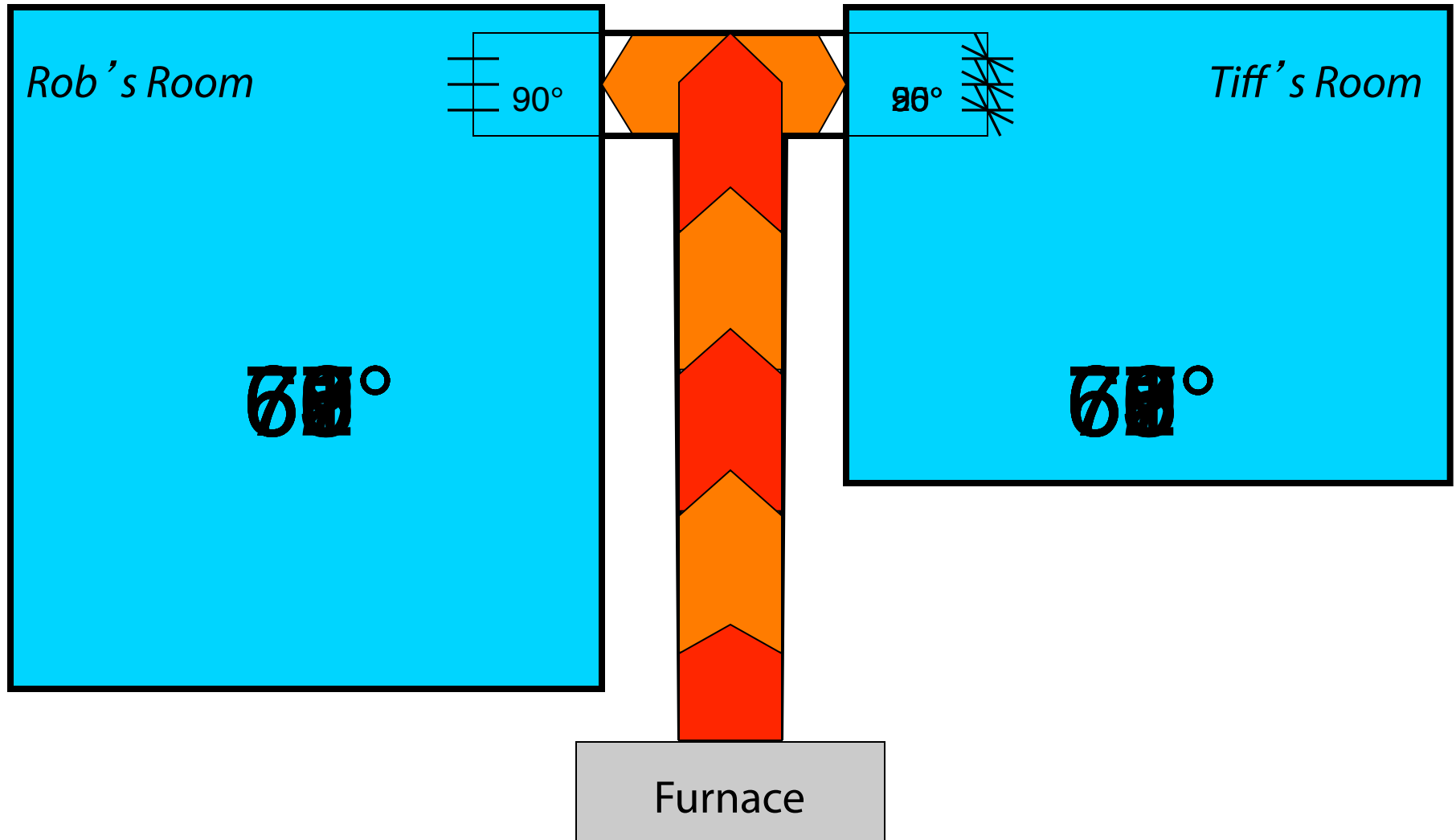
- ✓ Improve comfort
- ✓ Save energy
- ✓ Do-it-yourself install



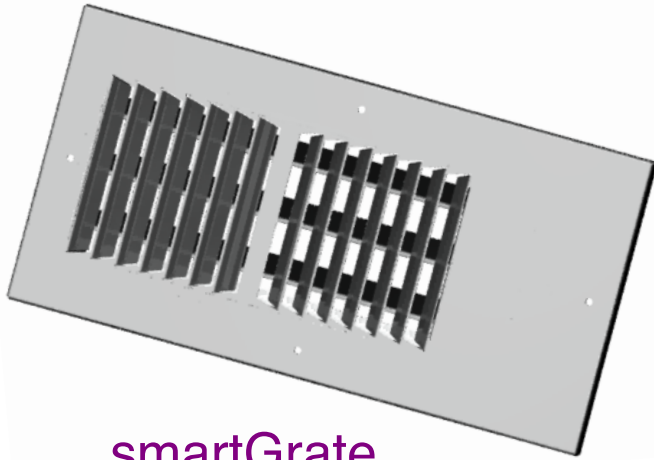
Typical Home



thermoSMART



Components



smartGrate



smartTemp



Coordinator



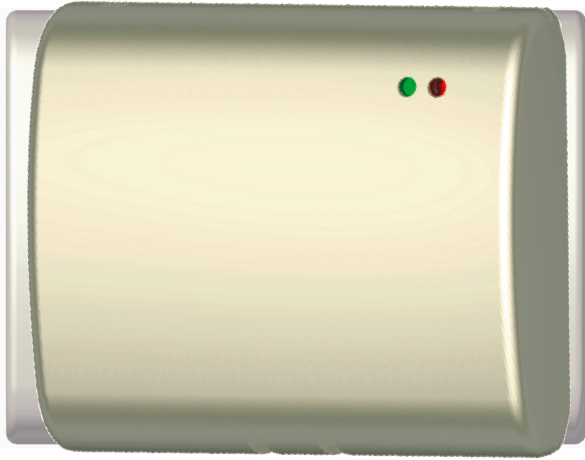
HVAC Controller

Comparison

Design considerations

Purchase Options		Improves Comfort	Improves Efficiency	Do-it-yourself	Cost
	Space Heater	✓		✓	\$70
	MyTemp	✓	✓		\$8,000
	thermoSmart	✓	✓	✓	\$400

thermoSMART



HVAC Controller

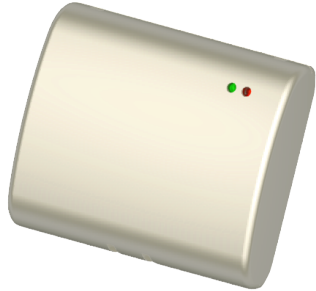


Usability Considerations

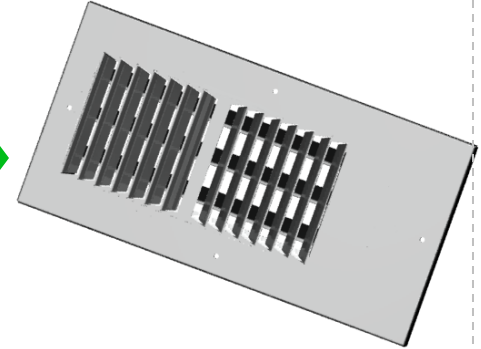
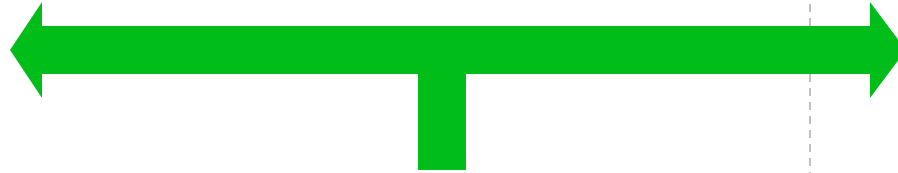
- ✓ Sufficient battery life
- ✓ Minimum tool requirement
- ✓ Wireless communication

Wireless Communication

HVAC Controller



Furnace



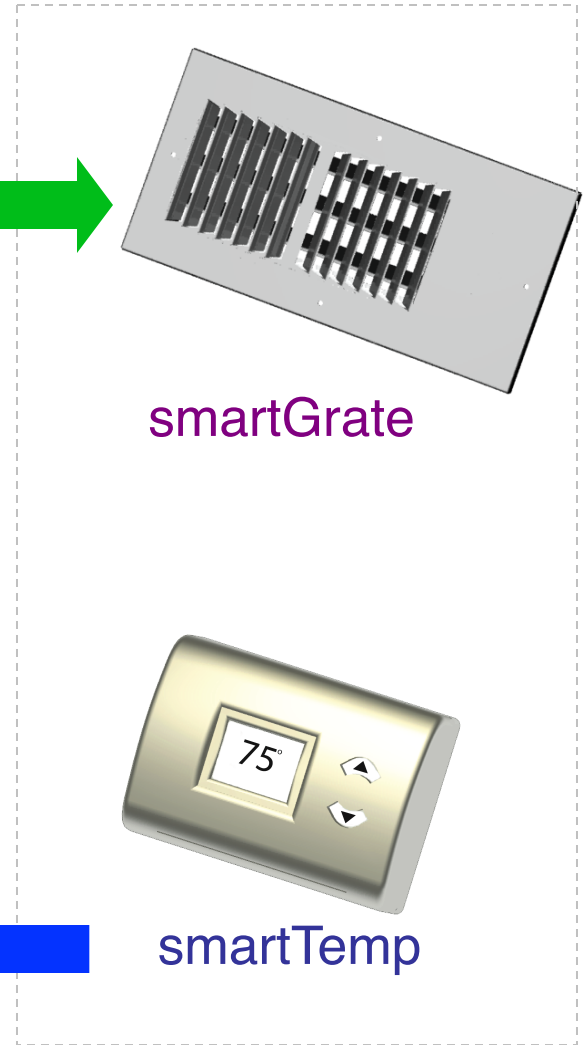
smartGrate



Coordinator

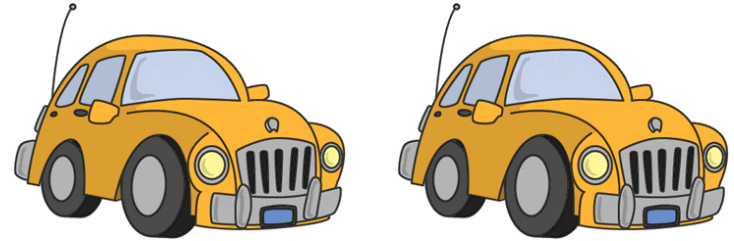


smartTemp



Saving Energy

- ✓ Time to temperature
 - ✓ Up to 15% reduction
 - ✓ \$200 off heating bill!



- ✓ Scheduling feature
 - ✓ Additional 7% reduction
 - ✓ \$100 more off heating bill!



Comfort

- ✓ Even temperature distribution

 - Eliminate overheating

- ✓ Desired temperature

 - Room-by-room basis

“I used to work down in the basement. It was so cold that I had to turn the heat up in the entire house to 76° in order to keep from freezing. I had to move my office upstairs so I could keep the house at 68°.”

- New England homeowner

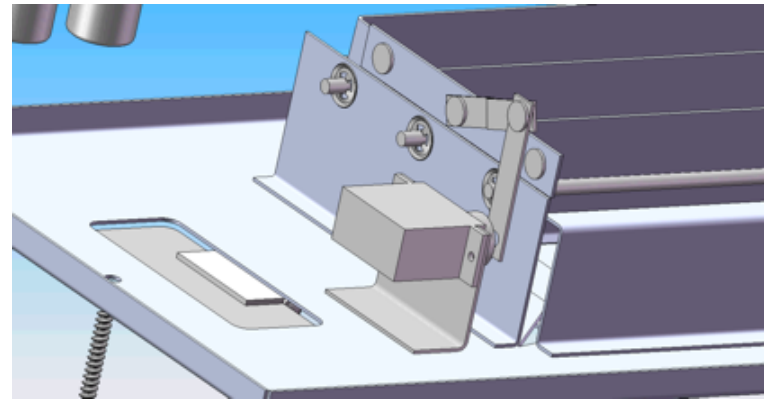
Technical Considerations

Simulation to model system constraints

- ✓ Healthy air flow into rooms
- ✓ No damage to furnace

Control algorithm

- ✓ Determine grate position



Actual Result

- ✓ 10% reduction in the required heating time in a house
- ✓ Correlates to 10% energy savings



Future Development

short term

- ☐ Implementing the scheduling function
- ☐ Consolidation of electronics

long term

- ☐ Multiple grate sizes manufacture
- ☐ Universal HVAC Controller interface

Purchase Options

basic pack

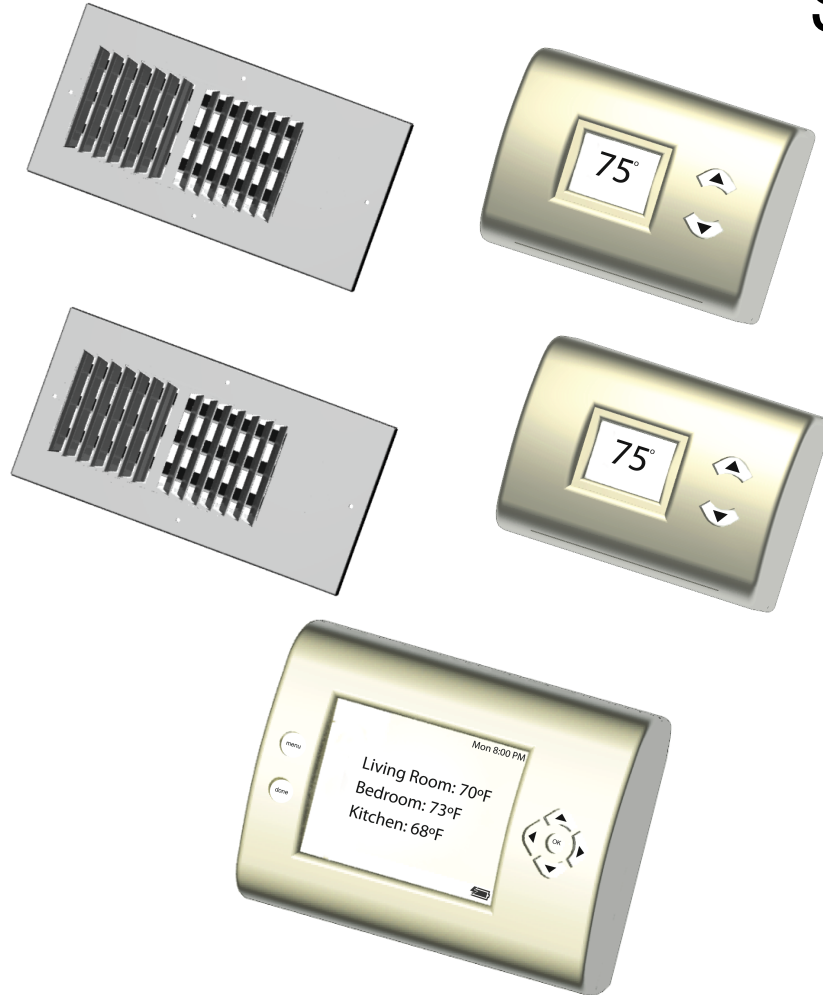
\$179.99

Basic

Premium

Expansion
Pack

HVAC
Controller



Purchase Options

premium pack

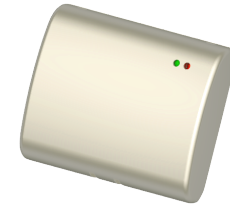
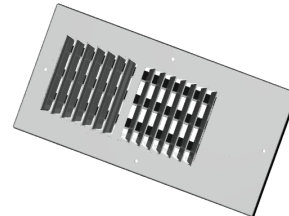
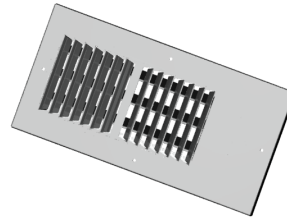
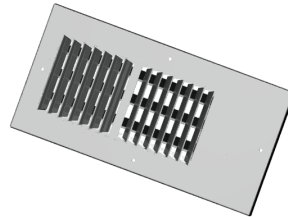
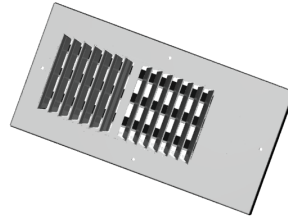
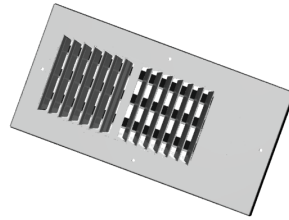
Basic

Premium

Expansion
Pack

HVAC
Controller

\$389.99



Purchase Options

expansion pack

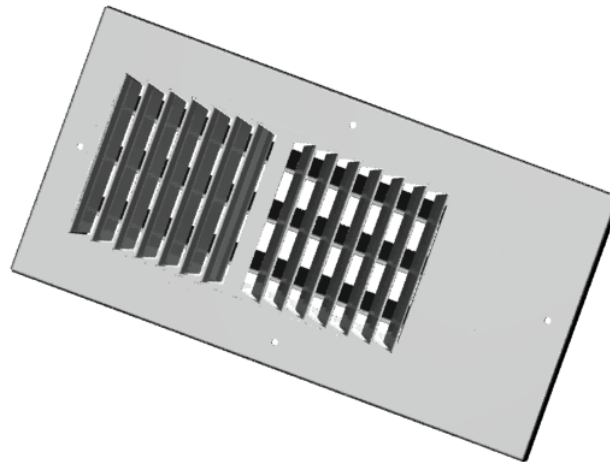
\$58.99

Basic

Premium

Expansion
Pack

HVAC
Controller



Purchase Options

HVAC Controller

\$34.99

Basic

Premium

Expansion
Pack

HVAC
Controller

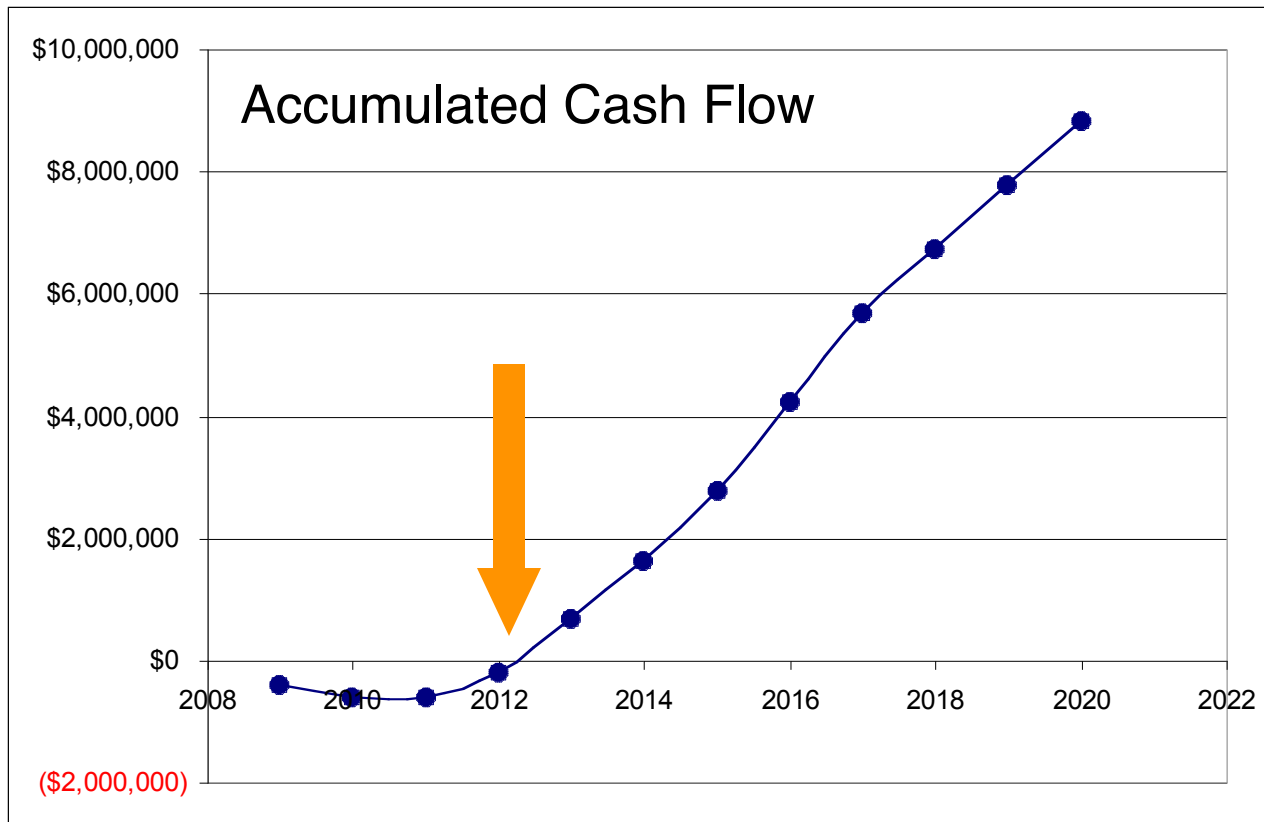


Demo Results

- ✓ Maintain rooms at desired temperatures
- ✓ Controls heater with HVAC Controller



Business Model



Net Present Value: \$2.6 million
Internal Rate of Return: 62%

thermoSmart



Thank you!



Professor Wallace and all 2.009 staff, Professor Culpepper, Juhan Sonin, Jane Kokernak, Peter Nielsen, Adele Phillips, Darthur Petron, Zachary Clifford, Professor Leeb, Professor Brisson, Brian Hemond, Stephen Samouhos

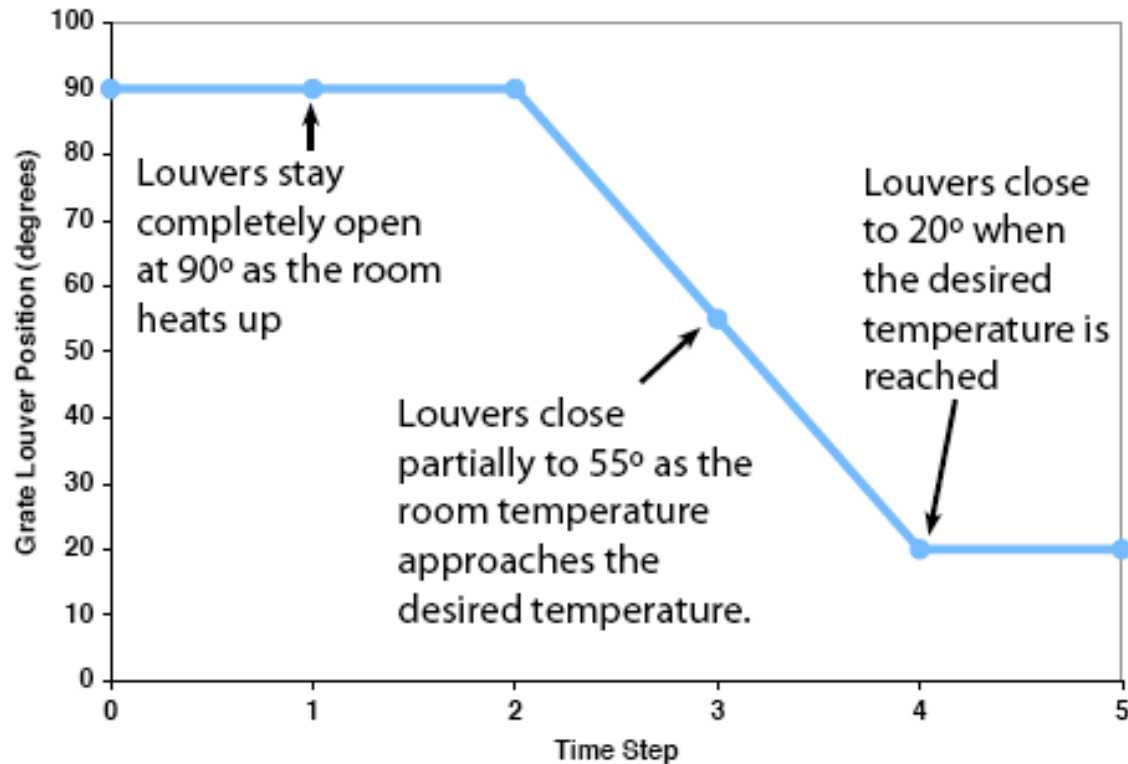
The logo features a stylized orange house icon above the word "thermo". The word "thermo" is in orange, and "Smart" is in blue italics.

thermo*Smart*

Control Algorithm

- If $T_{\text{desired}} - T_{\text{current}} > T_{\text{current}} - T_{\text{past}} \rightarrow \theta = 90^\circ$
- If $T_{\text{desired}} - T_{\text{current}} < 0 \rightarrow \theta = 20^\circ$
- In all other cases $\rightarrow \theta = 55^\circ$

Simulation Modeling



Business Plan Assumptions

- ✓ \$1 Million development cost
- ✓ Sales increase by 5% per year
- ✓











