ME 462-Capstone Design
Fall 2004
ASHRAE Fresh Air Ventilation System

Faculty Advisor: Prof. Jie Chen

Dr. Sivakumar Krishnan

Team Members: Duane Colter, Melody Cruz, Sien Yong & Tzen Yong

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Project Objective

- Develop a “Fresh-Air” Ventilation System
  - Supplies “Fresh-Air” for a single level, single family dwelling, exchanges air in house once every 24-hours.
  - Designed to work in conjunction with the Carrier furnace model 58MVP.
  - Meets the ASHRAE 62.2P Standard

    (American Society of Heating Refrigeration and Air-Conditioning Engineers)

    - Defines the air quality standards for single family homes.

Design Challenges

- Operating Environment
  - Winter – cold air entering the house
    - Increased furnace operating cost
  - Summer – hot humid air entering the house
    - Increased A/C operating cost
    - Condensation leading to corrosion
  - Dust and other Allergens entering the house, counter-acting the intent of the system
- Easy to Operate
- Initial Cost
- Quiet Operation

Design Specification Development : Targets

Total Volume of air to be Exchange	**14400ft ^{3}**
Ventilation rate per hour	**600 $\frac{ft^3}{h}$**
Continuous Local Ventilation	**10 cfm**
Outdoor Air Temperature	**32°F**
Air in the temperature duct before entering the furnace	**65°F**
Power required by the system	**100 $\frac{W}{h}$**
Target Cost	**$1500**

Benchmarks

Fresh Air Ventilation Systems

Fresh Air Year-Round.

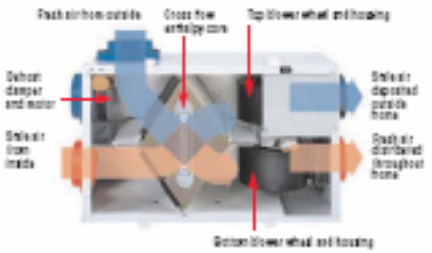
Heat Recovery Ventilator (HRV)

- Provides continuous fresh air
- Helps reduce window condensation and excess moisture
- Uses about the same amount of energy as a 100-watt light bulb
- Offers five speeds for specific demands, including frost control

Energy Recovery Ventilator (ERV)

Includes all the features of an HRV system, plus:

- Transfers both heat and moisture between incoming and outgoing air streams for maximum energy efficiency
- Helps reduce amount of humidity brought into home in summer and retain humidity in winter
- Uses about the same amount of energy as a 100-watt light bulb
- Offers five speeds for specific demands, including frost control



Your contractor or heating and cooling expert can help you determine the best Honeywell fresh air ventilation system for your home.

* According to the Environmental Protection Agency

Honeywell

Automation and Control Solutions
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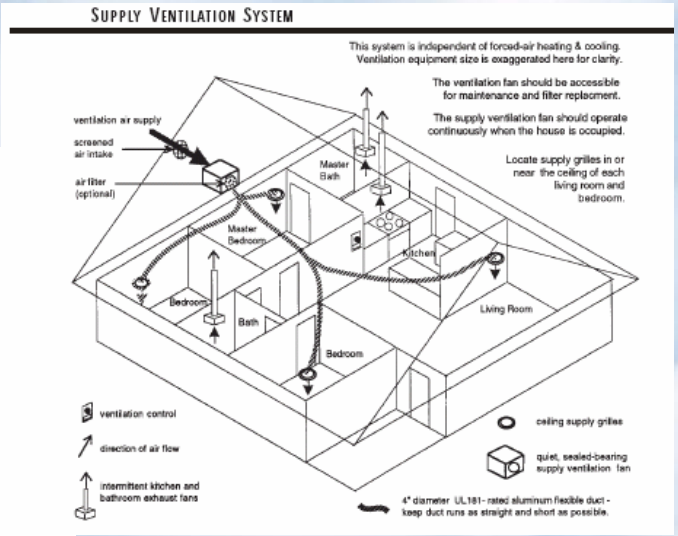
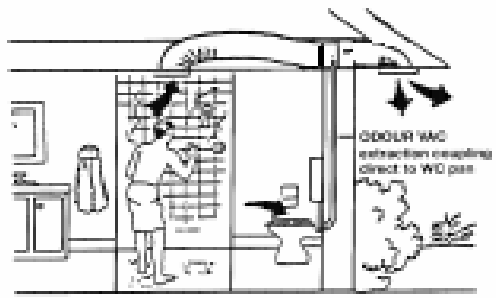
EPA Ventilation System



Odurvac Ventilation System



Concepts Evaluation: Decision Matrices

Absolute Decision Matrix →

	Criteria	Importance	Alternatives: Micro-turbines	Air Convection	Heat Induction
1	Affordable	9	-1	S	S
2	Dilute contaminants	9	S	S	S
3	Easy to adapt to an existing furnace	8	S	S	S
4	Easy to maintain	7	+1	S	S
5	Easy to operate	7	S	S	S
6	Energy cost in the long run	7	+1	S	-1
7	Fulfill critical parameters	8	S	S	S
8	Quiet Operation	5	-1	S	S
9	Remove contaminants	8	S	S	S
10	Remove Humidity from incoming fresh air	9	S	-1	S
11	Remove excess heat/cold from incoming fresh air	9	S	S	S
12	Technology readiness	7	-1	S	+1
		Total +	4	0	5
		Total -	1	2	1
		Overall	-3	3	4
		Weighted Total	-7	-9	0

Legend: -1= weaker than the other 2, S=same as the other 2, and 1=better that the other 2

	Criteria	Datum	Alternatives: Micro-turbines	Air Convection	Heat Induction
1	Affordable	Honeywell Perfect Window	-1	1	1
2	Dilute contaminants		0	0	0
3	Easy to adapt to an existing furnace		1	1	1
4	Easy to maintain		0	-1	0
5	Easy to operate		-1	0	0
6	Energy cost in the long run		1	0	0
7	Fulfill critical parameters		0	0	0
8	Quiet Operation		-1	0	0
9	Remove contaminants		0	0	0
10	Remove Humidity from incoming fresh air		0	-1	0
11	Remove excess heat/cold from incoming fresh air		0	0	0
12	Technology readiness		-1	0	0
		Total +	0	1	2
		Total -	3	2	0
		Overall	-3	-1	2
Legend : -1 = weaker that the datum, 0 = same as datum, & 1 = Better than the datum					

← Relative Decision Matrix

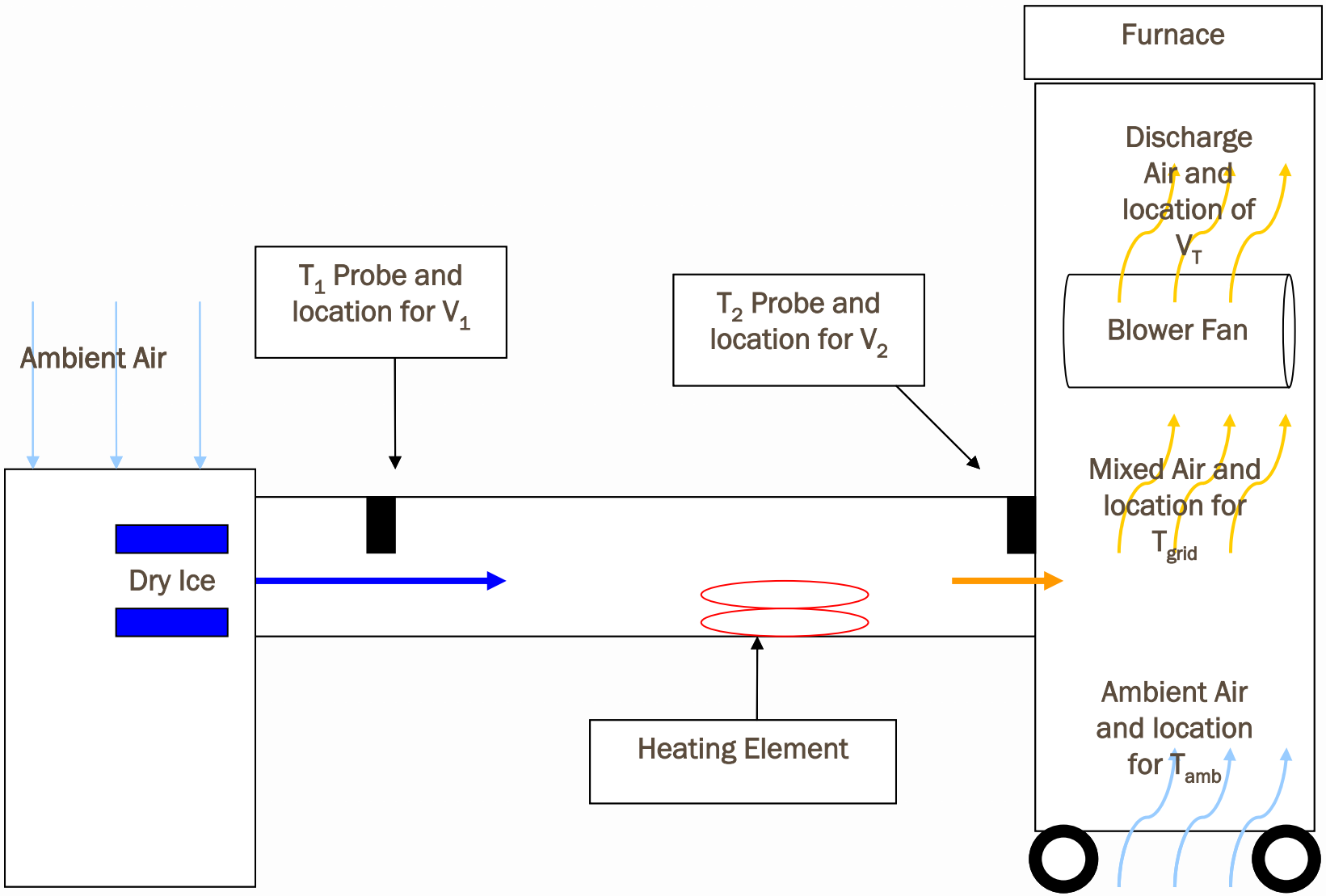
Advantages of Design

- Simple and It Works!
- Brings Fresh-Air into the House versus filtering existing air
- Ease of Operation
- Low Maintenance
- Lower Cost than Competitors

Prototype Features

- Obtained the Desired:
  - *Increase in Temperature*
  - *Ventilation Airflow*
- Utilized Induction-Heating
- Work with the Test Furnace in the Engineering &Technology Lab

Schematic View of Prototype

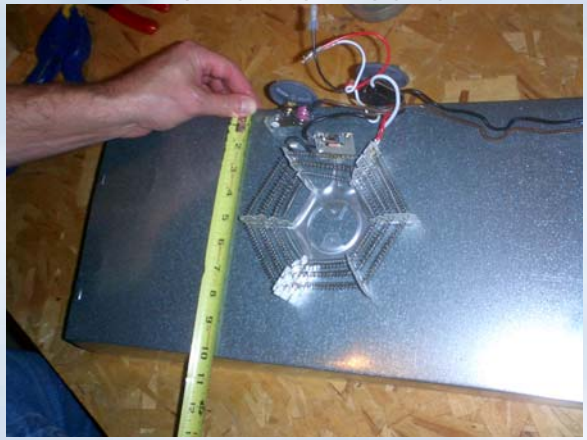


Prototype Overview

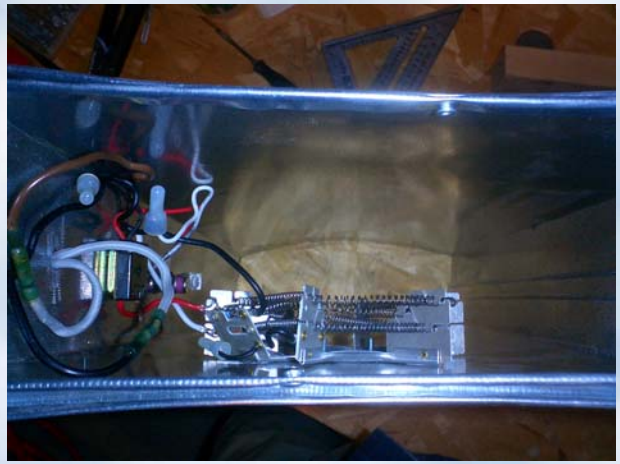
- Air from the room flow over the Dry Ice (to simulate winter conditions)
- Temperature of cooled air is measured after entering duct
- Air flows over Heating Element
- Temperature of heated air is measured just prior to entering

Let's Build a Prototype!

Heating Element from a Portable Heater

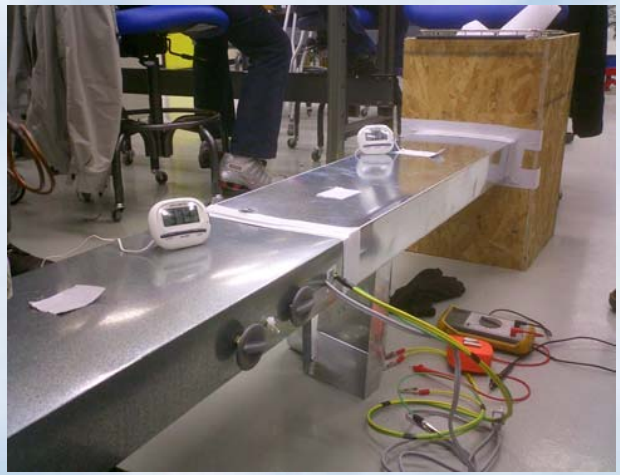


Element in Duct



Heating Element 'ON'

Prototype is Ready for Test



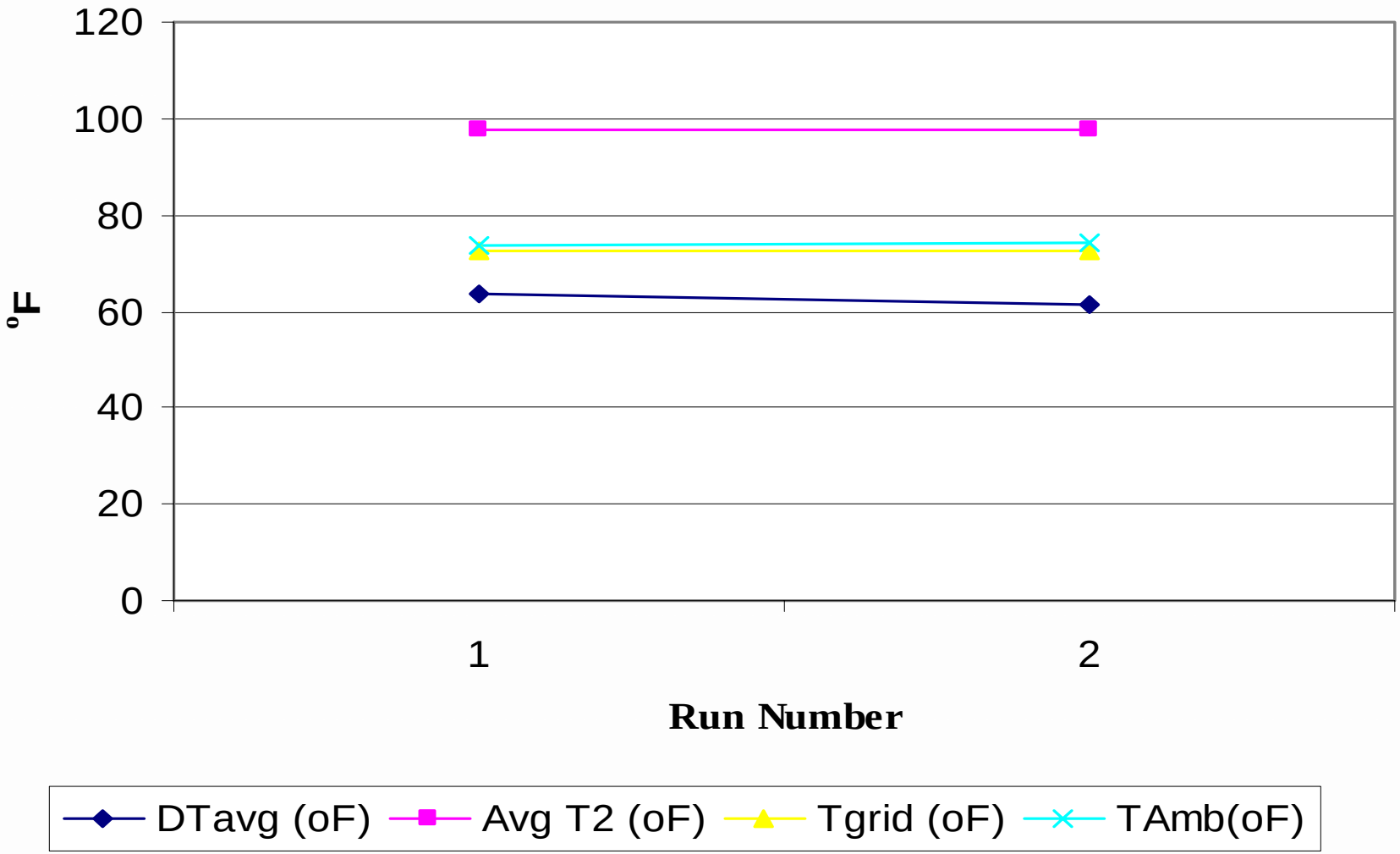
Who Knows, This Thing Might Work?

Video of experiment

Prototype Test Results Summary

- The Heating Element was able to provide a ~DT of the desired 65^{o}F.
- The Volumetric Airflow was 10-12 cfm.
- The Prototype did not have a significant negative impact on the temperature entering the furnace.

Delta T of 65°F Held Across the Prototype



Conclusions

- The requirements for winter operation of this system have been addressed.
  - Based on Prototype testing the airflow, temperature and energy requirements can be met.
  - Estimated cost < $200

Continuing Improvements

- Continue to advance the design in the following areas:
  - Control Algorithm development
  - Investigate the concept of Micro-Turbines as a means to reduce the energy consumption cost.
  - Duct Routing to Optimize Airflow

Lessons Learned

- Time Management is Paramount
- Microsoft Project, a useful tool for project planning
- Each person on a Team brings a unique set of skills
- Allocate time for mishaps

Acknowledgements

Professor Jie Chen

Dr. Sivakumar Krishnan