

ME 462-Capstone Design

Fall 2004

ASHRAE Fresh Air Ventilation System

Faculty Advisor:

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Team Members:

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Presented:

December 15, 2004



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 |

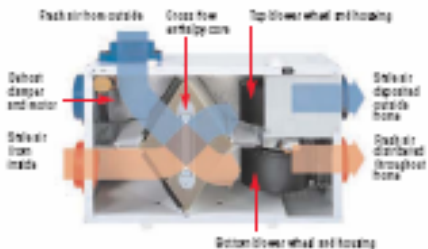
Benchmarks

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

In the US: Honeywell, 1005 Douglas Drive North, Golden Valley, MN 55422-3992
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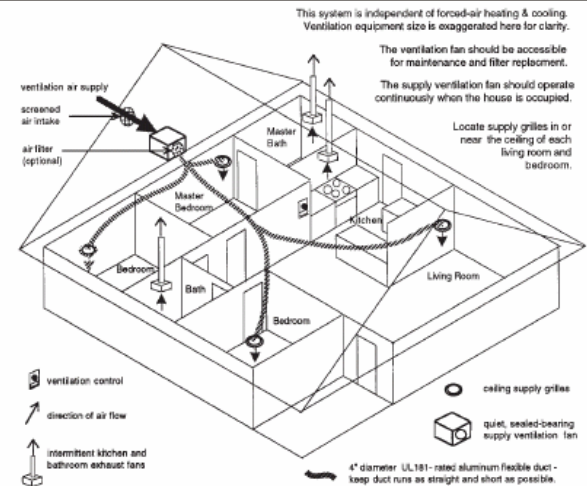
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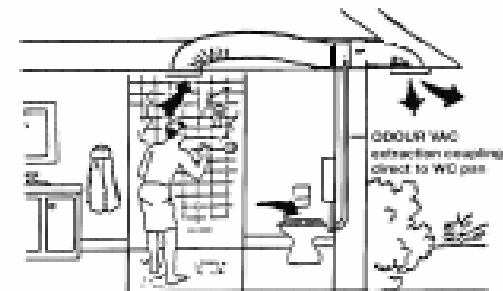
www.honeywell.com/yourhome

EPA Ventilation System

SUPPLY VENTILATION SYSTEM



Odurvac Ventilation System



Laundry/shower/toilet etc. through one fan

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 |

| Criteria | Datum | Alternatives | | |
|--|--------------------------|----------------|----------------|----------------|
| | | Micro-turbines | Air Convection | Heat Induction |
| 1 Affordable | Honeywell Perfect Window | -1 | 1 | Legend: -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 than the other 2, S=same as the other 2, and 1=better than the other 2

Relative Decision Matrix

Legend : -1 = weaker than the datum, 0 = same as datum, & 1 = Better than the datum

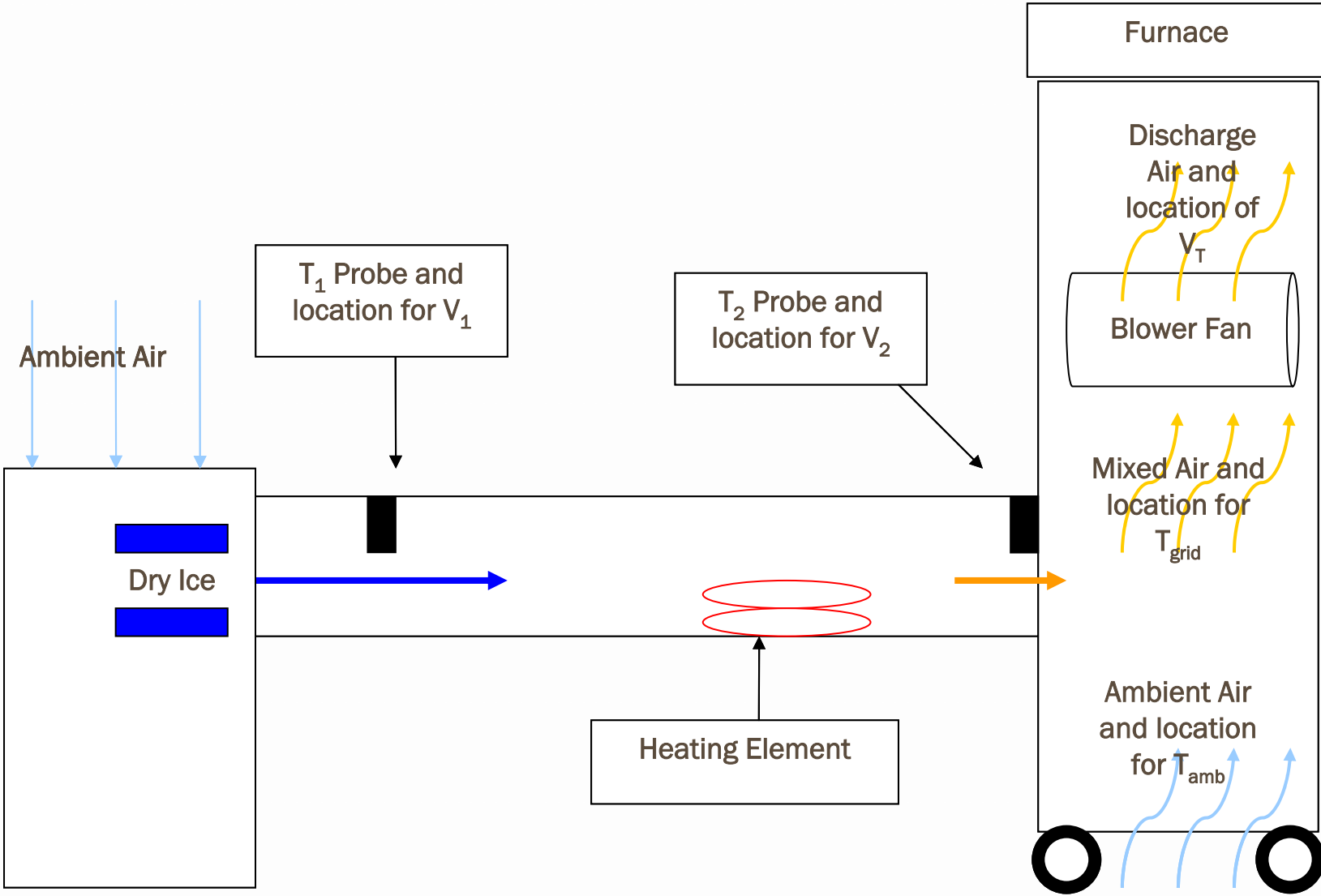
Advantages of Design

- 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

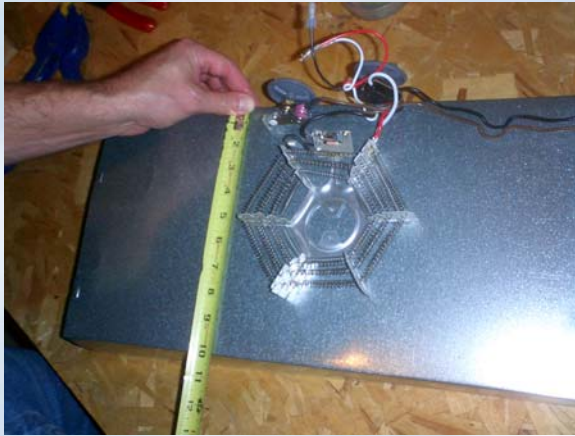


Prototype Overview

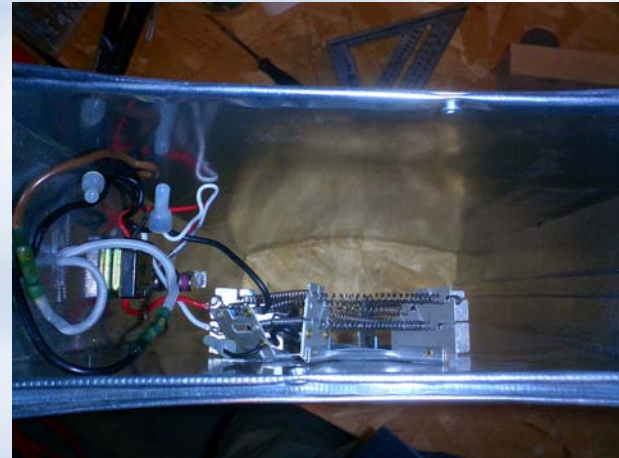
- Air from the room flow over the Dry Ice (to simulate winter conditions)
- Temperature of cooled air is measured after entering duct
- Air flows over Heating Element
- Temperature of heated air is measured just prior to entering furnace plenum

Let's Build a Prototype!

*Heating Element from a
Portable Heater*



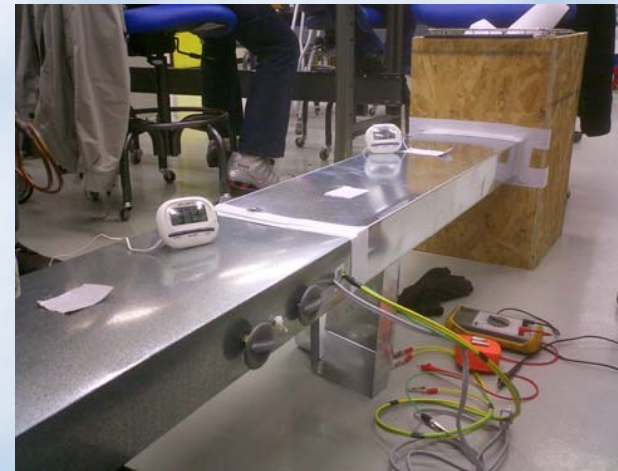
Element in Duct



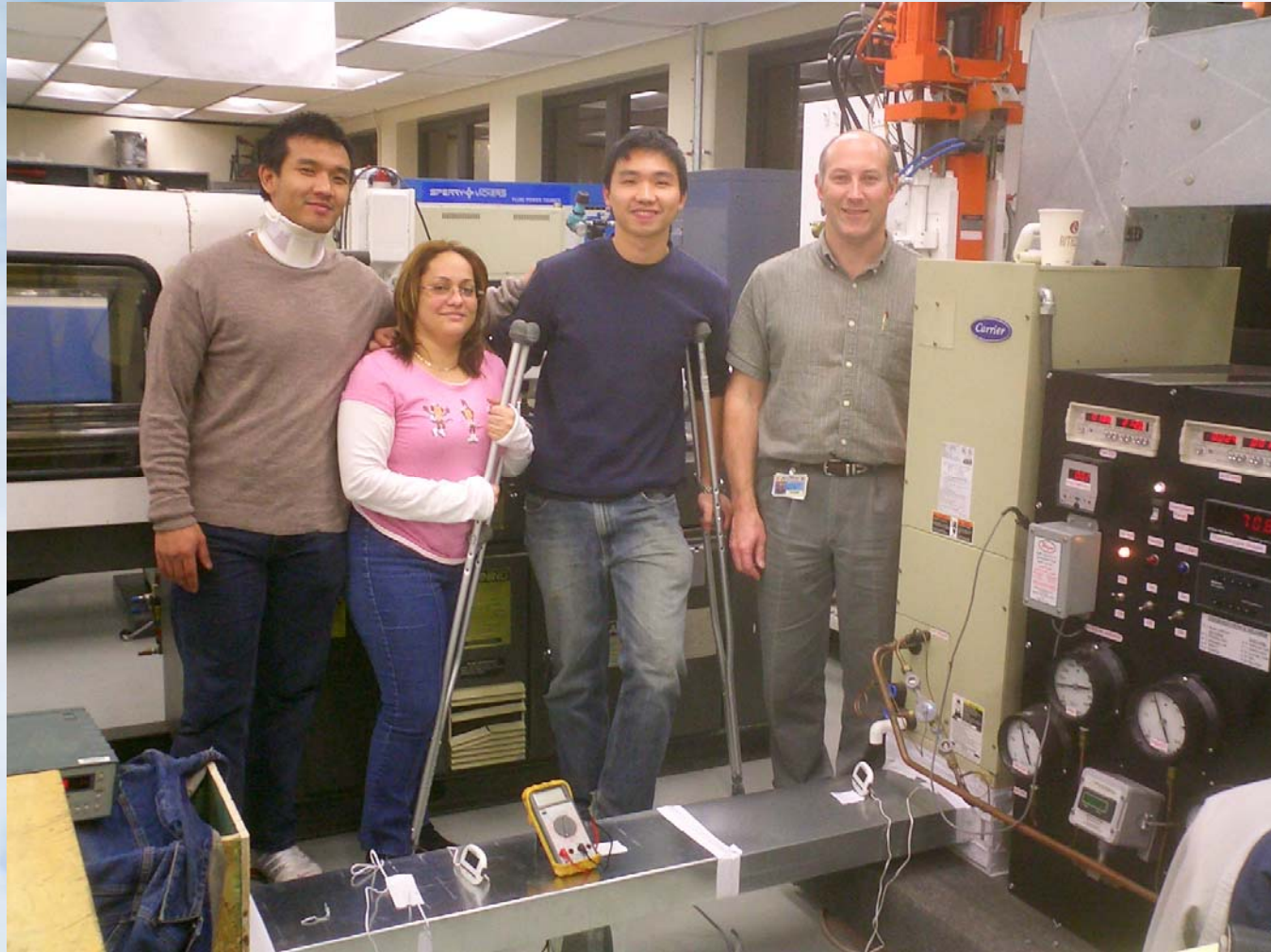
Heating Element 'ON'



Prototype is Ready for Test



Who Knows, This Thing Might Work?



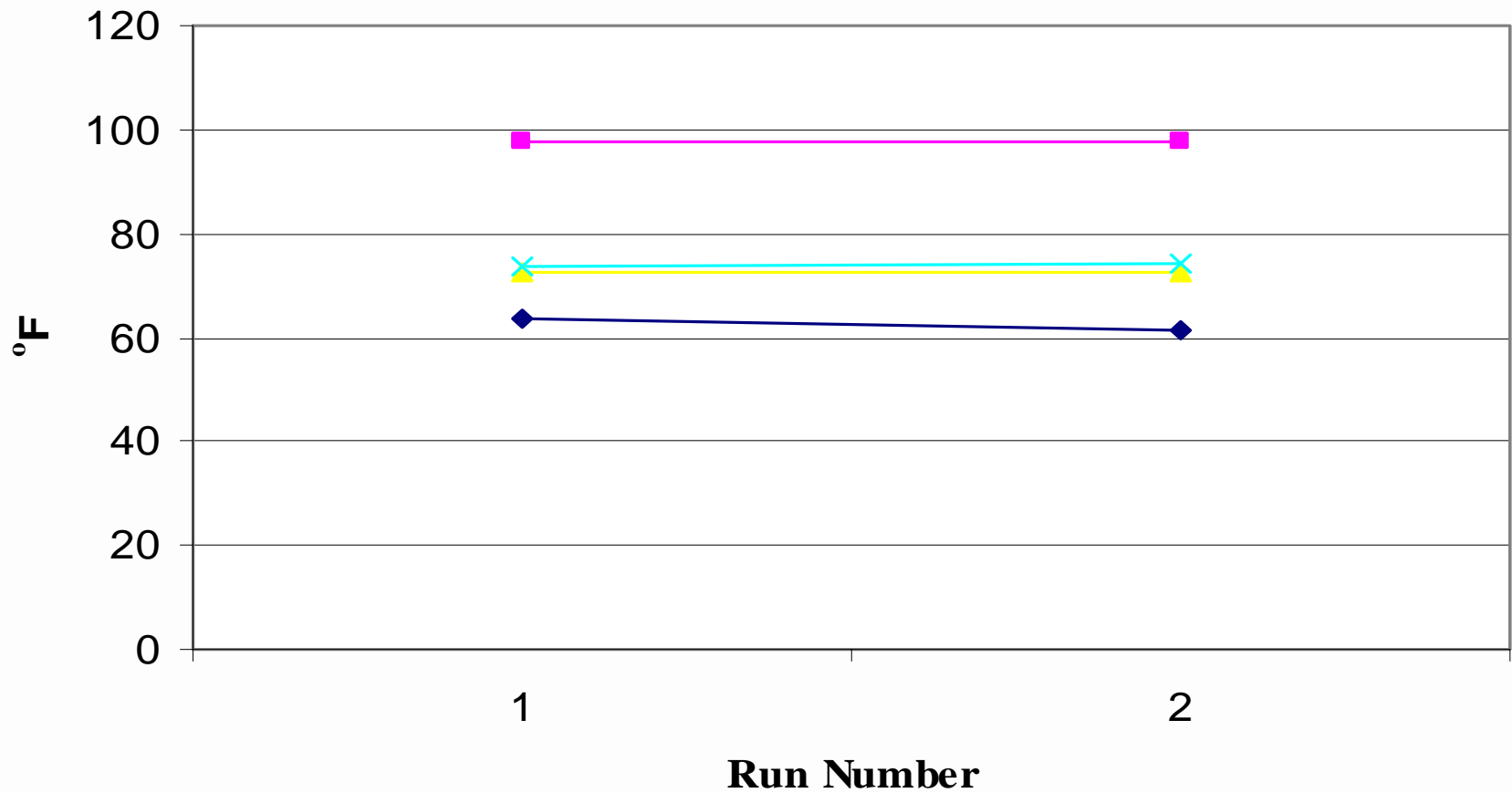
Video of experiment



Prototype Test Results Summary

- The Heating Element was able to provide a \sim DT of the desired 65°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



—◆— DTavg (oF) —■— Avg T2 (oF) —▲— Tgrid (oF) —x— TAmb(oF)

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