Importance of Behavior in HVAC and its Impacts on Energy Efficiency

Claudia Barriga
Kristin Heinemeier
End user

“Middle Men”

Energy Savings

Information Competence Trust

User Interface Comfort Conditions

Psychology Sociology Physiology

Technology
The Power of the Middleman

- Understanding the relationship between building owners and their service technicians and contractors will shed light on that magic moment when an HVAC system is not performing well and it should be replaced with something, hopefully something efficient.
There's More Than One Middle Man
Residential End Users and Their Thermostats
The technicians and their tools
The End User Meets the Technician
Technician brings in influences from diverse institutions
Who are under other influences themselves...
Each actor or group of actors brings in different sets of knowledge, motivations and beliefs about each other.
Researchers need to understand these
Researchers also need to understand how these affect each other
It gets better!
Research Questions

- What is driving each of the actors? Motivation
- What does each actor believe about each other? Do these perceptions meet or clash?
- What does each actor say to each other? Flow of information
- What kind of relationship do they establish? What does each give/get?
- What is the system of rewards? What gets encouraged/discouraged?
- What are the goals of the different actors? convergent or divergent?
We just want to tell you, "you have to have this system and you have to pay all this money" and you say "that's not what I'm looking for, you're just trying to sell me on the most expensive thing." It's not what we are trying to push on you. "Are you being honest with me? What is the problem and that I really need to replace that part? Or are you trying to replace that part because it's going to make you money?" We don't have a way to show efficiency. We just don't. I wish we did. That would be the biggest no brainers in the history of mankind, it would make it simple. "There's a lot of people who are looking to be green and to feel like they are saving the world and what not...some people want to be net zero, I want to be green...it's like, I can do that..."
Research Roadmap—Recent and Upcoming

- **Residential End Users:** Understanding Maintenance (residential survey), In-home Energy Display Experiment, Market Intelligence Collaborative, Smart Home Energy Intervention Experiment
- **Commercial End Users:** Understanding Maintenance (commercial focus groups), Advanced Thermostats Usability
- **Facilities Technicians and Managers:** AirCare Plus M&V Observation, FDD Operator Behavior
- **Contractors:** Technician Observation, Understanding Maintenance (contractor interviews), Compliance Survey, What’s in YOUR Attic program, HVAC Technician Instrument Lab
- **Technicians:** Technician Observation, Understanding Middlemen, Compliance Improvement Advisory Group, WHPA Compliance Committee, Content Analysis of Trade Press and Discussion Forums
- **Sales Engineers:** Western Cooling Challenge Observations and Interviews
- **Utilities/CPUC:** Behavior Research Roadmap
- **Manufacturers:** Western HVAC Performance Alliance
- **Distributors:** Understanding Middlemen, Western HVAC Performance Alliance
- **Trainers and Certifiers:** Western HVAC Performance Alliance
- **Researchers:** Western Cooling Challenge
Thank you to our sponsors....
# Understanding Maintenance—Characteristics of Residential Survey Sample

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regularly maintains Air Conditioner</td>
<td>143</td>
<td>53%</td>
</tr>
<tr>
<td>Has had (ever) the AC professionally serviced</td>
<td>193</td>
<td>71.5%</td>
</tr>
<tr>
<td>Has had professional service within the last year</td>
<td>97</td>
<td>35.9%</td>
</tr>
<tr>
<td>Has been offered an HVAC maintenance agreement</td>
<td>140</td>
<td>51.9%</td>
</tr>
<tr>
<td>Currently has an HVAC maintenance agreement</td>
<td>33</td>
<td>12.2%</td>
</tr>
</tbody>
</table>

270 RRS of SCE Territory Residents
Understanding Maintenance—Residential Survey: Attributes of AC
Understanding Maintenance—Residential Survey: Attributes of AC

- Car
- Air Conditioner
Understanding Maintenance—Residential Survey: Attributes of AC

![Bar chart showing the attributes of air conditioners and refrigerators.](chart.png)

- (Bad) Good
- (Unpleasant) Pleasant
- (Harmful) Beneficial
- (Worthless) Valuable
- (Dangerous) Safe
- (Unimportant) Important
- (Unnecessary) Necessary
- (Inexpensive) Expensive
- (Unhealthy) Healthy
- (Dirty) Clean
- (Ugly) Beautiful
- (Low Tech) High Tech
- (Wastes Money) Saves Money
- (Low Maint) High Maintenance
- (Boring) Exciting
- (Simple) Complicated

Legend:
- Air Conditioner
- Refrigerator
## Understanding Maintenance—Small Business Owners Focus Group

<table>
<thead>
<tr>
<th><strong>Key Finding 1:</strong> Small business owners are not convinced that regular HVAC maintenance saves money.</th>
<th>Recommendations: Show customers approximate (or best yet, actual) energy savings on bill that result from active participation in maintenance programs. Develop tools or techniques to field test AC unit efficiency before and after measures are implemented.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key Finding 2:</strong> Small business owners do not understand how to properly maintain HVAC equipment.</td>
<td>Recommendation: Create a guide for small businesses owners to use as a screening tool to find good contractors and as a double check for existing contractors.</td>
</tr>
<tr>
<td><strong>Key Finding 3:</strong> Small business owners do not like complicated rebate programs.</td>
<td>Recommendation: Streamline rebate process or encourage contractors to take on the role of rebate collectors to minimize inconvenience to small business owners. Another idea is to provide the rebate as a credit on the utility bill.</td>
</tr>
</tbody>
</table>
In Home Energy Displays—Simulated Displays in Mall Experiment

![Energy Display Screenshots]

**Take Action**

- Replace your air conditioner! Your air conditioner is 17 years old, and uses 30% more energy than a new Energy Star model. According to our measurements, important components of your air conditioner are worn or nearing breakdown, and it may only last two more years.

- Call a professional to maintain your air conditioner! According to our measurements, your air conditioner is wasting 30% of its energy use because of airflow restrictions produced by lack of regular maintenance.

- Change your thermostat setpoint! According to our measurements, your thermostat is currently set to 68 degrees. 21-35% more energy is currently used than if you changed it to 75 degrees.
Technician Observation—Results

The graph shows the number of tasks completed correctly against service duration for different groups:
- **Not Certified, Part, Chain, or Owner**
- **Certified**
- **Prog. Part.**
- **Nat’l Chain**
- **Owner**

The x-axis represents service duration in minutes, and the y-axis represents the number of tasks completed correctly.
What would happen to him if he got caught?

WHPA Compliance Committee Survey of 268 Contractors

Would your competitor get caught for not taking out a permit?

- Yes
- Probably
- Don't Know
- No
- Probably Not

Out of Business
Lose License
Major Fine
Minor Fine
Have to Get a Permit
Get a Warning
Go to Jail
Lawsuit

What would happen to him if he got caught?
Why would he take this risk?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lose Bid Otherwise</td>
<td>36%</td>
</tr>
<tr>
<td>Lower Profits</td>
<td>15%</td>
</tr>
<tr>
<td>Customer Doesn't Want</td>
<td>10%</td>
</tr>
<tr>
<td>Code Counter Inconvenient</td>
<td>8%</td>
</tr>
<tr>
<td>Measures too Hard</td>
<td>7%</td>
</tr>
<tr>
<td>Forms too Hard</td>
<td>4%</td>
</tr>
<tr>
<td>Risk? What Risk?</td>
<td>5%</td>
</tr>
</tbody>
</table>

N = 268
Measurements are used to charge air conditioners with the optimum amount of refrigerant.
  - Too much refrigerant wastes energy.
  - Too little refrigerant wastes energy.

Technicians’ Instruments may not be accurate enough to do the job.
  - How accurate are technicians’ instruments?
  - How easy are they to use?
  - Are technician measurement processes appropriate?

Establish a laboratory apparatus to test tools and technician processes.
Understanding the Role of “Middlemen”

• Identify the role “middlemen” *currently* play in early retirement, the adoption of emerging technologies and Quality Installation/Quality Maintenance.
• Identify the role that they *could* play.

  • Interviews with Homeowners and Commercial Building Decision-Makers
  • Interviews with Contractors and Technicians
  • Survey of Distributors
  • Content Analysis of Trade Publications
Thank you! Questions, Comments