Designing for Behavior Change
The uci@home Project

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CALIT2 PLUG-LOAD ENERGY EFFICIENCY WORKSHOP
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Energy Frontiers

- FROM TEV TO KWH
- NEITHER AN ENERGY EXPERT NOR A SOCIAL SCIENTIST
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- How to design a residential energy feedback system that is effective & affordable?
- Collaboration between physical & social scientists at UC Irvine:
  - Prof. David Kirkby
  - Joe Middleswart
  - Andrea Hernandez
  - Robert Lord
  - Prof. Daniel Stokols
  - Nora Davis
  - Kristen Gamble
  - Beth Karlin
  - Angela Sanguinetti
- Supported by a campus grant from the UC Irvine Environment Institute
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- Now analyzing survey (N>800) of environmental attitudes and residential energy behavior
- June-July pilot study in 5-10 homes
People Consume Energy

- Changing our behavior is potentially easier than solving “grand challenge” technical problems (batteries, nuclear, solar, ...)

- Basic obstacle is that electricity is an invisible, intangible resource
Decisions, Decisions...

Designing for behavior change involves:

- Triggering a re-evaluation of old habits
- Providing new information to influence choices and offer sense of control
“...consider groceries in a hypothetical store totally without price markings, billed via a monthly statement... how could grocery shoppers economize under such a billing regime?”

KEMPTON & LAYNE 1994

We consume our energy in an information vacuum
Feedback: Key Findings

- Feedback is most effective when it is:
  - Specific
  - Frequent
  - Compelling
  - Motivational

- Typical energy savings realized are 5-15%

- See Darby 2006, Fischer 2008
HOWEVER, FEEDBACK IS “ONLY DATA”, WITH NO GUARANTEES OF DESIRABLE BEHAVIOR CHANGE
Two Paradigms

**MONITORING SIGNALS**

**DIRECTLY CONTROL ENERGY USAGE**

**COMPLEXITY/COST VS. EFFECTIVENESS**

**CONSUMERS ARE ESSENTIAL PIECE OF FEEDBACK LOOP**

**DEVELOPS ENERGY LITERACY, BROADER IMPACTS**
Automated feedback does not guarantee energy savings.

Homes relying on programmable thermostats can consume more energy than those where the occupants set the thermostats manually (Sachs 2004).
Specific Feedback

☐ TIE FEEDBACK TO SPECIFIC ACTIONS, APPLIANCES, OR LOCATIONS
Specific Feedback
Frequent Feedback

- Frequent sampling allows consumers to correlate their consumption with their daily activities, providing vital context for decision making.

- Low latency empowers consumers to immediately see the effects of changing their behavior.
A nation that plays together, flushes together too

Water consumption in Edmonton during the Olympic gold medal hockey game between Canada and the U.S. is illustrated below. As the graph shows, there were severe spikes between periods, and just after the medal ceremony.

Water consumption in Edmonton during Olympic gold medal hockey game, in millilitres

End of first period
End of second period
End of third period
Face off
Hotel water demand, Feb. 27
During gold medal hockey game, Feb. 28
Medal ceremony
Canada wins

CARRIE COCKBURN/THE GLOBE AND MAIL SOURCES: VANOC, EPCOR
Frequent Feedback

Hub aggregates household data and presents via web

Wireless updates sent every 2 secs

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Compelling Feedback

- Kilo-What? Energy units are not intuitive.
- Cost is compelling but rate schedules obscure direct relationship.
- Secondary parameters (e.g., temperature & lighting) have interesting potential to provide multidimensional context relevant to comfort and productivity.
- The importance of fun...
Compelling Feedback

Quantity & Quality of Lighting

Ambient Temperature

Pass-Through Power Consumption

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Compelling Feedback

- COMBINE WEB-BASED DETAILED DATA WITH IMMEDIATE PASSIVE FEEDBACK (PULL VS. PUSH)

- Ambient lighting is...
  - Natural / Artificial

- Ambient temperature is...
  - Above / Below comfort zone

- Power consumed during past 10 mins / 24 hrs exceeds preset threshold

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Chirp! Chirp!

Cricket Image: Kenneth John Brown / flickr.com
Motivational Feedback

- EFFECTIVE FEEDBACK SHOULD ADAPT TO INDIVIDUAL MOTIVATIONS OF EACH CONSUMER IN A HOUSEHOLD.
Motivational Feedback

- Offer (but not require) goal setting & tracking
- Provide customized high-level prompts
- Design for least motivated consumers (Froelich 2009)
- Group comparisons raise potential privacy issues
Summary

- Changing consumer behavior requires that you understand your consumers.

- Feedback on energy consumption (and related parameters) is one effective strategy:
  - Specific, frequent, compelling, motivational

- The engineering is “easy”. The challenge is to effectively integrate the social science into the design process.