Session IV: Occupant Behavior

Moderator: Bobi Garrett
Panelists:
Nancy Carlisle
Nicki Johnson
David Mooney
Design Decisions and Occupant Behavior

Nancy Carlisle, AIA
Director, Integrated Applications Center

July 28 2011
Behavior is a component of an integrated solution.

- As owner, we knew the importance of behavior going in
- Our Buildings R&D and Deployment expertise informed our knowledge
- Behavior change is part of the portfolio of savings opportunities
Pre-planning for the RSF Requirements

- General Development Vision suggested 3-4 story office modules at 50 feet by 300 ft to meet 100% of the daylighting requirement
- Design charrette held and recommendations made to achieve energy requirement
- Buildings research staff modeled the load and set the energy reduction target
- Construction staff and Executive Management toured examples of offices without ceilings and workstations with low walls during the design phase
The Owners Responsibilities

- Set an informed vision
  - Involves pre-work resulting in the RFP

- Willingness to change NREL\DOE Policies
  - Operable windows were not compatible with security

- Owner needs to involve multiple department and change procedures
  - IT staff in switched standard to lap top computers. (This required us to begin to purchase lap tops 3 years prior to move in )
  - IT staff supplied multi-function copiers\printers on each wing
  - Procurement staff purchased energy star fridges
  - Communications dept. ran the educational programs

- Socialized the building concept in order to shift the culture
  - Forbid individual printers, refrigerators, heaters, and many other appliances in work stations
  - Balance the need for equipment versus energy (software collaboration rooms)
Quantifying the Impact of Human Behavior in the RSF

- Human behavior can have a measurable impact on energy use
- Chart below shows importance of reducing nighttime use (i.e. use Motion Sensor Power Strips or Plugs enabled by Light Switch)
- Modeling assumptions were consistent with our expectations

### Annual Plug Load Energy Use Intensity (kBtu/ft²)

<table>
<thead>
<tr>
<th>Night Plug Power Density (W/ft²)</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
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<tr>
<td>0.1</td>
<td>2.39</td>
<td>4.52</td>
<td>6.66</td>
<td>8.79</td>
<td>10.93</td>
<td>13.07</td>
<td>15.20</td>
<td>17.34</td>
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<tr>
<td>0.2</td>
<td>2.64</td>
<td>4.77</td>
<td>6.91</td>
<td>9.04</td>
<td>11.18</td>
<td>13.32</td>
<td>15.45</td>
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<td>0.3</td>
<td>2.89</td>
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<td>13.57</td>
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<td>17.84</td>
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<td>7.41</td>
<td>9.54</td>
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<td>13.82</td>
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Design-Builder Response to RFP

- Selected D-B understood the tradeoffs in budget needed to meet the energy goal
- Budget tradeoffs included very limited interior drywall, no finished ceilings, narrow open office plan, less space for storage
Key Design Decisions That Impact Behavior

- Size of offices and workstations (primarily 3 size options only, finishes not size to distinguish grade level)
- No enclosed offices on south façade
- “Enclosed” offices on north façade – No ceilings, glass walls and doors, walls 66” high
- Workstation panel only 42” high
- Huddle rooms, phone closets, quiet rooms and balconies for private communications
- A variety of meeting and conference rooms for collaboration
- Outside space and lunch room for collaboration and privacy
- Central printing\copying
- Daylighting\lighting systems and controls, operable windows (with operation tied to PCs)
Standard Office Configurations

Student

Standard Office

Standard Work Station

Senior Manager Office
## Design Solution – Workstation Equipment Choices Integrates Culture and Human Behavior

Removing Desktop Printers Saves ~460 Watts/Printer

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Power (Watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop Computer (Energy Star)</td>
<td>300</td>
</tr>
<tr>
<td>Typical 19”-24” Monitors</td>
<td>30-50</td>
</tr>
<tr>
<td>Laptop</td>
<td>30</td>
</tr>
<tr>
<td>24” LCD Energy Efficient Monitors</td>
<td>18</td>
</tr>
<tr>
<td>VOIP phones</td>
<td>2</td>
</tr>
<tr>
<td>Multi-function Devices</td>
<td>100</td>
</tr>
</tbody>
</table>

Reduces “vampire” energy use

Removing personal space heater saves 1500 Watts

Sensor-controlled LED task lights - 3 Watts

Fluorescent task lights - 35 Watts

iGo Power Smart Towers

Reduced “vampire” energy use

Removing Desktop Printers Saves ~460 Watts/Printer

Multi-function Devices 100 Watts (continuous)
Summary of Key Planning Steps

- Owners responsibility – pre-planning and setting the vision
- Design-builder – Understand and plan to achieve owners objective and priorities
- Design-Build – understand and get the details right
  - Controls, parasitics, plug loads
  - Small thermal breaks around windows, overhang connection, insulation detail around parapet
- Owner—Align policies and practices to work with D-B to achieve objectives
  - Recognize the energy considerations of the large (and small) decisions
    - Plug loads, laptops, printers, etc.
- Owner -- Enable the design team to recommend high efficiency operations and owner installed equipment
- **It all comes down to trust and teaming to get the job done!**
Preparing Staff to Work in the RSF

Research Support Facility Workshop

Nicki Johnson,
Corporate Communications

July 28, 2011
Communicating with Staff

How we got the word out

- Developed key messages
- Began “socializing” building early
- Used variety of communication tools
- Found internal champions
- Involved employees
- Listened and responded to concerns
Key Messages

The RSF is one of the most energy-efficient buildings in the world.

- Showcase for energy efficiency and renewable energy technologies

The RSF is a living laboratory.

- Employees play a major role in the successful operation of the building

The RSF will help change the way commercial buildings are designed and built.
Communication Methods

Employee newsletter
Working in the RSF web page
Brown Bag lunch series
Workstation prototype
Tours and open house
YouTube videos
E-training
Blog
Polls
Frequency of communications

Communication campaign:
Began in 2008 and is ongoing

Living laboratory:
Employee feedback and building performance data means ongoing education
- Power management
- Lighting
Employee concerns - before

Privacy
Noise
Adequate storage space
Time to move
Fear of change

…and more
“Can you please dispel the rumor that we aren’t going to be able to have 2 monitors? Most of the analysts in my group use two monitors and consider them essential to their tasks.”

“Can you provide more info on what technology/method will be used to filter the tap water in the RSF? We are hoping that we will no longer need a bottled “water club” for our office when we move.”

“Smoking is an issue now with sealed windows. How is it being addressed for the RSF with open windows?”

“Can you let us know which windows will be operable and maybe we who have asthma and allergies can sit further from those open windows. Will we be hanging fly strips and given butterfly nets to catch the bugs & birds?”
Prototyping the RSF workstations

Golden Hill, Bldgs 52 & 7

- Tested workspace configurations
- Tested new technology

Tours invaluable

We learned what worked

We learned the pain points
Employee concerns – post move

Noise
Lights
Temperature
Paper towels

... and more

“I heard there were mice in the RSF. Is this true? What types of things were done to exterminate or relocate them?”
Employee feedback

One year later

- Huddle Room availability
- Temperature
- Noise

The good news

- Open workstations mean improved collaboration

The bad news

- Open workstations mean more noise
We continue to celebrate our building’s success with staff…
and they continue to learn how they impact that success.
Even with high-performance, innovative building features, we have found that 30% of building performance is related to occupant behavior.
### Energy Modeling

#### NREL RSF Energy Use Breakdown

<table>
<thead>
<tr>
<th>End Use</th>
<th>kBtu/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Heating</td>
<td>8.58</td>
</tr>
<tr>
<td>Space Cooling</td>
<td>0.85</td>
</tr>
<tr>
<td>Pumps</td>
<td>0.48</td>
</tr>
<tr>
<td>Ventilation Fans</td>
<td>1.88</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>0.90</td>
</tr>
<tr>
<td>Exterior Lights</td>
<td>0.12</td>
</tr>
<tr>
<td>Lights</td>
<td>2.07</td>
</tr>
<tr>
<td>Office Plug Loads</td>
<td>7.87</td>
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<tr>
<td>Task Lights</td>
<td>0.10</td>
</tr>
<tr>
<td>Data Center</td>
<td>12.11</td>
</tr>
<tr>
<td>Data Center Cooling</td>
<td>0.02</td>
</tr>
<tr>
<td>Data Center Fans</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Credit: Stantec
Credit: Chad Lobato/NREL
Occupant Interactions and Controls

• Occupant control of the lighting system
  o Manual on, auto off

• Operable windows
  o Manual open – occupant notification
  o Auto open overnight
RSF Plug Load Reduction Strategies

Elevators
- Use energy efficient traction elevators
- Change elevator lighting to energy efficient fluorescent lighting
- Turn off elevator lighting when the elevator is unoccupied

Break Rooms
- Increase the number of people that use each break room from approximately 40 to 60
- Eliminate the cooler on the drinking fountain

Task Lights
- Move from 35W fluorescent task lights to 6W LED task lights

Phones
- Go from 1000 standard phones to 1000 VOIP phone that consumes 2W each

Copiers, Printers, Fax Machines
- Decrease the number of people that use individual copiers, printers and fax machines
- Increase the number of people that use common, or group, copiers, printers and fax machines from 15 to 20
- Increase the use of all-in-one machines

Computers
- Go from approximately 260 laptops, 33% of staff, to 720, 90% of staff, ensure standby mode works for all workstations

Data Center
- Blade Servers with Virtualization
- High efficiency UPS
- 65W/employee current to 48W/employee in RSF

The result of these strategies is a 47% reduction in plug loads
October 2010 – June 2011 Plug Load Power Density

Credit: Marjorie Schott/NREL

Note: The elevators are included in the plug loads.
Operations Lessons – Plug loads

• Daytime loads lower than predicted
  o Model did not account for actual occupancy

• Nighttime loads still difficult
  o Programmable outlets added after the fact
  o Automatic Laptop standby/hibernate functionality deployed system-wide
  o Staff have not fully utilized desktop based power strip controls

• Need to develop an optimal workstation plug load control system
  o Programmable power strips to disconnect all plugs at night?
  o Easy to use office plug load disconnect switch?
October 2010 – June 2011 Lighting Power Density

Credit: Chad Lobato/NREL
Operational Lessons- Lighting Controls

- Vacancy sensors in enclosed offices successful
- Night sweeps turn off all lights (almost)
  - 2-3 kW of lights (1%) on at night (~700 W are control parasitic)
- Have had to provide a few control modifications to unique workstations
  - 2 task lights
  - Remove daylighting controls in one space because daylighting blocked by datacenter and break room