Living in a High Performance Green Building:

Lessons Learned about the Building/Occupant Interface

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The most intensively studied Federal building in the US

- Energy
- Water
- Underfloor air distribution
- Acoustics
- Air quality
- Workplace functionality
- Vegetative roof
- Daylight
- Occupant experience

Two national labs, four universities, four private sector firms, two federal agencies

Building Performance

Design Goals

Energy:
ENERGY STAR 75
52 kBtu/gsf/yr

Water:
1,719,738 gal/yr

Certification:
LEED Silver

Occupant Experience:
"Enhance health and productivity" – general goal, not specific

Measured Performance

Actual Energy:
ENERGY STAR 94
76 kBtu/gsf/yr

Water:
3,970,000 gal/yr

Certification:
LEED Gold

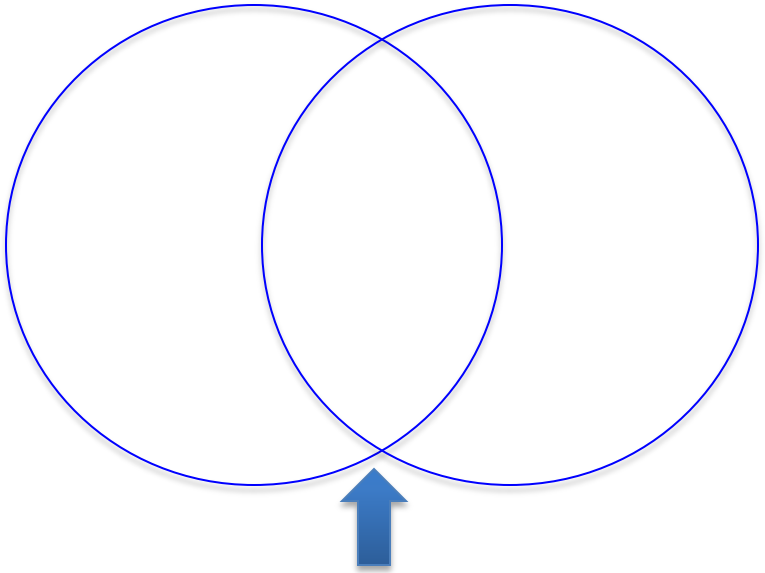
Occupant Experience:
62% said bldg had positive impact on personal productivity

Building Performance:
A Socio-Technical Perspective

Social System –

The system of people

- Behavior
- Culture
- Mission



Physical system–

The system of things

- Technologies
- Operations
- Design

Influence of social system on building performance

Influence of physical system on human health, comfort and performance

Part 1.
The Impact of the Human System on Building Performance

Why is energy use so much higher than projected?

- Stack effect in building
- Plug and process loads – not included in modeling
- Lighting controls not working effectively
- Legacy data center

Plug and Process Loads

- ENERGY STAR rating dropped 2 points when conference room equipment installed
- Legacy data center
- Desk top plug loads – computers **plus** radios, battery chargers, speakers, fans, printers, personal lamps, heavy duty calculators, clocks
- Extensive security equipment (not studied)

Behavior change experiment (with NREL)

- Information campaign urging people to shut down device when away from desk
- Competition among workstation pods
- Automatic shutdown using occupancy sensors to identify occupant presence

120 Subjects

Each condition tested for one month

Baseline at start, return to baseline at end

Results of Experiment

Experimental method	Total annual energy savings (extrapolated for 775 people) (kWh/yr)	Percentage energy reduction from baseline	Percentage of whole-building electricity reduction (extrapolated for 775 people)	Total annual cost savings ($/yr)	Total CO_2e savings (tons)
Control system	34,757	21%	0.9%	$3,476	30
Competition	9,912	6%	0.3%	$991	9
Letters	-407	0%	0.0%	-$41	0

Issue: participants could opt out of having computers turned off – most took advantage.

Water use

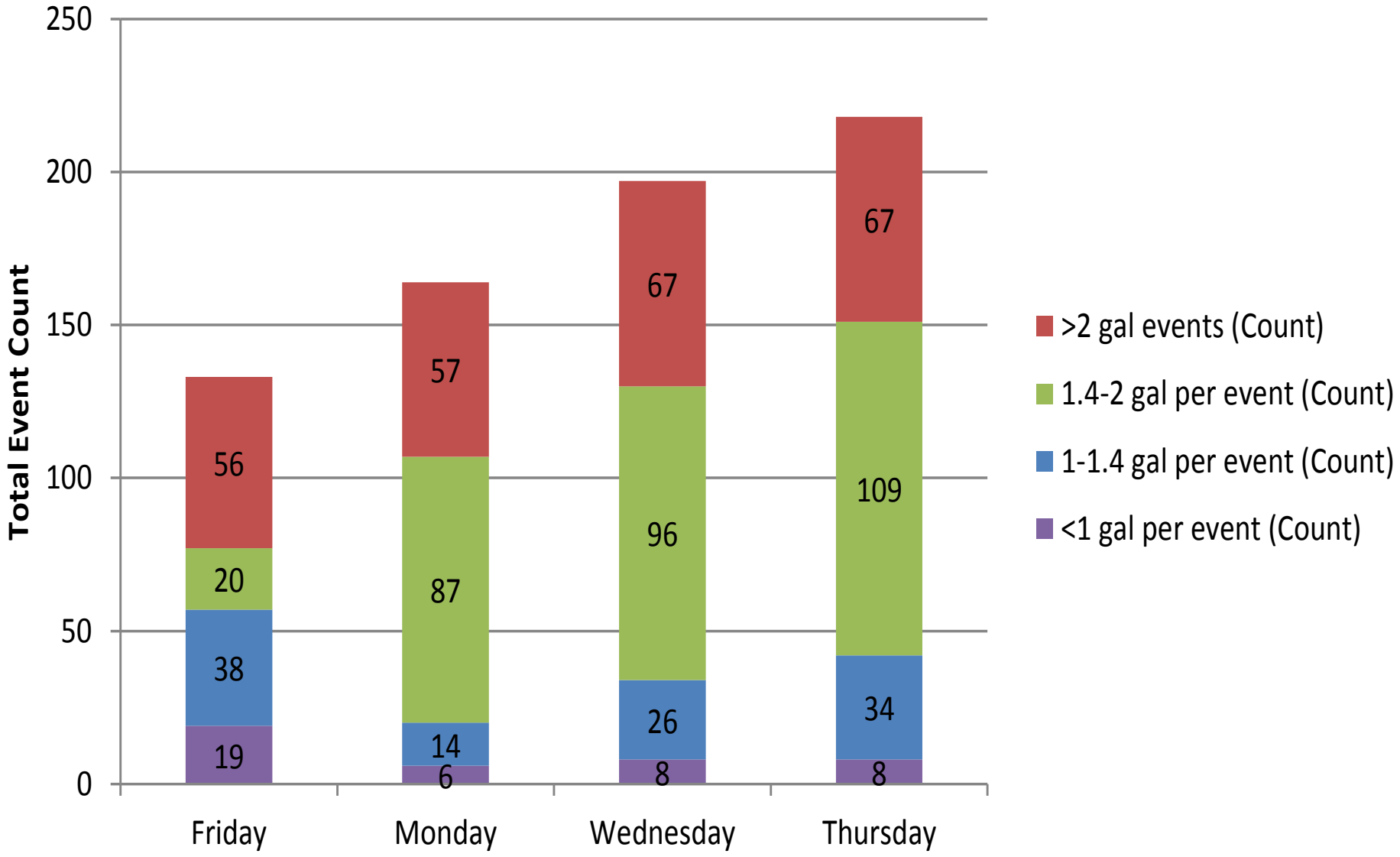
- Valve problem in steam system – water use dropped considerably when fixed
- But an issue with indoor water use remained

RESEARCH FINDING:

Water use from dual flush toilets was higher than anticipated – Why?

Signs told occupants how to use the dual flush toilets.

Wynkoop 7th Floor Water Metering Pre-retrofit
Event occurrences by volume (gallons per event)



THE PROBLEM:

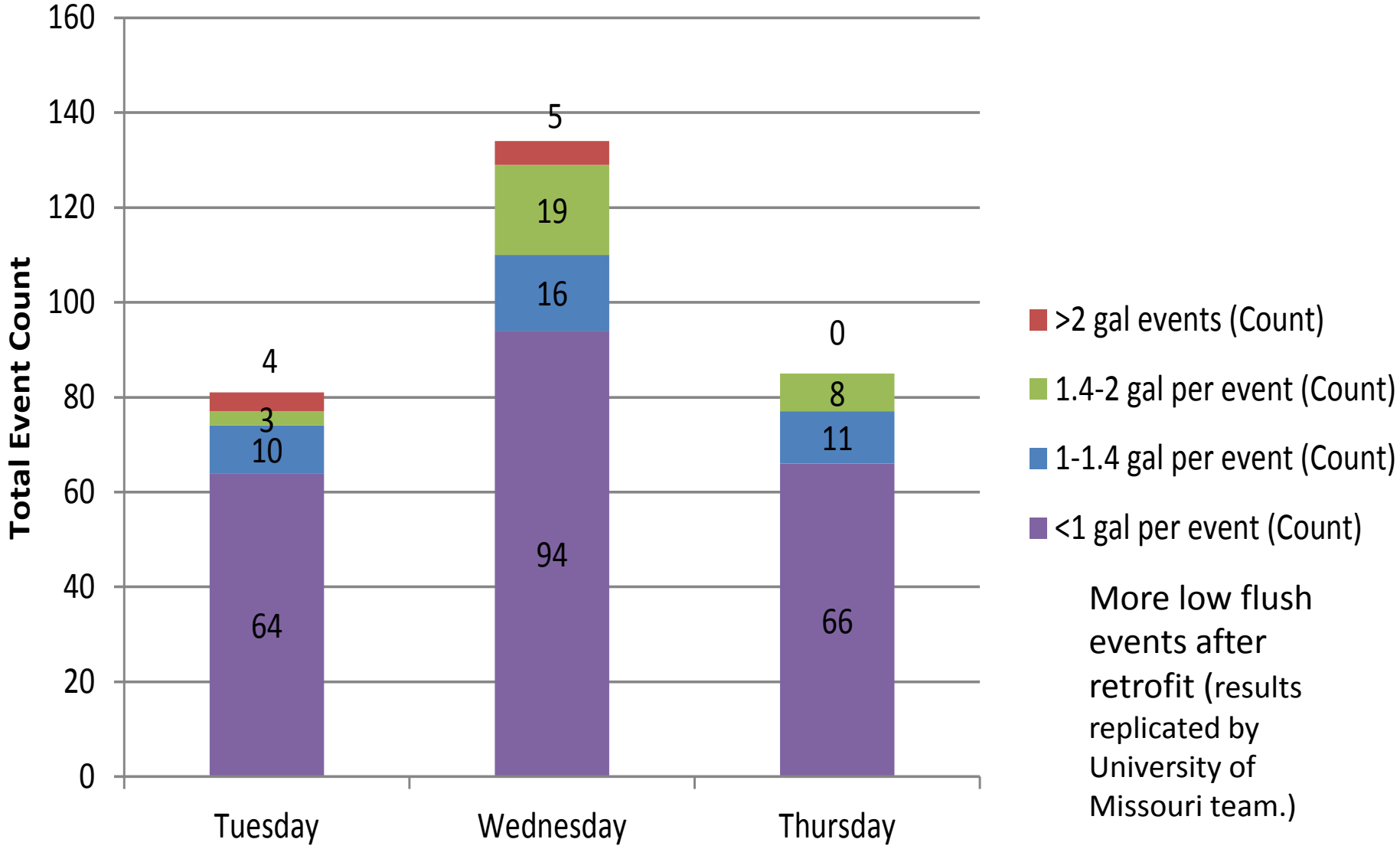
Habits are hard to change. Flushing is a highly conditioned response.

THE SOLUTION:

Handles are easy to change.

EPA changed the handles on all toilets in the building – making low flush the habitual default condition.

Wynkoop 7th Floor Water Metering Post Retrofit
Event occurrences by volume (gallons per event)



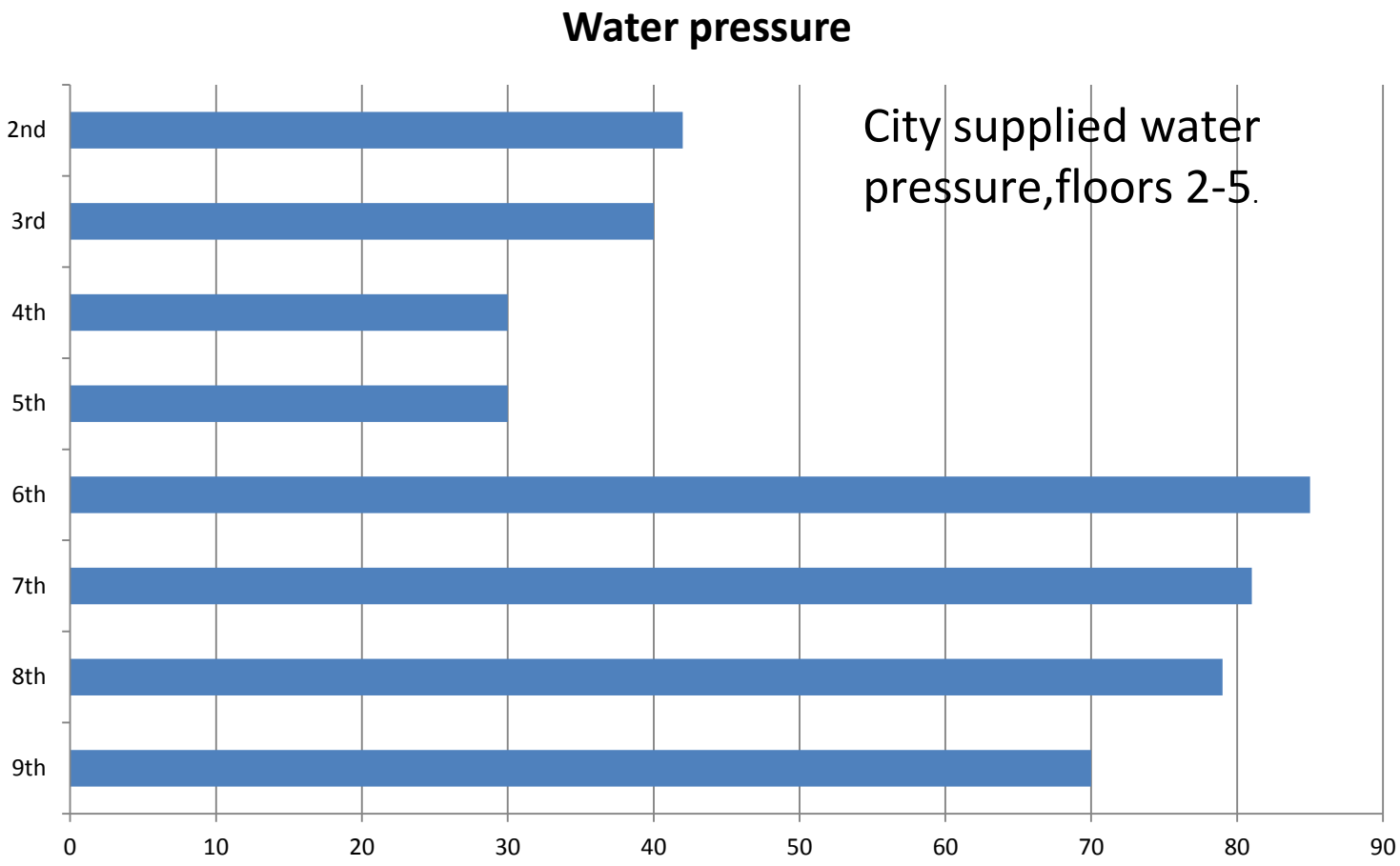
More low flush events after retrofit (results replicated by University of Missouri team.)

However, impact on total building water use was difficult to determine.

Issues:

- variation in occupancy
- some concerns about metering accuracy
- savings low relative to total building water use
- variation in water pressure

Water Pressure per floor (psi)



City supplied water pressure,floors 2-5.

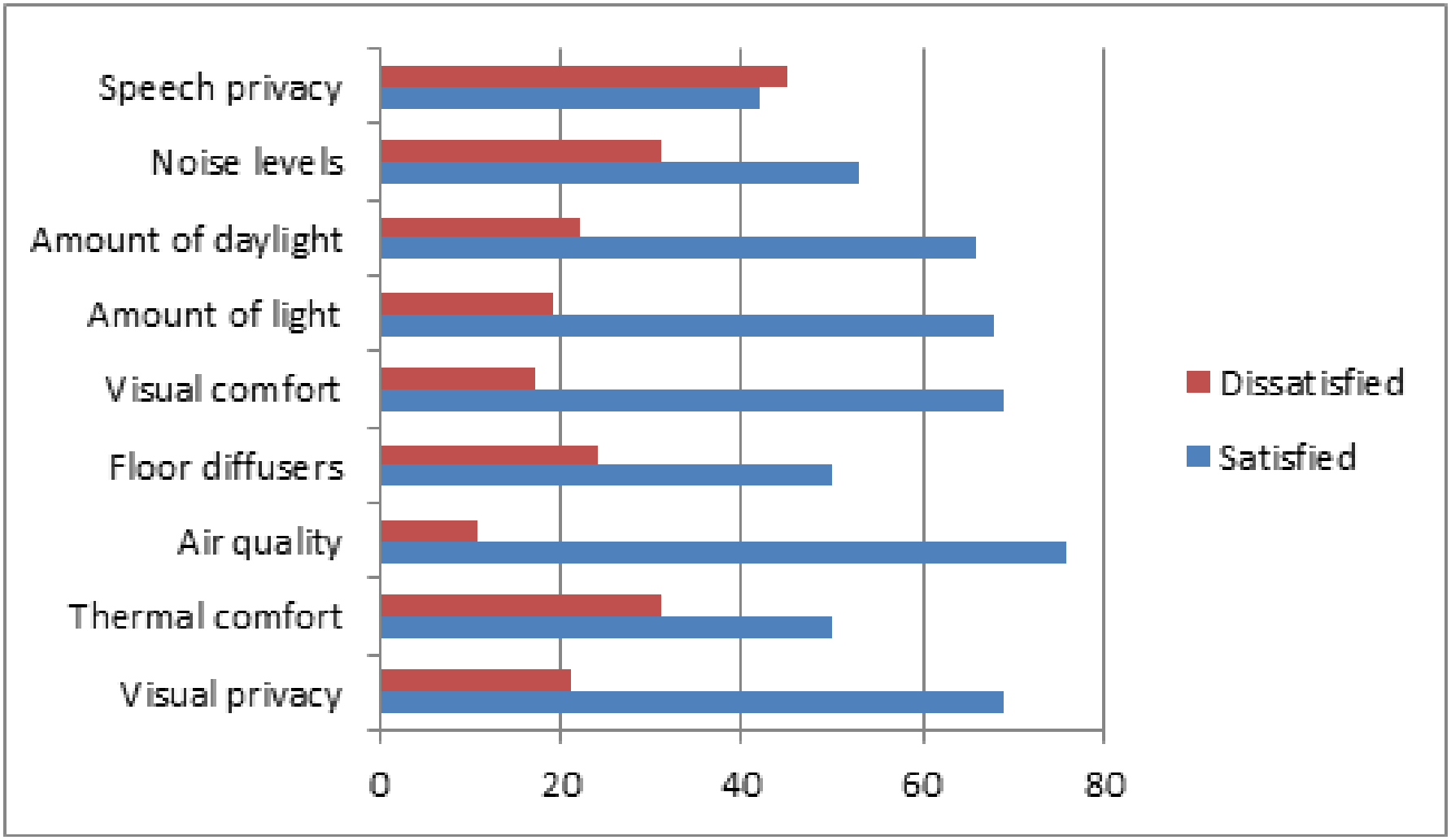
Booster Pump, floors 6-9.

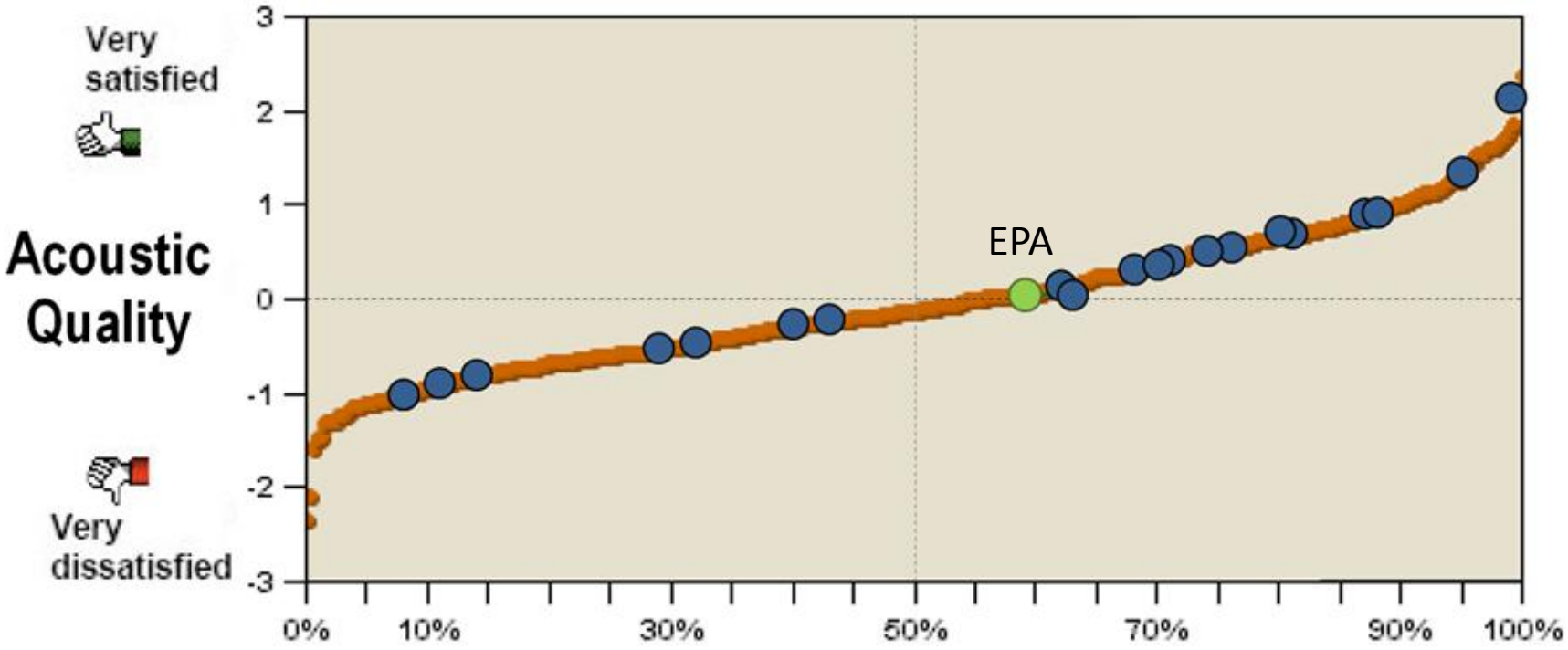
Part 2:
The Impact of the Physical System on Human Comfort, Health and Performance

Occupant Experience

- UC Berkeley Center for the Built Environment On-Line Survey
- GSA Functionality Analysis

Comfort and Satisfaction





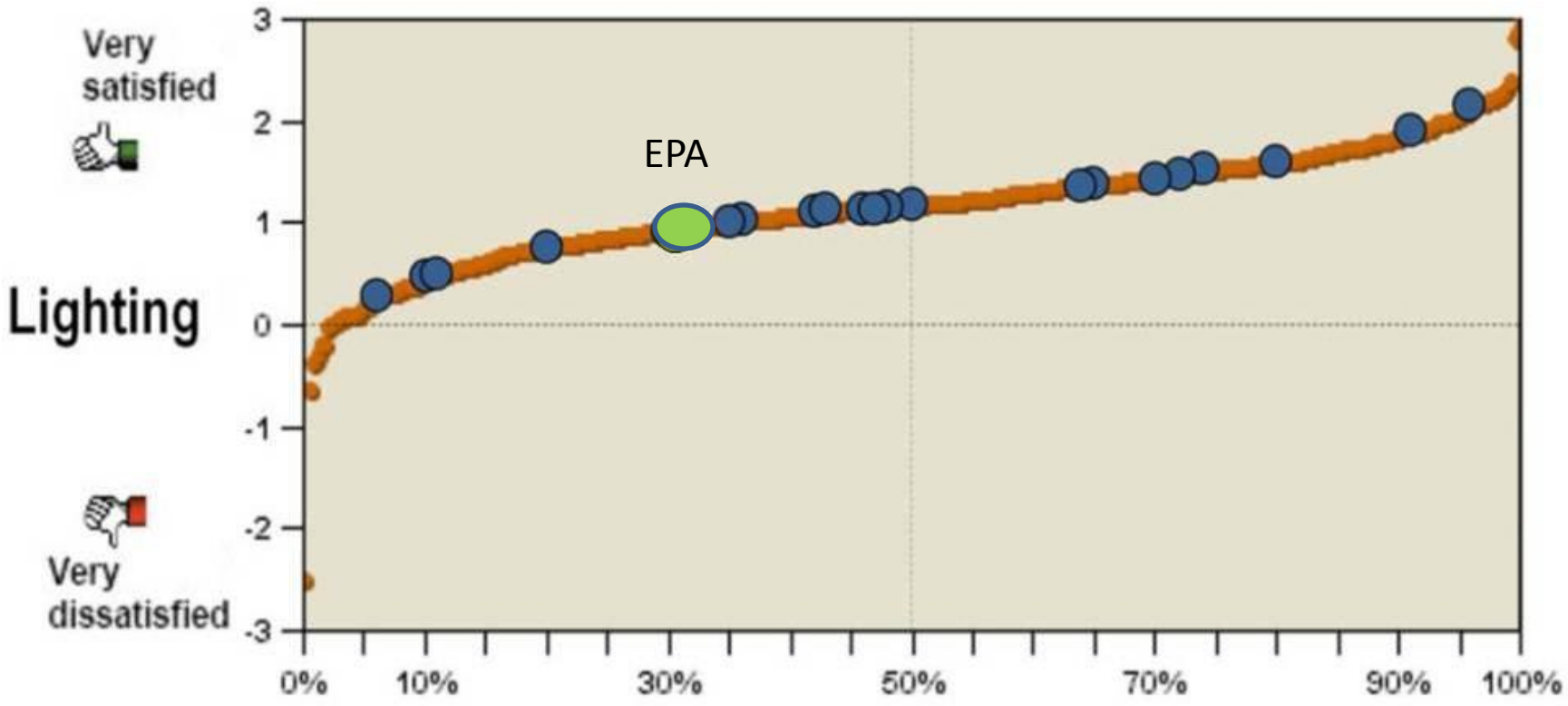
Key concerns: distractions from people talking nearby and lack of voice privacy.

THE ACOUSTICS CONUNDRUM.

But:

59% said they stop and talk to others in the corridors and workspaces

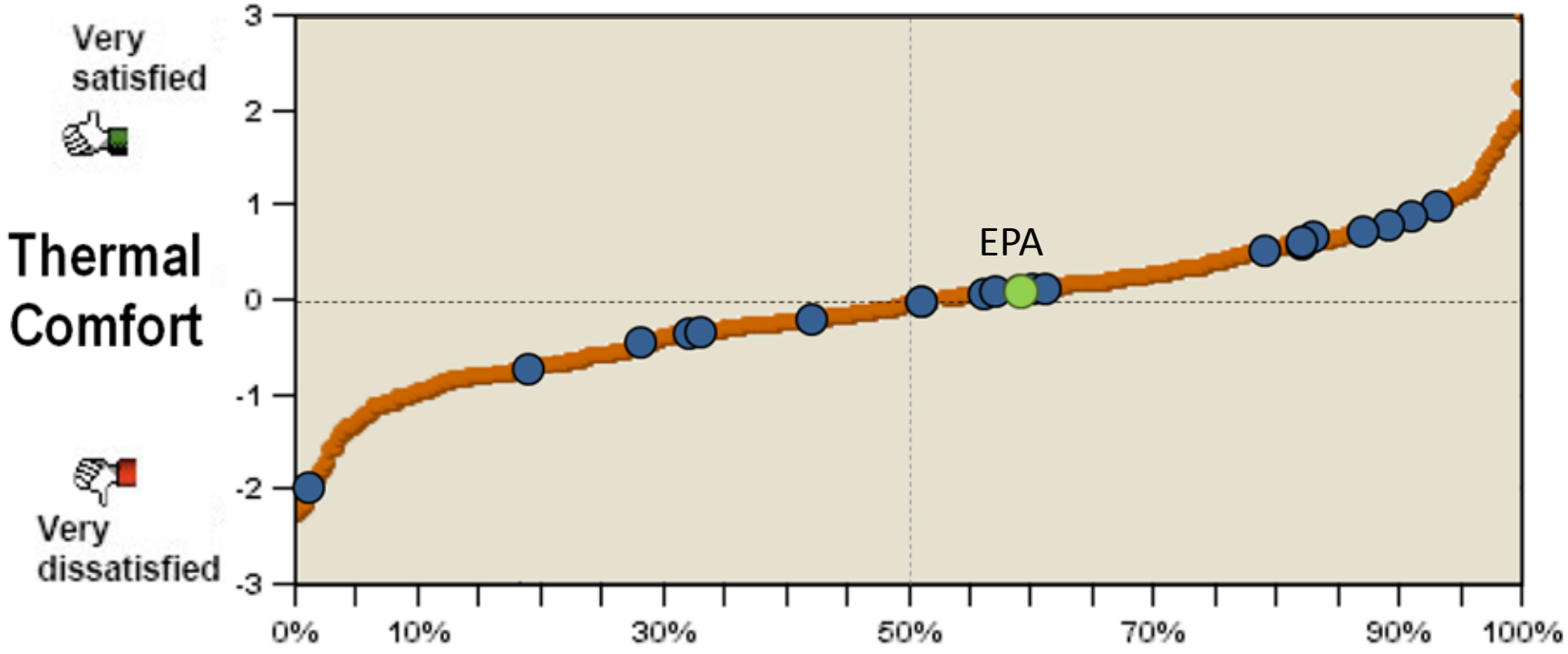
78% said they learn a lot by overhearing conversations.



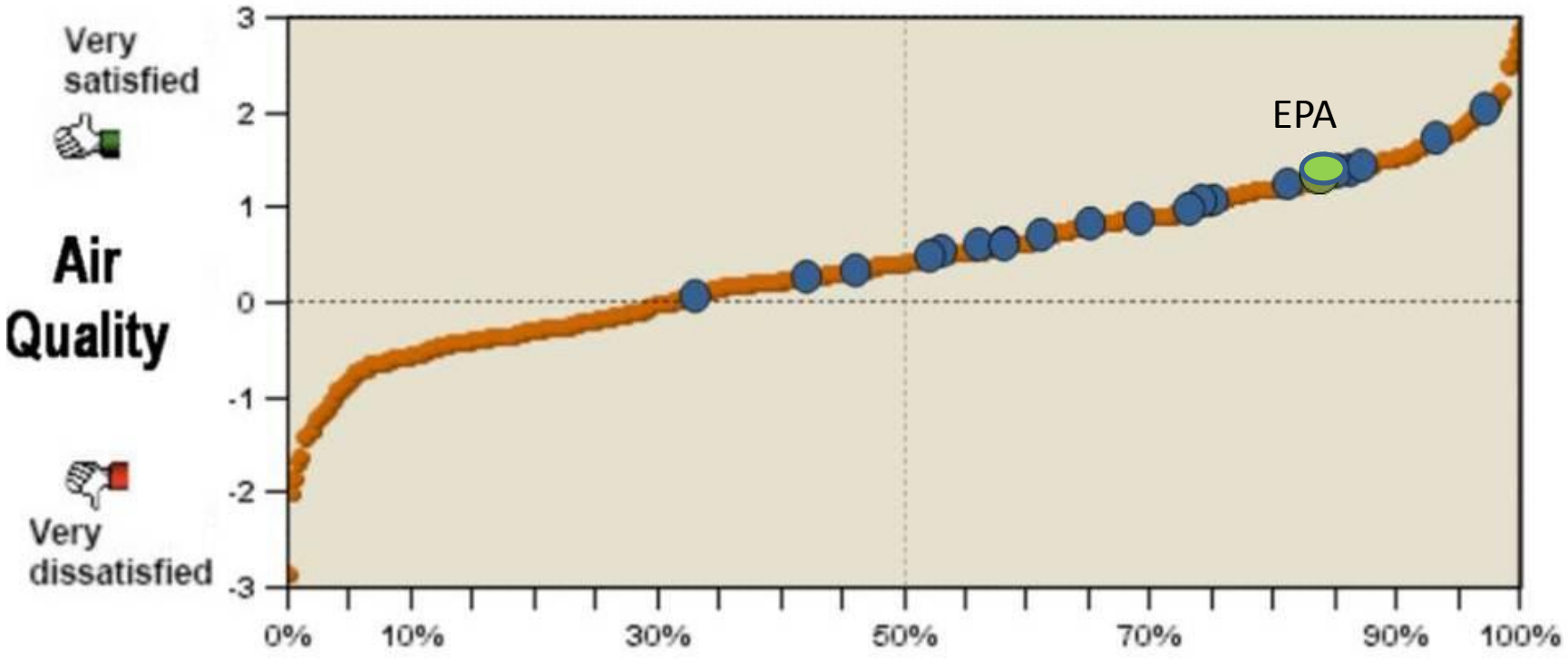
Multiple concerns: control system, too bright for some, too dark for others, glare in some areas, too dark when there is lower occupancy, lack of access to views.

High partitions block
access to views and daylight - and
contribute to sense of isolation.

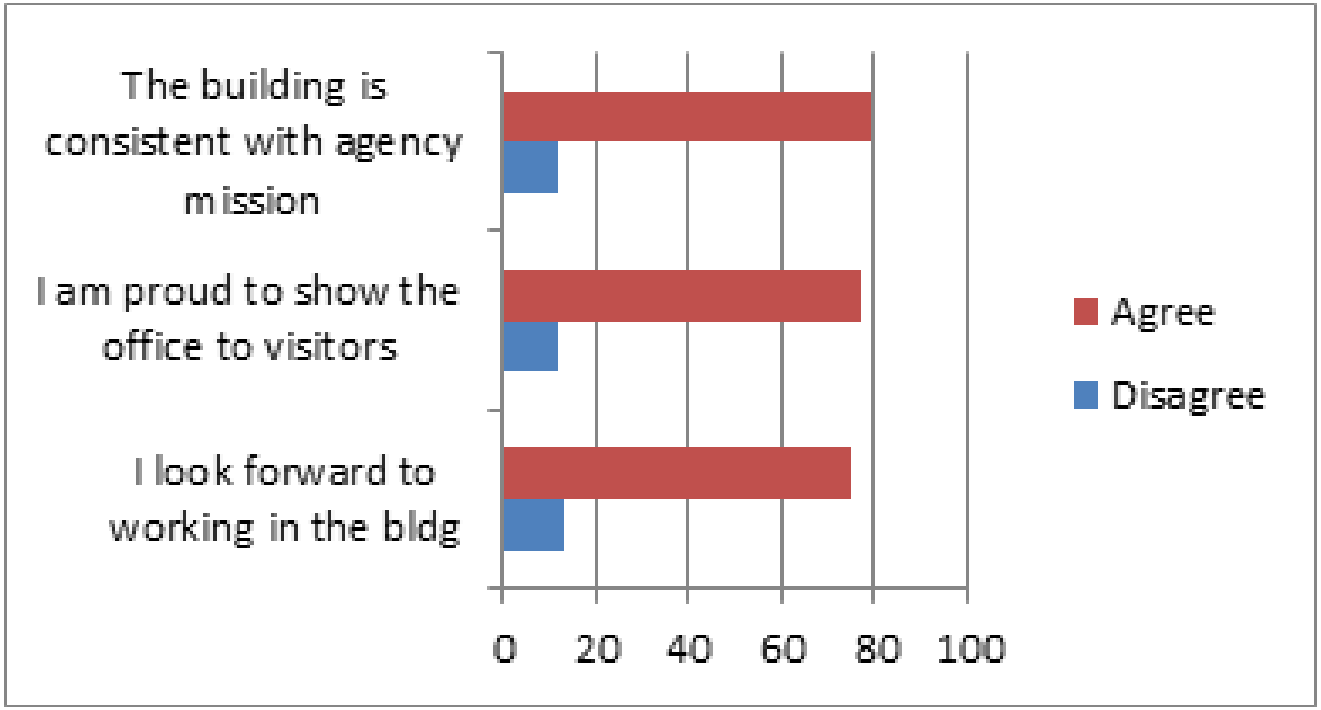
One person's
solution to getting a
view.



Key concern: temperatures perceived as too cold in both summer and winter.


Very satisfied
Air Quality
Very dissatisfied
3
2
1
0
-1
-2
-3
0%
10%
30%
50%
70%
90%
100%
EPA

Impact on Morale



A Closing Thought….

Why don’t we have goals for occupant comfort, health and satisfaction?

How do we know if a building is successful, from the occupants’ perspective, unless we set targets?