

# **Productivity in Buildings: the Killer Variables Updated**

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**Adrian Leaman**

Drawing on material developed jointly with Bill Bordass

# **This is about ...**

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- **A straightforward answer to a difficult question.** How do buildings affect productivity at work?
- Findings are supported by **survey information by Building Use Studies**, including the **Probe** series, in Britain, Australia and worldwide.
- **It's an update of something first written in 1997.** One new 'killer' variable has been added to our original list of four.
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- More detailed information is available on application from Adrian Leaman and Bill Bordass and from the Probe and Publications pages of [www.usablebuildings.co.uk](http://www.usablebuildings.co.uk).

# It's a difficult question because ...

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- Workplace productivity has become a **Holy Grail** for management. Claims for productivity gains achievable through buildings can be misleading and inflated.
- **Short-term business agendas** trump building and environmental long-termism.
- **Productivity in buildings can only be measured practically by subjective means.** Although perfectly valid for their purpose, subjective measures seem not to satisfy everyone however well-founded they are.
- **Believable data on perceived productivity is hard to find.**
- **What exists is usually not put into a context** which designers, building managers and corporate decision-makers can easily understand.

# 'Green' buildings expected to save millions in operational costs

*Individuals will be able to change the temperature for only their work space with a switch*

By **WILLIAM McCALL**  
THE ASSOCIATED PRESS

If workers get a little too hot or cold at their desks in one of the newest sky-

scrapers under construction in New York City, they will be able to adjust the temperature with switches tailored to individuals, not entire floors or buildings.

The individual controls, expected to save millions of dollars in operational costs, are among the many new designs being incorporated into "green" buildings, including the One Bryant Park

building in the center of Manhattan that will be the new Bank of America headquarters.

The building will be a showcase for the U.S. Green Building Council, which is holding its national conference this week in Portland — considered the "greenest" U.S. city by the council.

Rick Fedrizzi, council chairman, said : Portland has been a leader in the effort

to improve the energy efficiency of buildings while providing healthier working conditions and promoting environmentally friendly practices.

The council, established in 1993, promotes its Leadership in Energy and Environmental Design, or LEED, rating system as a voluntary national standard. Requests for LEED certification

Please see **GREEN**, Page C3.

The building, which will serve as Bank of America headquarters, will cost about \$375 a square foot to operate, according to estimates.

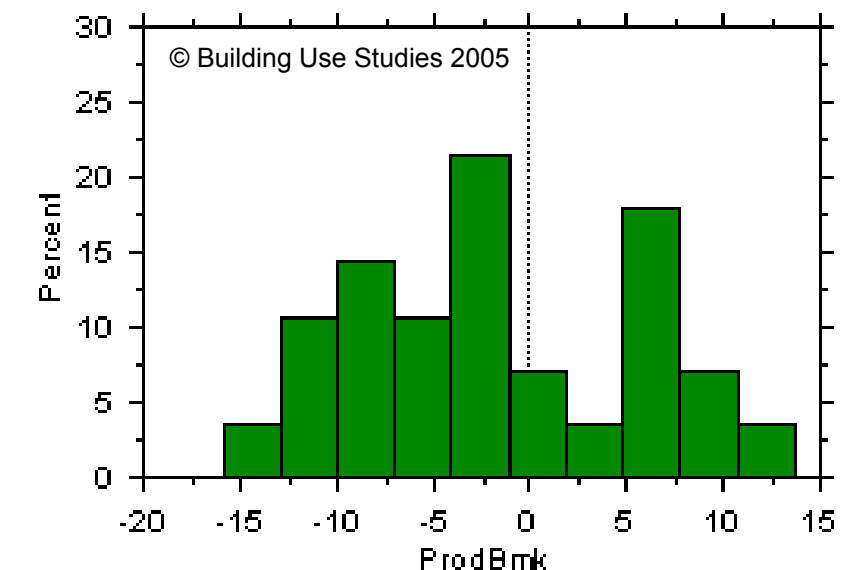
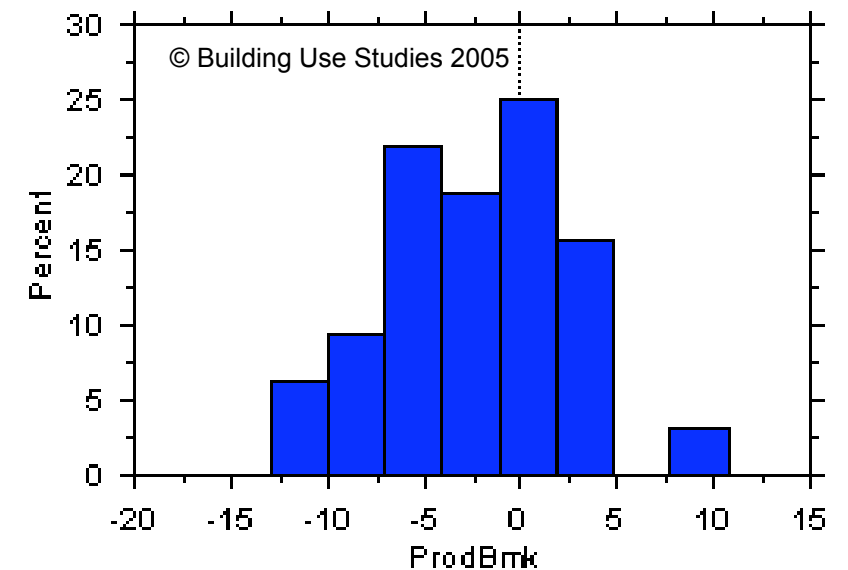
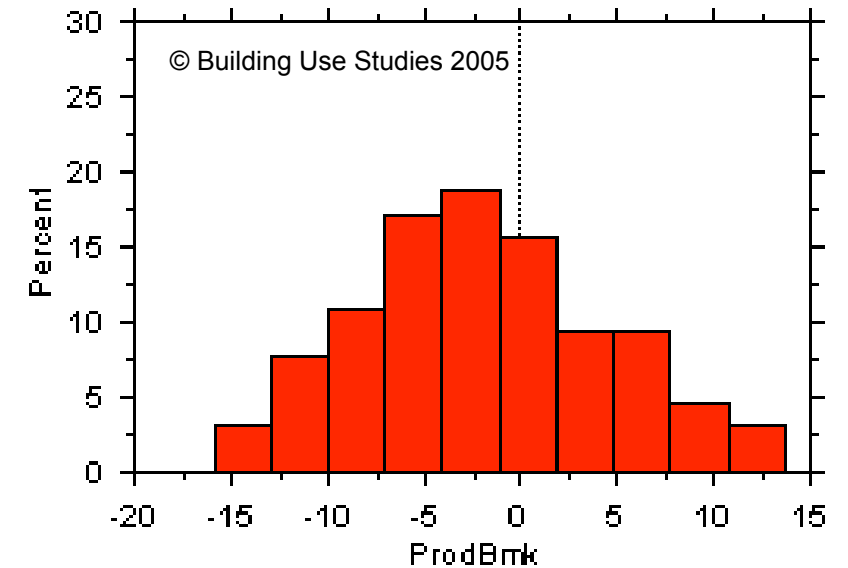
But if each worker increases productivity by just 1 percent — about five minutes a day — because of improved health and mood, it will result in huge savings over time, Fox said.

The actual savings probably will approach 5 percent to 10 percent, he said. "because it will dramatically decrease sick days and increase productivity."

From **The Oregonian**  
Friday 19 November, 2004

# Basic productivity statistics

- Building Use Studies international dataset; n=192
- **All buildings (top):** perceived productivity mean minus 1.9%
- **Air conditioned (middle):** mean minus 2.35%
- **Non-Air conditioned (bottom) (i.e. NV, ANV, MM):** minus 1.57%
- **Only one-third of buildings have scores greater than 0%**
- **Range: minus 15% to plus 15%**



# WHAT IS AT THE TOP?

- Pleasant internal environments
- Reasonable outside awareness (*interior views to atria and “streets” can sometimes count*).
- Not too hot in summer (*but not within tight band if occupiers have some autonomy*).
- Not overcrowded, not too noisy.
- Some personal control (*or good management*)
- Responsive cooling and ventilation systems (*where response is necessary*).
- Effective and responsive management (*or simple systems with good user autonomy*)
- Openable windows (*usually*).

***GOOD DESIGN and GOOD MANAGEMENT***

# WHAT IS AT THE BOTTOM?

- Poor internal environments
- Poor outside awareness (*remote from windows*)
- Hot in summer (*and sometimes in winter too*)
- Overcrowded (*and often noisy*)
- Little personal control (*in where you sit too*)
- Unresponsive cooling and ventilation systems
- Poor and unresponsive management
- Natural ventilation systems, both old and new

*Inadequate space, systems and controls*  
*Not much the occupant can do themselves*  
*Insufficient management resource*



# Productivity killer variables

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1. **Avoid discomfort**, thermal (especially too hot) first, but don't forget noise, lighting, air quality ...
2. **Rapid response** to need: especially in avoiding crises and getting the small things right. Needs vary between work tasks.
3. **Size and complexity** (which also maps on to ventilation type): once spaces move out of the domestic scale it gets more difficult ...
4. **Workgroups**: maintain lines of sight and sound and avoid conflicts (*e.g. circulation routes and other workgroups*).
5. **Design intent clear**: people forgive faults if they know how things are supposed to work.

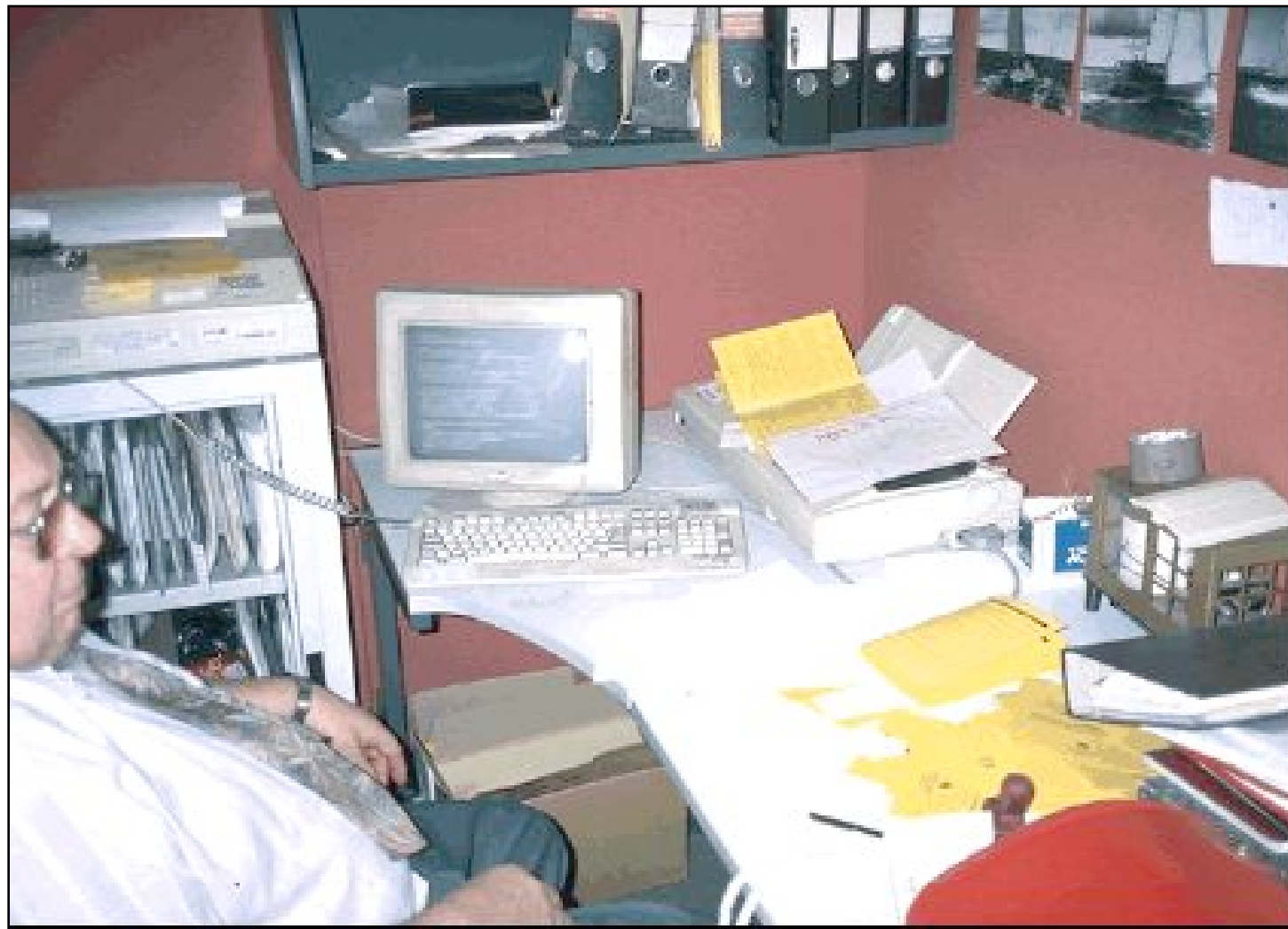
*Concentrate on things that designers and managers can deliver*



# Productivity killer variables

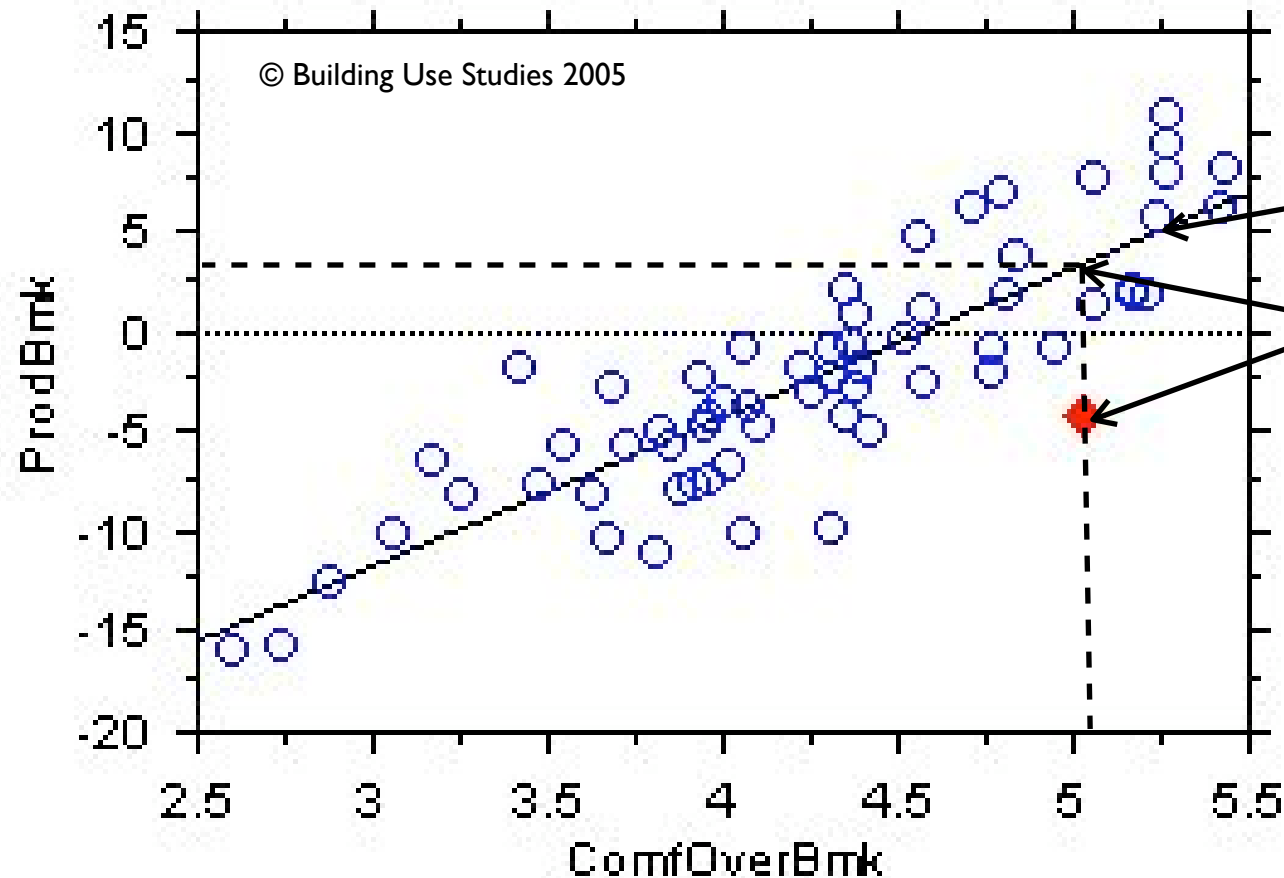
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- I. **Avoid discomfort**, thermal (especially too hot) first, but don't forget noise, lighting, air quality ...



*Thermal discomfort is usually the number one productivity killer*

# Comfort and Perceived Productivity



1. Because comfort and perceived productivity are closely related, we can model the relationship.

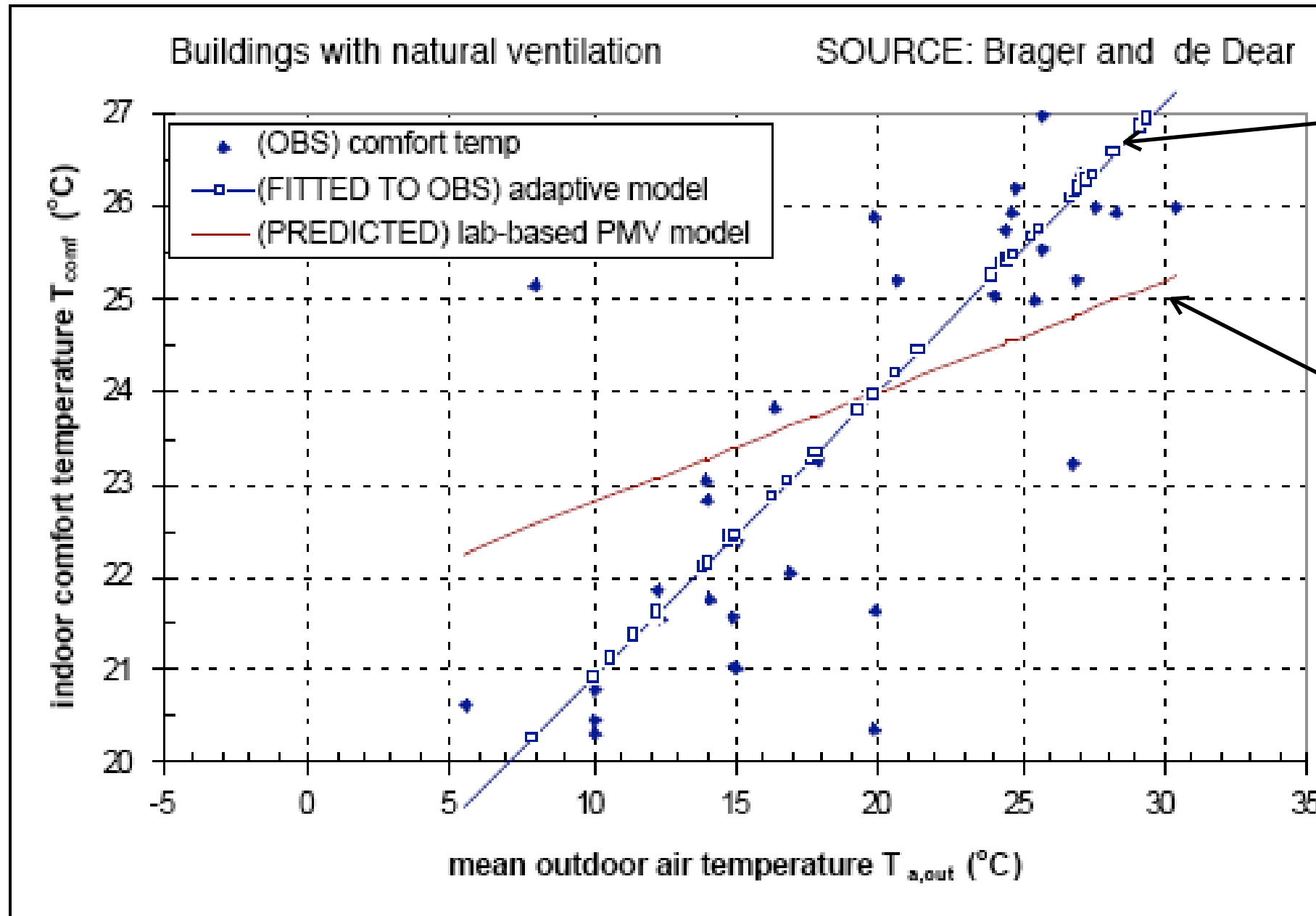
2. From the model, perceived productivity in the study building is much lower than might be expected by the comfort conditions.

3. Why? In this case mainly because half the building's occupants were software developers who are particularly susceptible to noisy conditions.

4. Why not allow for this in the statistics by weighting the scores?

5. Because this would tend to hide the very things we are looking for - anomalies and the exceptions that prove the rule, from which we learn most. **This is not about theory testing it is about diagnosing performance problems!**

# People are more tolerant when ...



1. ... they have some control.

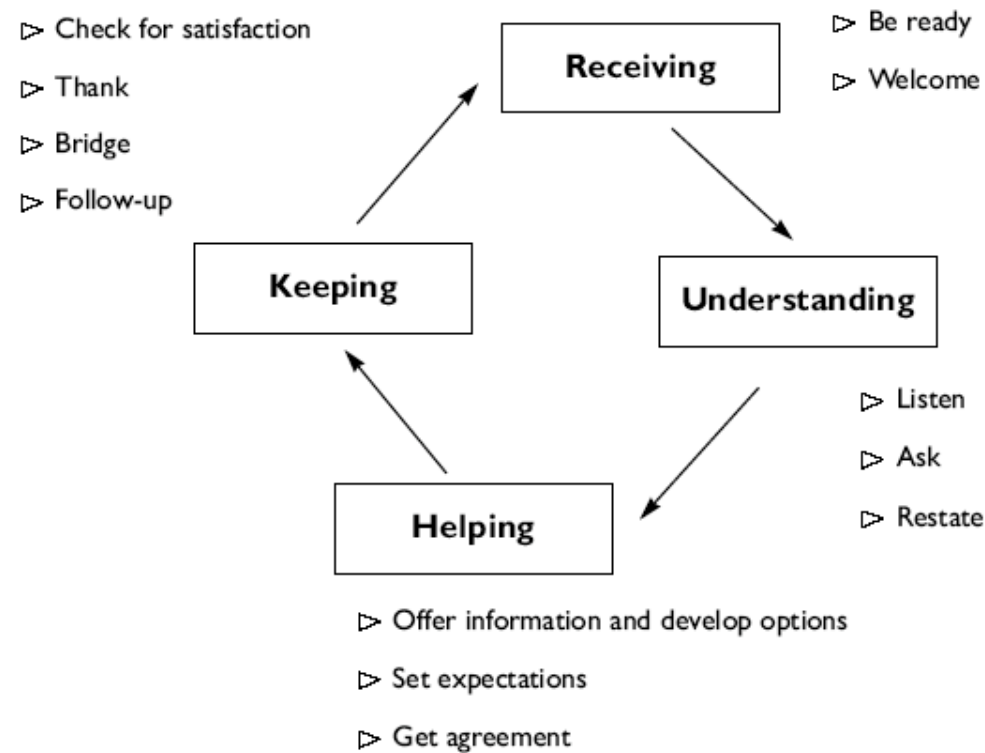
2. The curve is steeper (i.e. has a greater range of comfort conditions) in real (observed) situations than in the predictions from laboratory experiments.

This means that people are more likely to be tolerant when they have more control, **even if the conditions themselves are not measurably better!**

# Productivity killer variables

2. **Rapid response** to need: especially in avoiding crises and getting the small things right. Needs vary between tasks.

Standard Life Customer Care; Source; Mouse mat, Tanfield House, Edinburgh



Although you are asked to close and lock the door in the train toilet there is no indication to tell you that the sliding door **is** locked!

GNER Disabled toilet



***Buildings that deliver rapid response to need either through the physical design or the management system are usually better***

# Productivity killer variables

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3. **Consider size and complexity:** once spaces move out of the domestic scale it gets more difficult ...

As buildings get deeper, they require more services. Air-conditioned are usually the most complex, domestic naturally-ventilated the least. Mixed-mode has the potential to offer the best of both worlds. 'Green' buildings can often make the mistake of introducing too much unwanted complication.



*Complexity often ends up with systems defaulting to the 'least worst' for everyone*



# Low road to high road

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Before



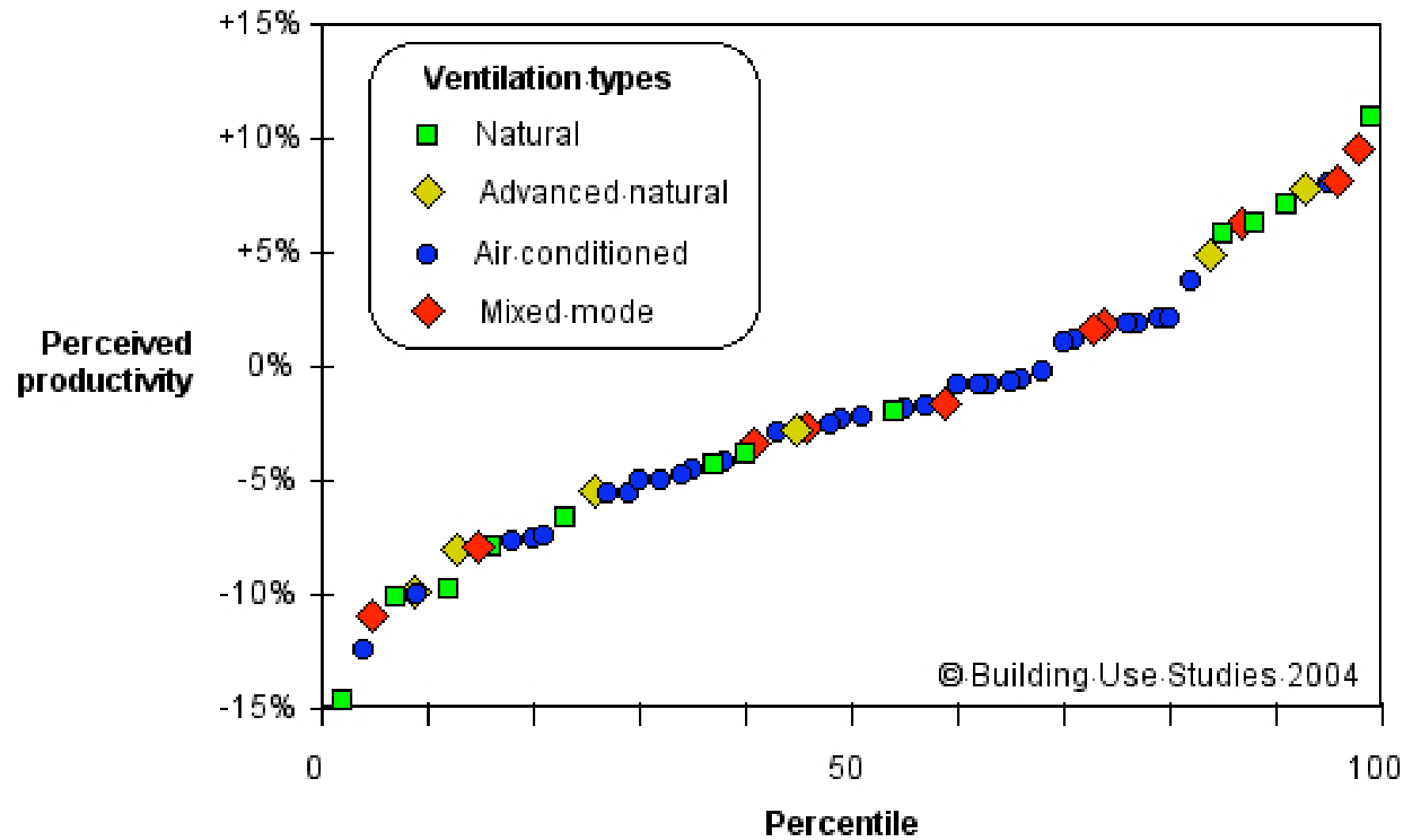
After



Stewart Brand: How Buildings Learn

*Before and after. Which is best?*

# Horses for courses





# Productivity killer variables

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4. **Consider workgroups:** maintain lines of sight and sound and avoid conflicts (e.g. circulation routes and other workgroups).

A regular layout was transformed over a weekend by managers working with local tradespeople to try to find a practical layout that fitted workgroup requirements better.

Before



After



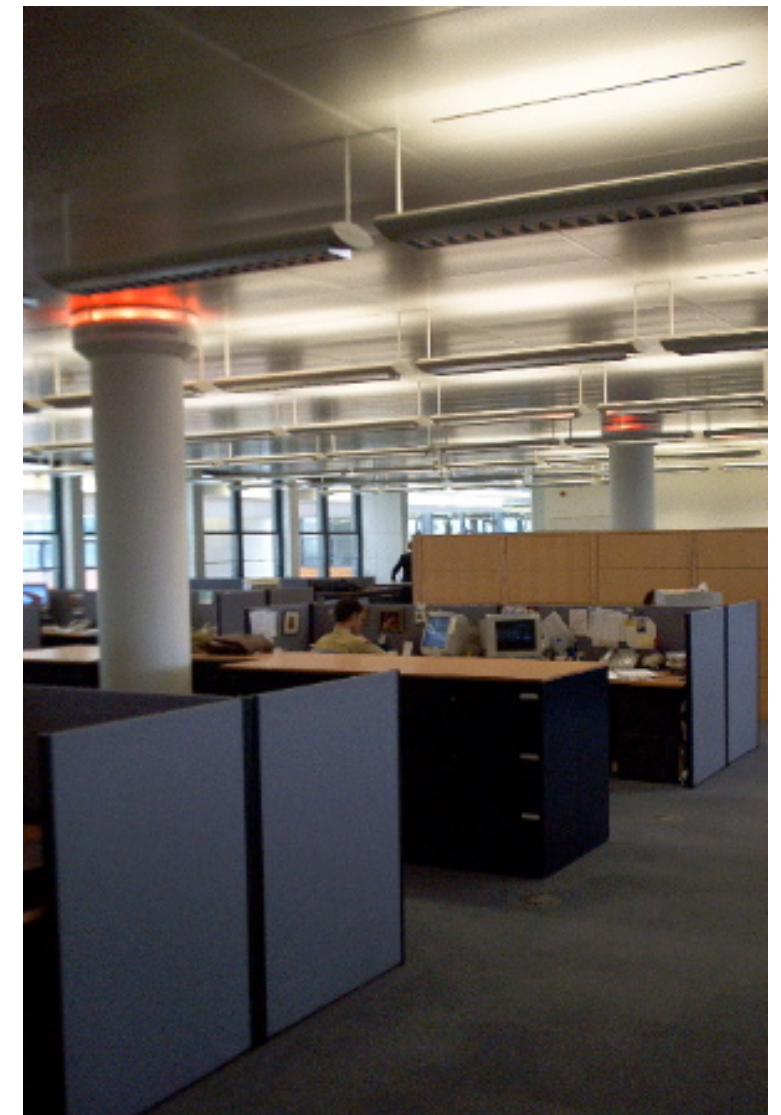
*The more workgroup boundaries 'map' onto building services zones the better*

# Productivity killer variables

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5. **Make design intent clear:** people forgive faults if they know how things are supposed to work.

The mixed-mode approach at BT Brentwood, Essex, UK, makes design intentions clear.



*While not perfect this approach has much of merit*

# Design intentions ...

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1. What the design is supposed to do.
2. What users think it actually does.
3. When 1 and 2 don't contradict good outcomes usually result.
  - The clearer design intentions are, the more occupants seem to be likely to tolerate performance problems.
  - Design intentions are often clearer in naturally ventilated buildings.
  - Designers occupying their own buildings are often much less critical than people may think **because they understand intentions.**
  - Where design intentions are hidden or absent, or when occupants are suspicious of them, occupants are much less tolerant when things go wrong.

# So ...

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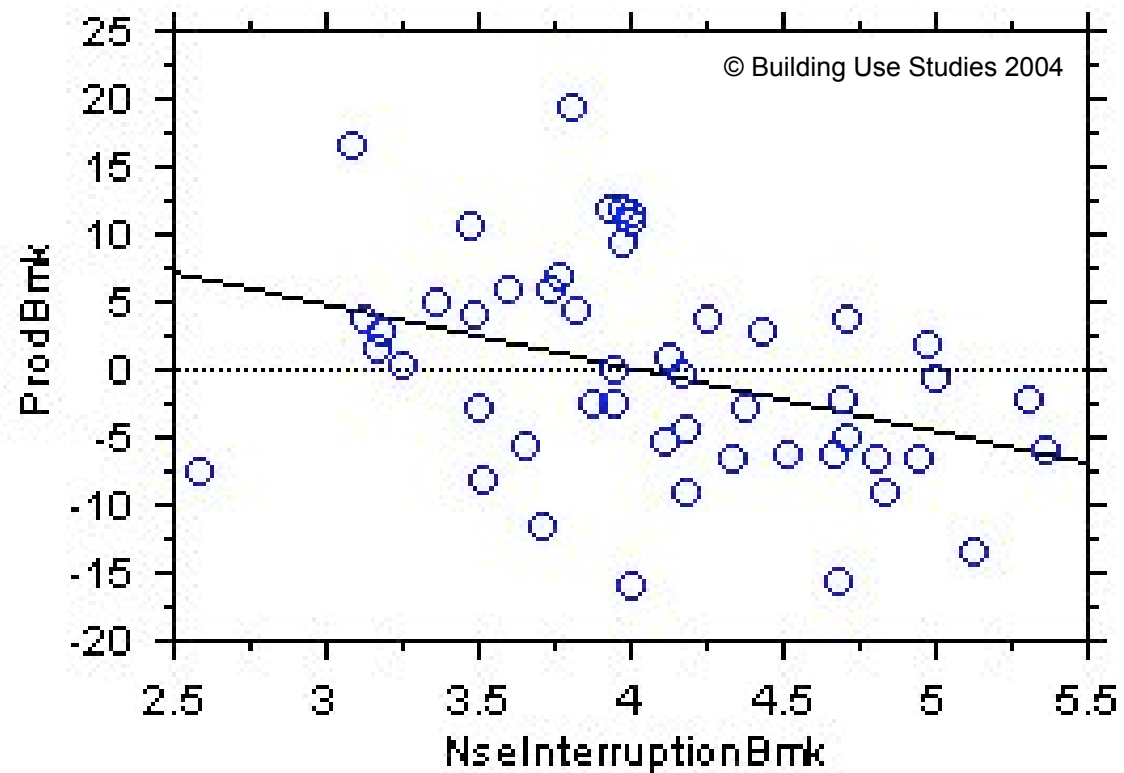
- **Perceived productivity gains are only made in about 30 per cent of new buildings.** Be suspicious of inflated claims.
- The biggest productivity killer is poor **thermal discomfort**.
- The reasons are mainly to do with:
  - **better management;**
  - **responsiveness when things go wrong linked to assiduous monitoring;**
  - **simplicity of technology including greater employment of passive systems;**
  - **clearer design intent for users.**
- Beware the single issue, and mixing up ends and means!

# Supplementaries for questions and discussion

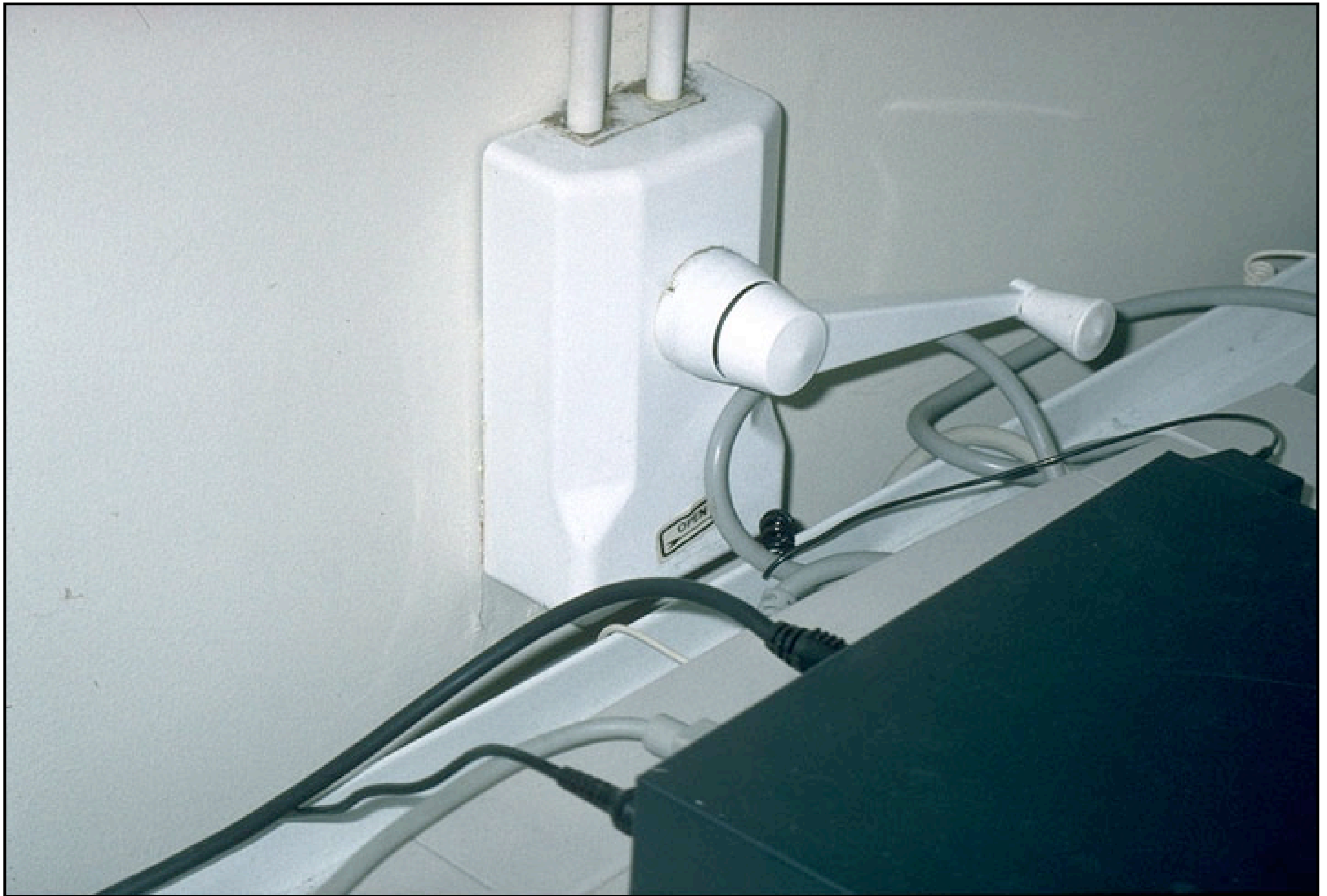


# Unwanted interruptions

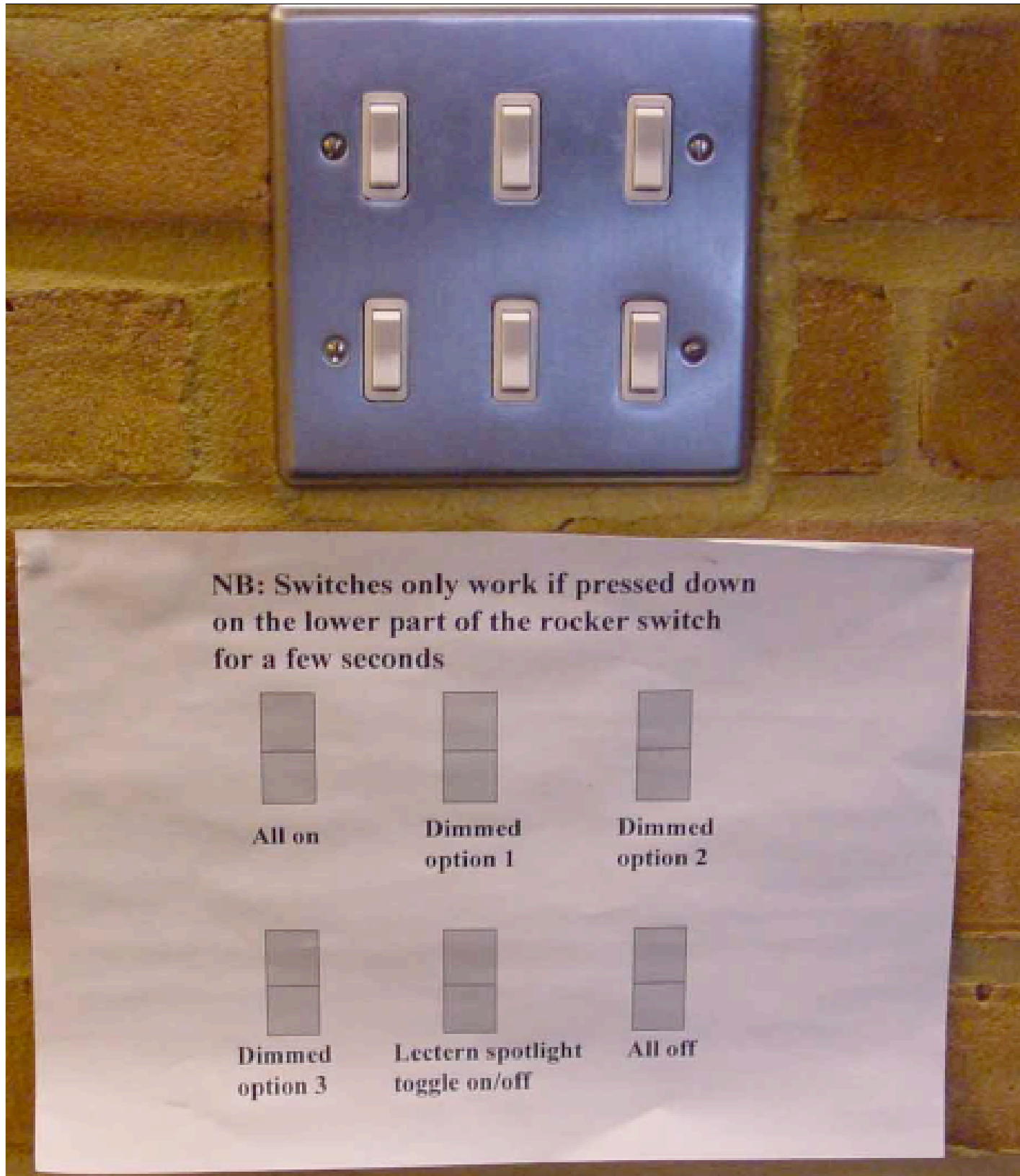
As might be expected, more unwanted interruptions mean lower perceived productivity.



$$\text{ProdBmk} = 18.839 - 4.663 * \text{NseInterruptionBmk}; R^2 = .137; ; p=0.0082$$







# Technological complexity

More

Less



Type A

Type D

More

*Effective with greater functionality but often costly*

*Can be thoughtful and imaginative, but sometimes less user-friendly*

Type C

Type B

Less

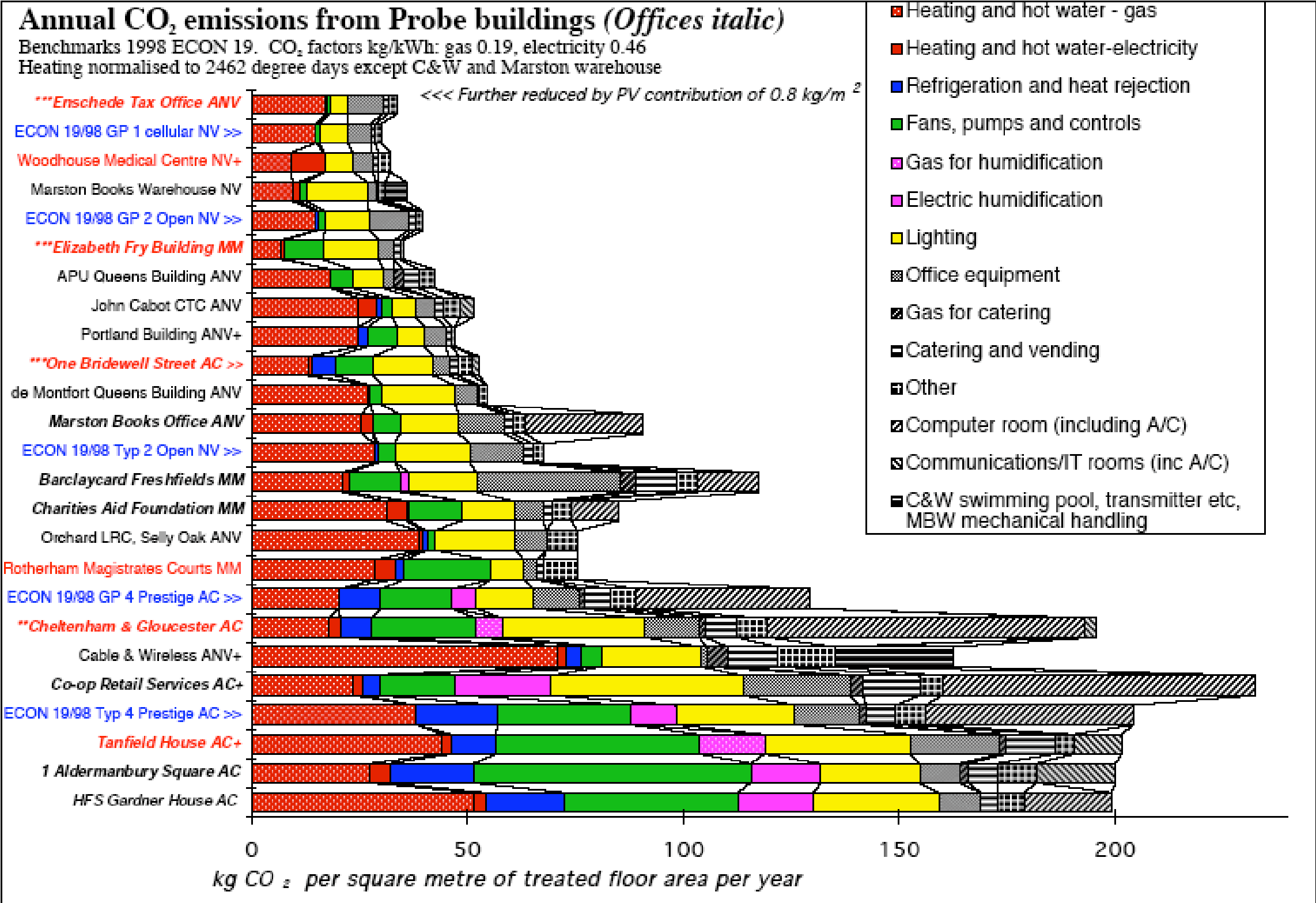
*Risky with performance penalties*

*Effective and can be low impact but often small scale*

**Management input**



# Probe buildings: Annual CO2 emissions



# SOME IMPLICATIONS

## LOOK AT WHOLE SITUATIONS

Not just people-machine interactions.

## PUT PEOPLE IN THE CONTROL LOOPS

*(but only where this makes good sense!).*

## CONSIDER THE FULL RANGE OF USERS AND CONTEXTS.

Don't focus on an average subset.

## TAKE DEFAULT STATES SERIOUSLY

Will this be what you want? ... *or what is least trouble, but is neither comfortable nor efficient.*

## PROVIDE GOOD FACILITIES FOR INTERVENTION

*People who can get themselves out of trouble tend to be happier, more productive ... and less of a headache for management.*

## IF YOU REMOVE OPPORTUNITIES FOR INDIVIDUAL ADJUSTMENT ... How will you replace what you take away?

*This may require more money, design and management than you think!*

## AND FINALLY ...

*Designers are not users, though they often think they are ... J NEILSEN*