Real People, Real Buildings

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Drawing on material developed jointly with Bill Bordass
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This is about …

- A simple answer to a difficult question. Is productivity at work better in ‘green’ buildings?

- No, because not all ‘green’ buildings are low impact in the ways intended.

- Possibly, when we look at low carbon emissions across all buildings, not just the supposedly ‘green’ ones.

- Findings are supported by survey information by Building Use Studies, including the Probe series, in Britain, Australia and worldwide.

- More detailed information is available on application from Adrian Leaman and from the Probe and Publications pages of www.usablebuildings.co.uk.
It’s a difficult question because ...

- Workplace productivity has become a **Holy Grail** for management, heavily mythologised.

- Business agendas tend to 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

From The Oregonian
Friday 19 November, 2004

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.”
Productivity killer variables

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 includes 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

1. **Avoid discomfort**, thermal (especially too hot) first, but don’t forget noise, lighting, air quality …

*Thermal discomfort is usually the number one productivity killer*
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 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!
2. **Rapid response** to need: especially in avoiding crises and getting the small things right. Needs vary between tasks.

Buildings that deliver rapid response to need either through the physical design or the management system are usually better.
Productivity killer variables

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

Before and after. Which is best?

Stewart Brand: How Buildings Learn

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Horses for courses

![Graph showing ventilation types and perceived productivity.]

Ventilation types:
- Natural
- Advanced natural
- Air conditioned
- Mixed mode

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Productivity killer variables

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.

*The more workgroup boundaries ‘map’ onto building services zones the better*
Productivity killer variables

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*
NB: Switches only work if pressed down on the lower part of the rocker switch for a few seconds

- All on
- Dimmed option 1
- Dimmed option 2
- Dimmed option 3
- Lectern spotlight toggle on/off
- All off
Design intentions ...

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.

Source: Donald Norman (1986)
So …

- 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.

- People are happier with:
  - better management;
  - responsiveness when things go wrong sometimes linked to assiduous monitoring;
  - simplicity of technology including greater employment of passive systems or ‘fit and forget’ systems;
  - clearer design intent for users.

- Beware the single issue, and mixing up ends and means!
Energy efficiency and human performance are associated

Positive and significant relationships

**IMPORTANT:** Please treat the data in these charts as indicative of likely relationships rather than proof of them. They are based on buildings used in Probe studies plus 3 others, which is not a representative sample.

Econ 19 CO2 rating
- 4 = Typical
- 6 = Good practice

- **Overall comfort**
  - $\rho = 0.610; p = 0.0012$

- **Perceived productivity**
  - $\rho = 0.477; p = 0.0492$

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Low-carbon buildings tend to be ...

- Monitored

- Procured by more motivated clients

- Well-briefed with higher aspirations and better problem ownership

- Easier for users to understand (i.e. have clearer design intentions, but there are horror stories as well)

- Less complex

- Easier to manage
The most crucial of these are ...

- Monitored
- Procured by highly motivated clients
- Well-briefed with higher aspirations and better problem ownership
- Easier for users to understand (i.e. have clearer design intentions, but there are horror stories as well)
- Less complex
- Easier to manage

*Which is why any building with these characteristics can work well.*
Probe buildings: Annual CO2 emissions

Annual CO₂ emissions from Probe buildings (Offices italic)

Benchmarks 1998 ECON 19 CO₂ factors kg/kWh: gas 0.19, electricity 0.46
Heating normalised to 2462 degree days except C&W and Marston warehouse

<<< Further reduced by PV contribution of 0.8 kg/m²

- Heating and hot water - gas
- Heating and hot water-electricity
- Refrigeration and heat rejection
- Fans, pumps and controls
- Gas for humidification
- Electric humidification
- Lighting
- Office equipment
- Gas for catering
- Catering and vending
- Other
- Computer room (including A/C)
- Communications/IT rooms (inc A/C)
- C&W swimming pool, transmitter etc, MBW mechanical handling

kg CO₂ per square metre of treated floor area per year

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Technological complexity

- **More**
  - **Type A**: Effective with greater functionality but often costly
  - **Type C**: Risky with performance penalties
- **Less**
  - **Type D**: Can be thoughtful and imaginative, but sometimes less user-friendly
  - **Type B**: Effective and can be low impact but often small scale

Management input

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Annual carbon dioxide emissions from operational energy use in an environmental award-winning head office building complex in England

- **BREEAM estimate**
- **Design estimate**
- **ECON 19 "Good Practice" benchmark >>**
- **Actual emissions two years after completion**
- **ECON 19 "Typical" benchmark >>**

Annual carbon dioxide emissions (kg/m² treated floor area)

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