

Productivity in buildings

What are the critical factors affecting human productivity in buildings?

Productivity at work is affected by buildings and the prevailing conditions in them. At best, improvements of 10-15 per cent are attributable to building effects, but productivity can also be depressed. Many other factors also affect productivity, such as job type and stress at work, but most of these cannot easily be improved by building design or facilities management interventions. In the best buildings, occupant behaviour, design features and management action complement each other to the benefit of all.

Productivity is perceived by occupants to be best with:

- small, well-integrated workgroups;
- spaces perceived as one's own;
- good control over heating, cooling, ventilation, lighting, noise and privacy;
- fresh air, daylight and views out;
- clean, comfortable, safe, stable and healthy conditions;
- rapid and effective reaction when things need to be changed or go wrong.

People seem to be most productive where they:

1. work in small well-integrated groups, or have a room or space perceived as their own;
2. have high levels of perceived control over heating, cooling, ventilation, lighting, noise and privacy (which often go with 1.), feeling that they are part of the environmental control system rather than at the mercy of it;
3. perceive that there is plenty of fresh air and daylight (which is well within their personal control, as in 2.);
4. feel comfortable, healthy and safe in clean sur-

roundings;

5. can quickly intervene and do something effective if conditions change for the worse.

Buildings which best reinforce these characteristics often have:

- some sort of natural ventilation with well-designed openable windows and designed not to get hot in summer;
- shallow-plan forms (12-14 metres across);
- simpler domestic-like controls and services.

However, these are not always necessary. Productive staff are also be found in buildings with air conditioning, deep-plan forms and more complex servicing **as long as the design and management of these features compensates for perceived human losses** such as lack of control or increase in noise.

Effective compensation can be achieved by:

- providing stable, basic conditions which are comfortable, healthy and relatively predictable, but which have ...
- quick response when things need to be changed (if necessary with the aid of a well-resourced help-desk).

Occupants are happiest when they:

- can intervene positively themselves, making small adjustments to make things marginally better or stop things getting any worse, especially with chair, desk and VDU positions, windows (for ventilation or cooling), blinds (glare

Occupants crave feedback about:

- what a control device is actually supposed to do;
- whether it is working;
- whether something is happening as a result;
- if the intended effect is achieved.

control) and light switches (especially control over off-switching for better natural light); but ...

- do not have to make too many adjustments, especially in the spring and autumn when conditions outside may be more unpredictable and variable;
- have freedom to make trade-offs between undesirable conditions eg too much heat or too much noise, but not both together;
- have a view out of a window (which helps rest eyes) especially if they use a VDU for more than four hours a day or in concentrated periods;
- do not sit too close to - or with their backs to - sources of distraction such as kitchens, photocopiers, circulation spaces and end-doors.

Occupants want feedback as well as the freedom to control things. Every time people use a switch or a device to try and change something, ideally they should immediately be able to perceive:

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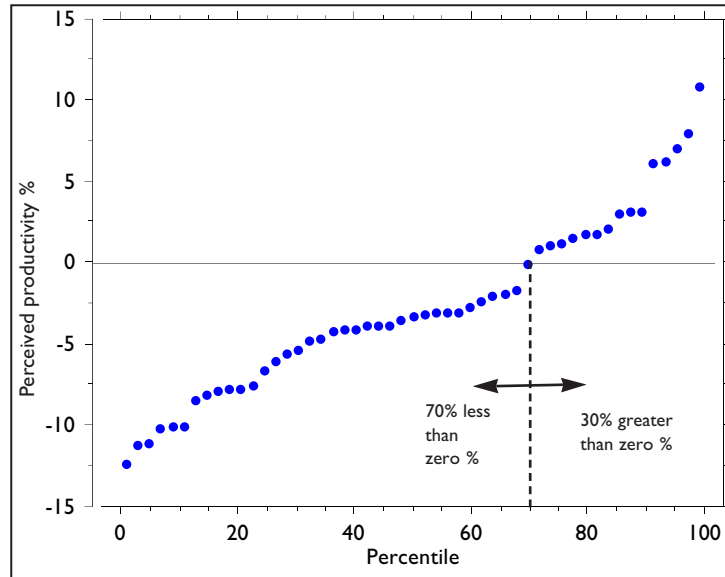


This crank was intended for opening a high-level ventilator which occupants could not see! It has been abandoned because it was not sufficiently clear what it was for, and it did not work very well anyway.

- what the control and/or device is actually intended to do - this should be self-evident;
- whether it is working - perhaps by a feedback light or an audible click;
- whether something is happening as a result - if not immediately apparent (eg a window opening or lights going on) an indicator showing progress;
- the intended effect is achieved.

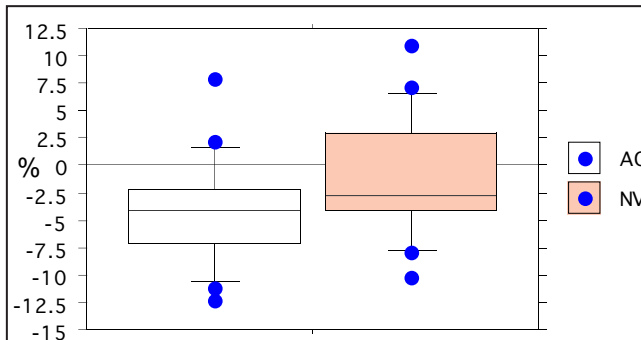
Remarkably, a high proportion of building controls and devices accessible to occupants (including maintenance staff) do not fulfil these simple criteria. As a result, uncertainty and frustration as well as discomfort are the inevitable outcomes. User-friendly controls are “no brainers” because they are effective and intuitively obvious, and accomplish all four without the occupant having to think about it; the less successful can be quickly abandoned if they do not work properly (see example above).

Perceived productivity, as might be expected, goes with comfort and health. More surprisingly perhaps, productivity is also associated with energy efficiency. The link is **performance monitoring**, promoted by management awareness and aided by well-defined targets and effective practice. This creates self-fulfilling, “virtuous” causation with good effects in one area carrying over into others. For example, a daily reporting-back system operated by the cleaners may improve security and mainte-



Perceived productivity: percentile scores for 50 most recent buildings in Building Use Studies dataset

Seventy per cent of UK offices report perceived productivity to be less than zero.
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Differences in perceived productivity for air conditioned (AC) and naturally ventilated (NV) buildings (UK 1990-98)

Each box plot shows 10th, 25th, 50th (median), 75th and 90th percentiles. For means AC= minus 4.1%; NV=minus 1.3%. This plot does not include mixed-mode (MM) or advanced naturally ventilated buildings (ANV).

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nance, picking up things that go wrong more quickly, and highlighting equipment faults and breakdowns. Energy targeting against best-practice yardsticks may uncover occupancy inefficiency - such as bringing on the entire air-conditioning system for one or two people at weekends. Solutions can then be targeted on these people, improving comfort and service for them and improving energy consumption everywhere.

Building Use Studies data shows that about 30 per cent of British office buildings have staff who report productivity gains attributable to the building they work in (top box). These figures are based on perceived productivity - not actual productivity gains and losses, which are too difficult to measure across all the varied tasks that are carried out in offices. When researchers have tested relationships between perceived and actual productivity, they are found to be within 5 per cent of each other. Only about 10 per cent of buildings have reported perceived gains higher than 5 per cent. It is rare to find any building with gains better than 10 per cent.

Are naturally-ventilated (NV) buildings perceived as more productive than air-conditioned (AC)? Yes and no! The box plots (bottom box) show NV buildings to be better, but when tested more thoroughly they are nearly but not quite significantly different ($p=0.07$ at the 95% level of significance). People prefer natural ventilation in winter and air conditioning, reasonably enough, in the hot, humid parts of summer, so well-designed “mixed-mode” offices have much to offer.

References

This is a distillation of LEAMAN A. and BORDASS W., Productivity in Buildings: the killer variables, first published at the Workplace Comfort Forum, London, 1997, October 29-30 (also available from the Usable Buildings Publications page) and revised as Probe 15: Productivity: the killer variables, Building Services, The CIBSE Journal, 1998, June, pps. 41-43. A review of further research may be found in OSELAND, N., How best practice can improve productivity: the relationship between energy efficiency and staff productivity, Workplace Comfort Forum, London, 1997, October 29-30.