

Operational measures of productivity in buildings

Observations by Adrian Leaman

Work on this subject has been around since the 1920s in military and civilian contexts. It has become something of a Holy Grail. There is an intimidating literature, much of it inconclusive and 'single issue', on topics such as "Does daylight affect work productivity?". Management tends to be dazzled by the promises the area offers: productivity statistics in building occupant surveys are usually the first thing examined in survey results, for instance.

But there is a problem. At one end of the spectrum - common sense - it is obvious that conditions in buildings affect workplace productivity. If people are too hot and uncomfortable, and it is too noisy and stuffy, for example, most will suffer (cussedly, there are always exceptions when people are involved!). At the opposite end - proof - buildings are complicated systems with a multitude of variables, many of them surrogates for each other, so it can be difficult, or perhaps better put more strongly, impossible, to account for all the effects and causes. Proof always tends to be a tantalising step away.

This is compounded by unrealistic expectations. What is studying workplace productivity actually about? Is it 'only' (use the word very cautiously, see later) a measurement tool, or is it something more than that? Research on workplace productivity often lures researchers beguilingly towards a search for cause and effect, aided by statistical techniques and methods which may not be best suited for the quest. Buildings are expensive to study; they are not laboratories, so inputs and contexts cannot be controlled as if they were in an experiment. 'Multivariate' statistical methods like factor analysis and its siblings, which are supposed to help find a way through the maze, often make it worse, re-arranging variables and leading up blind alleys.

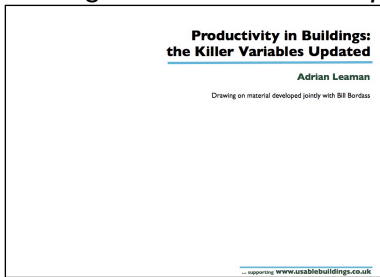
Usually, over-inflated expectations and cost scupper projects. Is this real-world research or is it more like applied psychology, drawing on statistical modelling, hypothesis testing, causality, etc.. Our experience is that it is only practical to follow the real-world research route. For us, this means detailed case studies, supported by a relatively small amount of data, collected with great care, paying close attention to physical aspects (the building and its technical systems) and behavioural (user tasks and attitudes, including management). The more buildings that can be looked at, the better, obviously. But is much better to have fewer cases (say 10) targeted very well, than a larger number shot at with a blunderbuss.

The following are some of the reasons why building performance, including workplace productivity, is hard to study. We argue that it is different enough from mainstream research to be a discipline and research area in its own right (although this is not yet recognised as such). It is not enough to import bespoke methods from other disciplines. There are too many pitfalls.

1. Contexts are hard to characterise, but buildings, by definition, are contexts for behaviours. Their whole point is to increase the potential for human activity. They cannot be treated as you would a laboratory experiment or a computer simulation, by fiddling with inputs and studying consequential outputs. In the world of building performance, inputs are usually givens, and vary a lot from one case to the next.
2. Apparently minor differences (to contexts, the givens) (e.g. occupant densities) may bring about unpredictable/unstable/large outcomes. It is these effects/outcomes that you are looking for.

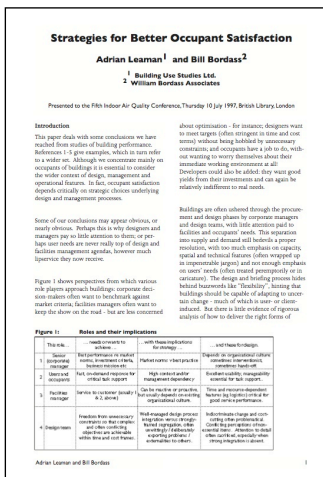
3. There are both physical and behavioural considerations, but these can be hard to characterise and capture. What is important and what can be ignored? People/researchers tend to use 'found' categories that are already embedded in the literature, but these may be framing things wrongly, or have, as AN Whitehead put it, 'misplaced concreteness', thereby putting the emphasis on the wrong things and mistakingly treating concepts as reality.
4. Also, beware category errors, such as too much stress on 'design' or 'space', and not enough on the wider building and its economic, social and urban support system.
5. Means and ends are often merged or confused, especially by professionals in the design team. Designers' agendas can also dominate, which should be resisted (e.g. too much emphasis on aesthetics and not enough on use over time and changes from one condition/state to the next).
6. Behaviour should be treated as what people actually do and how needs are really met, not what psychological theories say that they might do, or what aspirations people might have.
7. Everything is connected to everything else in the sense that you find a lot of interdependence between variables. But this raises the spectre of spurious or incomplete statistical significance. For instance, you may find that daylighting and perceived productivity are significantly associated, but have you checked all the other likely effects like noise and thermal comfort, which may be much more important in that particular situation, so you may be missing the most important effect. Analysis of variance can cope with some of this contextual variation (as it was invented in the 1930s for measuring crop productivity under conditions of local variation), but the complexity is usually too challenging in building studies.
8. Where do you draw the boundaries? In our work, we say that anything whose effect is not 'building-related' is out of scope. So ambient comfort conditions are obviously included, but things like 'morale of workforce', and 'workplace stress' are deemed out, interesting as they may be. You have to draw the line somewhere. "Need to know, not nice to have" as we put it.
9. Other topics like 'absenteeism' (modern variant 'presenteeism') are also excluded. If you ask about things involving deception, people will lie. Then you are faced with liars' paradox problems: how do you know they are lying? Better to use more subtle means of getting at this information.
10. What really do you need to know, and at what level? Is it nominal (i.e. conditions are better now than they were before), ordinal (this result is an order better than the benchmark) or interval/ratio (the perceived productivity gain in the study building is plus 4.24 per cent). Usually 'measurement' is conceived as the latter, with a great deal of huffing and puffing on numbers, the assumptions behind them and the meanings of terms employed ('averages', 'normality', 'independence', 'normalisation' etc.). But it can be preposterous to measure down to two decimal places on data sets that are basically 'noisy' or incomplete. You compound the felony by then using the assumed-to-be-precise data for cost-benefit estimations: for example, by multiplying 4.24 (the deemed productivity gain) by that proportion of the annual salary bill, then claiming that the building has 'saved' so-and-such amount of money. Researchers may be often forced to make such calculations because that is what the decision-makers expect. But what is their validity? Far better to be more modest in the aims and to nail the important effects through skilled diagnosis rather than spreadsheet-driven gerrymandering.

For further information on the above please refer to the accompanying presentation "*Productivity in Buildings: the Killer Variables Updated*".



This 2005 presentation summarises work going back to 1985, and is based on hundreds of building studies.

The accompanying 1997 paper "*Strategies for better Occupant Satisfaction*" takes a wider view (please note, Fig I has low resolution, sorry about that). The conclusions remain at the time of writing, so there is no need to rework them here.



In light of the above we have found that it is better to adopt a broader 'systems' perspective rooted in on-site observation and diagnostics, backed by occupant surveys and technical interrogations. Here focus is on:

1. How goals are set, and the ways in which these are embodied in the building (through briefing and design) and ongoing action (through management, experience of use and maintenance).
2. Whether the goals, from point 1., if set and known, are actually met.
3. How much intervention (by management) is required to meet them (the resources and skills at disposal).
4. Rules and constraints in operation in a particular context (often physical, such as layout, circulation, density of occupation).
5. Information flows or lack of (especially related to complaints from occupants, usability and aspects of human factors).
6. Positive / 'virtuous' feedback processes (the processes that actually make a significant improvement).
7. Negative / 'vicious' feedback processes (the sources of chronic, and more seriously, acute, failures).

- 8. Material stocks/stores and flows in the system and the constraints / bottlenecks affecting them (energy, people, goods, etc.). How efficiently things work. Note information flows are in point 4.
- 9. Numbers describing any of the above in 1-8.

The above list is a development of Donella Meadows' *Leverage Points: Places to Intervene in a System*, The Sustainability Institute, 1999 .

http://www.donellameadows.org/wp-content/userfiles/Leverage_Points.pdf



The most important parameters/variables (the terms are inter-changeable) in buildings from a productivity viewpoint tend to be the length of delay in feedback loops / speed of response to specified user needs, density of occupation, comfort conditions, physical layout for e.g. workgroups and usability/manageability of systems and controls. These were termed "Killer Variables" in our 1995 paper "Productivity in Buildings: the killer variables " (see earlier).

Figure 6: Three routes for better occupant satisfaction

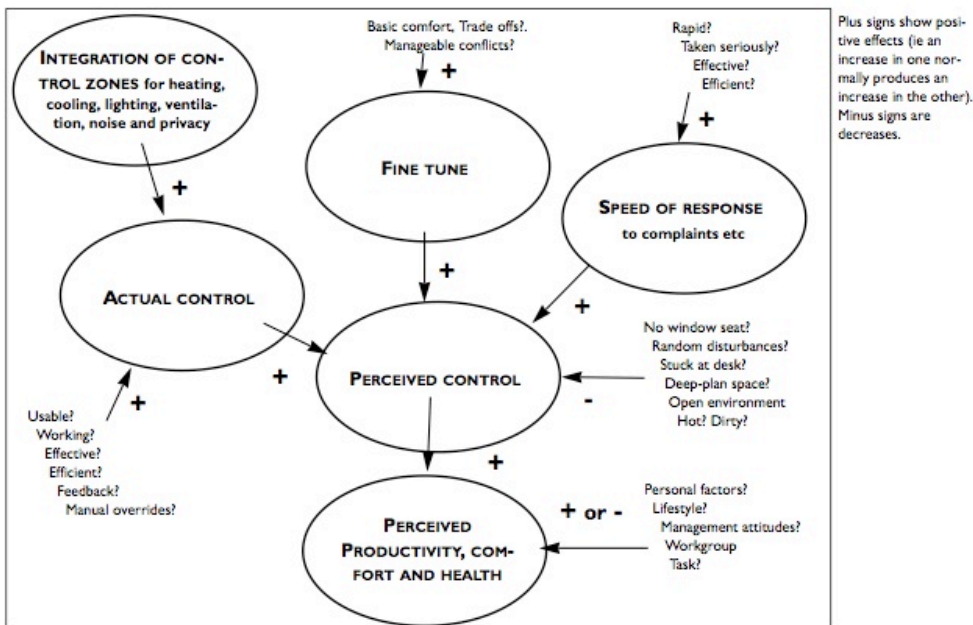


Figure 6, page 7 of "Strategies for Better Occupant Satisfaction" is an example of how interdependencies may be conceptualised in a 'systems' view. The diagram basically shows levels 5,6 and 7 from the above list. Please note: 1. This is from an earlier 1993 paper with emphasis on perceived control (placed at the centre of the diagram). 2. Perceived productivity, perceived comfort and perceived health are clustered together, mainly because the statistics are strongly associated. An updated version of this could be developed around the "killer variable" paper, or

produced anew from other evidence. The important parts are the plus and minus signs: positive and negative feedbacks.

Essentially you are searching for interventions which have best effects in the long term in the wider system. This involves looking at all levels in the system, not simply at level 9, which is the unfortunate norm in this area of study.

In our survey work with the BUS Occupant Survey (now called "BUS Methodology") we use one question on perceived productivity (out of over 50 in the survey itself). This was first introduced in 1985 and has not been changed since. On many occasions we have heard critics say: "Your question only (sic) deals with perceptions, it is not objective because it does not measure actual productivity at work".

<p>Productivity at work <small>Please try to evaluate this building with respect to your experience of using buildings in general.</small></p> <p>Please estimate how you think your productivity at work is decreased or increased by the environmental conditions in the building?</p> <p>Productivity <small>-40%</small> <small>Please tick one point on the scale</small> <small>+40%</small> Productivity Decreased or less <small>-30%</small> <small>-20%</small> <small>-10%</small> <small>0</small> <small>+10%</small> <small>+20%</small> <small>+30%</small> or more Increased by ...</p> <table border="1"><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr></table> <p>Comments about productivity</p>	1	2	3	4	5	6	7	8	9	© Copyright BUS Methodology 2013
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Two main points from this. First: for our purposes "subjective" assessments are just as good, because the purpose is building evaluation, of which productivity at work is just one part, albeit important. We have never found this to be a disadvantage, especially as we tend to compare things at the more modest nominal and ordinal levels (see above), and are wary of more detailed numeric comparisons. "Subjective" is not a dirty word; it's the way people relatively see things!! Second point arising: no-one has thought of a better and more practical way of assessing workplace productivity, especially when viewing things across many types of workplace tasks and circumstances. We will happily update our question if someone suggests a better way of doing it! Remember also that offices include people doing things other than office work. There will be certain circumstances where actual productivity could be measured (as this no doubt already is in places like call centres). However, we have never been given privileged access to any such buildings. We once came across a call centre where 'productivity' was being measured (and where people were moved desks every day making it ideal for a single measure analysis of variance), but were denied study access to the building by management's fear of reprisals from trade unions. However, would the results be of any wider use because the circumstances were so atypical?

AL 16 April 2013