Productivity Improvement

Chapter 19 of Building in Value Volume 3

Adrian Leaman
Building Use Studies Ltd.

www.usablebuildings.co.uk

Introduction

There are many sources of information on human productivity in buildings. They range from ergonomic studies of, for example, keyboard performance right through to pot-boilers for facilities managers [1]. A useful review is by Oseland [2].

This chapter deals with some of the findings from studies of buildings carried out by Building Use Studies. We will deal with the basics first, then progressively unravel some of the implications.

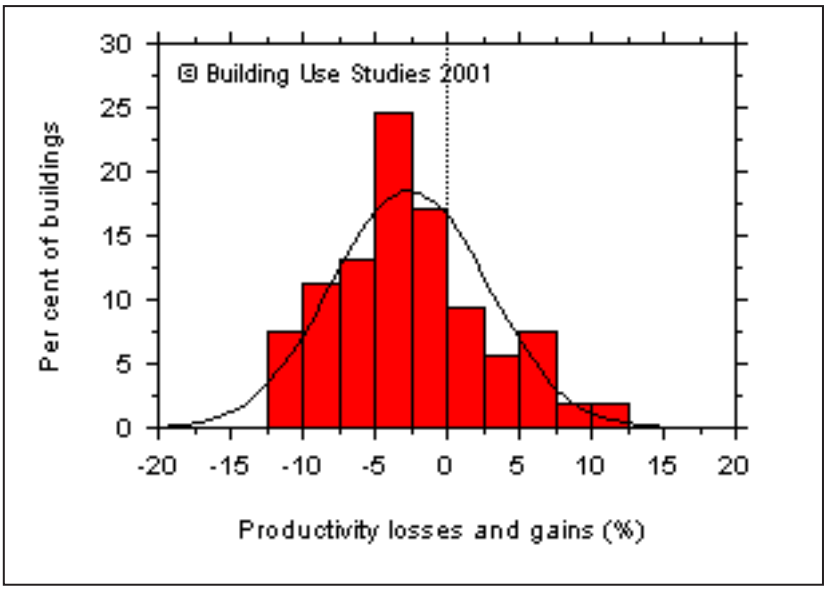
We find that productivity at work is affected by buildings by about 15 per cent upwards or downwards. To be more exact (see Figure 1 for the UK) our current data say 12.5% upwards and 17.5% downwards. In other words, in the "best" buildings workplace productivity seems to be lifted by, at best 12.5%, and the "worst" it is reduced by 17.5%.

Having said this, three begged questions immediately need tackling. What do we mean by "normally", "best" and "worst"?

- "Normally" means in "the course of normal operation";
- "Best" means the top five percent of the buildings we have studied;
- "Worst" means the bottom five percent.

We restrict ourselves to the buildings actually visited by ourselves or our licensees, we do not use secondary sources or hearsay. There will be buildings out there where productivity is better and worse than the ones we have found. The normal curve superimposed on the real data in Figure 1 gives a rule-of-thumb prediction of where the real upper and lower limits lie.

Figure 1 Perceived productivity in 50 UK buildings



This is an example of building occupant benchmarking taken from the Building Use Studies dataset.

It shows the distribution of perceived productivity for 50 UK buildings. The benchmark (i.e. the average) is minus 2.6%. The range is plus 12.5% (best) to minus 17.5% (worst) .

For example, looking at the leftmost bar on the chart, 7.5% of buildings in the dataset (from the vertical axis) have average productivity scores of minus 10% or worse (bottom axis).

In all, we have covered about 200 buildings in the UK and about 20 in ten other countries since 1990. About 80 per cent of these are offices. Statistically, these are paltry samples, but buildings are expensive and (can be) obstinate to study, and the samples are large enough to convince all but the most sceptical.

Methods

We give a standard questionnaire to staff with permanent work spaces (this includes part-time and peripatetic staff). The questionnaire has over 40 self-assessment categories covering comfort, health, satisfaction, design quality, user needs and several more. The productivity question is just one of this group of over 40.

In buildings with complex user profiles (like schools or magistrates' courts, for example) there may be variations on the basic questionnaire for different user groups (teachers, pupils, office staff, judges, prisoners, local users etc.).

These questions (plus opportunities for comments) fit on to two A4 pages, and can be answered in 5-10 minutes. [3] Why not more? Because:

- the longer the questionnaire, the less chance we have of managers allowing us in to study the building;
- more questions generate too much information which is costly to manage effectively over many buildings.

We use "need to know" criteria for choice of content, not "nice to have". In other words we resist:

- changing the questionnaire too much from one study to the next because this makes it much harder to manage the benchmarks efficiently; and
- asking unnecessary questions (it is vital for good response that all the questions are relevant to the respondents and they see their response as useful)

Why a paper-based questionnaire, rather than e.g. an internet-based survey?. We can use either but prefer paper because:

- response rates are much higher using "traditional" hand-out-and-collect methods (we almost always get over 90% response with paper);
- it is much more difficult to make questionnaires appear short and concise on the internet because of limitations on the ability to control page layout and font definition;
- with hand-out-and-collect there is always a researcher on the spot to deal with queries and, sometimes, to be shown things by respondents.

Why use "subjective" responses, not "objective" measures? We do sometimes use physical measurements (of e.g. light levels or temperature) as checks, but self-assessments from questionnaires:

- are reliable for what we are doing (which is either feedback or diagnosis, see below);
- are much cheaper;
- get to the heart of the matter more quickly (results can be turned round in days).

As Gary Raw has said: "People are the most valid measuring instruments: they are just harder to calibrate!". [4]

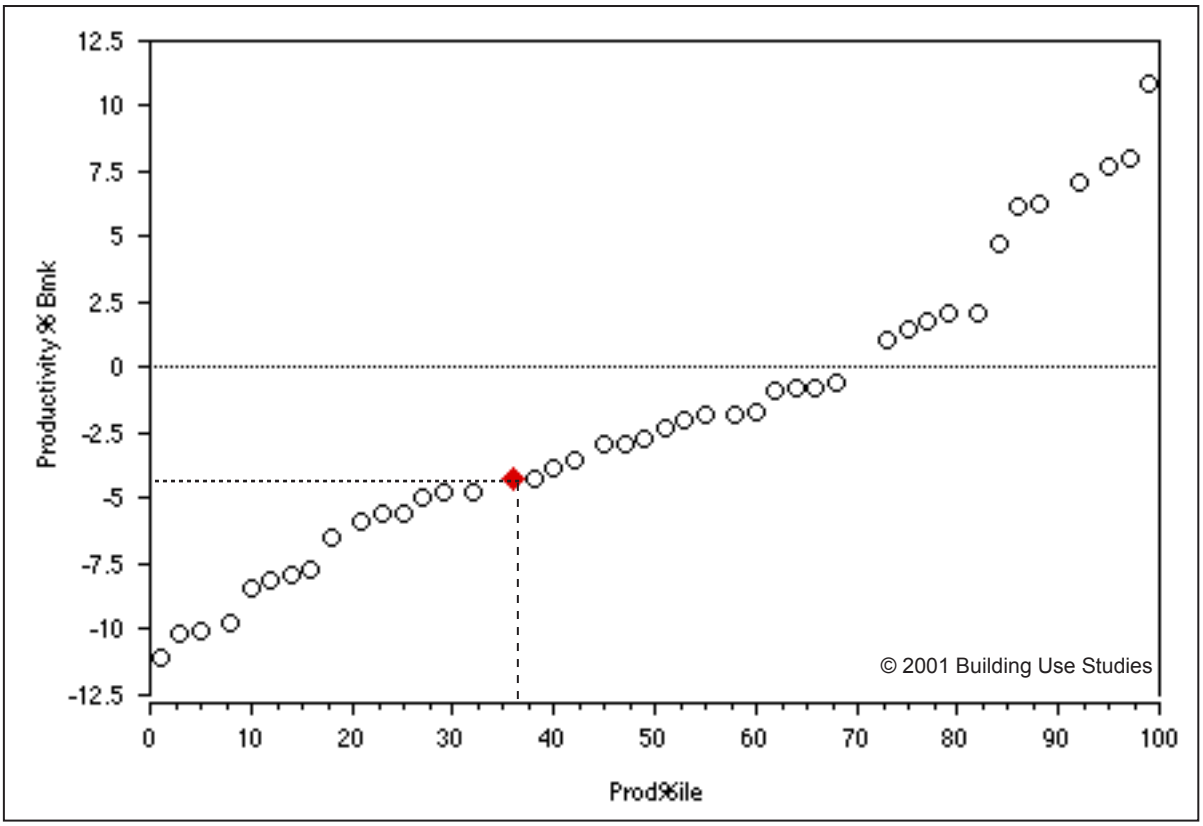
Whole questionnaires can be devoted to just one topic (e.g. health [5] or productivity). However, our studies are not normally about finding causes or testing research hypotheses on specific topics. We want to find out where buildings stand and whether they have improved or got worse - a kind of quality control writ large. We may also want to diagnose technical or design faults. This approach is "real-world" research in Robson's parlance. [5]

We use the last fifty buildings studied to produce performance benchmarks for UK buildings. As yet, we do not have large enough samples for national benchmark comparisons.

For this dataset we may:

- examine mean scores for buildings for each of the individual variables in the questionnaire (the benchmarks) against individual scores for the survey

Figure 2 Perceived productivity benchmarking



This is an example of how scores for individual buildings are benchmarked with the Building Use Studies method.

This shows results for the productivity variable (vertical axis) and the benchmark dataset (horizontal axis) sorted from lowest (left) to highest (right) and put on a percentile scale (i.e. lowest is at 1% and highest is at 99%).

The study building (diamond shape) has a mean score of minus 4.5% for perceived productivity (vertical scale) which comes at the 36th percentile on the bottom scale. The benchmark is at (or close to the 50th percentile) which in this case is minus 2.2%.

The study building (a school) thus falls in the bottom 40% of buildings in the current (2001) dataset.

building/s;

- compare the changes in benchmarks to see if things are getting better or worse (e.g. are buildings getting more or less comfortable?;
- examine relationships between the variables (e.g. how closely is health and perceived productivity related?);
- examine trends among individuals across all the buildings (e.g. do people sitting next to windows report more favourable perceptions?).

All our work on productivity so far has been reported in papers and chapters like this one [6]. We have not yet carried out an exhaustive analysis of all the data we hold on productivity because:

- our main funding is for individual building studies;
- although we collect data in a rigorously maintained format, retrospective analysis over (say) fifty buildings in still costly;
- we do not think it is really necessary - most of the conclusions of note can be extracted without detailed analysis.

Building Use Studies licences the questionnaire. In exchange for a licence (which is free to postgraduate students, with a fee charged to others) you get the latest version of the questionnaire plus a pre-formatted data file. Licensing helps us to:

- develop a relationship with researchers carrying out the studies so that they get the benefit of our experience and

we, in exchange, get their data files, the statistics from which can then be anonymously added to the benchmark dataset;

- keep in touch with the most recent work so that this can be publicised on our website, or,
- if the findings are not to be placed in the public domain, guarantee their confidentiality;
- get independent criticism and quality control from researchers on the development of the methodology;
- publicise the findings (without necessarily saying which buildings are involved).

Without this type of licensing arrangement, we would not know who is using these techniques and the feedback loop is thus broken. As the whole point is feedback, the licensing helps "manage" the loop.

Findings

It cannot be over-stressed how difficult buildings are to study properly. In the jargon they are "complex dynamic open systems", with hundreds of apparently relevant variables. Not only are they "multivariate" - which is headache enough - but their contexts change from one building to the next. Their circumstances are always different, so not only do you have the complexity of the buildings and occupants to contend with (and the interactions), there is also the small matters of site, design, procurement, ownership, history, aesthetics and so on.

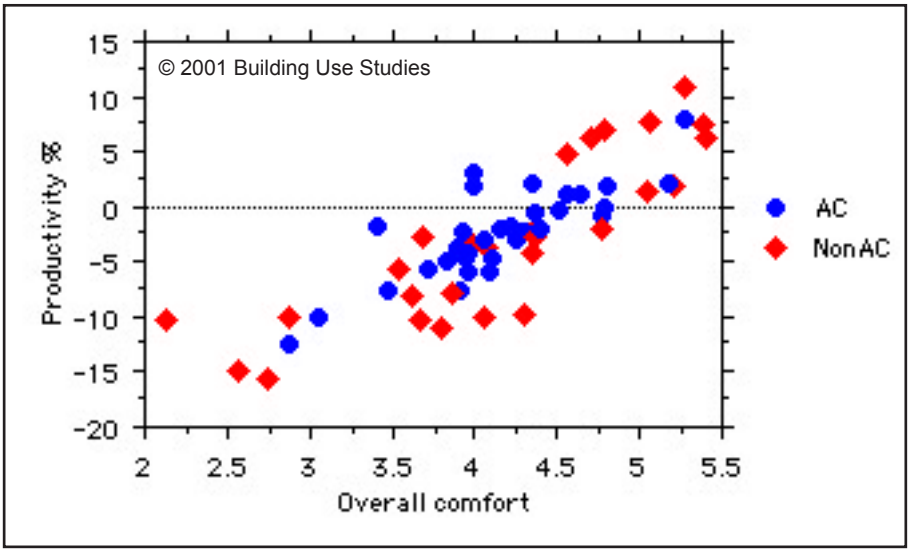
A researcher may need to account for all this variety because some of it may be relevant in a particular case, and you cannot tell in advance what might be. But if you let the variety dominate, you will be overwhelmed by an incomprehensible data mountain. Do not assume that statistical methods like multivariate analysis will help - they will probably make things worse by reorganising the complexity and repeating it back to you in another form. In general, we prefer to use simple, stripped-down statistics which tell a simple story clearly, or have good "question-answering ability" where the data give unambiguous answers to simple-defined questions.

We use a simple, robust method not only to obtain the data relatively efficiently, but also to convince the sceptics. Over the years, we have learnt which of the multitude of variables are most likely to yield useful results in pinpointing whether occupants think buildings work well or not. Many of our findings are "nearly obvious" - they are common sense. However, it is remarkable the extent to which people will only believe them once they have been shown the quantitative evidence.

We find from the dataset as a whole:

- Productivity, health and satisfaction variables are almost always linked to comfort - the better the occupants think the indoor environment is, the more likely people will say they are productive, healthy and happy, see Figure 3 (similar graphs can be shown for e.g. comfort and perceived health).
- People usually say they are more productive when they have relatively more control over the heating, cooling, ventilation, noise and lighting in their immediate vicinity (often in that order of importance).
- If control is not available to occupants through physical means (like window blinds and radiator controls) it usually can be made up for by pro-active, rapid, or even, in the absence of anything else, honest responses from friendly and diligent facility management staff.
- People want things that are usable, manageable and work well for them on demand or without holding them up too much. Despite what designers think, nice-looking working environments tend to be lower down occupants' priority lists. This said, a good-looking building will sometimes make people more tolerant of a buildings' shortcomings (we call this "forgiveness").
- simple naturally-ventilated buildings often (but not always) give better results for productivity than air-conditioned, mainly because there is usually more user control. But the "objective" conditions in them do not necessarily have to be better. The obverse is that "overstressed" naturally-ventilated buildings (such as those that are too deep in plan, too densely occupied, or with limited

Figure 3 Comfort and perceived productivity relationships



These are data points for 77 UK buildings from the Building Use Studies dataset. The relationship between Overall Comfort and Perceived Productivity is highly significant with the correlations nearly the same for air-conditioned buildings (=0.824) and naturally-ventialed or mixed mode (=0.84).

Note how the very good and very poor buildings tend to be non-AC, whereas AC tend to be more clustered in the middle.

or idiosyncratic user control) can produce dreadful conditions, especially in the height of summer.

- The more functions and activities people have to cope with, the less likely they are to say they are productive as well. So open plan often scores worse simply because the number of activities is greater and so is the potential for unmanageable conflicts (there are always exceptions, though).
- Noise is a growing problem, especially with random distractions created by activities which are perceived as irrelevant to a particular individuals' requirements. This, obviously, is worse in open plan.

These generalisations can also be presented as the aspects of buildings which people prefer. Again, readers will already know most of the answers from their own experiences of buildings. The following list is adapted from the Probe studies [7].

High occupant satisfaction is easier to achieve when all or most of the following features are present in the total system (because they help "virtuous" processes develop or give occupants better control, which ultimately improves their tolerance).

These include:

- Shallower plan forms and depths of space (usually less than 15m across the building).
- Degrees of cellularisation (not necessarily in single-person offices, but at least laid out so that workgroup integrity is preserved).
- Thermal mass.
- Absence of gratuitous glazing.
- Stable and comfortable thermal conditions.
- Controlled background ventilation without unwanted air infiltration.
- Openable windows.
- Views out.
- Usable controls and interfaces.
- A non-sedentary workforce (people are not at e.g. VDUs all day long).
- Predictable occupancy patterns.
- Well-informed, responsive and diligent management.
- Places to go at break times inside or away from the building.

Published examples of buildings which meet most of these criteria with high levels of excellence are the Elizabeth Fry Building, Norwich UK [8] and the Tax Office, Enschede, Netherlands [9], both in the Probe series.

The tendency for things to become unmanageable, and thus for occupants' tolerance to decline, can be made worse by some or all of these:

- Deeper plan forms with variable qualities of indoor conditions (e.g. worse towards the middle, better towards the windows).
- Senior staff monopolising the best places, often also leaving them unoccupied when others have to suffer.
- Areas in use for staff workstations which were not originally intended to be so (e.g. converted storage areas, basements and meeting rooms).
- Large open work areas with little variety in them.
- Larger workgroups (above about six people).
- Workgroups where people are not sitting within line of sight and earshot of each other, perhaps with people split between different locations.
- People sitting too close to sources of noise and random distraction like entrance/exit doors, kitchens, photocopiers and touchdown areas.
- People sitting with their backs to colleagues or circulation areas.
- Too many conflicting activities in one area (especially where people needing to concentrate are mixed in with people needing to communicate frequently).
- Higher densities (thresholds differ so there is no rule of thumb).
- Longer working hours.
- Presence of complex technology.
- Ineffective, absent or bossy facilities management.

It is easier to produce bullet points of do's and don'ts, than make them work in any given situation. For example, in the UK we have found productivity losses of 15 percent in a building with most of the features in the first (supposedly "good") list - shallow plan, naturally ventilated and so on. The reasons why it was so poor were:

1. poor thermal performance in summer;
2. occupant densities which were too high for the "carrying capacity" of the spaces. The high densities were created by a sudden demand for extra staff produced by a recruitment campaign.

We have also found buildings which on the surface seem candidates for poor workplace productivity (with several of the features in the second list) which turn out to be surprisingly good. Usually, the reason is that the occupiers have devoted sufficient resources to facility management functions so that problems can be quickly dealt with as they arise and - importantly - the occupants can see the positive results for themselves.

The best results are usually obtained where:

1. the indoor environmental conditions are comfortable, stable and predictable;
2. when things go wrong (not just with the ambient conditions) but with other things as well (like office equipment or furniture failures) there is a rapid and effective response system in place. This can be empowered individuals using their initiative and common sense (e.g. with window and blind controls, or cleaning up things (like spilt coffee) for themselves) or a management system which works properly. Rapid response if the key: anything that prevents this happening in practice will reduce perceived productivity.

However, if the building is basically too hot or too cold, or both, or has some other kind of unmanageable discomfort (like noise from traffic) it is usually pointless trying to apply lipstick on the gorilla. For example, it may be better in the long term to sort out a poorly functioning air-handling system than try a new space plan.

A broader perspective

Looking at buildings from other points of view (such as comfort, health and energy efficiency) we have found that it is best to avoid:

- unmanageable complexity;
- excessive technological and management dependency;
- fragile systems (i.e. those that break down easily);
- tightly-coupled systems (i.e. those with

many interdependent parts);

- situations where the occupiers cannot "own" problems which direct affect them.

This list is a distillation of an approach to building briefing, design and procurement for which more details may be found on www.usablebuildings.co.uk. A shorter version is in Figure 4!

Things tend to go wrong when interactions between technology and management break down or do not work properly. Low productivity is one such effect (another is poor energy efficiency). Both are symptoms of chronic building performance problems which tend to endure (and sometimes get progressively worse, as in the case of "sick" buildings).

Figure 5 divides buildings into four types using technological complexity and management input as the dimensions. The most effective from an all-round performance perspective are Type A (complex but with high management inputs) and Type B (simpler with lower or minimal management inputs). The danger zone is Type C - buildings which are relatively complex but do not have enough management resources to service the complexity. Type Cs form the majority of the office stock in the UK. The public sector is particularly prone to Type Cs (for further discussion see [10]). Type Ds are much rarer, but are often unrealistically used as exemplars.

The key to productivity improvement at the strategic level is to ensure that buildings are clearly placed either in the Type A box or in the Type B and to avoid producing more of the sadly ubiquitous Type Cs.

The intensification of many buildings, with more equipment, greater space productivity, and longer hours of operation; all requiring high levels of management and support services - ideally lead to the Type A buildings in Figure 5. However, this intensification activity can lead people to think that soon all buildings will be like this.

However intensification is just one part of a larger system. It is inextricably connected to its companion, diversification, as when intensified office headquarters support people who also spend some of their time in dispersed locations. Some of these locations may be intensified too (e.g. hotels) but many are simpler.

Figure 4: Simple Guidelines

PROCESS before PRODUCT
PRODUCT and back to PROCESS
PASSIVE before ACTIVE
SIMPLE before COMPLICATED
BETTER before MORE
PREVENTION before CURE
80 before 20
ROBUST before FRAGILE
SELF MANAGING before MANAGED
EFFICIENT before ELABORATE
TRICKLE before BOOST
INTELLIGIBLE before INTELLIGENT
USABLE before ALIENATING
FORGIVING before DEMANDING
ASSETS before NUISANCES
RESPONSE before PROVISION
OFF before ON
EXPERIENCE before HOPE
THOUGHT before ACTION
HORSES before CARTS

Source: Bill Bordass (1996) used in client presentations.

If intensified buildings are just the tip of the iceberg, many uses may go best in highly robust, adaptable, environmentally benign buildings: ideally Type Bs in our parlance.

If productivity improvement is a serious goal and not just lipservice, then it makes sense to try to create a new generation of office buildings which are simpler, smaller in scale and height, more robust in their capability to deal with change of use, more controllable for their occupants, more likely to have at least some natural ventilation and more benign environmentally.

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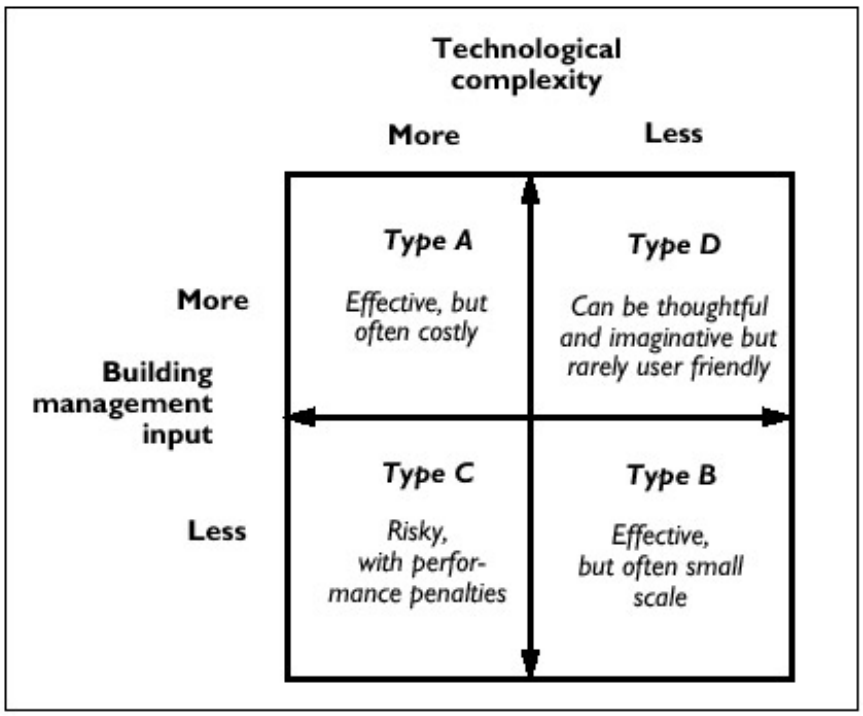
Figure 5: Building types



Source: Bill Bordass and Adrian Leaman