Research papers

Quantifying the impact of environmental conditions on worker performance for inputting to a business case to justify enhanced workplace design features

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Abstract

Despite the plethora of research showing the impact of environmental conditions on performance, the majority of UK businesses do not accept changes in productivity as part of the business case justification for improvements to the working environment. The authors' intention was to develop a practical methodology to help predict the potential gain in worker productivity that can be expected following design improvements. They carried out a literature review of productivity research and conducted a meta-analysis of 75 studies to quantify the impact of environmental conditions and design factors on performance. The unique aspect of the literature review is that the reported percentage changes in performance were weighted according to the relevance of the research study to real offices and office workers. The weightings converted the widely varying raw research results into what appears to be a more credible range of performance effects. The authors believe that their figures are ones that are more likely to be accepted by financial directors when used in building a business case. Due to the lack of rigorous multiple-factor studies, they proposed that the effect on performance of single factors can be added, but using a relationship based on the law of diminishing returns. Re-analysis of recent research of combined factors indicates that a 'two-thirds, one-third' rule of thumb may be appropriate. The authors believe that they have created a robust methodology for quantifying performance effects. The approach is

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one that is more likely to be accepted by financial directors for use in the business case for workplace improvements.

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PRODUCTIVITY HISTORY AND RATIONALE FOR FURTHER RESEARCH

Interest in measuring productivity dates back to the Sumerians some 7,000 years ago, who kept individual records of each worker's performance. Empirical research on the impact of environmental conditions on worker performance has been conducted since the early 20th century; the beginning of these studies coincides with the increasing popularity of large commercial offices and the introduction of scientific management to measure efficiency.[1] Over the last 15 years there have been many literature reviews all highlighting a clear effect of environmental conditions and design features on individual and business performance. Those published by UK professional bodies include CIBSE,[2] CABE/BCO[3] and RICS.[4] Several of the reviews acknowledge that organisational and motivational factors are likely to have the biggest impact on productivity but conclude that environmental factors may account for a 5–15 per cent increase.

It is now well documented that in the region of 85 per cent of a business's costs are related to staff salaries and overheads, with the remainder covering amortised office construction and operating costs over a 25 year cycle.[3,5] This breakdown implies that reducing staff costs by 15 per cent while maintaining performance, or conversely increasing performance for similar salary costs, would cover all office costs. Indeed several reports, in particular those published by North American-based organisations such as BOMA[6] and the EPA,[7] quantify productivity effects by monetising them using average salary costs. They illustrate their approach by calculating the change in productivity, based on salary costs, required to offset the investment of installing air-conditioning and the associated additional energy consumption. It could be argued that the economic benefit should be based on the typical revenue generated by the staff, or at least on the full 'on-cost' (including overheads), rather than simply using their base salary costs. More recently, Burt *et al*.[8] explain how to develop a business case for flexible working and suggest:

> A final method is to actually estimate the financial benefit of the so-called 'non-tangible benefits'. As an example, estimate the percentage reduction in absenteeism, or the additional hours worked, and convert them to the equivalent in salary costs or revenue generation.

Despite the abundance of research showing the impact of environmental conditions and workplace design on performance, and despite the tried and tested method of converting productivity gains to cost savings, the majority of the UK design and construction industry does not consider changes in productivity as part of the business case for investment (financial investment appraisal) in new office fit-outs or refurbishment. In their study of how to measure the impact of office design on productivity, Oseland and Bartlett found that only one in eight organisations had productivity metrics in place and none monitored the relationship between the environmental conditions and business performance.[9] The main reason given for not making such measurements was that it is too difficult to quantify productivity gains for office workers. Furthermore, the justification for investment in the workplace was predominantly based on cost savings, which are more easily measured, and the potential impact on business performance (whether good or bad) was ignored.

It appears that ignoring productivity is not uncommon across the wider design and construction industry:

> [. . .] there is a seemingly endless drive for improved efficiency in the workplace, and a tendency for the performance of property . . . to be measured on efficiency grounds alone . . . effectiveness of the workplace receives relatively few column inches of coverage and may even be compromised in a blind drive for efficiency[4]

Anecdotal evidence, derived from client conversations and conference discussions, indicates that financial directors who readily accept a business case based on space saving and associated reduced property costs are unwilling to entertain a business case built upon potential productivity gains, as they have little confidence in the results reported in performance studies. In fairness, this attitude is partly justified due to the wide range of productivity gains reported in the research literature. The authors' own literature review of productivity research revealed reported gains in performance ranging from 0.3 per cent to 160 per cent (see the tables in Appendices A to F, available in the online version of the journal only). There is therefore clearly a need to provide productivity data that are acceptable for use in developing a business case.

OBJECTIVES OF THE RESEARCH

The Atomic Weapons Establishment (AWE) occupies some 215 buildings with approximately 6,000 people all working in a similar company culture. The AWE carried out a post-occupancy evaluation (POE) of 1,420 of their staff located in 14 of their office buildings. The Building Use Studies questionnaire was administered, which includes a long-established question on self-assessed performance.[10] The POE revealed a correlation between perceived productivity and the quality of the working environment (quantified by the AWE's in-house building condition survey). People in the AWE's 1950s legacy buildings believed that their productivity at work was 2.2 per cent lower than that reported in their more recently built (Portland) building. Furthermore, the mean perceived productivity was 4.8 per cent lower in the legacy buildings than in AWE's newest (Gemini) building. While it is arguable that perceived productivity may not directly equate with actual productivity, the data did show that there are differences in perceived productivity due to observable differences in quality of work environments. As a consequence of the POE and condition survey, the AWE recognises that worker performance is undoubtedly affected by environmental conditions and office design.

The AWE has a standard business case process for justifying spend on improving offices. The process includes Monte Carlo analysis to predict the risk of cost overrun on workplace projects. However, the process does not account for any potential change to productivity. The AWE therefore approached the authors to establish a methodology to account for changes in productivity that would align with their standard business case process. The aims of the research were to:

- review the productivity literature and conduct a meta-analysis to quantify the impact of design factors on performance;
- create a 'rule of thumb' for potential benefits of design factors;
- develop a methodology that predicts the improvement in staff productivity that can be expected following design improvements to the working environment;
- estimate the full financial value of design changes.

A practical tool was needed that would enable a range of businesses to use a similar approach to determine how building design can affect staff performance. Basically, input variables were required to be used in the business case for office improvements. The authors believe that their methodology and findings are sufficiently generic to apply to all office environments and be sufficiently convincing to be adopted by any sceptical financial directors.

LITERATURE REVIEW AND META-ANALYSIS

A literature review was carried out on productivity research related to the impact of environmental conditions and office design. The original papers reviewed were mostly those highlighted within the productivity literature reviews mentioned in the introductory paragraphs. In addition, relevant papers freely available on the web, and case studies or internal reports to which the authors had access, were also reviewed. Over 200 research papers were initially considered, but the research studies included as part of our analysis (listed in Appendices A to F in the online version of this paper) are those that i) involve experimental research; ii) clearly identify dependent and independent variables; and iii) report a measured percentage change in performance. So, for example, opinion papers and reported results without methodology details were excluded from the review.

The tables in the appendices highlight that the experiments of 75 different researchers were included, and between them they reported the results of 135 different performance metrics. It is acknowledged that the productivity research reviewed by the authors is not exhaustive, but it is believed that it is representative of the better-quality productivity research.

The main independent variable (environmental factor) was identified for each of the research papers. Lighting (L), noise (N), temperature (T), ventilation (V), personal control (C), furniture (F), space (S) and general (G) were identified as key factors. 'General' refers to studies that explored the impact of all environmental conditions combined, for example a questionnaire survey with an overall satisfaction score. The tables in Appendices A to F are ordered according to these eight environmental factors. Some of the papers reviewed are studies of multiple independent variables, but they usually have a predominant factor. Multiple acronyms are used in the tables to identify these multiple factor studies.

Once the research studies were collated, it was evident that the studies varied considerably in approach. It is therefore not surprising that there is such a range of reported performance gains, as discussed earlier. The authors identified three broad categories of methodological differences, each with eight subcategories, which were then weighted according to their relevance to office work (see Table 1).

Research environment (category 1) refers to the place where the productivity research was carried out. Much of the earlier productivity research was conducted in industrial settings, and many studies are carried out in laboratories or office simulations. There are fewer studies in real offices or call centres, and some research is simply based on broader office surveys or a review of reported studies. Clearly, the studies carried out in real office or good office simulations are more relevant to the impact of office design on productivity than, say, those carried out in factories; and as such are awarded a higher weighting.

Performance metric (category 2) refers to the measurement made to evaluate the change in productivity. Much research is based on self-reported or perceived performance and some studies rely on surveys of multiple offices or an estimate concluded from a literature review. Fewer studies use performance tasks or an embedded business metric. Another subcategory is HR-related metrics such as absenteeism and staff attrition (turnover). The weighting reflects that quantified and objective metrics such as performance tasks or embedded business metrics are more likely to be favoured by financial directors than the more subjective metrics such as self-rated performance.

Activity time (category 3) refers to the amount of time that the measurement might be observed in a real office building and are weighted accordingly. For example, some performance metrics such as paper-based activities or manual labour may apply to only a small proportion of the typical office worker's day. 'Heads down' refers to all

Table 1: Three categories of methodological differences each with eight subcategories

1. Research environment	*Weight*	*2. Performance metric*	*Weight*	*3. Activity time*	*Weight*
Literature review	39%	Review/estimate	35%	Manual	1.0%
Survey/poll	40%	Survey/opinion	50%	Absenteeism	8.4%
Light industry	46%	Manual task	47%	Heads down	31.9%
Heavy industry	35%	Perceived performance	48%	Paper-based	7.9%
Laboratory	40%	Performance task	51%	Attrition	15.7%
Simulation	53%	Absenteeism	67%	PC work	24.0%
Call centre	70%	Attrition	65%	Call centre	79.3%
Office	82%	Business metric	68%	Office	63.5%

desk-based work, which may include a combination of PC and paper-based work. HR metrics or measurements in real offices would apply to all the time spent in the office, but exclude holiday, sickness and training etc.

The authors believe that the three main factors above affect the relevance of the research studies and their reported changes in performance. Other productivity researchers have previously identified that productivity results should be weighted according to the types of metrics used and the research environment.[11] Their subcategories for weighting did overlap with those of the authors, but they could not be mapped directly onto the subcategories derived from the present literature review. It was therefore decided to develop weightings based on expert opinion. The authors approached the Office Productivity Network, 'the premier information resource for managers of office based businesses to improve the productivity of their workforce through their office environment'.[12] The literature review was shared at a workshop and the members were asked to weight the subcategories of the experimental environment (category 1) and the performance metrics applied (category 2). The mean of the weightings of the 14 members present at the workshop are shown in Table 1 and incorporated into the analysis.

To weight the activity time (category 3) a time utilisation survey database was referred to. The Space Occupancy Survey of AMA[13] includes observations of work activities in over 140 buildings with 48,000 workspaces. AMA provided the authors with the mean time spent at work carrying out PC work, paper-based work, heads-down activity and total time at the desk for general office workers and call centre staff. The authors calculated the HR metrics, attrition and absenteeism, using the reported benchmark figures of the CIPD.[14] The AMA figures were adjusted to reflect holiday, training and sick leave. Manual labour was estimated at a notional 1 per cent. The weightings for activity time are also shown in Table 1.

Each research study was assigned a single overall weighting to reflect its relevance to the office environment and the authors' confidence in the reported results (column O in the appendices). This overall weighting is the product of the three most relevant subcategory weightings, as identified in Table 1. Thus, for example, a study of real offices using embedded quantified metrics was given more credence and received a higher overall weighting than a questionnaire study in a laboratory. The overall weighting was applied to the performance gain measured in each research study; a simple multiplication of the performance (P) by overall weighting (O) was used to determine the adjusted effect. The mean and quartile range of the weighted effect was then calculated for the clusters of single factor and multiple factor studies, as shown in the tables in appendices A to F in the online version of this paper.

SINGLE VERSUS MULTIPLE FACTOR RESULTS

Table 2 shows the mean and quartile range for the performance effects reported in the single factor studies. The weighted means for the majority of the environmental factors are in the order of 1–2 per cent. The result for the impact of space on performance is higher, but there are fewer studies of space in the literature review, and this may introduce a higher margin of error. An alternative explanation is that the space studies concerned new office layouts and designs, so may genuinely have a greater effect.

The authors propose that the means and ranges of the weighted performance gains for a single environmental factor be used in business cases to model the potential productivity benefits of office design features that enhance that particular factor. At this initial stage of the research, they recommend that the upper quartile value be used in cases where the designer has complete confidence in their design proposals, and it is recommended that the mean value be used for less confident proposals. Later, with more development and data, it may be possible to model a more accurate performance effect rather than use the mean or upper quartile range.

Table 3 shows the means and quartile ranges for the multifactor studies, grouped according to the predominant environmental factor. It can be seen that the means and ranges are more diverse than for the single factors shown in Table 2. Counter-intuitively, the mean effect on performance of a predominant factor, including its other multiple factors, is not always greater than the corresponding single factor, eg L versus L+ and T versus T+. The inconsistency in range for the multiple factor studies is believed to be due to the lack of data, as there were fewer than ten studies for each predominant factor. The authors therefore have less confidence in the multiple factor results other than the General (combined study) factors, which are based on 22 studies.

The lack of confidence in the multiple factor studies places a restraint on the use of the data in financial investment appraisal, as most workplace design projects will change a number of environmental factors rather than one alone. In his review of the combined effect of temperature and ventilation on comfort, Toftum 'proposed that simple addition of the percent dissatisfied due to each factor was appropriate'.[15] However, looking at their own results, the authors were not convinced that simply adding the percentage performance increase of single factors would be accepted by financial directors in a business case. An alternative method of calculating the impact on performance of combined single actors was therefore required.

The 'Law of Diminishing Returns' is a universally accepted economic concept, which states

> We will get less and less extra output when we add additional doses of an input while holding other inputs fixed. In other words, the marginal product of each unit of input will decline as the amount of that input increases holding all other inputs constant.[16]

As there is little evidence to suggest otherwise, the authors propose that this law will apply to workplace environments that are being improved through additional design features. Most articles on diminishing returns show the relationship of the output to input as a logarithmic growth curve, where the magnitude of the output (dependent variable or ordinate) eventually flattens out regardless of the increase in input (independent variable or abscissa). However, the coefficients in the equations defining such relationships vary depending on the type of input and output variables. So there is no published basic equation that can be

Table 2: Weighted effect for single factor studies

Factor	*Count*	*Unweighted mean*	*Weighted effect*		
			Mean	*Lower quartile*	*Upper quartile*
Lighting (L)	17	9.5	1.1	0.1	2.0
Noise (N)	10	27.8	1.4	0.2	1.7
Temperature (T)	16	17.0	1.2	0.0	1.9
Ventilation (V)	16	9.0	1.4	0.2	1.7
Control (F)	10	8.0	1.2	0.3	2.1
Furniture (F)	8	15.7	2.1	1.0	2.1
Space (S)	3	24.1	3.5	1.7	4.4
Average/Total	**80**	**15.9**	**1.7**	**0.1**	**2.0**

Table 3: Weighted effect for multiple factor studies

Factor	*Count*	*Unweighted mean*	*Weighted effect*		
			Mean	*Lower Q*	*Upper Q*
Lighting (L+)	4	11.0	0.4	0.2	0.7
Noise (N+)	3	72.0	3.9	0.6	5.6
Temperature (T+)	8	12.0	0.7	0.1	1.0
Ventilation (V+)	6	12.4	0.6	0.0	0.1
Control (C+)	2	24.5	2.1	1.8	2.4
Furniture (F+)	6	33.1	5.8	4.3	8.4
Space (S+)	3	22.0	3.7	1.0	5.0
General (G)	22	16.7	2.7	1.2	3.2
Average/Total	**54**	**25.5**	**2.5**	**0.2**	**5.2**

adopted to describe the relationship between performance and environmental conditions.

In recent years the Danish Technical University has published several studies that have attempted to estimate the additive effects of combined environmental conditions. Clausen and Wyon[17] studied the impact on ratings of acceptability with overall indoor environment in an environmental chamber set up with three overarching conditions: i) poor condition or no improvements (0 per cent); ii) improvements partly implemented (50 per cent); and iii) improvements fully implemented (100 per cent). The improvements related to various combinations of noise, temperature, lighting and air quality conditions. The mean acceptability rating from the three conditions is shown in Table 4. Balazova *et al.*[18] conducted a climate chamber study on the effect of temperature, noise and air quality (pollution load) on acceptability. The subjects were exposed to a combination of good (G) and poor (P) conditions for all three variables. The mean rating of acceptability for each permutation of G and P is shown in Table 4. Witterseh *et al.*[19] studied offices where they introduced three levels of temperature and two levels of background noise. The mean ratings of self-assessed performance for the best (good, G) and poorest (P) temperature levels and the two noise levels are given in Table 4. Although the dependent variable in these studies is acceptability or perceived performance, there is sufficient evidence to suggest that the ratings on such scales correlate with objective measure of performance. See Oseland[2] for review.

For all three multifactor studies, the authors considered the experimental setting with the best conditions to be the upper target (100%), and the effect as a result of the other conditions is expressed as a percentage of the best result. This normalisation of the study results is shown in parenthesis in Table 4. The mean normalised effect was then calculated for the three studies. The authors believe that these results provide an insight, albeit a crude one, into how the effect of single environmental conditions might be added together to calculate the overall effect of several combined conditions. The results indicate that, as a rule of thumb, a second environmental factor may have an effect on performance that is approximately two-thirds (68 per cent) the magnitude of the first factor, and a third factor is likely to have approximately one-third (36 per cent) of the effect. Thus the percentage effect on performance for the single factors, identified in Table 2, could be estimated using the following simple equation:

$$P_O = P_1 + \tfrac{2}{3} P_2 + \tfrac{1}{3} P_3$$

Where: P_O = the overall percentage performance change;
P_1 = percentage performance change due to 1st environmental factor;
P_2 = percentage performance change due to 2nd environmental factor;
P_3 = percentage performance change due to 3rd environmental factor.

It is fully acknowledged that this equation is based on a belief that the law of diminishing returns applies to performance measurement and is linked tenuously to the magnitudes of change observed in just three studies. However, until more robust findings and guidance are unveiled it is considered that the equation above is a good enough approximation for practical use in financial investment appraisal.

CASE STUDY AND WORKED EXAMPLE

To illustrate how the weighted performance effects can be used, improvements to an existing building (C4) on the AWE site were considered. The authors tested whether small changes in staff productivity would have an influence on the financial investment appraisal for refurbishing the building.

The current layout of Building C4 has a high proportion of enclosed space. The POE of C4 showed that noise was the biggest barrier to space efficiency, represented by a move to open plan space. Potential office designs and layouts were therefore costed for three scenarios: 1) basic open plan; 2) enhanced open plan; and 3) improved workplace. Scenario 2 was specifically designed to tackle the suppression of noise through layout, acoustic panelling and study/quiet rooms (see Figure 1). Scenario 3 included the improvements to the layout in Scenario 2 but also included modifications to the building, such as new double-glazed windows and reconditioned heating and cooling systems,

Table 4: Result of multiple factor studies

Clausen & Wyon	*Acceptability rating*	*Balazova et al*	*Acceptability rating*	*Witterseh et al*	*Perceived performance*	*Mean*
100% improved (G)	−0.08 (100%)	3 × G, 0 × P conditions	0.64 (100%)	2 × G, 0 × P levels	81 (100%)	**100%**
50% improved (P/G, average)	−0.12 (67%)	2 × G + 1 × P conditions	0.32 (51%)	1 × G + 1 × P levels	71 (87%)	**68%**
0% improved (P)	−0.64 (13%)	1 × G + 2 × P conditions	0.10 (16%)	0 × G, 2 × P levels	64 (79%)	**36%**

aimed at improving the occupants' thermal comfort.

The three design proposals were then analysed using a version of the Design Excellence Evaluation Process (DEEP), an existing design analysis tool used by the Ministry of Defence.[20] DEEP was used to help identify the potential impact on comfort of the improvements made to the building under the three planning scenarios. The DEEP scores were then used to estimate the probable likelihood of achieving all the gains in productivity identified in Table 2. DEEP indicated that the maximum productivity gain derived by resolving noise issues was unlikely to be fully realised and in the order of 45 per cent of the maximum was more realistic. Thus 45 per cent of the upper quartile value for change in performance for noise (from Table 2) was therefore used. Likewise DEEP indicated that 62 per cent of the productivity gain from temperature was more likely than achieving the maximum effect. Thus 62 per cent of the upper quartile change in performance for temperature (in addition to noise) was used for Scenario 3, and weighted by two-thirds as it is the effect due to a second factor. Most organisations would not have access to DEEP and, as suggested, would use the mean or upper quartile values of the weighted performance effects depending on their confidence in the workplace design generating an effect.

The cost for the basic open plan (Scenario 1) was estimated at £8,921,000, the cost of the enhanced open plan (Scenario 2) would be £9,062,500 and the improved workplace (Scenario 3) was costed at £10,752,000. The cost of the salary of the 430 staff who would occupy the building was calculated to be £25,418,000 per annum. A simplified summary of the investment case is presented in Table 5.

The above financial illustration shows that the additional investment in the enhanced open plan (Scenario 2) is low-risk as the payback period is less — just over one year. In contrast, the business case for the grander workplace improvements (Scenario 3) is less clear as the payback period is much longer and approaching the typical five-year expected payback period if judged on productivity improvements alone. As the return is based on salary costs alone rather than the full 'on-cost' of staff, including overheads, this appraisal is considered conservative. The authors' approach to modelling the financial savings associated with improved performance was accepted by the AWE investment board.

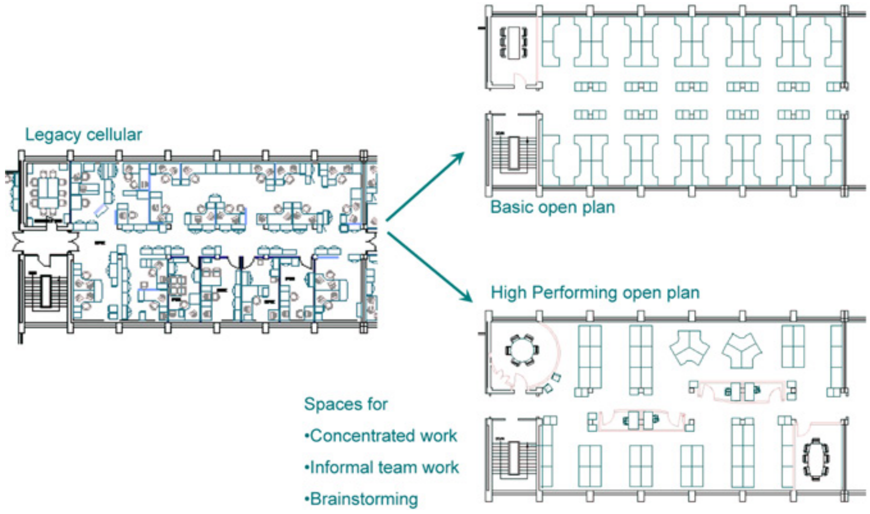

Figure 1: Comparative space plans developed for Building C4

Table 5: The business case for workplace improvements in building C4

Cost/Benefit	*Scenario 2*	*Scenario 3*
Extra costs for improvements (above Scenario 1)	£141,500	£1,831,000
Estimated (mean) percentage change in productivity (based on Noise for Scenario 1 and Temperature for Scenario 3)	0.8% (45% × 1.7%)	1.6% (0.8% + (62% × ⅔1.9%)
Staff cost savings per annum (based on 430 salaries)	£203,344	£406,688
Payback period (ratio staff savings to additional cost)	1 yr 5 mths	4 yrs 6 mths

DISCUSSION

Despite the extensive literature on productivity research, most confirming a positive effect of good office design and conditions on worker performance, it is generally not acceptable in the UK to include productivity benefits in financial investment appraisal. The AWE recognised this omission in their own business cases, and instructed the authors to develop a methodology to enable potential percentage changes to productivity gained from workplace improvements to be input to the business case to help justify the spend on those improvements. The approach was to be sufficiently robust that it would be accepted by the AWE's own investment board and the financial directors of the wider industry. The authors believe that they have created such a methodology, but nevertheless accept that the approach can be improved over time as more relevant research is generated.

The main approach was to review the productivity research literature and extract studies with clear performance measures (dependent variables) that are affected by various environmental conditions (independent variables). The unique aspect of the literature review is that the authors weighted the reported changes in performance according to the relevance of the research study to real offices and workers. The results were weighted by i) the performance metrics actually used in the study; ii) the environment in which the study took place; and iii) the length of time that the performance metric directly relates to real work activity. The weightings converted the widely varying raw research results into what appears to be a more credible range of performance effects. The authors believe that their figures are ones that are more likely to be accepted by financial directors when used in business case development.

However, the results for the single environmental factor studies are more convincing than those for the multiple factor studies. It is believed that this is due to the lack of multiple factor studies reviewed. As a consequence, the authors proposed that the effect on performance of single factors can be added but using a relationship of diminishing returns — specifically a 'two-thirds, one-third' rule of thumb. It is acknowledged that there are some leaps in logic in drawing this conclusion and the findings certainly need testing further. However, this is currently the authors' best recommendation based on the information available, and more advanced than previous attempts to quantify productivity gains.

So key areas for future research are: i) developing a method to determine a specific change in performance rather simply using the mean or upper quartile; ii) determining if revenue generated by staff rather than salary should be used to monetise the benefits; and iii) developing a more robust method for adding the effect of single factors.

Quantifying the relationship between worker performance and environmental conditions, or more broadly office design, is considered by some (eg Morrell[3]) as the 'holy grail'. Most researchers and practitioners acknowledge that there is a relationship, but as it is difficult to quantify an effect on productivity, it is often simply ignored. This approach is particularly disturbing with the current focus on reducing space and property costs. Not only do we not know how much our designs are affecting individual and business performance, but we do not even know if they are having a large negative affect on performance. The approach here has focused on justification for additional spend on improved environmental conditions and workplace design. However, it is to be hoped that it also serves as a reminder to the design and construction industry of the possible dire consequence of lack of investment in good workplace design.

Note

The author's own literary review of productivity research revealed reported gains in performance ranging from 0.3 to 160 per cent. The full figures appear in Appendices A to F, which are published in the online version of the journal only.

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