Evidence-Based Design: Theoretical and Practical Reflections of an Emerging Approach in Office Architecture

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Theoretical and Practical Reflections of an Emerging Approach in Office Architecture

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Abstract

Evidence-based design is a practice that has emerged only relatively recently, inspired by a growing popularity of evidence-based approaches in other professions such as medicine. It has received greatest attention in design for the health sector, but has received less in office architecture, although this would seem not only to be beneficial for clients, but increasingly important in a changing business environment. This paper outlines the history and origins of evidence-based practice, its influence in the health sector, as well as some of the reasons why it has been found more difficult to apply in office architecture.

Based on these theoretical reflections, data and experiences from several research case studies in diverse workplace environments are presented following a three part argument: firstly we show how organisational behaviours may change as a result of an organisation moving into a new building; secondly we argue that not all effects of space on organisations are consistent. Examples of both consistent and inconsistent results are presented, giving possible reasons for differences in outcomes. Thirdly, practical implications of evidence-based design are made and difficulties for evidence-based practice, for example the problem of investment of time, are reflected on.

The paper concludes that organisations may be distinguished according to both their spatial and transpatial structure (referring to a concept initially introduced by Hillier and Hanson in their study of societies). This means that evidence-based design in office architecture needs to recognise that it deals with a multiplicity of possible organisational forms, with specific clients requiring case-dependent research and evidence gathering. In this evidence-based design practice differs markedly from evidence-based medicine. Finally, we suggest a framework for systematic review inclusion criteria in the development of Evidence-Based Design as a field of practice. We argue that it is only through the development of an approach tailored to the specific nature of design practice and organisational function that research evidence can properly be brought to bear.

Keywords
Architecture; Design Practice; Evidence-Based Design; Workplace; Research; Case Study.

During the last decade evidence-based design has emerged as a new approach to improve the quality and fitness for purpose of building designs. In a situation where the business world is constantly striving for more efficient and effective management models, while at the same time taking account of the crucial role of individuals as main source of knowledge and value creation, the role of design needs also to be reconsidered. First of all, design should be made to fit a client organisation's needs, i.e. it ought to provide a solution to the specific problems faced by a client, and hence, be effective and tailored. Second, a design does not need to fit just anyone, but it needs to suit the specific user(s) concerned.

These considerations follow an attitude expressed by the Dutch architect Herman Hertzberger:

> *"What can architecture be other than concerning oneself with situations in daily life as lived by all people? It's rather like clothing, which must after all not only suit you well, but also fit properly. (…) Architecture, indeed, everything that is built, cannot help playing some kind of role in the lives of the people who use it, and it is the architect's main task, whether he likes it or not, to see to it that everything he makes is adequate for all those situations. (…) So we are not in fact free to go ahead and design exactly what we please – everything we do has consequences for people and their relationships. (…) The art of architecture is not only to make things beautiful – nor is it only to make useful things, it is to do both at once – like a tailor who makes clothes that look good and fit well." (Hertzberger, 1991, p. 174)*

It is for exactly this purpose – to create spaces that fit well – that the evidence-based approach to design has been proposed. What the concept of evidence-based design means and implies theoretically; how this problem of well-fitted design solutions has been tackled by research in the past; what can be learnt from these pieces of work for office architecture; and finally, how evidence-based design may fit into the everyday work of an architectural practice, will be presented using examples drawn from several research case studies.

Evidence-Based Design – Theoretical Reflections

Origin and Applications of an Evidence-Based Practice

Evidence-based design (EBD) is an approach based on its conceptual predecessor, evidence-based medicine (EBM) which was defined as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research." (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996).

EBD in contrast focuses on slightly different issues with respect to the specifics of design as a discipline:

> *"An evidence-based designer makes decisions – with an informed client – based on the best available information from credible research and evaluations of projects. Critical thinking is required to draw rational inferences about design from information that seldom fits a unique situation precisely. The process works especially well in the health-care field." (Hamilton, 2006, p. 1)*

It is worth noting that evidence-based practices[1] differ depending on the discipline and profession they are applied to.

Scientific rigour is at the core of EBM. To assist medical researchers as well as practitioners to keep up to date with the relevant evidence in their field of interest, the Cochrane Collaboration[2] was founded in 1993. It produces and disseminates systematic reviews[3] of healthcare interventions and promotes the search for evidence in the form of clinical trials and other studies of intervention, applying rigorous quality standards to their review and presentation of results. Thus, EBM is built upon a very well established scientific and theoretical basis (the clinical trials it relies on need to consider the aetiology of the disease – that is the underlying scientific theory of the mechanisms involved), uses well constructed methodologies (double blind case control trials, proper statistical sampling, controlling for other possible variables etc.), and last but not least compiles the findings all trials using systematic review, in which the strength of the evidence across trials is weighed up against how careful the methodology is on all these preceding factors. Research findings that do not meet the systematic review criteria for inclusion are left out, and the evidence base is built only upon firm findings of well constructed and managed studies.

In contrast EBD is less well defined and less rigorously constructed, as can be observed in the definition quoted above, which refers to 'best available information from credible research', hence, it stresses 'information' instead of 'evidence' and 'credible' instead of 'systematic' research, but also includes the vague notion of 'evaluation of projects'. How architecture as an underlying discipline to EBD is constituted; which problems EBD currently has, and how the field may be grounded and redefined, will be elaborated in the following section.

Evidence-based Design and Research in Architecture

The design process as the core of the architectural work has often been described by different scholars, for example as a process of making (Schön,

[1] Another evidence-based practice that has been formulated recently is evidence-based management; for more details on this concept compare: (Pfeffer & Sutton, 2006a, 2006b)
[2] Compare: http://www.cochrane.org/index.htm (last accessed: 30th March 2008)
3 Each review consists of an abstract, a summary of findings, objectives, the description and method of the study and most importantly a judgement and discussion on the methodological qualities of the study, thus allowing for a balanced and well-informed decision making.

1991), as experimental in nature and a trial-and-error approach (van Schaik, 2005), as 'learning by doing' phenomenon where the problem and solution emerge together (Lawson, 2006), as neither procedural nor systematic, but as a process where multiple alternative solutions are simultaneously tested (Dursun, 2007).

Often it is argued by designers that their practice is a form of research, for example by Lawson (2002). However, a recent initiative by the Royal Institute of British Architects (RIBA) has underlined the importance of architectural research and made it very clear that designing and researching are two different activities. They argue against the often stated myth that designing a building is a form of research in its own right by comparing the process of designing a building with Bruce Archer's definition of research as 'systematic inquiry whose goal is communicable knowledge':

> *"Architects clearly have to be thorough, but they are not necessarily systematic. Choices and decisions are made but not normally through systematic evaluation. More crucially, whilst architects may believe that knowledge is there in the building to be appropriated by critics, users or other architects, they very rarely explicitly communicate the knowledge. It thus lies tacit, thereby failing Archer's second test of communicability. Designing a building is thus not necessarily research. The building as building reduces architecture to mute objects. These in themselves are not sufficient as the stuff of research inquiry." (Till, 2007)*

It becomes clear that design and research may be considered two very different worlds. Traditionally, architecture has been argued to embody an experiential design process resulting in original and ingenious forms, thus complying with the Vitruvian idea of 'venustas' or delight; however, we argue here, in opposition to some of the authors quoted above that this is not the whole story. In addition, the design process may also be grounded on research to act in accordance with the other Vitruvian principles of 'firmitas' (firmness) and 'utilitas' (commodity).[4] To bring these two diverse positions together, the intuitive designer and the systematic researcher, EBD was posited by various scholars (Hamilton, 2006; Kroll, 2005; Lawson, 2005; Martin & Guerin, 2006; Suttell, 2007; Ulrich, Quan, Zimring, Joseph, & Choudhary, 2005).

EBD has mainly been applied to the health sector, were it was particularly well received, possibly because of the conceptual closeness to the medical evidence-based culture. It prompted a stream of research (Ulrich et al., 2005) on the outcomes of hospital design on the well-being and healing of patients. However it seems that often the words "evidence-based" have been used as a new label for a practice that is not necessarily more systematic and rigorous.

This can be shown with the help of two examples, firstly the tool InformeDesign[5] introduced by Martin and Guerin (2006) and secondly the above mentioned report by Ulrich et al. (2005) on hospital design.

[4] This paper is mainly interested in the way architecture should be made to fit its purpose, thus it focuses on the Vitruvian idea of 'utilitas'. The function of architecture to please shall not be disregarded, but is not elaborated any further.
[5] http://www.informedesign.umn.edu/Default.aspx, (last accessed: 07 March 08)

InformeDesign provides a searchable online database of around 12,000 summarised peer-reviewed articles and translates research findings into design criteria. What could potentially have emulated the Cochrane system for design practice fails in many respects: first of all it does not include works older than the 1990s, thus missing seminal contributions to the discourse, for example Tom Allen's work on communication between engineers as a function of distance (Allen, 1984; Allen & Fustfeld, 1975). Secondly, even in the years covered it contains only parts of the discourse, specifically focussing on papers with authorship from the US and so misses out the substantial contributions to the field from European research. Thirdly and most profoundly, it does not apply systematic criteria of equivalent rigour to the Cochrane Collaboration, but includes studies with intrinsic methodological weaknesses.

For the second example Ulrich et al. (2005, p. 3), report a great increase in rigorously researched studies from 84 studies in 1998 (when the authors first searched for evidence) to more than 600 studies in 2005. However, if the appendix to their report is looked at closely, it becomes clear that here again studies of low methodological rigour are included in their review. The research team has grouped the reviewed studies into various categories (A, B, C, D), but then fails to explain in depth what 'rigorous' meant to them, how the categories were constituted, or how a paper categorised as D may add to a reliable evidence-base. Additionally, the measurements used to understand the impact of spatial design on organisational or other outcomes (e.g. health) are not always well defined. To give an example, Ulrich et al. come to the conclusion that single bed rooms should be provided in all hospitals to improve the wellbeing and recovery of patients. They rely on studies analysing single patient rooms in contrast to open wards, which argue that open wards are more stressful and may increase contagion among patients. However, the specific spatial configuration of an open ward may differ significantly from one design to another; this was neither controlled, nor systematically taken into account. Thus, the conclusions made from this type of evidence stand on shaky ground.

It can be concluded that most EBD is less well grounded than evidence-based medicine. Not only does it lack rigour and quality control in its reviews of studies, it also lacks a concise definition of design variables. Yet this is not the whole story. As will be outlined in the following section for the specific field of workplace environments, the evidence-base available is often contradictory and hence difficult to use.

Workplace Environments: Space and Organisation

EBD for offices and workplace environments is rare. Although some architects and consultants[6] advertise an 'evidence based' approach to workplace design, relatively few publications apply the concept to office design.

It is argued here that this lack of take up of EBD in this sector is due to contradictory evidence in the field of office design. If a wider body of

[6] For example: http://www.georgesonworklife.com/consult7.php (last accessed: 26 March 08) or: http://www.spacesyntax.com/main-nav/service-offer.aspx (last accessed: 26 March 08)

research evidence on the question of how environmental design affects organisational outcomes like behaviours, workplace performance, staff satisfaction etc. is taken into account (Allen & Fustfeld, 1975; Allen & Henn, 2006; Becker, 1981; Davis, 1984; Gerstberger & Allen, 1968; Hatch, 1987; Hillier & Penn, 1991; Kampschroer & Heerwagen, 2005; Kampschroer, Heerwagen, & Powell, 2007; Monge, Rothman, Eisenberg, Miller, & Kirste, 1985; Penn, Desyllas, & Vaughan, 1999; Pfeffer, 1982; Price, 2002, 2007; Steele, 1973; Sundstrom, 1986), it becomes clear that the issue is not that easily settled.

Not only are the measurements and variables to describe knowledge-intensive organisations very diverse – there are numerous ways of measuring aspects of performance or communication, but design variables are also often only loosely defined, as was seen for evidence-based hospital design. As a result the evidence base for office environments is highly contradictory. An effect shown as highly significant in one study will often not be verified by another. To give an example, if all the early studies that analyse the changes in communication behaviour as an organisation moved from an enclosed office space to open plan offices are looked at, four of them report communication to increase (Allen & Gerstberger, 1973; Brookes & Kaplan, 1972; Hundert & Greenfield, 1969; Ives & Ferdinands, 1974), three find communication decreased (Clearwater, 1980; Hanson, 1978; Oldham & Brass, 1979) and another four show either ambiguous results or no changes at all (Boje, 1971; Boyce, 1974; Sloan, n.d.; Sundstrom, Herbert, & Brown, 1982). This inconsistency can be argued to be a result of the significant differences in measuring variables and setting up the studies, for example in data gathering procedures, research designs, and physical settings.

Another reason can be suggested for the failure of the evidence-base on office architecture becoming consolidated, thus, impeding evidence-based design in this area: office environments are strongly influenced by organisational structures, hierarchies, atmospheres, and an organisational identity and culture, which all sum up to act as confounding variables disturbing the clear study of the effects of physical spaces on communication, interaction or performance. Hence, it may be assumed that contingent results occur more often.

Effective Workplaces – Case Study Research in an Architectural Practice

Research Programme and Methods

The research and reflective practice presented in this paper is the result of the collaborative project 'Effective Workplaces' between the Bartlett School of Graduate Studies at University College London (UCL) and Spacelab architects.[7] Its main aim is to produce knowledge on the powerful relationship between spatial configuration and social behaviours in workplace environments by case study research and hence transform an intuition-based

[7] Supported by the UK government through the Technology Strategy Board under the Knowledge Transfer Partnership scheme, see: http://www.ktponline.org.uk/default.aspx (last accessed: 18/03/2008)

architectural practice into an evidence-based one (for more details on the concept see: Sailer, Budgen, Lonsdale, Turner, & Penn (2007)). By drawing on various case studies with corporate clients and the PhD work of the lead author[8] consistent measurements and research designs are implemented to be able to build up a reliable evidence base.

This paper presents insights from various case studies conducted within the last years under the lead of Y architects on various corporate clients in the media and advertising sector in the UK. The studies each compared an organisation before and after it moved into a Y-designed office. A multilayered methodological approach combining qualitative methods such as ethnographic space observations, semi-structured interviews with unit managers and on the other hand quantitative methods like a space syntax analysis of spatial layouts (Hillier, 1996; Hillier & Hanson, 1984), targeted space observations, and staff questionnaires, including social network analysis (Wasserman & Faust, 1994) was used to capture the character, atmosphere, and work cultures of the studied organisations. To compare results across different organisations, two further cases studied by the lead author as part of her PhD research on a university school and a research institute have been included.

In the following section, three different lines of argument will be presented: firstly results from a pre-post comparison of an organisation are presented showing how a new design positively changed the way staff related to each other. Secondly various results across cases are compared to show consistent and inconsistent results. An interpretation regarding the cause of inconsistent results as well as suggestions to handle this difficulty will be made. Thirdly, some implications of the practical implementation of evidence-based design will be outlined.

New Spaces for a Radio Station

A UK based radio station was studied first in 2005 and again in 2006 before and after moving into a newly designed space. The major change from the old to the new design (compare figure 1) was reducing the amount of unused spaces and offering a compact and efficient building layout. Instead of dividing people between three floors, as was the case in the original building, everyone was brought together on one floor, mostly in one open space. The figure shows the visual integration, a measure introduced by Turner, Doxa, O'Sullivan, & Penn (2001). It is based on the space syntax[9] measures of Hillier and Hanson (1984), and shows the visually accessibility of locations. Locations with fewer numbers of turns to all other locations in the building are called "integrated", and have high visual integration. When this measure is averaged

[8] The PhD thesis of Author with the working title "The Spaces of Collective Intelligence" is forthcoming by the end of 2008.

[9] Space Syntax is a research method and theory based on representing and quantifying the configuration of a spatial system, i.e. the way the parts are put together. For a simple presentation of this sophisticated approach see (Bafna, 2003); for an in depth treatment, refer to the works he cites, in particular Turner et al. (2001) defines the measures presented here.

for every location in each building as calculated with Depthmap (Turner, 2006), it rises from 1.975 (pre) to 5.223 (post) and is thus more than doubled.

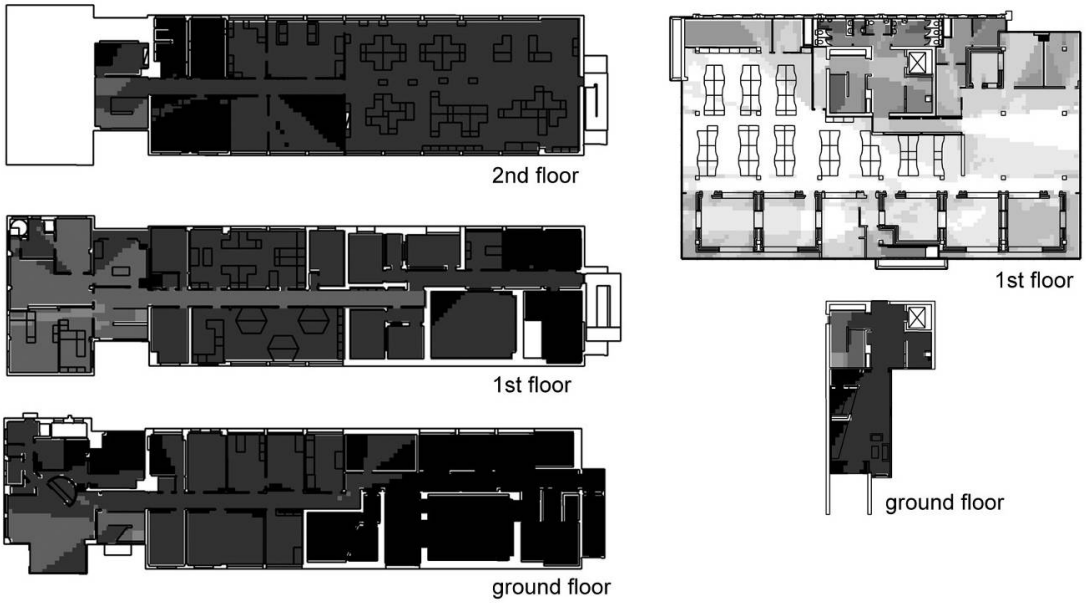


Figure 1: Visual graph analysis of the old spaces (left) and the new ones (right); brighter colours are more visually integrated.

This significant change in the spatial structures being used every day by the organisation was followed by new patterns of behaviour. Not only did the overall levels of contact[10] increase (pre: 3.0, post 3.7), people also adopted new patterns of interaction and collaboration. The new design showed influence on the formation of the social networks in the organisation. A social network analysis (SNA) (Borgatti, Everett, & Freeman, 1999) revealed a strengthening of the feeling of mutual usefulness within the organisation, as the networks of individual people, so called egonets[11], grew wider and reached across group and discipline boundaries with the move into the new building. Figure 2 shows the egonet of usefulness of one of the freelancers working for the programmes section in a pre-post comparison. In 2005 this person only has connections to colleagues from the same discipline, i.e. the programmes. Not only does the quantity of links double in 2006, but the connections now cover nearly all roles within the whole organisation, including the general management, marketing, sales and traffic. People at the heart of the organisation do not experience the same change of networks, but for those at the periphery (like freelancers) it makes a greater difference to share the same space with everyone.

[10] Measured on a five point scale by a questionnaire with all staff (5=daily, 4=several times a week, 3=weekly, 4=monthly, 5=less than monthly contact).
[11] An Egonet is the network of one person (Ego) that shows only the links Ego has to everyone else (Alters) and hides all other nodes and ties.

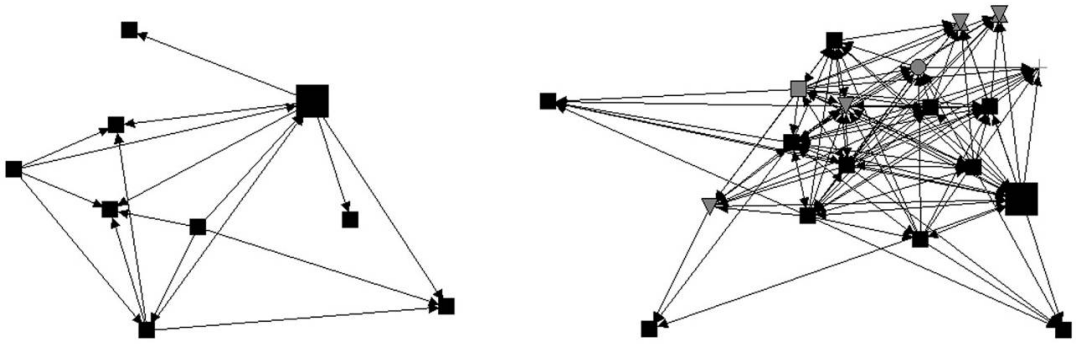


Figure 2: Egonet of one the freelancers (big black square) in 2005 (left) and 2006 (right). Nodes are coloured and shaped according to the disciplines of staff.

To summarise, these findings suggest that the increased overall spatial integration may be reflected in increased overall levels of seeing others more frequently. Social networks get wider and become denser, especially for freelance staff members or those not regularly present or working out of usual office hours. In conclusion, the results of the pre-post comparison of an organisation show that while the organisational structure stays the same, the change in the spatial design and configuration may influence important organisational behaviours such as interaction, collaboration and performance, and the resulting social networks of perceived individual usefulness.

Consistencies and Inconsistencies: Space and Organisational Culture

In the following section we present a broad variety of data on a number of case studies of two different space-organisation relationships in order to investigate the consistencies and inconsistencies in findings.

Consistent results are found for the hypothesis that in spaces with higher general levels of visibility, staff interact more with each other. Figure 3 shows the correlation between the average visual integration of a building (as measured using space syntax methods) and various measures of interactivity based on observations[12] across six different buildings – four media companies, one advertising agency and a university school. The results show that firstly the interactivity ratio (number of people interacting/number of people present), secondly, openness of interactions (the reach of interactions, i.e. the area covered by an interaction between two people in square meters) and thirdly, spontaneity of interactions (reach of mixed type interactions, i.e. the area covered by an interaction between people of different activities, e.g. standing and sitting) all increase as spaces become more visually integrated.

[12] Observations were done as so called snapshots where activities of people (sitting, standing, moving, interacting) are repeatedly recorded throughout a full working day and mapped onto a floor plan.

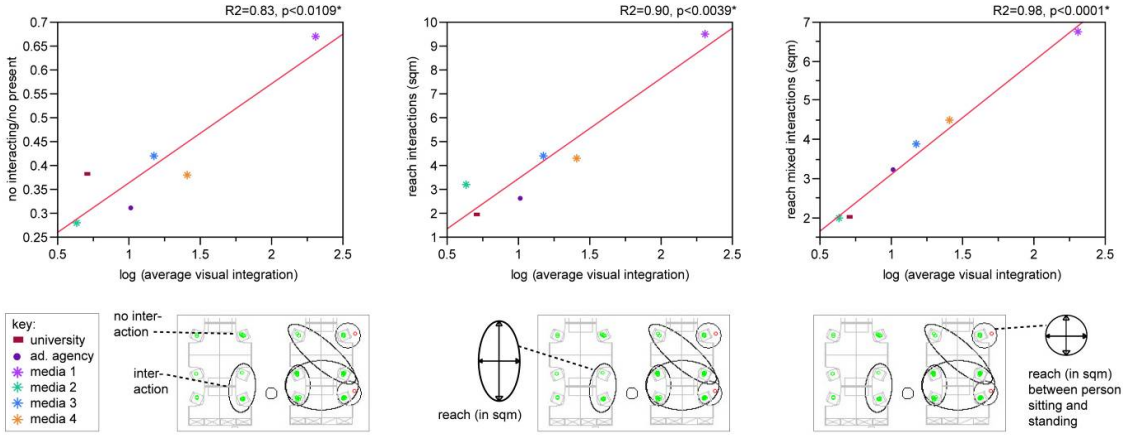
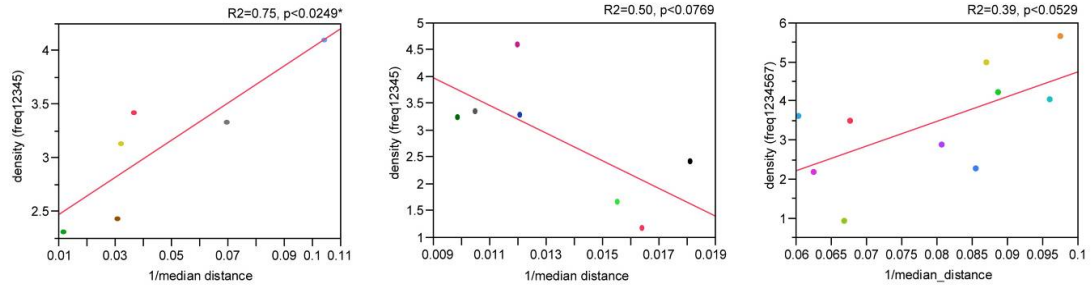


Figure 3: Average visual integration of a building correlates with the interactivity of the inhabiting organisation across six different cases

This shows a strong global pattern that is valid across cases even if the organisation type or spatial configuration is very diverse (the university school for example is located in a very segregated environment with mostly single or double offices in contrast to the other cases that occupy open plan offices of different sizes and layouts). So far no single case where these measurements have been studied has showed an inconsistent behaviour.

In contrast, inconsistent results across cases are to be found for the assumption that the density of interaction networks of teams would increase with increasing levels of proximity between team members. Figure 4 shows the correlations of interaction network densities[13] with group-related distances for three different organisations, a university school, a research institute (of theoretical physics) and an information business in the media sector. Whereas the interaction patterns in the university school are significantly governed by the distances between team members (see left image), the information business (see right image) shows the same positive tendency (although not at a statistically significant level), but in the case of the research institute this relationship does not hold. Here groups tend to interact more when they are seated further apart from each other; however this correlation is not significant either.



[13] The density of a network is the sum of all tie values (taken from the used frequency scale) over the number of potential ties the network could possibly have given its size.

Figure 4: Distances between group members only partially governs interaction densities: groups in the university school (left), the research institute (middle) and the information business (right).

The key to understanding this inconsistent behaviour lies in the very specific character and culture of the research institute which comprises around 180 staff, but has only four permanent researchers (and some additional long-term positions) for the leading directors and researchers. Everyone else works there on a temporary contract ranging from several months as a visitor to 1-2 years as a PhD or postdoc. Additionally the institute hosts around 10-12 workshops and seminars of 2-4 weeks length with around 1,000 guests a year, thus it functions rather like a hotel where different researchers in the field are temporarily present discussing their work together and collaborating. Since the field of theoretical physics is very specialised, little clusters of experts are crucial to the work progress, but groups can be as large as 50 researchers. Taken all together, the group as a unit is a highly fluid concept in this case with little in the way of clear organisational boundaries or structure; work processes are driven instead by the expertise and interest of the individuals. Hence, not everyone in a group needs to interact with everyone else, and this leads to the specific results for interaction network densities.

To summarise, it is suggested here that physical space influences the way in which organisations communicate, interact, and perform. It has become clear that results may vary in their strength and significance from one organisation to another: a spatial feature that influences one organisation massively might not exist for another or may easily be overcome by their organisational culture. However, some influences of space on an organisation seem to be consistent, for example, increased levels of interactivity with increased visibility.

Practical Reflections on the Process of Evidence-Based Design

Evidence-based design is not an easy, straight forward practice. Not only is architectural research still a very young field, it is also very unusual in a discipline that draws so much on intuition, artistic inspiration, learning-by-doing, and practical experience. The complications and challenges of an evidence-based design practice will be outlined using the example of a research case study carried out in 2007 and 2008 to accompany a design project.

The organisation was a large UK-based media company with a variety of brands (magazines, events organisers and information businesses) comprising a total of 1,400 staff. The design project involved the process of relocating different departments and sections of the corporation from six different buildings in different locations in London into one big newly refurbished building. Due to the very tight constraints of the design and construction programme it was not possible to study the organisation fully in advance and feed this information into the design process. Instead the study comprised a pre-move phase (2 months before moving) and post-move phase (8 months after moving), both carried out independently of the design, to contribute to an evidence base that will be brought to bear on future design projects. The results of the pre-study were then used as a basis for reflection on the proposed design, given for example, the rich feedback on staff satisfaction with their old buildings, wishes for a new space, relationships and

collaboration patterns between business units as well as between individual staff, interaction patterns of staff and movement flows through the building.

In order to investigate the question of how this evidence would have changed the design process as well as the outcome, a focus group meeting[14] was held with eight architects of Spacelab, five of whom had been closely involved in the design project. All of them agreed that having had this specific evidence prior to the design process would have completely changed their whole design approach, specifically on the issue of how teams are distributed within the building, how teams split, but also on the general design of the fit-out. With the evidence there would have been more scope to mix up teams and provide a greater diversity in terms of spaces (e.g. private areas, soft-seating, less desk-based and more choice and flexibility for different ways of working and activities), thus making the whole space more creative and interesting. This reflects some of the issues that were mentioned by staff in questionnaires, but without this evidence the client (i.e. the facility team and upper management) insisted on pronounced and fixed boundaries between the teams and the need to accommodate as many people as possible in the building. The outcome was a design criticised by staff as "impersonal and bland", that "feels like a call centre", "typing pool" or "a factory – clinical, mechanised, controlled – lacks personality, sapped of culture". This leads to the second major difference identified by the focus group: the process of the design would have been very different. The architects argued that with this type of hard facts and evidence a proper and detailed brief could have been created prior to the design, thus easing the discussions with the client senior management and forcing them to decide what they wanted ahead of the design. Instead the project kicked off with no clear goals and massive changes occurred throughout the process. In conclusion the focus group was absolutely convinced that the result of the design, the building, would have been better with evidence than it turned out to be without it.

This raises two issues: of time on the one hand, and of an informed client on the other. While the process of evidence-based design would clearly benefit the quality of the design outcome and educate the client, time is a crucial issue in a business environment where designers are often asked to deliver solutions within days or weeks. The time is hardly ever available to properly study an organisation and how they use their spaces in order to suggest a specifically tailored solution for them. This remains one of the main challenges facing an evidence-based design practice, which does not just propose generic solutions based on what others have found for other organisations, but brings custom-made evidence to bear in design as to the requirements, wishes, character and organisational culture of a specific client and their workforce.

[14] The focus group meeting was held over a one and a half hour session; it kicked off with an input presentation of the evidence found in the case study and was followed by a lively open discussion around the question "What would have been different if we would have had this data before?".

Conclusions

Not all organisations are the same. Neither do they use and appropriate spaces in the same ways. We outlined above that the evidence on how space influences organisational behaviours and performance differs for different organisational cultures and sub-cultures. At the same time it was shown that the same organisation reacts differently to different spatial configurations (as the example of the radio station in their old and new building showed) and that some influences are consistent across cases (for example, the interaction-visibility benchmark), hence, spatial configuration and design clearly influence people's behaviours within an organisational context.

Two major conclusions can be drawn from this: first of all, that space not only acts as a "field of probabilistic encounter" as argued by Hillier et al. (1987), but also that space may have a so called 'generic function':

> *"Generic function refers not to the different activities that people carry out in buildings or the different functional programmes that buildings of different kinds accommodate, but to aspects of human occupancy of buildings that are prior to any of these: that to occupy space means to be aware of the relationships of space to others, that to occupy a building means to move about in it, and to move about in a building depends on being able to retain an intelligible picture of it. Intelligibility and functionality defined as formal properties of spatial complexes are the key 'generic functions', and as such the key structures which restrict the field of combinatorial possibility and give rise to the architecturally real." (Hillier, 2007, p. 223)*

Thus, insights as the dependency of interactivity on visual integration may be used generically as criteria for the design of any office building. Hence, there is value in the creation of a case-independent evidence-base, but only if evidence is created based on rigorous criteria for study inclusion in a systematically grounded EBD review process.

Secondly, it is argued that organisations differ in their spatiality. A concept that Hanson and Hillier (1984) have brought up in the context of the study of societies, that some elements of society can be considered operating spatially and that some function transpatially, (i.e. organised by means other than space), can be applied to the study of workplaces. This means that spatial and transpatial organisations can be distinguished: on the one hand there are organisations which are to a great extent governed by spatial patterns such as the distances and proximity, visibility and spatial integration with which parts are disposed with relation to each other (for example the university school). On the other hand organisations with strong organisational cultures or very specific organisational models may overcome the influential power of space, because they are organised and driven by a different logic and set of mechanisms (for example the research institute).

Hence, each client and each case needs to be considered anew as a unique instance of a spatial or transpatial organisation. This implies that proper time needs to be allocated in the design process for the specific research to take place and to allow briefing to be conducted properly.

Towards a New Evidence-based Design Practice

To conclude, a newly framed EBD practice is suggested that would be realigned with the systematic rigour of EBM. We suggest that the core concept of EBM in systematic and scientifically sound reviewing has been ignored or overlooked by the design community for too long.

At the same time it needs to be acknowledged that the two fields of practice and science are very different. While medicine looks at the way that the human body functions and can go wrong, thus it looks at large numbers of very similar entities and their many pathologies, design deals with a series of unique cases since every building and every organisation which inhabits a building can be considered to be substantially different. Additionally, the factors involved in organisational performance are much more complex and make it hard to eliminate variables to produce a 'controlled trial'. This means that the kind of science behind functional performance and failure in building design is very different to that in medicine and the processes involved in EBD must therefore be substantially different.

Taking these two aspects into account: the need for systematic rigour and the uniqueness of cases; we suggest that a new EBD practice would require its foundations to be built on the following components:

1. a scientific and theoretical basis in organisational sociology and its relationship to physical/spatial design;
2. the equivalent of 'aetiology' in a hypothesised 'mechanism' (organisation theory, sociology and their relationship to design) behind the proposed intervention;
3. a well constructed methodology including: a method of measuring the organisational performance outcomes of interest; a method of measuring the design variables that the aetiology suggests are relevant to these performance outcomes; proper case study based approach to pre and post analysis; a valid statistical analysis that is not reductionist, but that recognises that the systems under observation are highly complex and variables cannot be excluded for scientific convenience, but must be controlled for through representation, quantification and inclusion in the statistical analysis.

Applying this framework would inherently mean excluding a large number of known studies and approaches from the evidence-base for design, especially since only few approaches seriously measure design variables[15]. However, it would also mean firmly and convincingly grounding a new evidence-based design practice in the specific nature of design research, rather than merely taking on the trappings of other scientific fields, along the lines of Richard Feynman's famous "cargo cult" characterisation of certain of the 'softer' sciences (Feynman, 1974).

[15] Among those clearly defining spatial variables is Space Syntax, because it creates a set of independent spatial representations and measures that clearly distinguish one setting (e.g. an open plan office) from another in terms of the configuration of its plan layout.

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