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Pre and Post Occupancy Evaluations in Workplace Environments

Theoretical Reflections and Practical Implications

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Abstract

Understanding the way in which design interventions in an office affect everyday users, and thus shape organisational behaviour, should be high on the agenda for architects, designers and consultants alike. Surprisingly, this seems rarely to be the case. Here we aim to help close this gap by studying a variety of organisations in depth both before and after an office move from the point of view of design practice. This paper thus aims at understanding how a newly designed office is seen, used and filled with life by staff, so that planners can continuously and systematically reflect on and learn from experience, and create effective and well-used workplaces for the future.

The research and reflective practice presented in this paper resulted from a collaboration on 'Effective Workplaces' between The Bartlett School of Graduate Studies at University College London and Spacelab architects. Insights from in-depth case studies conducted over the last four years on various corporate clients in the media sector in the UK will be drawn upon. The studies each compared an organisation before and after it moved into a Spacelab-designed office.

Two different lines of argument will be presented: firstly, results of the pre-post comparison of organisations before and after moving into a newly designed space suggest that physical space influences the way in which organisations communicate, interact, and perform in many ways. Secondly, the practical side of evidence-based design will be discussed. It can be seen that designers would do things differently if they had had the specific evidence prior to the design process. At the same time, difficulties arise in conducting 'evidence-based' practice, for example the problem of time in a business environment where designers are often asked to deliver solutions within days or weeks, whereas gaining a good understanding of a complex organisation may take months. These issues will be reflected on. General conclusions on the use and usefulness of Space Syntax in an architectural practice will be drawn.

Keywords: Offices; Pre/Post Occupancy Evaluation; Space Syntax; Evidence-Based Design; Practice

1. Introduction

Architectural design is mainly driven by the experience and intuition¹ of a designer and their style of creating space. The design process has been described as a process of making (Schön, 1991), as experimental in nature and a trial-and-error approach (van Schaik, 2005), as a '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).

The design of office spaces, more specifically, is often guided by general typologies (cellular office, group office, open plan office) to describe the quality of interactions in office structures. This can be seen in countless architecture publications presenting best practice examples based on typological frameworks. The matrix introduced by Duffy (1997) to describe future ways of working depending on the level of autonomy and interaction of staff may serve as an example; it suggested categorising built examples into four distinct types of offices, i.e. those hosting individual processes ('hive'), group processes ('den'), concentrated study ('cell') and transactional knowledge ('club'). This approach was later refined by Hascher et al. (2002) acknowledging that an office did not necessarily fit into one category only; thus a detailed activity-based model of combinations of the four processes (individual, group, concentrated, transactional) was created. Similar approaches are known, simply referring to distinct sets of terminologies, for example the 'narrative', 'nodal', 'neighbourly', and 'nomadic' office type (Myerson and Ross, 2003), or the office as 'academy', 'guild', 'agora', or 'lodge' (Myerson and Ross, 2006).

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While these and similar concepts are popular among architectural practices, they fail to provide more than fuzzy guidelines for the design of office spaces. Rather than providing evidence on the complex relationships between physical space and organisational outcomes, most typology-driven approaches remain suggestive, lack scientific rigour² and fall short of appreciating detailed differences in spatial configurations within one typology.

At the same time an increasing body of rigorous studies, including but not limited to Space Syntax research, which have emerged over the last decade linking physical space with organisational outcomes such as interaction, collaboration, innovation or organisational performance (Penn, et al., 1999; Toker and Gray, 2008; see for example: Heerwagen, et al., 2004; Peponis, et al., 2007; Sailer and Penn, 2007; Wineman, et al., 2009; Steen, 2009), remain relatively poorly known amongst architectural practice.

Attempts to introduce evidence-based processes into design have become increasingly popular over recent years (Martin and Guerin, 2006; Hamilton, 2006; Lawson, 2005; Suttell, 2007; Ulrich et al., 2005), resulting in programmes linking research outcomes with design interventions mainly in the health sector. Even though referring to the successful movement of Evidence-Based Medicine (EBM)³, evidence-based design (EBD) still lacks recognition, as well as seemingly, the scientific rigour and validity which EBM has gained (for a comprehensive criticism of EBD compare: Sailer et al., 2008). Not only do practitioners fail to recognise evidence-based design, but its spread is also

hindered by the lack of case-independent research results. A report by the UK based Commission for Architecture and the Built Environment similarly concluded that 'the ways in which office accommodation can create value for a business ... are [still] inadequately understood.' (CABE, 2005)

Two arguments may be drawn from this: firstly, more research is needed to gain a better understanding of the relationship between physical space and organisational outcomes. This research not only needs to employ scientific rigour in its setup and definition of variables of interest, but also needs to build up a reliable evidence-base to allow for comparisons and benchmarks. Data gathered alongside design projects and hence only available to architectural practices needs to be accessible to researchers to further develop the field. Secondly, it is argued that a knowledge gap between researchers and practitioners in office design exists with serious consequences for office architecture. Recent surveys of workforces in the US and UK have shown that in the average company only 43% of staff (US) and 26% of staff (UK) are satisfied with their workspaces and that this is closely linked with organisational performance (Gensler, 2008a, 2008b).

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Knowing how a workplace design - and thus its resulting spatial configuration - affects an organisation in its collective behaviours should be a major concern of architects, facility managers and consultants alike. Those who create space should be able to incorporate evidence on the relationship between spatial configuration and organisational behaviours into their workplace solutions. Although Post-Occupancy Evaluations (POE) or Pre- and Post-Occupancy Evaluations (PPOE) are increasingly promoted by Workplace Professionals (Stanley, 2010), they are still used relatively rarely.

To provide this knowledge and make it readily available and used, research needs to be closely involved with architectural practice; therefore this paper stems from practice-led, yet research-intensive case studies conducted from the perspective of an architectural company.

2. Research Programme and Methods: Pre-Post Comparison of Office Spaces

The research and reflective practice presented in this paper is the result of the collaborative project 'Effective Workplaces' between University College London and Spacelab architects.⁴ Its main aim was to produce knowledge on the powerful relationship between spatial configuration and social behaviours in workplace environments by case study research, and hence to transform an intuition-based architectural practice into an evidence-based one (for more details on the concept compare: Sailer et al., 2007b).

The case studies presented in this paper were conducted over the last four years under the lead of Spacelab architects on various corporate clients in the media sector in the UK before and after moving into a Spacelab-designed office. A multilayered methodological approach combining qualitative and quantitative methods was used to capture the character, atmosphere, and work cultures of the organisations as well as their spatial configuration. A space syntax analysis of spatial layouts (Hillier, 1996, Hillier and Hanson, 1984) and space observations provided evidence on space structure and

space usage patterns. Semi-structured interviews with unit managers inquiring into relationships among business units, staff questionnaires captured satisfaction and perception of spaces, but also patterns of interaction and collaboration among staff. These data were evaluated with the help of Social Network Analysis (SNA) (Wasserman and Faust, 1994). Thus the collective behaviours of staff in the workplace could be investigated in relation to the spatial environments in which they were enacted.

In the following section two in-depth case studies will provide evidence of behavioural change resulting from changes to the spatial configuration and environment of the workplace. This will underline the importance of spatial configuration for organisational performance, but also point towards possibilities of using this knowledge strategically for future design solutions. However, evidence-based design may also be considered problematic, since it requires expert knowledge, time and resources. Hence the difficulties and implications of evidence-based design processes will be reflected upon from the point of view of an architectural practice.

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3. Case One: New Spaces for a Radio Station

A UK based radio station had commissioned Spacelab architects to design their new workspace in 2005; the main aim of the project was to increase external brand awareness of the radio, but also to improve the internal integration of people and functions. The organisation and spatial settings were 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 (see figure 1) was reducing the amount of unused space and offering a compact and efficient building layout, where everyone was located on one floor, mostly in one open space. Additionally, studio spaces and workspaces were closely interlinked in the new design. As a result, visual integration⁵ of the whole building rose from 1.975 (pre) to 5.223 (post) and was thus more than doubled.



Figure 1: Visual graph analysis of the old spaces (left) and the new (right); the image of the new design (post stage) shows the close integration between studio spaces and the social area and workspaces

This significant change in spatial configuration was followed by new emerging patterns of behaviour. Not only did overall levels of interaction⁶ increase (pre: 3.0, post 3.7), but people also adopted new patterns of interaction and collaboration. The managing director reported an increase in face-to-face interactions; whilst the numbers of internal phone calls dropped by 40%. Moreover, the feeling of mutual usefulness within the organisation was strengthened as can be seen in the social networks⁷ of individual people: the so called egonets (Hanneman and Riddle, 2005)⁸ 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 staff members working for the programmes section in a pre-post comparison. In 2005 this person only had connections to colleagues from the same department, i.e. the programmes. Not only did the quantity of links double in 2006, but their connections reached nearly all roles within the whole organisation, including management, marketing, sales and traffic.

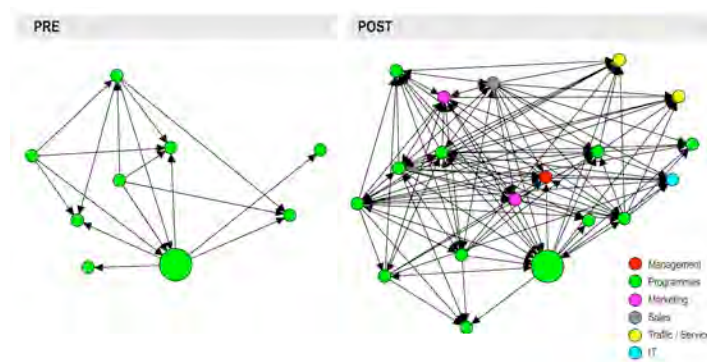


Figure 2: Egonet of one staff member of the programmes section (big green node) in 2005 (left), and 2006 (right). Nodes are coloured according to departmental affiliation.

To summarise, these findings suggest that the increased overall spatial integration of the new office may be reflected in increased overall levels of seeing others more frequently. Social networks reached further and became denser. In conclusion, the results of the pre-post comparison of this organisation show that while the organisational structure stayed the same, the change in the spatial design and configuration influenced important organisational behaviours such as interaction, collaboration and performance, and the resulting social networks of perceived usefulness.

4. Case Two: Integrating Different Businesses in a Large Media Corporation

A large business-to-business media group based in London underwent significant changes to its spatial configuration when it restructured its business in relation to its building portfolio with the help of Spacelab architects. By co-locating brands and businesses, which had previously been spread across different buildings, into a single workspace, the organisation wanted to establish synergies between the businesses, centralise certain functions (such as Marketing), create efficient spatial layouts, and save on property costs. Four business units of the media group (two publishers, [C] and [R], as well as an information business [W] and an events organiser [K]) were studied as a sample, located in four distinct buildings in 2007 (pre study) and co-located in one building in 2008 (post study). The major change from the old spatial configuration to the new one certainly was the co-location of approximately 1,330 staff across 60 different brands and titles. The new workspace comprised three floors of a large office building (see figures 3 and 4): an open reception area on the ground floor with adjacent

meeting rooms that lead to a central café area on the first floor; workspaces as well as central facilities (printing points, meeting rooms, soft seating areas) were spread across the first, ground and lower ground floors.

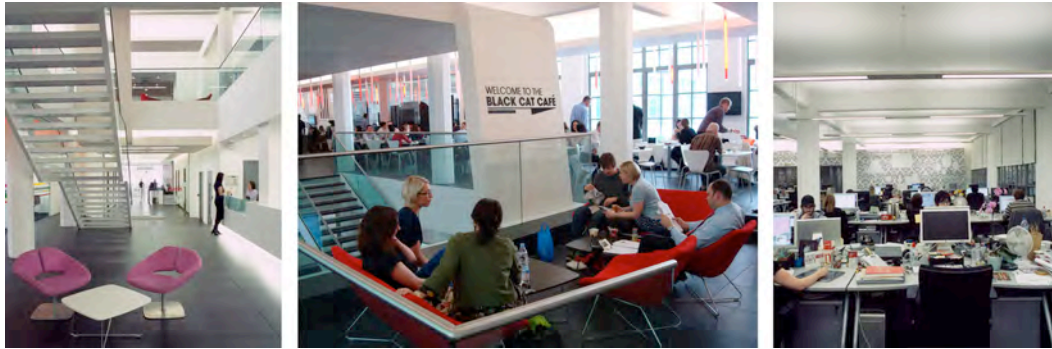


Figure 3: Images of the look and feel of the new spaces of the media corporation (post stage) showing the central staircase that connects the ground with the first floor, the central café, as well as the new workspaces.

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Although the building was very large, it was well integrated as the visual graph analysis (see figure 4) shows. The design decisions to connect the two major floors by an open staircase and to create a void in the centre of the floor plate, as well as to place the central café adjacent to it in order to achieve the desired level of business integration with the help of increased levels of spatial integration were taken by Spacelab architects based on a Space Syntax analysis.

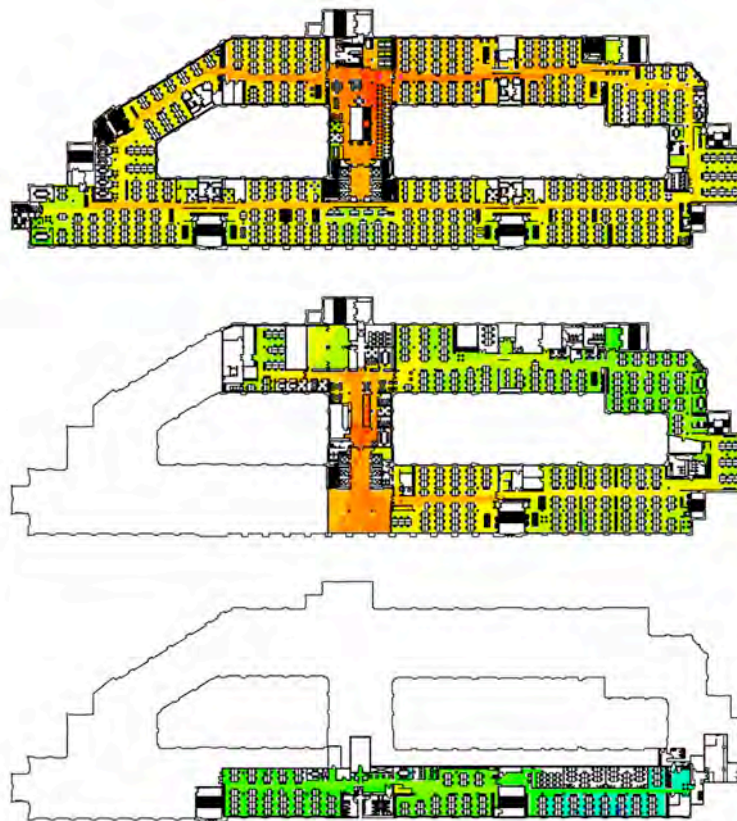


Figure 4: The visual graph analysis (based on accessibility) shows how lobby and café form an integration core, spreading activity and 'buzz' across the large floor plates.

As a result of spatial configuration (i.e. shape of the floor plate, as well as co-location of staff in one large workspace), the levels of observed movement in the circulation spaces in the new building increased significantly compared to the previous buildings (see figure 5 for the visualisation of pre and post movement flows). Movement density, measured as the number of movements occurring per square metre of circulation space and per hour, ranged from 1.3 (spaces of events organiser K) to 5.5 (spaces of information business W) in the old workspaces, whereas in the new building movement density was as high as 8.1 to 9.3 in the various areas of the first floor. Therefore, movement density more than doubled from pre to post. What this means for the organisation in its everyday work processes can be brought to life by a simple figure: in the main circulation route⁹ of the building each row of desks was passed on average by one moving person every 22 seconds.



Figure 5: Observed flow of movement in four buildings of the media corporation (pre) and the new workspace (post)

This high intensity of movement in the main circulation space was perceived as a source of noise and annoyance by some staff, as reflected in the following comments: “It is often very noisy, there is constant human traffic going past a few feet away from me, trolleys, cleaners, deliveries, staff etc. Nearby staff are often very loud on the phone, mobile ring tones can be intrusive.” (member of staff, publisher C) or “With facilities being spaced out the amount of people walking around can make you feel like you work in an airport.” (member of staff, business PS).

It is argued here that movement was first and foremost perceived as a factor causing noise and disturbance (similar results are reported in: Steen, 2009) rather than creating opportunities to meet and encounter people for recruitment and further processes of interaction (Backhouse and Drew, 1992). At the same time, the amount of interactivity around desks was reduced in the new spaces of the media corporation. While occupying the old buildings, the level of interactivity, i.e. the percentage of people observed to be engaged in face-to-face interactions at any one moment in time ranged from 26%-28%; in contrast, only 12%-24% of staff were observed to be interacting in the new spaces. This relationship between increased levels of movement density and decreased levels of interactivity can be confirmed taking more cases into account, as figure 6 illustrates. The correlation between movement density and interactivity shows a significant and negative relationship ($R^2=-0.56$, $p<0.0081$) across a benchmark of eleven buildings of organisations in the media and advertising sector, all occupying open-plan offices (and all studied by Spacelab with the same methods). This means that interactivity at workstations generally decreases as movement density increases, specifically as movement density becomes very high.

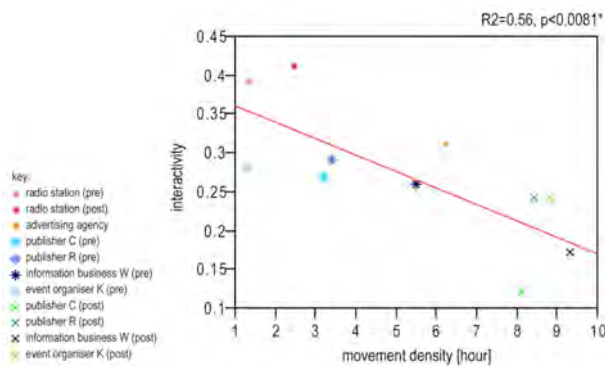


Figure 6: Correlation between movement density in circulation spaces and interactivity in adjacent workspaces for a benchmark of eleven buildings from the media and advertising sector.

However, this decrease in interactivity around desks does not necessarily mean that interaction has decreased in total. It rather points towards a significant change in the overall patterns of interaction. More light can be shed on the phenomenon of newly emerging organisational behaviours and organisational cultures of interaction and collaboration as a result of a new workspace by analysing questionnaire results on the frequency of contact and the perception of usefulness of colleagues. First of all, the overall frequency of face-to-face contact increased slightly (+4%) for the sample of four business units from an average of 2.43 to a value of 2.52 (measured on a seven point scale)¹⁰. Likewise collaboration (as measured by the level of mutual usefulness) has increased by 6% from an average of 1.77 to a value of 1.87 on a three point scale. Since people report being in more intensive face-to-face contact and finding their colleagues more useful than before, yet less interactions occurred around individuals' desks as observed, this means that personal contact took place somewhere else, for example in the newly provided café (where 20% of people present were interacting). These results point towards organisational behaviours that were more planned and less spontaneous. The same tendency can be seen in the levels of contact within and across business units as well as the average number of interaction and collaboration partners, as shown in figure 7.

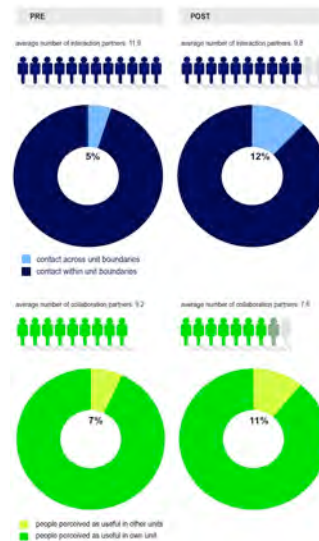


Figure 7: Changed patterns of interaction and collaboration from 2007 (pre move) to 2008 (post move); (Source: Online questionnaire with all staff of the four sampled business units; respondents n=155 [pre] and n=141 [post]).

It seems that in the new workspace people interacted more in total, yet with fewer interaction partners (9.8 instead of 11.9 on average) and collaborated more, yet also more concentrated on fewer partners (7.6 instead of 9.2 on average). At the same time, interaction and collaboration across the boundaries of business units increased, since after the move 12% of interactions and 11% of collaborations reached across business units (compared to 5% and 7% pre move).

So in essence, interaction and collaboration patterns increasingly became planned and targeted, focusing on those people that someone really needed to talk to and found particularly useful for their own work processes. This means that the strategy of the business aiming for increased synergies and integration of its diverse business units and brands was supported by the new building design and spatial configuration, yet at the expense of spontaneous and unplanned interaction, which has been argued elsewhere to provide important sources of new information to create innovative potential in organisations (Allen, 1984, also see argument in: Hillier and Penn, 1991).

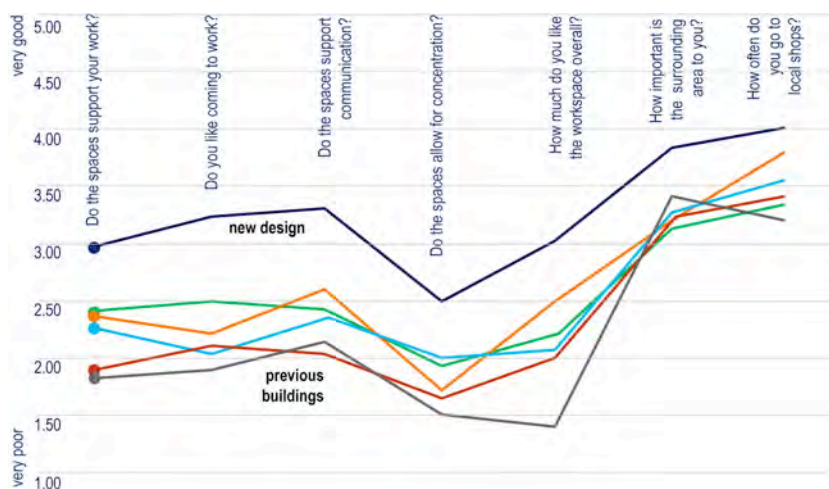


Figure 8: Levels of satisfaction and performance of the new building have increased as compared to staff perception of the previous buildings (Source: Online questionnaire distributed to all staff; respondents n=182 [pre] and n=267 [post]).

Despite some of the outcomes the spatial configuration of the building and its resulting high levels of movement density in terms of the decrease in interactivity at desk level and the loss of unplanned encounters, staff were generally satisfied with the building and perceived it as supporting their work processes, specifically concerning communication (see figure 8).

To summarise the lessons learnt from this case study, it can be concluded that as a result of the move into a shared building a variety of organisational behaviours - the level of interactivity, the choice of interaction and collaboration partners, the perception of noise and disturbance, as well as levels of satisfaction in the new building - emerged in relation to specific spatial constitutions, for example co-location, spatial configuration and movement densities.

5. Evidence-Based Design Practice - Implications and Complications

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Before drawing final conclusions on the study of office spaces in a pre-post comparison, we will reflect upon some of the practical implications of an evidence-based design from the point of view of an architectural practice; wider theoretical and academic interests will also be touched on.

With the help of evidence from empirical in-depth case studies we have shown how organisational behaviours in knowledge-intensive organisations changed as a result of changing spatial configurations. This knowledge in itself is valuable, especially since 'before and after' studies are still rarely conducted. Not only do they serve as evidence of beneficial change and so assist architectural practices in future projects, they are also important in cases where results are surprising. For example, in the case of the media corporation, spatial integration and efficient circulation routes were expected to lead to significant movement flows, yet the implications of this in terms of reduced interaction at the workstation were not understood beforehand. With the evidence at hand, the client can be continuously consulted and changes to be initial scheme suggested, as discussed in more detail in the following section. This also highlights the fact that spatial configuration is a powerful foundation for organisational life, yet the impact of design interventions will only be understood fully in usage. For example in this case a strategic space usage decision taken by the client, i.e. the introduction of shared printing and recycling points, increased the amount of movement even further, over and above the movement flows induced by spatial configuration.

Apart from the changes to the design process, potentially transforming the project-centred nature of architecture into a more process and operations focus, another advantage of evidence-based design lies in its power to improve the design solution itself.

With results from a focus group meeting¹¹, which was held after the pre-study with eight architects from Spacelab, five of whom had been closely involved in the design of the media corporation, it can be shown that designers would have done things differently, if evidence had been available. All of them agreed that having had specific evidence prior to the design process would have completely changed their whole design approach, especially 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 benefit of evidence from the pre study 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 management) insisted on pronounced and fixed boundaries between the teams and the need to accommodate as many people as possible in the building. It may well have been the case that by breaking up the large open-plan office spaces to a greater degree by offering soft seating alongside the heavily used circulation route¹² the level of unplanned encounter could have been held steady. 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.

However, evidence-based design is not an easy process and may bring additional complications despite the positive influences mentioned above. Three main issues are discussed here: first of all the problem of time and expertise, since it has to be acknowledged that evidence-based design requires additional time as well as skills that are not part of what architects typically do. Clients need to agree to fees for special consultancy services, but also be able to provide the time necessary to conduct studies ahead of the design process. Time is a crucial issue in a business environment, where designers are often asked to deliver solutions within days or weeks. In some projects there is simply no time available to properly study an organisation and how it uses its space in order to plan a tailored solution. This remains one of the main challenges facing an evidence-based design practice.

This is closely related to the second issue - the difficulties of communicating evidence-based design. 'Educating the client' becomes part of the process and service, as the complexity of Space Syntax and other methods (like SNA) need to be explained in order for a client to understand and appreciate design solutions as an answer driven by evidence. While images of visual graph analysis are relatively easy to communicate and laypeople may intuitively read them correctly, for example, other methods or processes are inherently difficult to explain without missing crucial details.

Last, but not least, practice-led or consultancy-led research has its own character. While it gives easy access to case study material and generally produces lots of data, the possibilities of analysing this richness of evidence in great detail are somewhat more limited. The client, who after all is paying for the analysis, is only interested in a problem-based solution which has to be achieved with relatively little effort. Most of the data produced then remains tacit for further theory-building, because there is no time to explore new phenomena for academic and wider theoretical interests. These limitations may be turned into opportunities for a shared and enhanced learning experience through collaborations with academic partners.

6. Continuous Consultancy - A New Stage of Organisational Life in the Media Corporation

Almost two years after the post study of the Media Corporation Spacelab was brought in once more to re-evaluate space usage and working processes. The company had changed quite significantly in the meantime: it had been sold to an investing group, had grown and shrunk certain areas, had restructured its internal organisation to form five major divisions and in consequence had shuffled the desk locations of approximately 1,100 people; but it had also decided to have one of its prominent brands operate on its own on the lower ground floor of the building, so that the rest of the business was only split between the ground and first floors. Overall, the corporation felt that its working environment did not reflect its values and buzz as a media company and lacked creative spaces as well as identity.

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Over the course of 4 weeks, Spacelab conducted an occupancy study highlighting usage of desks as well as meeting rooms, but also lead interviews with senior management asking for spatial requirements, and the character and culture of each of the divisions. By analysing occupancy patterns over four weeks for the business as a whole, but also broken down to division and team level it was possible to unpack the different working styles, processes and production cycles of the various parts of the business. With an overall occupancy of 51%, equalling 599 empty desks on an average working day it became apparent that there is scope for flexible ways of working within the organisation, which would then free up space to create more diverse working areas. Another result of the study was that the organisation was incredibly diverse regarding their daily, weekly and monthly working patterns. This organisational diversity however was not reflected in the workplace environment. Due to the limitations of the brief for the 2007 refurbishment project whose main aim was to unite increasing numbers of teams and people under one roof, the resulting layout was quite homogeneous and did not allow for diversification. As can be seen in the visibility analysis, especially on the first floor (see figure 4 again), the majority of workstations offer exactly the same type of environment for everyone. This unifying approach was even enhanced by all managers sitting open-plan. In order to allow for flexibility, no specific branding or signage had been implemented, resulting in difficulties for staff to find other people or teams. In short, the company had focused too much on global integration ('all under one roof') and paid too little attention to local integration and the emergence of a local sense of place and identity.¹³

At the time of publication of this paper in spring/summer 2010, the consultancy project with the Media Corporation was still ongoing, potentially leading to changes in ways of working and the internal layout of the building. The fact that Spacelab had been appointed to re-evaluate an organisation and how it operates within its built environment years after various already conducted studies as well as an extensive refurbishment project highlights the importance of a long-term view and lasting client-architect relationships that are fostered through the use of research methods in combination with the tools and approaches of a design practice.

7. Conclusions

In spite of being at times a hard to communicate and time consuming process, evidence-based design clearly is a useful way of establishing user needs, integrating the character of an organisation in all its complexity into a spatial design and thus making sure a workspace fits the clients' work processes and culture. Specifically, being able to learn from an in-depth study of the spatial and organisational constitution of a client before the design process, and then comparing this to the situation after moving into a new design through post occupancy evaluation, is not only of theoretical interest, but proves rewarding for an architectural practice interested in what Donald Schön once called the 'reflective practice' (Schön, 1991). Evidence-based design also opens up new markets and opportunities to architects in workplace consultancy.

Bringing custom-made evidence to bear in design in consideration of the requirements, wishes, character and organisational culture of a specific client and their workforce, instead of proposing generic solutions based on what others have found for other organisations, is a great asset for the creation of well-used future workplace environments.

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8. Notes

¹ Further descriptions of the process of design and its implications for architecture as a built form have been made elsewhere by the authors of this paper (Sailer, K., et al., 2007a; Sailer, K., et al., 2008).

² An exception are recent studies by German scholars on office typologies, where it is argued that different office typologies (single cells, double cells, group offices, open plan offices, combi-offices) differ significantly in the quality of encounters they allow for (see Muschiol, 2006). They also differ in the performance of the organisation as perceived by staff (see Spath and Kern 2003).

³ EBM has been defined as the 'conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients' (Sackett, D. L., et al., 1996). It thus adds scientific rigour ('current best evidence') to the experiential judgement ('making decisions', 'judicious use') of medics regarding their profession ('care of patients').

⁴ This Partnership received financial support from the Knowledge Transfer Partnerships programme (KTP) in 2006-2008. KTP aims to help businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within the UK Knowledge Base. KTP is funded by the Technology Strategy Board along with the other government funding organisations. Compare: <http://www.ktponline.org.uk/default.aspx> (last accessed: 18/05/2010).

⁵ Visual integration was measured based on the introduction by Turner, et al. (2001) and calculated with Depthmap (Turner, 2006).

⁶ Measured on a five point scale by a questionnaire with all staff (frequency of contact: 5=daily, 4=several times a week, 3=weekly, 2=monthly, 1=less than monthly contact).

⁷ All social network analysis results in this paper were produced with the software package UCINET and Netdraw (Borgatti, S. P., et al., 2002).

⁸ An Egonet is the network of one person (Ego) that shows their complete network, i.e. the links they hold to everyone else (Alters) as well as ties among Alters.

⁹ The fact that this is the main route is important in this case, since not every desk was passed by a person every 22 seconds, but only those desks at the end of a row, which means that the disturbance emanating from this high level of movement density was not felt equally by all staff.

¹⁰ Measured on a seven point scale by a questionnaire with all staff (frequency of contact: 7=several times a day, 6=twice daily, 5=daily, 4=several times a week, 3=weekly, 2=monthly, 1=less than monthly contact).

¹¹ 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 pre case study only and was followed by a lively open discussion around the question “What would have been different if we would have had this data before?”

¹² Actually, this idea was included in one of the first design solutions presented to the client, but was discarded later by the client in an urge to accommodate more people in less space.

¹³ This issue is also discussed in a more recent publication (see: Sailer and Penn, 2010).

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