

Jacqueline C. Vischer

## CHAPTER 4

### User-Centred Workspace Design: Applications of environmental psychology to space for work

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As the complexity of work increases, the importance of the psychological and behavioural effects of environmental features in places designed for work has grown. This field, known as the environmental psychology of workspace or workspace psychology, has expanded rapidly since the 1980's and now forms a substantial body of knowledge not only for researchers but also for organisations in terms of the design, operation and management of space for work. This chapter provides an overview of approaches to studying, understanding and applying workspace psychology to planning for worker comfort and productivity, cost effectiveness of accommodation, technology-supported mobile work, and rapid organisational change.

Space for work – or workspace – is increasingly diverse. Office planning was once based on simple division of workspace into large rooms containing rows of desks and a few private offices for managers and executives. Contemporary workspace includes a range of individual and shared spaces, communal areas and amenities, and access to sophisticated electronic tools (Gillen, 2006). Advances in telecommunications mean that people no longer need to be fixed in space and time to work together. Mobile work, work in public spaces such as airports and hotels, and non-territorial and 'drop-in' or convenience workspace are all increasing. Barriers between work and personal life are breaking down as people seek career opportunities rather than jobs, work different hours, make a social life at work, and sleep, eat and exercise in their employers' buildings. The meaning of workspace in all lines of work is changing and we are finding out more about the psychological impact of physical environments on work.

Companies are increasingly applying quality as well as cost criteria to workspace design (Becker & Kelley, 2004; Preiser & Vischer, 2015; Vischer and Malkoski, 2015). Workspace is no longer a backdrop – that is, a passive setting – for work. Environments are planned and designed to actively support workers' tasks (Nicolaou,

2006; Vischer 1996). Consequently, knowledge of how building occupants behave as a function of their physical environment is increasingly being applied to the creation of supportive, efficient and adaptable workspace. Research indicates that workspace design and management affect not only how people feel about their job, but also work performance, employee loyalty and engagement, and the value of human capital to the organisation. The focus of this chapter, then, is on the behaviour of building occupants - meaning not only workers' actions and responses, but also their attitudes, feelings, expectations, values and beliefs towards their workspace. It is useful to think of the user-environment relation as dynamic and interactive: that is to say, the user's environmental experience includes the consequences of his or her behaviour in that environment. The user/occupant is not a passive receptacle experiencing the built environment statically, as input; her experience of the environment is itself transformed by the activities she is performing. The relationship is better characterised as transactional or negotiated (Gray & Daish, 1996; Moore, 1980; Vischer, 2008a).

### **Satisfaction and Productivity**

Studies aimed at analysing and understanding the relationship of users to their workspace have largely focused on two outcomes: user satisfaction and worker productivity. While acknowledging that both outcomes are difficult to measure, the implicit logic that features of workspace design can be evaluated in terms either of how much workers like them or of how much more work is produced because of them has been hard to displace. Typically, user satisfaction is measured through survey responses in the form of ratings of various environmental features, and effects on productivity are assessed either in the form of self-report ('are you more or less productive as a function of workspace features?') or pre and post measures of task performance.

The extent to which environmental characteristics affect users' satisfaction has guided research on the environmental psychology of office environments since the 1980s and often still does (Marans & Spreckelmeyer, 1981; Ornstein, 1999; Veitch et al, 2007). Post-occupancy evaluation relies on survey questionnaires that ask building users to identify what they 'like' and 'dislike' about their work environment, on the assumption that users' self-reported satisfaction with individual features is a *de facto* measure of building quality. If users feel positive (satisfied), the workspace is successful, whereas if they are dissatisfied, the building (its design, management, work environment) is not performing or has somehow failed. Substantial knowledge

of users' preferences has emerged from workspace satisfaction research. For example, user surveys consistently find that office workers are dissatisfied with 'open plan' workspace, whether this is due to noise levels, distractions, lack of privacy, or the sameness of 'cubicles' (Borzykowski, 2015; Churchman et al, 1990; Hedge, 1986; Konnikova, 2014; Maher & von Hippel, 2005). However, the prevalence of this finding has not prevented employers from favouring some form of open plan – in part because it is cheaper to construct and more flexible to reconfigure than a traditional partitioned office layout, and in part because more desks and more equipment can be fitted into open plan layouts. A more useful research question is the degree to which workers are supported in the performance of their tasks by different open plan layouts – in other words, to what degree is their ability to work affected? Studies show that, on the positive side, open workstations facilitate communication by enabling workers to exchange information rapidly and informally and support flexible work-group participation. On the negative side, the open environment can generate noise and distractions that prevent workers from concentrating on their tasks (Davis et al, 2011). Moreover, the trend towards densification of workspace contributes towards distracting noise levels that many experience as a reduction of privacy (Vischer, 2012).

Whether workers like or dislike workspace features pertains more closely to happiness research than to understanding how effectively the physical environment supports work (Kolbert, 2010; Stone and Mackie, 2013). More complex models of user-environment interaction – such as how well people can perform tasks, access needed tools, engage in appropriate communication, and identify territory – are needed to guide inquiry into workplace performance, that is, the effectiveness of workspace whose explicit objective is to support the performance of work. A performing workplace is designed to optimise worker productivity (Clements-Croome, 2006). The concept of productivity is used for a wide range of desired behavioural outcomes (Ouye, 2008; Haynes, 2007). Many studies use respondents' self-reports of 'improved' or 'reduced' productivity because research measuring quantifiable output per worker or team is more complex to execute (Bordass & Leamann, 2004; Oseland, 2009).

Part of the difficulty of measuring the effects of workspace on worker productivity is confusion about definitions. There are at least three types of productivity that are influenced by environmental design, each of them in different ways. Each of the three categories – individual, group, and organisational productivity – denotes a variation in scale of environmental influence (Vischer, 2006). Individual productivity is

typically evaluated at the scale of the individual workpoint, examining how the micro-environment - specifically environmental conditions such as lighting and visual conditions, variations in temperature and humidity, furniture ergonomics, and noise privacy - influences individual task performance in terms of effects on speed and error rates as well as on incidence of illness and absenteeism. The productivity of groups sharing workspace, such as a teamwork environment, is typically evaluated in terms of the quality and quantity of group processes such as rate of innovations, number of creative ideas, and speed of decision-making. Teamwork is affected by the design and layout of the team workspace, including access and circulation, as well as by ambient conditions such as noise. Group processes are affected by workgroup size and the relative proximity of team members. Other environmental determinants of workgroup effectiveness include the positioning of work areas and shared space, and access to shared tools and equipment (Heerwagen et al, 2004; Oseland et al, 2011).

A third level of productivity is assessed in terms of an organisation's accommodation, that is, its overall work environment, including appearance and location, workspace and amenities, communications tools and technology, and the ways these are used. Accommodation supports business objectives and increases competitive advantage to varying degrees. The organisation-accommodation (O-A) relationship evolves and changes over time as a function of cultural and business changes inside the organization (Vischer, 1996). The quality of support that the organisation obtains from its accommodation can range from highly positive – actively supporting work – through neutral and poor, to highly negative. In a positive O-A relationship, workers' tasks are supported and in a negative O-A relationship, workers' time and attention are lost dealing with adverse environmental conditions. The O-A relationship is dynamic and evolving as firms become attuned to the benefits of adjusting and updating workspace in response to changing business tools and processes. Locational advantages and ease of access, balancing consolidation under one roof (centralisation) with dispersion of different groups in different facilities over manageable distances, and amenities such as fast elevators, convenient bathrooms, adequate parking, and attractive eating areas all affect organisational effectiveness (van der Voordt, 2004; Vischer, 2006). Studies have shown that both worker performance and organisational success is compromised “when the physical environment interferes with actions taken towards achievement [of objectives]” (McCoy & Evans, 2005).

Individual task performance is measured using tools for ergonomic analysis as well as questionnaire surveys that focus on the effects on workers of ambient conditions such as lighting, noise levels, furniture comfort, temperature, and indoor air quality. Team effectiveness studies tend to be more dependent on indirect measures such as social network analysis, gaming, and comparing outcomes among comparable workgroups in different environments (Horgen et al, 1999; Springer, 2011). Reviewing methods for evaluating organisational effectiveness has led to the conclusion that none is entirely satisfactory, as this is an elusive concept to define and measure, although tools are available.

While evidence accumulates that workspace design influences workers' effectiveness, accounts of workspace change suggest that employees resist 'social engineering' solutions where employers envision a work environment aimed at eliciting maximum work performance (Vischer, 2011). Such an approach violates the socio-spatial contract, the implicit social contract between worker and employer that promises to provide a certain level of workspace quality in return for the worker's energy, effort and knowledge (Vischer, 2005a). Contract violations cause workers to feel devalued and increase resistance to workspace change. In many organisations, moving workers out of enclosed offices and into open workspace is a socio-spatial contract violation: the status, confidence and responsibility that the employer communicates through private enclosed workspace is called into question by allocating workspace that is the same as everyone else's.

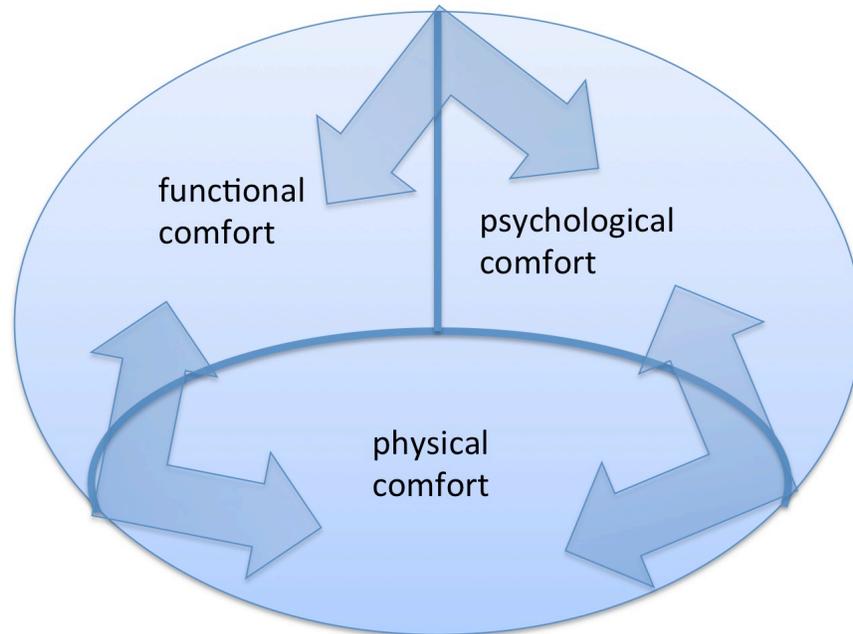
Managers who consider supportive workspace to be an investment in their workforce need to use research evidence to guide their environmental design decisions. Evidence-based design causes workspace planning and design alternatives to be tested empirically, or evaluated in terms of published research results before a decision is made (Hamilton & Watkins, 2008; Vischer and Zeisel, 2008). Like information technology, workspace can and should be a tool for performing work. In order to design workspace as a tool for work, reliable information is needed on what workers do, how they perform tasks, and ways in which they are or are not helped by workspace elements. Such an approach applies to all three categories of productivity: individual task performance, teamwork effectiveness, and organisational accommodation.

## Concept of workspace comfort

The connection between workspace satisfaction and productivity is functional comfort. The term comfort is frequently applied to interior conditions, especially to temperature and ventilation in commercial buildings. For example, temperature, air speed and relative humidity measure thermal comfort; air speed, circulation and freshness measure ventilation comfort; and brightness, contrast conditions and luminance measure lighting comfort. The results of comfort studies form the basis for comfort standards in buildings. The term adaptive comfort refers to the interactive nature of human comfort in terms of user control over environmental conditions (Nicol and Stevenson, 2013). Others point out that comfort is socially and culturally defined and the users' experience workspace is in part a function of organisational culture (Cooper, 2009; Chappells, 2010).

Functional comfort assesses the degree of support for their tasks that workers obtain from their physical environment. Measuring functional comfort offers more than feedback on worker satisfaction by capturing the impact of workspace features on work performance at the three productivity levels of individual tasks, team or collaborative work, and organisational effectiveness. In expanding functional to workspace comfort, the model recognises that, while assessing the degree to which the environment supports work provides useful diagnostic data on building performance, occupants' experiences are more complex and have multi-level effects (Vischer, 2008b). As shown in the diagram below, functional comfort is one of three constituents of workspace comfort. Physical comfort, defined in terms of meeting building codes and comfort standards, ensures that people feel healthy and safe in the buildings they occupy. Without physical comfort there can be neither functional nor psychological comfort. Both physical and functional comfort are affected by psychological comfort: people's sense of belonging, territory and environmental control, often expressed through the need for privacy.

Figure 4.1 Tri-partite model of workspace comfort



The functional comfort approach has been applied to diagnosing workplace performance in numerous office buildings (Rioux et al, 2013; Vischer, 2005b; Vischer & Malkoski, 2015). Levels of functional comfort are diagnosed using reliable feedback from building occupants. A standardised survey questionnaire measures occupants' experience, thereby avoiding the temporal and calibration limitations of instrument-based data collection. However, instrumentation is often useful to help interpret users' responses. Occupants' ratings on a series of five-point scales assess how much or how little specific environmental features (for example, temperature, air quality, lighting, human and equipment noise levels, space for meetings, access to equipment) support their work. Data are analysed to provide a profile of functional comfort for a given work environment, the results providing a diagnostic yardstick for designers, planners and managers. A functionally comfortable workspace is a performing workplace, signifying to employers that they are receiving a return on their workspace investment. Sometimes relatively small changes can lead to important improvements in workers' functional comfort and therefore overall productivity; there is also evidence that functional comfort and psychological comfort have interactive effects.

Workspace diagnosed as functionally uncomfortable slows down work and increases worker fatigue, leading to workspace stress. In unsupportive environmental conditions, workers are employing their energy to solve environmental problems. Consequently, their effectiveness is compromised, energy for creative thinking and innovation is reduced, and the value of its human capital is not realised by the organisation (Vischer, 2007). The notion of environmental support for work means not just receiving support from, but also being able to act on the environment to achieve a desired, supportive result. Stress occurs when elements of the physical environment interfere with the attainment of work objectives. Potential physical stressors that interfere with task performance, motivation and social relationships “can influence physiological processes, produce negative affect, limit motivation and performance, and impede social interaction” (Evans & Cohen, 1987).

While workers’ satisfaction ratings provide information on attitudes, measuring functional comfort yields a more useful diagnosis of workplace performance (Francescato et al, 2017 in press). Balancing environmental demands with the skills and abilities of users to act on their environment is a way of defining optimal workspace for creativity and flow (Csikszentmihalyi, 2003). The concepts of positive stress and of environmental competence recognize that some environmental challenge is necessary to ensure active engagement (Pedersen, 1999; Selye, 1979). Moreover, workspace cannot be designed to be a one-time, final, and permanent ergonomic support for all office tasks, but rather needs to be adaptable and negotiable to be most supportive to users. Users need the skills and opportunities to engage with and adjust their environment successfully, over time and with changing task requirements, in order to optimize comfort and manage workspace stress successfully.

Measuring levels of functional comfort in a building provides an indicator of both more stressful/least comfortable and of less stressful/more supportive environmental elements. Reliable occupant feedback shows that all workspace environments fall somewhere on the continuum ranging from functionally comfortable and supportive of work to dysfunctional and stressful.

## **Psychological Comfort**

Psychological comfort links psychosocial aspects of work with the environmental

design and management of workspace through territoriality, privacy and environmental control (Augustin, 2009; Vischer, 2005a). Psychological comfort is a function of a sense of belonging (territorial appropriation), along with loyalty and commitment to the organization, and environmental control, all of which are mediated by the socio-spatial contract and the behavioural expectations it implies.

The primary component of psychological comfort is sense of territory - both individual and group territory. Territory has psychological value both as space for one's work and as symbolic of one's place in the organization. Underlying these is a behavioural schema expressed in terms of the personalization and appropriation of space: marking territory and constructing boundaries of social and environmental control. Workspace personalization and space appropriation behaviours are more noticeable in offices where denser and more open office configurations have been installed (Wells & Thelen, 2002). The introduction and use of new technology and better communications tools have also affected workers' perceptions of and attitude towards their physical environment and territory (Cascio, 2000; Lai et al, 2002). Territorial boundaries are not simply physical elements that enclose space: territoriality signifies sense of privacy, social status and control. When people move out of private enclosed offices into open workstations studies show they judge their environment more negatively, citing lack of privacy, acoustic conditions, and confidentiality problems (Brennan et al, 2002; Rishi et al, 2000). These reasons are given irrespective of whether or not their work is confidential, or of whether or not they need to be alone to perform tasks effectively. Complaints about lack of privacy abound in studies of workspace change, independent of physical characteristics such as furniture configuration and partition height (Haans, 2007; McElroy & Morrow, 2010). On the other hand, data collected from professionals in open workstations who were not faced with a territorial threat such as an imminent move indicated that the demands of the job are more important than individual privacy (Kupritz, 1998).

Environmental control affects workers on at least two levels: mechanical or instrumental control, and control over process, or empowerment. Experimental efforts to increase users' control over their environment provide evidence of beneficial psychological effects (Niemala et al, 2002). Environmental control can be mechanical, such as chairs and worktables that are raised and lowered, shelving and tables on wheels, operable windows, switchable lights, and a door to open and close. Evidence indicates a positive psychological impact from mechanical control in situations where employees are informed and even trained to make use of the controls available (McCoy & Evans, 2005; Tu & Loftness, 1998). An important form of

environmental control is the opportunity for personalisation (Chalmers, 2015). Behaviours such as placing symbolic objects, family photographs, plants and posters in individual and team workspace increase sense of belonging, loyalty and morale.

Opportunities for employees to participate in workspace decision-making increase empowerment and sense of environmental control, both directly linked to psychological comfort. Studies have shown that worker participation in the design process has a positive effect on people's response to and feelings about their workspace (Lee & Brand, 2005; Veitch & Newsham, 2000). People who are informed about workspace-related decisions and who participate in decisions about their own space are more likely to feel territorial about their workspace and to have feelings of belonging and ownership. This enables positive coping with environmental demands and encourages workers to find new ways of solving environmental problems (Vischer, 2007).

Finally, research suggests a connection between workers' psychological traits and their reactions to the built environment at work. In focusing on cognitive processes, this line of inquiry addresses the effects of users' individual differences and how workers' evaluation of their workspace affects their perception of themselves at work (Elsbach, 2003). Not only do employees' cognitive and affective processes affect their perception of their work environment, but their perception and assessment of their workspace influences how they see themselves as workers and their professional effectiveness (Fischer et al, 2004). Studies comparing open with enclosed office users indicate that extraverts respond more positively to more possibilities for communication, and therefore do better in open office settings than workers with more introvert personalities (McCusker, 2002).

## **Conclusions and Directions for Future Research**

While considerable knowledge has accrued from studying the environmental psychology of workspace, important gaps remain. Findings to date have given rise to new and important questions that are fruitful directions for future research. The future of this field of study aims towards strengthening theoretical frameworks and lending greater coherence to existing knowledge.

The results of environmental satisfaction research offer a broad and comprehensive database of people's workspace preferences. However, satisfaction is not a practical

outcome for measuring workplace performance. While occupants' ratings provide data on their likes and dislikes, satisfaction studies generate little information about environmental support for task performance, about adding value to business processes, or why owners and managers should invest in workspace improvement. Measuring functional comfort provides diagnostic data on workspace support to individuals and teams. Results are applied to prioritising decisions about how and when to intervene to solve environmental problems and effect improvement through removing, replacing or changing workspace features. User feedback on ambient conditions can be used to diagnose building systems problems that are amenable to intervention and correction. Functionally comfortable workspace leads to better individual task performance and increased teamwork effectiveness and ultimately improves organisational productivity.

Measuring productivity in terms of occupants' self-reports is prone to social influence and lack of clarity about what exactly is being measured. However, more objective productivity indicators such as reduced illness rates, increased speed and accuracy of task completion, and even rates of generating new ideas, are also used as measures of environmental effects on productivity. Moreover, characteristics of the work environment affect the creation and transmission of knowledge in organisations (Von Krogh et al, 2000; Vischer, 2010). Companies are interested in understanding how knowledge accrues in their organisations and how to distribute and share new knowledge. Workspace plays an important role in these processes. Worker productivity in the knowledge economy is less a matter of improving speed and accuracy of routine tasks and increasingly a function of generating new ideas, being creative, working effectively in teams, and generating knowledge that adds value to the organisation (Holman et al, 2003). The concept of 'ba' – conditions that support and encourage knowledge creation, not only through the design of space but also through the nature and operations of the social and cultural environment – offers researchers a new and promising direction for analysing how features of the work environment add value to an organisation's human capital (Nenonen, 2004; Nonaka, 2008).

Finally, psychological comfort - the feeling of belonging - is an important predictor of employee retention and reducing costly staff turnover. More extensive measurement of territorial behaviour and appropriation at work will yield more information about how and why environmental features affect employees' sense of privacy and support constructive appropriation behaviours. A better understanding of territoriality, privacy and environmental control will help organisations determine how and to

what degree investment in environmental quality will affect both recruitment and retention of high-quality employees.

All three types of workspace comfort interact with sustainability or the 'green' qualities of commercial buildings (Baird, 2010; Brown et al, 2009; Leaman & Bordass, 2007). Workspace psychology looks, first, at the effects of sustainable building features, such as natural ventilation, water recycling and passive cooling technology on occupants and their work; and second, at the behavioural changes anticipated from users as a result of sustainable design features in buildings where they work. Such behaviours might include turning off lights when leaving, dropping blinds on sunny windows to reduce heat gain, and using public transportation to get to and from work. Some studies indicate a positive effect on psychological comfort where occupants are proud of working in sustainable buildings and feel empowered to make these kinds of decisions, while others show little evidence of more supportive workspace in sustainable buildings. Anecdotal evidence exists of buildings supplied with innovative sustainable design features that occupants have either not wanted or not been able to use. There is also some evidence that giving occupants a more active role and responsibility for changing their behaviour in environmentally sustainable buildings is a necessary condition for their success.

The environmental psychology of workspace is a rich and diverse field of study that is growing fast. As human beings in all parts of the world spend increasing amounts of time at work, the effects of the physical environment on occupants' performance, health and morale urgently needs to be understood. The knowledge yielded by workspace psychology research will inform employers' decisions as well as corporate investments in the work settings they create, and will assist and improve the building industry as designers, facilities managers, leasing agents and construction professionals draw on it. Business managers also need to understand more about how workspace affects their personnel as companies become more agile by making on-going changes to workspace and even dispersing co-workers to more than one geographic locale (Beard, 2012; Harrison et al, 2004). Finally, all indications are that a better understanding of occupant comfort is a prerequisite for successful sustainability and an effective impact on climate change.

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