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Chapter 6

THE PHYSICAL ENVIRONMENT OF THE OFFICE: CONTEMPORARY AND EMERGING ISSUES

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INTRODUCTION

An organization's workspace, the physical environment an organization provides for its employees to carry out their work activities, constitutes the second largest financial overhead (after human resources) for most organizations (McCoy, 2005). Of the workspace provided, most employees in developed countries work in some form of office environment (Duffy, 1997) and studies of this practice have found that it has a powerful role in shaping a diverse range of psychological and behavioral outcomes, including individual work motivation (e.g., Oldham & Brass, 1979), job satisfaction (e.g., Veitch, Charles, Farley, *et al*., 2007), and patterns of interactions (e.g., Boyce, 1974; Ives & Ferdinands, 1974; Sundstrom & Sundstrom, 1986). Furthermore, the impact of offices upon their occupants' personal productivity has been estimated to be somewhere in the region of 20% (e.g., Leaman & Bordass, 2005).

Within the organizational literature, offices have been typically described as either traditional (sometimes referred to as enclosed or cellular offices) or open-plan. Traditional offices tend to house one or two individuals in private rooms, enclosed by walls, often containing most of the amenities required for their job (Danielsson & Bodin, 2008). Open-plan offices are characterized by a lack of interior walls, tend to be larger and contain greater numbers of workers, with individual workstations arranged within the office in groups (Brennan, Chugh, & Kline, 2002; Brookes & Kaplan, 1972). Workspace design, however, is currently under organizational scrutiny due to the changing nature of work. It is evident that many organizations are re-evaluating their facilities to ensure

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their workspace meets the needs of an increasingly diverse and demanding workforce (see e.g., Laing, 2006). Architects have noted a definite shift in terms of how employees, especially knowledge-based workers, spend their time, the kinds of task they engage in and, crucially, where they choose to work (Duffy, 2000). As Gillen commented: "Work environments are in a state of transition from something familiar and predictable to something not yet defined, multi-locational, virtual and physical" (Gillen, 2006: 62). In response, organizations are increasingly investing in innovative offices, upgrading the open-plan office to support more nomadic, group-based, flexible, or remote working styles. However, office redesign is often based upon managers' own interpretations and experiences of employee work patterns, largely without specific research or professional input (e.g., Laing, 2006).

Optimizing existing offices (embarking on office redesign) manifestly involves change for the individual workers concerned. Alterations to factors such as the physical layout or configuration of space, and the provision of office facilities and services, can have significant effects on how individuals or teams go about their work (e.g., Laing, Duffy, Jaunzens, *et al*., 1998). However, despite the extensive change management literature (e.g., By, 2005; Kanter, Stein, & Jick, 1992; Luecke, 2003; Pettigrew, Woodman, & Cameron, 2001; Weick, 1979), there is currently limited guidance on how the process of office design and implementation can be successfully managed. Developing an appreciation of managing such processes is important if we wish to avoid new offices, or the changes in working practices that they necessitate and/or foster, being rejected by disaffected workers or undermined by counterproductive work behaviors (e.g., Chapman, Sheehy, Heywood, *et al*., 1995; Vischer, 2005).

To help drive a fresh approach to the study of workplaces, and to aid managers' decision making, this chapter collates and synthesizes, from a disparate range of sources, the findings of research that has investigated workers' reactions to, and interactions with, their workspace. Given the prevalence of open-plan offices, we first appraise the value of such work environments and describe outcome-related contingencies. In so doing, we differ from previous reviews that have bounded or compartmentalized the literature by physical feature or design choice, thereby examining the effects of the density of a workspace separately from the openness of an office's design (e.g., Baron, 1994; Elsbach & Pratt, 2007; Oldham, Cummings, & Zhou, 1995; Sundstrom & Sundstrom, 1986). Second, we review ways in which open-plan offices are evolving to suit the modern organization and what the implications might be for individuals and organizations. Third, we discuss the need to manage the process of change that office design and optimization involves. We examine some of the approaches that have been applied to date and also reflect on the similarity to wider organizational change principles. The chapter concludes by identifying how industrial and organizational (I/O) psychology research can contribute to decision making regarding optimal office design by extending current theory and utilizing fresh methodological techniques.

RISE OF THE OPEN-PLAN OFFICE

The office has emerged as the stereotypical place of work for the post-industrial age (e.g., Becker, 1981), with over 70% of workers occupying a form of open-plan office at the turn of the century (e.g., Brill, Weidemann, & BOSTI Associates, 2001; Vischer, 1996). In this section we review the benefits and risks of open-plan working, consider the trade-offs involved in pursuing an open-plan strategy, and highlight individual and contextual factors affecting open-plan outcomes. In order to set the scene and provide appropriate context, we begin by revisiting the origins of research into the physical work environment and chart the rise of the open-plan office.

Historical Overview

The physical environment was a major topic of interest for early I/O psychologists (circa 1910 onwards), with attention focusing predominantly on the effects of ambient conditions (e.g., lighting, temperature, ventilation) on workers' productivity (e.g., Morgan, 1916; Vernon, 1919, 1921). This approach is still reflected in the more recent ergonomic and environmental psychology literatures (Baron, 1994; Becker, 1981; Brennan, Chugh, & Kline, 2002; Oldham, Cummings, & Zhou, 1995; Sundstrom & Sundstrom, 1986). Notable relationships were established, for example between excessive noise and workers' health and productivity (Baron, 1994). However, the publishing of the Hawthorne experiments (Roethlisberger & Dickson, 1939) marked a watershed in organizational research, with this long-running field study publicly failing to establish a link between changes to the physical environment and worker productivity. The lack of success in establishing environment–behavior links in the Hawthorne experiments coincided with a general decline in interest in the physical environment which would last until the 1960s (Oldham, Cummings, & Zhou, 1995).

I/O psychologists may have conducted little research into the physical environment during the 1940s–1960s; however, the topic was not wholly neglected and pockets of research activity by other disciplines did prevail. For example, social psychologists and architectural schools were researching the interaction of individuals with the built environment (albeit with limited attention to workplaces), demonstrating how the manipulation of the physical environment could produce profound differences in the way that people interact with one another. For example, the spatial configuration of furniture was found to influence the amount and nature of conversation between individuals (Osmond, 1959; Sommer, 1959), and the location of people within a building helped determine with whom they interacted and formed friendships (Festinger, Schachter, & Back, 1950).

The widespread introduction of open-plan and *bürolandschaft* (landscaped) offices in North America in the 1960s and 1970s (e.g., Brookes & Kaplan,

1972; Hundert & Greenfield, 1969; Zeitlin, 1969), saw I/O psychologists and organizational scholars begin once again to become interested in the relationship between workers and their physical workspace (for an excellent review of the development of office environments see Duffy, 1997). The effects that changes to established office design may have upon office occupants became a common concern and the issue was taken up by journalists (e.g., *Business Week*, 1978) and scholarly researchers (Brookes & Kaplan, 1972; Oldham & Brass, 1979). Proponents of the open-office predicted that it would produce better inter- and intra-team communication (Brookes & Kaplan, 1972; Lee & Brand, 2005; Pile, 1976). Such claims helped persuade scores of corporations to experiment with the demolition of interior office walls and so began the rapid rise of open-plan offices.

The open-plan concept soon became a vehicle for organizations to reduce their fixed overheads (e.g., Duffy, 1997; Vischer, 2005) and to increase the density of employees housed in previously enclosed spaces. Gradually, design features, such as the inclusion of plants and angled desk placements, were marginalized. At the same time, distances between neighboring desks were reduced and circulation space sacrificed for "efficiency" gains (Laing, 2006). In turn, concern over effectiveness triggered a new wave of research into the effects of introducing open-plan working (Brennan, Chugh, & Kline, 2002; Oldham, Cummings, & Zhou, 1995). These concerns are still influential within I/O psychology and management research, with a continuing emphasis upon the examination of key aspects of open-plan configuration, for example the density of workers housed within the office, the proximity of co-workers to one another, and the openness of the office (e.g., De Croon, Sluiter, Kuijer, *et al*., 2005).

Benefits of Open-Plan Offices

The open-plan office has become the dominant choice when considering workspace strategies (e.g., Brill, Weidemann, & BOSTI Associates, 2001; Vischer, 1996), primarily for economic reasons (Brookes & Kaplan, 1972; Duffy, 1997; Laing, 2006). Fewer interior walls (and enclosed offices) permit larger floor plans to be achieved, which allow greater numbers of employees to be accommodated (e.g., Marquardt, Veitch, & Charles, 2002; Vischer, 2005). Increasing the density of workers housed within an office space through open-plan configurations has consequently become an important method through which organizations attempt to reduce overheads (e.g., Duffy, 2000; Veitch, Charles, Farley, *et al*., 2007; Vischer, 2005). Higher office densities allow substantial savings to be made in either rental, land, or build costs and lower services (e.g., heating and ventilation) and security charges (e.g., Duffy, 2000; Zeitlin, 1969). Reflecting these savings, the latest figures show a 40% increase in average UK office density since 1997 (from 16.6 m^2 per person to 11.8 m^2 today; British Council of Offices, 2009).

Cost savings can also be realized through an increase in flexibility. It is far easier to move furniture around in a large open-plan office than within enclosed offices. This flexibility reduces the costs of future reorganizations, with desks readily reorganized as individual and organizational requirements change, for example as project teams change or new technology is required. Individuals and teams can also be organized around work-flows and departmental groupings, enabling rationalizations such as the centralized storage of group files and work materials (e.g., Foland, Rowlen, & Watson, 1995).

In addition to financial benefits, another driver of the rapid adoption of open-plan offices has been the proposition that they aid inter- and intra-team communication (Brookes & Kaplan, 1972). For example, advocates of the social relations approach have proposed that the physical environment is able to affect the frequency and nature of the interactions and communication that its inhabitants conduct (Festinger, Schachter, & Back, 1950; Oldham & Brass, 1979; Zalesny & Farace, 1987). It has been suggested that offices that facilitate greater communication and interaction (e.g., those that place individuals close to one another and remove physical barriers to communication, as open-plan offices frequently do) allow individuals to share task-relevant information, promote feedback, and create friendship opportunities (Oldham & Brass, 1979), leading in turn to increased inter-personal relations, reduced conflict, increased job satisfaction and motivation (Zalesny & Farace, 1987). Indeed, studies have found that more open workspace generates greater group sociability (e.g., Brookes & Kaplan, 1972) and an increase in interaction has been typically observed (e.g., Boyce, 1974; Hundert & Greenfield, 1969; Ives & Ferdinands, 1974; Sundstrom & Sundstrom, 1986). Furthermore, open-plan configurations have been found to affect the pattern of interaction, with less time spent in formal meetings and an increase in informal communication (e.g., more conversations held around desks) observed following its introduction (Brennan, Chugh, & Kline, 2002).

Changes to an organization's workspace can also act as powerful symbolism, with the physical environment communicating information about the organization and its values (e.g., Davis, 1984), effectively supporting or undermining the desired culture and working practices (e.g., Allen & Henn, 2007; Becker & Steele, 1995; Higgins & McAllaster, 2004; McElroy & Morrow, 2010; Turner & Myerson, 1998). For example, design has been used to connect employees to organizational missions and functions, symbolically reflecting and promoting the organization and its working culture. In the case of BMW's Central Building, for example, the physical flow of cars extends throughout the building, from the shop-floor through the design, technical, and corporate areas, thereby connecting (both physically and symbolically) staff from all functions within the plant to the company's core business of making cars (Gannon, 2006).

Open-plan offices have been proposed as a means to initiate and support more open and collaborative working practices, to integrate business

functions, and to reflect a lack of hierarchy (e.g., Brennan, Chugh, & Kline, 2002; Brookes & Kaplan, 1972). McElroy and Morrow (2010) have recently reported a post-intervention study, incorporating a treatment and control group. They found that office refurbishment (involving the combined use of brighter décor, new furniture, greater openness, and higher workspace density) yielded positive changes in employee perceptions of organizational culture, whereas no such changes were observed in respect of the control group. Employees in the refurbished, more open office reported their organizational culture as being more innovative, less formal, providing more professional control, and fostering greater collaboration than their counterparts in the non-refurbished control office. In addition, occupants in the refurbished office were found to report greater co-worker satisfaction and affective organizational commitment. Findings in respect of workspace perceptions showed that although employees in the refurbished office were more positive regarding the layout of their office, they were significantly more dissatisfied with the amount of personal space and degree of distraction that accompanied the refurbishment. The study's design precludes the examination of the contribution of each individual aspect of the refurbishment, with only the effects of the combined intervention observable. Despite the confounding nature of the intervention, these findings support the proposition that a new workspace can aid the adoption of changes to working practices and culture, with physical features imbuing meaning and serving to reinforce nascent change (Higgins & McAllaster, 2004).

Exemplifying this line of reasoning, Hall and Ford (1998) described the design of a new factory for Keltec which included the adoption of an open-plan office and manufacturing space to aid communication and improve quality processes. Following the redesign of the plant, which incorporated the removal of many of the physical barriers separating white collar and production teams, the staff demonstrated greater empathy and there was greater understanding between teams, together with speedier communications and resolution of problems. The removal of physical barriers was seen as symbolic of the desired cultural change within the factory and led to greater integration between design and manufacturing. Like the aforementioned McElroy and Morrow (2010) field study, this case study illustrates the potential for open-plan offices not only to cut overheads or affect the frequency of interpersonal interaction, but also to act as a catalyst for wider cultural change within an organization (for further discussion of the symbolism of design see Davis, 1984; Vilnai-Yavetz, Rafaeli, & Yaacov, 2005).

Risks of Open-plan Offices

The previous section highlighted the financial benefits that open-plan offices can deliver through savings on facilities and their associated overheads. Indeed, many organizations still regard the design of their office space as a

largely technical issue, best left to facilities managers and furniture designers (Duffy, 2000). However, we suggest that the design of physical workspaces poses considerable risks (as well as an opportunity for gain) for organizations in financial, organizational, and human terms. At present, the limited attention paid to the interaction between workspace and individuals by businesses (Duffy, 2000) and, indeed, by organization theorists (Becker, 1981), makes the design and implementation of new or refurbished work environments a relatively unmanaged risk. There is a need for managers and researchers alike to consider the risks that housing employees in an open-plan office may pose and to evaluate whether the predominant open-plan format (Vischer, 1996) adequately satisfies user and organizational needs.

Although some of the findings we are about to discuss concern environmental factors not solely related to open-plan offices, they are often associated with the implementation of open-plan working and as such are relevant considerations for designers, managers, and staff. For example, reduced architectural privacy (through the lack of walls or significant screens) and increased density in open-plan offices can increase the frequency of uncontrolled interactions (e.g., conversations initiated by particular individuals, which other workers in close proximity have little or no opportunity to avoid). Although increased communicative spontaneity is one of the fundamental outcomes that open-plan configurations seek to promote (cf. Brookes & Kaplan, 1972), open-plan offices risk negatively affecting cognitive processes and task performance and/or contributing to stress (e.g., Baron, 1994; Cohen, 1980; Evans, Johansson, & Carrere, 1994; Oldham, Cummings, & Zhou, 1995; Paulus, Annis, Seta *et al*., 1976; Stokols, Smith, & Prostor, 1975; Sundstrom, Town, Rice, *et al*., 1994).

One major risk of open-plan offices is the greater opportunity for cognitive overload or over-stimulation to occur. Cognitive theory indicates that negative outcomes will occur (e.g., withdrawal from the workplace, reduced environmental satisfaction, or decremented task performance) when individuals are subject to excessive social interactions or distraction, which cause them to become overloaded (e.g., Cohen, 1980) or perceptually over-stimulated (Desor, 1972; Paulus, 1980). The proposition is that distractions in the environment can increase cognitive effort, adding to the demands that work may place upon employees, and once an individual's finite information processing capacity is exceeded, organizations run the risk that task performance and attention will diminish (Baron, 1994). Increased distraction or interruption (e.g., Brookes & Kaplan, 1972; Hedge, 1982; O'Neill, 1994; Sundstrom, Herbert, & Brown, 1982; Sundstrom & Sundstrom, 1986; Sutton & Rafaeli, 1987), together with other risks, such as reduced levels of concentration (e.g., Oldham & Brass, 1979; Oldham & Rotchford, 1983) and lower levels of motivation (Oldham & Brass, 1979), have been consistently associated with high density, open-plan offices with relatively few physical screens between staff. Evidence regarding an organizational consequence of such reactions is provided by Craig's (2010) survey of 38 000 knowledge workers' use of predominantly open-plan office

space which found that one of the biggest losses of productive time during the day stemmed from interruptions by colleagues.

A further risk is the exposure of workers to a lack of psychological privacy (e.g., Brookes & Kaplan, 1972; Hedge, 1982; Kupritz, 1998; O'Neill, 1994; Oldham, 1988; Oldham & Rotchford, 1983; Sundstrom, Herbert, & Brown, 1982; Sundstrom & Sundstrom, 1986; Zalesny & Farace, 1987), which may result in inhibited overt behaviors; for example, personal or confidential discussions and work-related feedback have been found to decrease under open-plan or higher density conditions (e.g., Oldham & Brass, 1979; Oldham & Rotchford, 1983). Psychological privacy concerns the amount of control individuals perceive they have over regulating their social contact with others, not least the degree to which they feel visually and/or acoustically exposed (e.g., Altman, 1975; Sundstrom, Burt, & Kamp, 1980). The organizational consequences of reduced psychological privacy, such as inhibited confidential discussions and feedback, will likely vary in relation to an employee's job role and level, in addition to the tasks in which they are engaged.

Environmental satisfaction, usually taken as the degree to which an individual is satisfied with their immediate workspace or area, has frequently been measured in some form in studies involving the physical environment (e.g., Brennan, Chugh, & Kline, 2002; May, Oldham, & Rathert, 2005; O'Neill, 1994; Oldham, 1988; Oldham, Kulik, & Stepina, 1991; Sundstrom, Burt, & Kamp, 1980; Sundstrom, Town, Rice, *et al*., 1994; Sutton & Rafaeli, 1987). Open-plan workspaces (e.g., Brennan, Chugh, & Kline, 2002) and those offices with raised density or increased proximity of co-workers (e.g., May, Oldham, & Rathert,, 2005; O;Neill, 1994; Oldham, 1988; Oldham, Kulik, & Stepina, 1991; Sundstrom, Burt, & Kamp, 1980) have been related to reduced levels of environmental satisfaction. Given that environmental satisfaction has been found to be positively related to job satisfaction (e.g., Veitch, Charles, Farley, *et al*., 2007), and in turn to organizational commitment and turnover intent (Carlopio, 1996), clearly another risk that needs to be managed when introducing open-plan working is the potential risk of a concomitant decrease in job or work satisfaction (e.g., Oldham & Brass, 1979; Zalesny & Farace, 1987). Indeed, satisfaction with the physical environment is included explicitly as a component of some measures of job satisfaction (e.g., Warr, Cook, & Wall, 1979).

Yet another risk that needs to be managed in open-plan workspace is noise. Noise, defined as unwanted sound (Baron, 1994), has often been reported as the greatest issue of dissatisfaction that staff raise when questioned about their open-plan work environments (e.g., Sutton & Rafaeli, 1987). Indeed, Leaman and Bordass (2005) describe noise as the issue that workers would most like to be able to control. The reduction in walls, screens, and acoustical materials, in addition to increased numbers and groups of employees occupying a single space, can give rise to greater noise than would be experienced in single or low occupancy offices. In general, laboratory studies have found relationships

between increased background noise and detrimental task performance (e.g., Glass & Singer, 1972; Rashid & Zimring, 2008; Smith-Jackson & Klein, 2009). For example, Perham, Banbury, and Jones (2007) found serial recall of digits to be significantly reduced when participants were played background office noise. However, the evidence linking noise and real world job performance is more variable (e.g., Evans & Johnson, 2000; Sundstrom, Herbert, & Brown 1982; Sundstrom, Town, Rice, *et al*., 1994).

The risks associated with open-plan offices illustrate the need for workspace to be considered beyond traditional technical matters. The organizational risk that office design or redesign presents requires a structured response, both to identifying such risks and in evaluating the extent of the threat that they may pose – in essence appropriate risk assessment needs to be developed. Once such environmental risks have been identified mitigation strategies and techniques aimed at limiting or eradicating the effects may be employed. Later in this chapter we briefly revisit the issue of mitigation; reflect upon the trade-offs between the risks and benefits of open-plan working; and explore the potential for the evolving office to satisfy competing user and organizational needs.

Individual and Contextual Factors Affecting Open-plan Offices

Within the management and I/O psychology literatures, researchers have attempted to investigate whether employee reactions to their workspace, open-plan in particular, is uniform (whether negative or positive). A number of studies have attempted to assess the effects that job level and complexity might have on workers' interactions with their environments (e.g., Brennan, Chugh, & Kline, 2002; Carlopio & Gardner, 1992; Ferguson & Weisman, 1986; Hedge, 1982; Konar, Sundstrom, Brady, *et al*., 1982; O'Neill, 1994; Oldham, Kulik, & Stepina, 1991; Sundstrom, Burt, & Kamp, 1980; Sundstrom, Herbert, & Brown, 1982; Zalesny & Farace, 1987). With regard to job level, Carlopio and Gardner (1992) found that managers were more satisfied in enclosed offices than their clerical colleagues. The latter preferred more open arrangements. Sundstrom Herbert, and Brown (1982) found that managers who relocated from enclosed to open workspace reported larger reductions in their privacy than other staff members who experienced reductions in their workspace (e.g., through the use of barriers, screens, or cubicles surrounding their desk). In partial support of these findings, O'Neill (1994) found a weak but significant relationship between job level and environmental satisfaction. Although job level has not been found to be significant in all studies (e.g., Ferguson & Weisman, 1986; Oldham et al., 1991), overall results support the assertion that managers and supervisors respond more negatively to environments that reduce their privacy. The mixed results in this area may partly be explained by the differing operationalization of job level, with some studies simply classifying respondents as managerial or not (e.g., O'Neill, 1994), others using aspects such as job type and number of supervisees (e.g., Ferguson &

Weisman, 1986). Charles and Veitch (2002) have noted that, in the main, the literature points to groups of workers being differentially affected by variations in workspace density, with those individuals in lower level jobs being less affected. Sundstrom, Town, Rice, *et al*. (1994) have suggested that this is likely to be due to managers requiring greater confidentiality to perform aspects of their role. Alternatively or in addition, a symbolic interpretation would posit that managers and other higher level staff may experience negative reactions, not simply because of the functional inadequacies of an open-plan office, but also because of the loss of status and differentiation that uniform or smaller open-plan workstations confer (for further discussions of this issue see Davis, 1984).

The effects of task complexity on interactions with office space have also been investigated. Block and Stokes (1989) demonstrated that individuals performed better on a complex task in a room on their own, while a simple repetitive task was performed better in the presence of others. Furthermore, studies have found that specific skills can influence the relationship between job complexity and reactions to the physical environment. For example, stimulus screening skills – how well an individual is able to screen out unimportant, unwanted aspects of their environment (Mehrabian, 1977) – have been found to interact with job complexity, with stronger screeners reporting more favorable outcomes than weak screeners in more open or distracting conditions (e.g., Fried, 1990; Oldham, Kulik, & Stepina, 1991). However, overall the literature is inconsistent, some field studies not having found significant relationships between task-complexity and the work environment (e.g., Sundstrom, Burt, & Kamp, 1980).

In addition to examining job level and task complexity, researchers have employed a range of theoretical approaches to assess how individuals perceive or react to their environments. Such approaches include cognitive theories, for example information overload (Cohen, 1980) and overstimulation (e.g., Desor, 1972; Paulus, 1980); social interference theory (e.g., Baum & Paulus, 1987; Oldham, Cummings, & Zhou, 1995); and stress-based models (e.g., Paciuk, 1990). In general, cognitive approaches have suggested that workers who are not cognitively challenged by their work have greater capacity to accommodate unexpected social interactions or distractions (e.g., Baron, 1994).

A Trade-offs Perspective

Previous reviewers (e.g., Elsbach & Pratt, 2007) have noted that the design of the physical environment involves trade-offs in the management of competing tensions between its different aspects. The evidence surrounding the benefits and risks of adopting an open-plan workspace strategy illustrates the need to ensure that potential negatives, such as increased distraction, noise, and reduced privacy (e.g., Brookes & Kaplan, 1972; Hedge, 1982; Leaman & Bordass, 2005; O'Neill, 1994; Sundstrom, Herbert, & Brown, 1982; Sundstrom & Sundstrom, 1986), do not outweigh the financial and behavioral

positives that might be delivered (e.g., Duffy, 2000; Hundert & Greenfield, 1969; Ives & Ferdinands, 1974; Zeitlin, 1969). However, mixed findings (Boyce, 1974; Brennan, Chugh, & Kline, 2002; Brookes & Kaplan, 1972; Hedge, 1982; Oldham, 1988; Oldham & Brass, 1979; Zalesny & Farace, 1987) illustrate the difficulty in attempting to draw clear-cut conclusions in regard to when an open-plan office is most appropriate for an organization, or which aspects of such a design pose the greatest potential risk to an organization (e.g., higher density levels, lower level screens between or around workstations).

Although there are substantial risks to implementing an open-plan concept, there is the potential to minimize these effects. For example, techniques such as pumping in white noise (low-level unstructured noise from across the audible sound spectrum) or piped music, or the use of noise dampening materials, may be used to mask intermittent office noise (e.g., human speech or telephones ringing) (e.g., Vischer, 1989), although their efficacy is not confirmed (Navai & Veitch, 2003). Furthermore, Brennan, Chugh, and Kline (2002) have suggested that the use of agreed protocols may provide a technique with which to minimize the effects of disturbing unpredictable noise, such as co-worker conversations. In their evaluation of an office relocation, they commented that the increase in desk-side impromptu meetings, which accompanied the introduction of open-plan working, might have been avoidable if clear protocols had been agreed to regulate where such activities took place. The use of such behavioral protocols may be an alternative approach to reducing auditory interruptions, without resorting to costly technical or reconfiguration techniques.

Designers need to be aware that employees may not react uniformly to open-plan offices (Sundstrom, Herbert, & Brown, 1982), as the tasks and roles that staff perform influence the extent to which the design poses a risk. Furthermore, differences in the configuration of open-plan space, such as the spatial density of employees, may make an office less suitable for some types of employee (Charles & Veitch, 2002). Consequently, housing large, diverse groups of workers within a uniform open-plan office may be counterproductive for organizations. A more nuanced view is required, one that recognizes that open-plan inherently involves trade-offs. These trade-offs may in part be negotiated by varying the configuration of open-plan within an office, for example providing different forms of open-plan space for differing employees, striking a balance between competing needs. In summary, the flexibility of space that open-plan offices provide (e.g., Marquardt, Veitch, & Charles, 2002) may need to be adapted and fine-tuned to suit the needs of diverse sets of employees.

EVOLUTION OF OPEN-PLAN OFFICES

Open-plan offices may have become the workspace solution of the twentieth century but the office continues to change and evolve (Laing, Duffy, Jaunzens,

et al., 1998), posing fresh challenges to I/O psychologists' understanding of workers' interactions with their environments. Open-plan is evolving in that the format is being adapted and modified to engineer spaces that better reflect modern workers and the modern business landscape. In this section we discuss the driving forces behind such changes, the form that these new offices are taking, and what we currently understand about the effects of their design.

The Drivers of Change

The design and operation of workspace has always been driven by a number of often competing interests, such as:

1. The cost of building, maintaining and servicing the space;
2. Providing for the comfort and security of occupants;
3. Accommodating new technologies (e.g., the emergence of personal computers);
4. Supporting working styles and processes;
5. Upholding organizational structure and corporate image;
6. Aiding recruitment (through providing an attractive place to work); and
7. Location (e.g., Allen & Henn, 2007; Becker, 1981; Becker & Steele, 1995; Duffy, 1997; Duffy, McMahan, & Pringle, 1999; Laing, 2006; Sundstrom & Sundstrom, 1986; Vischer, 2005).

The work environment both reflects and accommodates the changing economic circumstances and the nature of work itself and so is prone to adaptation as business needs progress.

Just as new technology has shaped and influenced the nature of offices in the past (e.g., the typewriter produced large typing pools, the personal computer altered the nature of tasks performed at a desk), it is once again revolutionizing the way we work and the space requirements that this entails. The advent of increasingly affordable laptop computers means that workers are no longer bound to a single desk to operate the technology; computers can be readily moved around an office or multiple locations. Indeed, battery power and wireless network connections mean that traditional desks are not a prerequisite for work at all – coffee tables, touch-down spots, or even just an individual's knee can be sufficient.[1] Video conferencing, remote network access, and reroutable telephone lines allow workers to work with colleagues and teams from around the globe (Felstead, Jewson, & Walters, 2005; Laing, 2006). Colocation is no longer a necessity for work groups and teams may operate in

[1] Increased portability offers flexibility to workers regarding where they can physically work and allows them to maximize their working time. However, care needs to be exercised to ensure that working away from a desk does not compromise safe working. Ergonomic and health and safety considerations make permanent or extensive use of laptop computers or similar technologies in such conditions undesirable.

temporally disparate patterns (Bell & Kozlowski, 2002), enabling interaction with colleagues in other time zones. As with the rise of open-plan working, the adoption of such technologies is partly attributable to the organizational cost-saving that can be realized through the use of technologically enabled practices such as tele-working and home-working (e.g., Chapman, Sheehy, Heywood, *et al*., 1995; Felstead, Jewson, & Walters, 2005; Ng, in press) which allow both transport and accommodation costs of employees to be reduced.

In addition to technological advances and cost reduction, the changing nature of work is an important driver of current office evolution (Laing, 2006). Key to this evolution is the continued growth of knowledge working, both as a percentage of the economy and of the labor force (Davenport, 2005). Knowledge work can be described as involving the application of "theoretical and analytical knowledge," exemplified by individuals involved in areas such as product development or consultancy work (Parker, Wall, & Cordery, 2001). Knowledge work is often contingent upon the collaborative efforts of multiple individuals. Previously, open-plan offices enabled organizations to house workers in spaces that promoted inter- and intra-team information sharing and interaction, by locating individuals proximally to one another and removing physical walls and obstructions (e.g., Brookes & Kaplan, 1972; Hundert & Greenfield, 1969; Ives & Ferdinands, 1974). Whilst useful in supporting knowledge working, such an approach remains a relatively blunt tool, as it fails to acknowledge the variety of tasks that modern knowledge workers may be involved in, the distributed nature of their interactions, and the shifting temporal nature of their roles and tasks.

Our own preliminary analysis of data gathered from the post-occupancy evaluation of a new research and development facility supports the view that staff utilize different workspaces dependent upon the task with which they are engaged. For example, we have found that within the new facility, 70% of the facility's staff spend at least 40% of their work time in spaces other than their individual workstation (predominantly in formal or semi-formal meeting spaces) (Davis, Leach, & Clegg, 2010). Differences in the nature of tasks individual knowledge workers engage in have been noted by Becker and Sims (2001), who discuss evidence regarding how the time spent on solo tasks and more collaborative activities can vary widely between individuals of similar job titles. Indeed, Robinson (2010) analyzed how design engineers spend their time and established that individuals averaged over 55% of their work time engaged in information behaviors (including answering colleagues' questions and conversing socially), with around 31% of time spent on solo technical activities. Furthermore, Craig's (2010) study of task and space use of over 38 000 knowledge workers found that on average they spend at least 40% of their time engaged in interactive or collaborative tasks. Collectively, these findings illustrate that knowledge workers frequently undertake a range of tasks, that these tasks may be undertaken in different work spaces, and that the combinations of tasks and spaces are likely to vary between individual workers.

The changing nature of work and workspace is causing fundamental shifts in how organizations approach their space planning and manage their staff (Laing, 2006: 33). Architects and designers are being asked to deliver workspaces that are able to accommodate the competing demands of fluctuating occupancy levels, to enable employees to participate in a greater range of work tasks, and to facilitate collaboration across work groups and departments – and to do so within budgets that are more constrained than ever.

The Form of the Evolving Office

Alternatives to the established open-plan design and traditional enclosed offices are becoming more commonplace in practice (Gillen, 2006). One approach to accommodate the competing demands described previously is to design offices based primarily upon the patterns of work of its occupants and their respective needs for collaboration. Such designs often incorporate social hearts (or hubs) and "streets" that enable planned and unplanned encounters to take place. These offices also provide spaces that offer different functionality that all workers can access as and when required (e.g., team spaces, reading rooms, computer hubs, formal meeting rooms, and café areas). Financial and space savings can be realized through reducing the provision of strictly "individual" workspaces, with the emphasis upon providing mixes of space that are appropriate to groups of workers (see e.g., Allen & Henn, 2007; Becker & Steele, 1995; Gillen, 2006).

Other approaches such as utilizing hot-desking (where desks are available to any worker as and when required) or hoteling (where unassigned desks are reserved by workers for a given period) within established open-plan workspaces are also being employed. This can allow organizations to reduce the total number of desks (and concomitant office space) as they no longer have to provide or assign desks to each individual. These practices can be particularly useful where workers frequently work at client offices or spend a large amount of time traveling or in meetings. Such practices reflect the reality that office occupation rates are unlikely to be 100%, and in organizations that involve activities such as large amounts of traveling by sales staff or consultants, then this rate may be substantially lower (Markland, 1995).

To support more mobile or transient working patterns, non-traditional satellite offices or neighborhood work centers have been adopted to allow workers (either from the same or from a number of different organizations) to use office space based upon their location (Cascio, 2000). Non-traditional satellite offices tend to be sited in convenient locations and draw workers from across an organization based upon proximity rather than organizational structure. Neighborhood work centers serve a similar function, allowing workers to use offices closer to where they live or need to be; in these cases, however, the offices are shared by a number of organizations, allowing access to a greater

number of locations than a single organization could provide (Fritz, Higa, & Narasimhan, 1995). Workers are able to "hotel" at the office that is most convenient to them at the time, rather than being restricted to where their particular department is located or their company's nearest sole occupancy office.

Social and informal meeting spaces are also taking on enhanced roles in the evolving office. Becker and Steele (1995) observe that it is necessary for organizations to provide areas that allow workers to meet informally if intra- and inter-team collaboration is to flourish. This goes beyond simply removing office walls and partitions, or seating colleagues closer together; rather, the focus is upon designing a variety of spaces that can help to foster the types of interactions desired, in addition to allowing space for more individualistic tasks. Case studies exploring the provision of social space within contemporary office redesigns have consistently found that it helps to foster informal meetings and wider interactions (Becker & Steele, 1995). Furthermore, flexible workspace and easy access to meeting rooms have been related to higher job satisfaction and group cohesiveness (Lee & Brand, 2005).

Allen and Henn (2007) argue that it is important for the physical space to be configured to facilitate the communication and work patterns required by the job. This may mean providing what Becker and Steele (1995: 78) term "activity magnet areas," such as café areas where individuals may eat their lunch, have a drink, hold informal meetings with colleagues, or use for quiet reading. McCoy (2005) notes that providing a mix of different meeting spaces close to teams can help increase impromptu meetings and serendipitous interactions (e.g., Peponis, Bafna, Bajaj, *et al*., 2007), thereby encouraging team communication and collaboration. Providing adequate space for impromptu meetings to occur within the office may help to maximize the potential of open-plan working (e.g., increased visibility and communication) while limiting negative effects on those working on solitary tasks (i.e., by moving impromptu meetings away from co-workers' desks).

In a similar vein, Duffy (1997) has suggested that modern offices should offer workers a variety of differing types of workspace, dependent upon the characteristics of their job and work styles. These characteristics include the degree of autonomy that the job entails, the level of interaction required between colleagues, the duration of the work that they engage in, and the amount of office-based time (occupancy level). Duffy (1997) articulated a schema comprising four differing workspace solutions that are best suited to supporting distinct types of workers and working patterns, based upon dimensions of autonomy and interaction (the hive, cell, den, and club) (see Figure 6.1 for an illustration of this schema). According to Duffy (1997), increasing the fit between the design of the workspace and the demands of the work will lead to more effective and satisfied employees (see also Laing, Duffy, Jaunzens, *et al*., 1998). More generally, this approach of satisfying needs and demands

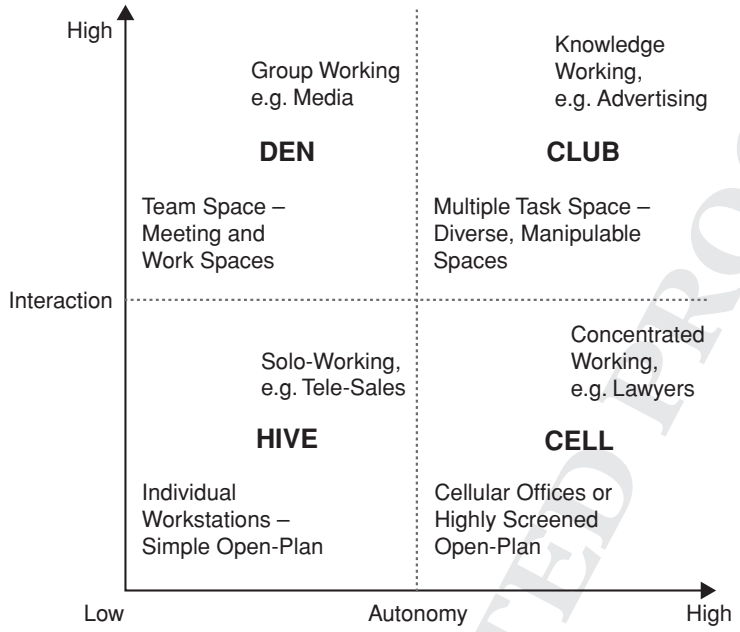

Figure 6.1 Schematic illustrating Duffy's (1997) distinction between differing office designs and their support for working practices. (Figure based upon concepts developed by DEGW, Frank Duffy and Andrew Laing, published in Laing, A., Duffy, F., Jaunzens, D., & Willis, S. (1998). *New Environments for Working: The Redesign of Offices and Environmental Systems for New Ways of Working*. London: Construction Research Communications Ltd., page 23, reproduced by kind permission of DEGW.)

is incorporated under the umbrella of psychological needs-based approaches to workspace design (see also Vischer, 1989). Such approaches have been found to be applicable in a range of organizational contexts, with working patterns and use of space largely explained by the particular classification system adopted (for additional representative examples see Allen, Bell, Graham, *et al*., 2004; Laing, 2006; Laing, Duffy, Jaunzens, *et al*., 1998).

Turner and Myerson (1998) suggest, from their experience of both research and the design of new workspaces, that "it is the rich and varied setting of the 'Club' which best illustrates the way the new office is going, with its high levels of both autonomy and interaction" (1998: 73). Duffy's (1997) schematic captures the way in which contemporary offices are becoming ever more diverse, ranging from the traditional enclosed single occupancy offices and high density open-plan forms, through offices containing large amounts of team space and meeting areas but which offer little individual desk space, to those which have large amounts of all of these spaces and more (e.g., reflective space, libraries, and cafés).

Effects of Evolving Offices

Contemporary office designers are increasingly seeking to provide a mix of workspaces within largely open-plan offices which provide for workers' diverse needs and reflect their increasingly flexible work patterns (see e.g., Laing, 2006). For instance, offices that incorporate a mix of differing workspaces (e.g., individual workspaces, quiet rooms, team-spaces, meeting rooms) to facilitate different styles of working and types of tasks have been successfully implemented by the architectural consulting group, DEGW, in a number of UK public sector refurbishment and redesign projects (Allen, Bell, Graham, *et al*., 2004). These projects have demonstrated that it is possible to design multiple workspaces, often within a broadly open-plan style office, which facilitate different levels of interaction, forms of working, and technology use. For example, a refurbishment of the UK's HM Treasury offices involved the introduction of a large number of informal meeting areas, partly to increase the amount of team-working space. This project was used to help support collaborative working and to ensure that the individual areas were sufficiently quiet to enable cognitively demanding work to be undertaken (i.e., space that is quiet enough for individuals not to require separate "quiet booths"). Within the UK Department for Trade and Industry, a flexible workspace concept was introduced utilizing modern IT (e.g., wifi, laptops, telephone systems that can reroute numbers to any desk) to allow hot-desking within open-team space. In addition, "touch down" spots (places with network connections around the facility to allow workers to use laptops without requiring a traditional workstation), project areas, quiet spaces, and a café were introduced to support flexible working around the building. Hot-desking and the inclusion of other work areas allowed the designers to reduce the individual desk space from 1 : 1 to 8 : 10, freeing space for a higher proportion of task relevant space.

Contemporary offices that involve a reduction in individual workspace (either to enable space rationalization or to allow the inclusion of other activity areas) or changes to working practices (e.g., compulsory remote working to allow a reduction in the number of desks) have not been introduced without controversy. Offices where employees do not have their own desk or personal space have been criticized for failing to provide adequate personal control or territory for individual workers (e.g., Danielsson & Bodin, 2008), which in turn can lead to counterproductive work behaviors (for a comprehensive review of literature concerning territoriality see Brown, Lawrence, & Robinson, 2005). Danielsson and Bodin (2008), however, have found somewhat conflicting evidence. They surveyed occupants of a number of different types of offices: cell office (tradition single enclosed room/workspace); shared room (two to three people sharing a room); small, medium, or large open-plan offices; "flex-office" (no individual workstations but comprising a variety of spaces to support different types of working); and the "combi-office" (employees spend more than 20% of their time in workspaces other than their own,

e.g., team-based space). Their findings indicate that workers are as satisfied in a flex-office as in a shared room or cell office, and more satisfied than in open-plan or combi offices. These results, although only based on a relatively restricted sample, suggest that in the right circumstances, flexible workspaces can offer both individuals and organizations a good solution to managing diverse work needs.

As noted by several authors, there is very limited evidence with which to evaluate the effects that workspace concepts such as tele-working, desk sharing, or hoteling might have on individual or organizational outcomes (De Croon, Sluiter, Kuijer, *et al*., 2005; Ng, in press; Vos & van der Voordt, 2001). There is a paucity of published work that describes the outcomes and contingencies for workers housed in these new workspaces, or for those who tele-work from home frequently. De Croon, Sluiter, Kuijer, *et al*. (2005), however, note that the limited evidence available suggests that desk sharing (or hot-desking) may improve communication between workers; although Vischer (2005) has highlighted potential dangers of implementing such radical shifts in workspace use as it can be accompanied by rejection of the new working practices that accompany such designs.

A recent study by Millward, Haslam, and Postmes (2007) of workers who had been randomly assigned fixed desks or hot-desking found relatively neutral reactions. For instance, they found that workers assigned to hot-desking were not alienated by the change, although they did place a higher value on electronic communication than their assigned desk counterparts.

Once again, organizational cost saving is suggested as a driving force behind the rapid promotion and adoption of tele-working and home-working (e.g., Cascio, 2000; Felstead, Jewson, & Walters, 2005; Ng, in press). Encouraging employees to work at home, or from client sites or coffee shops, allows organizations to shift some of the costs of providing workspace onto other parties or the employee themselves. In return the employee may be able to take greater control over choosing the work area that they feel most comfortable in, and in managing their work–life balance. Indeed, one recent review has suggested that home-working may provide a number of benefits to employees, including well-being, and job and life satisfaction (Redman, Snape, & Ashurst, 2009), although empirical analysis examining the individual experience of such arrangements is limited.

In summary, contemporary offices are evolving from the established open-plan format to become more diverse, less desk-bound, and more adaptive in form. Organizations are redesigning their existing open-plan office space to optimize it for contemporary working practices. This change is driven in large part by the advances in mobile and communications technology (e.g., Duffy, 1997; Felstead, Jewson, & Walters, 2005; Laing, 2006) and a desire for further cost reduction (e.g., Duffy, 2000), as well as the increasing prevalence of knowledge working (e.g., Davenport, 2005) and the diverse range of tasks that employees engage in (e.g., Becker & Sims, 2001). Optimized open-plan or more flexible office spaces often utilize techniques such as hot-desking, or

home-working, to allow space either to be saved or freed up to be used in different ways (e.g., Allen, Bell, Graham, *et al*., 2004).

The prevalence of more sophisticated open-plan and flexible workspace is likely to accelerate as organizations continue to redesign existing office space and to invest in new buildings that reflect ongoing technological advances and increasingly complex work and work patterns. In order to provide advice and insights that can inform the design and management of such environments, sustained research attention in this area is required, mindful of the fact that the introduction of new workspaces and the redesign of existing ones in ways that affect an individual's territory, work practices, or experienced control may produce negative reactions (Danielsson & Bodin, 2008).

MANAGING THE PROCESS OF CHANGE

This section reviews theory and research pertaining to the management of the process of change that accompanies the design of a new workspaces or the redesign of existing ones. While acknowledging that there is a substantial literature that concerns organizational change in general (e.g., Burnes, 2004; By, 2005; Clegg & Walsh, 2004) we focus upon theory and case studies that have been applied specifically to the domain of contemporary office environments. We discuss the idea that new or redesigned workspaces can involve significant changes for employees; the similarities of the process of workspace design to organizational change; the role of user involvement in changing physical workspace; and the application of socio-technical principles.

New or Redesigned Workspace Involves Change

Whether a firm embarks upon a modest refurbishment of an existing open-plan office or seeks to introduce a highly contemporary workspace, for example incorporating aspects of flexible space and tele-working, the activity of design and eventual occupation will almost certainly usher in changes, both for individual workers and for the organization as a whole. The design of a new office (or redesign of an existing one) often involves changes in spatial configurations, facilities, or technologies that can significantly alter the way in which individuals and teams go about their work (e.g., Laing, Duffy, Jaunzens, *et al*., 1998). This is aside from the altered sensory experience that features of a well-designed office, such as improved lighting or ergonomic furniture, may deliver. More specifically, the adoption of open-plan working can have major effects on employees' work experiences, most likely originating from differences in the frequency and nature of interactions (e.g., Ives & Ferdinands, 1974), visual and auditory distraction (e.g., Sundstrom & Sundstrom, 1986), and the location of other teams and colleagues (see also McElroy & Morrow, 2010). Indeed, even modest redesigns to existing open-plan offices, for example introducing break-out areas, may significantly affect work experiences for better or worse. For instance, a greater level of background noise for individuals

located near the break-out areas might have a detrimental effect on performance. Furthermore, introducing a radical new office concept, for example including street layouts, collaborative rooms, and reduced individual workspace, may require workers to embrace new working practices, including a more informal approach to meetings (e.g., Brennan, Chugh, & Kline, 2002) and hot-desking (e.g., Duffy, 1997). All of these changes to the physical environment, therefore, require careful design, facilitation, and implementation if the result is to reflect and meet the needs of individual employees (Becker, 1981).

Similarity to Organizational Change Management

The design and implementation of a new office concept, or the redesign of an existing one, can be considered as a form of discontinuous organizational change as it introduces a one-time change to the group affected (Luecke, 2003). However, active management of the design process leading up to the introduction of a new office environment and support following its introduction can transform the process into a less discrete change. Indeed, a new office can initiate and support changes to working practices (e.g., enhancing collaboration) and culture (e.g., Turner & Myerson, 1998), transforming such interventions into incremental forms of organizational change. Badly, managed, such interventions will breed resistance and resentment, as with any poorly orchestrated organizational change process.

Despite the substantial literature concerning change management within the management and I/O psychology domains (e.g., Brown & Eisenhardt, 1997; Burnes, 1996; By, 2005; Clegg & Walsh, 2004; Holman, Axtell, Clegg, *et al*., 2000; Kanter, Stein, & Jick, 1992; Kotter, 1996; Luecke, 2003; Pettigrew, 1985; Pettigrew, Woodman, & Cameron, 2001; Van de Ven, & Poole, 1995; Weick, 1979; Woodman, 1989), there is currently only a very limited acknowledgement of the potential for workspace to support or initiate change, whether intended or not (e.g., Lawler & Worley, 2006; McElroy & Morrow, 2010). Architectural and design-led studies exploring this issue have found that engaging end-users in, and allowing them a degree of control over, the design process is beneficial both to the design of new workspaces and to aiding employee acceptance of changes to working practices (e.g., Blundell-Jones, Petrescu, & Till, 2005; Turner & Myerson, 1998). Studies examining the effects of end-user involvement in the design of information systems and work processes show similar positive findings (e.g., Mumford, 1983). Oldham, Cummings, and Zhou (1995) have previously alluded to the potential positive effects of worker participation in the design of their own workspace. Studies of employee control over more specific features of their workspace (in the form of environmental control or physical adjustability) have generally found such opportunities to be related to increased job satisfaction, performance, communication, privacy, and satisfaction with the environment (e.g., Huang, Robertson, & Chang, 2004; Lee & Brand, 2005, 2010; O'Neill, 1994). Architectural research exploring the effects of building design in healthcare settings suggests that the

provision of control over the environment to patients is associated with tangible individual benefits including improved treatment completion times, reduced medication levels, and enhanced well-being (e.g., Lawson & Phiri, 2003).

More broadly, Vischer (2005) proposed seven principles specifically for the management of effective workspace change, which emphasize how the design process may be used to empower stakeholders to challenge the status quo, to re-evaluate work processes and structures, and to use the process to surface and overcome potential resistance. Underpinning Vischer's principles is a focus upon user participation and the bi-directional sharing of information and suggestions.

Vischer's (2005) approach and the wider architectural practice commending user participation and engagement (e.g., Blundell-Jones, Petrescu, & Till, 2005) share similarities with much of the change management literature, in which employee involvement is actively encouraged as part of a change management strategy (e.g., Armenakis & Bedeian, 1999; Clegg & Walsh, 2004; Kanter, Stein, & Jick, 1992; Mumford, 1983; Woodman, 1989). Supporting this principle, user involvement has been demonstrated as a key factor in determining the success of more general organizational change programs (Holman, Axtell, Clegg, *et al*., 2000).

We suggest that the design of a new work facility encompasses similar issues to change programs in general, and to technology-led innovations in particular, due to the tendency for "experts," such as IT professionals, to "design a system, and then push it at its end users" (Clegg & Shepherd, 2007: 215). In this context, the equivalent process is one whereby facilities managers or designers specify and design a new office space without due involvement of the workgroups to be accommodated. This is in direct opposition to what has been described as "pull-based user-owned change" (Clegg & Walsh, 2004: 235), whereby end-users pull the project through to successful completion by taking ownership of, and having input into, the design and implementation process, ensuring that it meets their needs. The involvement of employees provides a means to ensure that the work environment not only better reflects their requirements, but also allows them to take ownership over the process. Furthermore, acceptance of changes to workspace is important if new flexible concepts are being introduced that affect other aspects of work processes (e.g., introducing home or tele-working) (e.g., Baruch, 2001; Chapman, Sheehy, Heywood, *et al*., 1995; Daniels, Lamond, & Standen, 2001).

Successful User Involvement in Workspace Design

A number of studies within the I/O psychology and management literatures have examined the effects of changes in physical office design or configuration (e.g., Brookes & Kaplan, 1972; Oldham, 1988; Oldham & Brass, 1979; Zalesny & Farace, 1987) on employee reactions; however, there has been limited examination specifically of the process of change (McElroy & Morrow, 2010) and of user involvement in particular. Case studies from environmental

psychology and architectural spheres have demonstrated how the process of user participation in design can be used to successfully manage organizational change (e.g., Allen, Bell, Graham, *et al*., 2004). Furthermore, related approaches that incorporate user involvement (e.g., Socio-Technical Systems Design) support this contention (e.g., Mumford, 1983).

To highlight the techniques adopted and the potential benefits that user involvement may deliver, we describe two case studies. The first (Foland, Rowlen, & Watson, 1995) concerns the introduction of open-plan working, whereas the second (reported in Box 6.1) describes our own reflections on the redesign of an existing open-plan office. We present these case studies as exemplars of the work being conducted in this field and to spur further investigation in the area.

Box 6.1 Redesign of an Existing Open-Plan Office

Over the past 2 years, we have been involved in the redesign and evaluation of a number of large open-plan offices within the UK operation of a global aerospace and defense engineering company. During this time we have worked closely with a number of stakeholders and staff who have been involved in the redesign of their offices and/or who have been affected by changes that have been introduced. Our experience has demonstrated that when the staff are actively involved in the design process, either helping to make decisions regarding aspects of the design or providing real input regarding the needs they have for the workspace, the staff not only report that they are more satisfied with the quality of their workspace, but also that the space more accurately reflects and accommodates their functional needs.

In one set of refurbishments, two managers led a process that sought to engage with members of a 180 strong department to define their functional requirements. Representatives fed information and ideas forward and back to the managers and corporate facilities team. In addition to this, the proposed office plans were distributed to staff and physical mock-ups were constructed using the proposed furniture. Managers used the feedback from these activities to determine the aspects of the environment that were most important in enabling staff to perform their work tasks, in addition to establishing what they were not prepared to compromise on.

Crucially, the managers demonstrated leadership and flexibility in negotiating with their facilities colleagues. They were consequently able to work within the company's office standards to deliver increased desk space for a subset of the engineers (who required greater layout space for their work), together with a greater number of informal break-out areas to allow more spontaneous small group meetings (to relieve pressure on meeting

rooms). Importantly, the refurbished office achieved the overall corporate aim of an increase in density. The involvement of staff in the process was instrumental in helping to allay initial employee and union concerns over the headline density increases that the refurbishments initially appeared to embody. The case study demonstrates how involvement can help define core workspace requirements whilst acting within agreed organizational standards.

Foland, Rowlen, and Watson (1995) describe a project in which facilities managers at Amoco Oil & Gas embarked on a program to rationalize their workspace costs and to embed team-based working, moving from enclosed to more open-plan workspaces. In a pilot study, the facilities department worked closely with the leader of a specific work team to facilitate a highly participatory approach to the redesign of their office space. The process capitalized on the team's knowledge and expertise of their working practices, with staff involved in design decisions, for example furniture styles, seating arrangements, and use of workspace. The redesign became a process driven by the team's understanding of their work processes and needs. The emphasis was on how they could work more efficiently and how the new workspace could then be designed to support these changes in working practices. The authors noted that the process itself helped the department improve conflict resolution between team members and foster a greater understanding of group needs, as well as aiding the integration of interns and temporary workers within the teams taking part. The resulting new office, accompanied by the new ways of working it enabled and supported, produced a 25% decrease in project cycle times, 75% decrease in formal meeting time, increased team learning, increased problem solving, and led to higher quality products (Foland, Rowlen, & Watson, 1995: 683). However, when the organization attempted to roll out the new office concepts across other work groups, they encountered resistance from workers, largely due to the top-down implementation and absence of a participatory approach (Vischer, 2005). These outcomes show striking similarities to the wider change management literature (e.g., Clegg & Walsh, 2004) and earlier classic work on socio-technical design in office environments (Mumford, 1983). As it had worked well in one situation, management believed that the office concept could be simply replicated across the wider organization; they failed to appreciate the role that participatory design had played in crafting the most appropriate environment for that particular team and in helping the team to accept the resulting changes in work practices (cf. Mumford, 1983).

Applying Socio-Technical Principles

A related approach that is applicable to the design and management of workspace change, previously touched upon during our discussion of user

involvement, is socio-technical systems thinking (e.g., Cherns, 1976, 1987; Clegg, 2000; Mumford, 1983; Trist & Bamforth, 1951; van Eijnatten, 1997). Socio-technical systems thinking argues that an organization is a complex system made up of a number of inter-related parts, including the individual staff, the work processes, the technologies, and so forth. The approach grew out of a series of studies conducted at the Tavistock Institute of Human Relations, London, in the 1950s and 1960s (van Eijnatten, 1997). Trist and Bamforth (1951) published seminal work based upon their observations of the "long-wall" coal mining methods, following the introduction of large-scale machinery. The coal mining methods demonstrated the importance of autonomy, multi-skilling, and self-supervision and the need for behavioral issues to be considered during technological design and implementation. Socio-technical thinking continued to evolve and Cherns (1976) enunciated nine core principles of socio-technical design, later extended to 10 (Cherns, 1987). The approach has been refined further, with Mumford setting out the "Ethics" approach to the design of new information systems from the late 1970s onwards (e.g., Mumford, 1983, 1995; Mumford & Weir, 1979). More recently, Clegg (2000) elaborated and extended Chern's (1987) principles to apply to modern IT design (for a comprehensive description and timeline of the development of socio-technical systems theory, from its inception to modern advancements, see van Eijnatten, 1997).

The application of socio-technical theory has predominantly focused upon the industrial sector and the introduction of new technologies (e.g., Advanced Manufacturing Technologies and office-based technologies) (Clegg, 2000), with limited attention having been paid directly to the design of the physical work environment. Previously, Mumford (1983) applied socio-technical principles to the design of information systems. Mumford's approach involves large amounts of user participation in the design and configuration of new information systems and seeks to use technology to help improve the work experience and organizational effectiveness of the system as a whole. For example, user involvement in the design and implementation of a new word processing system was used by Mumford (1983) to find ways of meeting both user and organizational needs, increasing the acceptance of the system and its associated changes for all concerned.

Despite the success of applications of socio-technical theories, I/O psychologists have rarely applied the ideas and principles to the design of the physical environment. Authors from across disciplines have, however, suggested that the physical work environment should be considered as part of the overall organizational system (e.g., Allen & Henn, 2007; Becker & Steele, 1995; Blyth & Worthington, 2001; Ferguson & Weisman, 1986; Haynes, 2007; Lawson, 2004; Preiser, 1994; Trist & Bamforth, 1951; Turner & Myerson, 1998).

We argue that in practice socio-technical systems theory should be broadened to consider the whole work system, being applied more comprehensively to the design of the physical environment alongside the design of new processes,

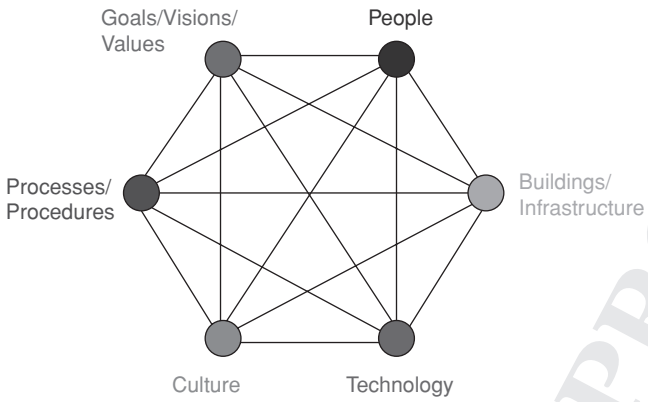

Figure 6.2 Socio-technical system, illustrating the inter-related nature of an organizational system. (Source: Challenger, Clegg, & Robinson, 2010.)

job roles, and technologies (i.e., extending the scope of the work system under investigation). Furthermore, this new application domain provides excellent opportunities for us to explore how current socio-technical design principles (e.g., Clegg, 2000) may be extended to take account of the specific challenges and contingencies that workspace design involves.

A systems approach is applicable to workspace design as it encourages conflicts or detrimental effects to be identified as decisions are made, minimizing the likelihood of one part of the system, or set of drivers, forcing unintended change upon the others (see Figure 6.2 for diagrammatic representation of the inter-related nature of a work system). Socio-technical theory acknowledges that design involves compromise, and this can be viewed as part of the process that establishes a balance between the competing elements of the work system (Clegg & Shepherd, 2007; Hendrick, 1997; Nadin, Waterson, & Parker, 2001). Indeed, as others have noted previously (e.g., Allen & Henn, 2007; Elsbach & Pratt, 2007; Sundstrom, Town, Rice, *et al.*, 1994), work environments involve trade-offs between what is most appropriate or desirable for the staff and other stakeholders involved and what is necessary or possible within organizational and technical constraints. A socio-technical approach to design can be viewed as one way of enabling and promoting open and systematic consideration of these competing demands, to help find new ways of working and working practices that may meet the joint needs of the various stakeholders and the organization (Ridgway, Cerulli, Davis, *et al.*, 2008). A socio-technical approach to the design of the physical work environment would encourage the integration of disciplinary knowledge and expertise, for example bringing together architects, engineers, psychologists, technology specialists, with users and stakeholders. To illustrate how the principles can be applied in practice, we present a recently completed case study that has investigated a socio-technical approach to workspace design (Box 6.2).

Box 6.2 A Socio-technical Approach to Workspace Design

Ridgway, Cerulli, Davis, *et al*. (2008) describe the application of this systems approach throughout the design of a new R&D facility. The design process was organized in a series of stages and included, in particular: early work (prior to the architectural brief) on the goals, mission, and vision of the new facility; development of a good understanding on the kinds of work and projects that would be undertaken, including the technologies that would be used; an understanding of the kinds of staff and numbers that would be employed; the definition of the working culture that the building was trying to promote and support; the design of the layouts of the office and shopfloor areas; the selection of décor and furnishings; the design of key social spaces, including meeting rooms, a social hub, and the dining and reception areas; and the overall design from sustainability and energy-use perspectives. The approach included: extensive user and stakeholder involvement (using a range of techniques); multidisciplinary design meetings (consisting of architects, facilities managers, other professionals and academics); and post-occupancy evaluations.

A key element of this process was the initial engagement and facilitation activities to define the brief for tendering architects, essentially setting the direction for the whole design process using scenario planning techniques (Clegg, Cooch, Hornby, *et al*., 1996). These preliminary activities included workshops with stakeholders and staff to identify the organizational vision, structure, and working practices for the factory. During the stakeholder event, break-out groups discussed key questions relating to the factory: What is our vision of the new factory? What excites us about this new factory? What are the key operational decisions we need to make before we start building? During the scenario planning workshop, stakeholders were encouraged to examine different scenarios for the new facility in terms of its main processes, staff, and outputs.

Overall, this socio-technical approach not only identified previously unknown requirements for the R&D facility, which would not have been highlighted without the involvement of frontline staff, but also ensured that design aspects of particular importance to stakeholders and staff were not engineered out to reduce costs (e.g., the social heart and flexible break-out areas) (Ridgway, Cerulli, Davis, *et al*., 2008). The involvement of the staff provided insights into the functions that the workspace would need to provide and confirmed that a generic space would not be adequate to support the varied nature of the engineers' roles. It was especially apparent that meeting space was a high priority and the level of space provided for this would need to be far higher than was anticipated prior to consultation (based on traditional assumptions as to the nature of the

engineers' jobs), with a mixture of both formal and informal meeting spaces being supplied.

Post-occupancy interviews have demonstrated that although the user involvement did not always result in employees feeling that they had had a meaningful impact on the end design (potentially due to budgetary constraints limiting some design features), they reported that the process had helped them to understand the change that was imminent and to feel included in the design process. Ultimately, the combination of techniques used to understand the human and organizational needs for the new workspace have resulted in a building that provides a mix of office and engineering space, reflecting the diverse tasks that the staff are involved in (McGourlay, Ridgway, Davis, *et al*., 2009).

In summary, the design and implementation of new offices alter how individuals and teams go about and experience their work (e.g., Laing, Duffy, Jaunzens, *et al*., 1998; McElroy & Morrow, 2010) and can act as an enabler for wider cultural change (e.g., Turner & Myerson, 1998). The organizational change management literature (e.g., Brown & Eisenhardt, 1997; Burnes, 1996; Kanter, Stein, & Jick, 1992; Kotter, 1996; Luecke, 2003; Mumford, 1983; Pettigrew, 1985; Pettigrew, Woodman, & Cameron, 2001) argues that for such organizational changes to be successful, they need to be managed effectively. To date, however, there has been limited application of existing organizational change theory to this domain (McElroy & Morrow, 2010). Nevertheless, architectural and environmental psychology principles (e.g., Blundell-Jones, Petrescu, & Till, 2005; Vischer, 2005) have emphasized the importance of user involvement and information sharing during the design and implementation of new offices and buildings, as did earlier work informed by socio-technical systems thinking (e.g., Mumford, 1983). Although these principles are similar to the central tenets of general change management theories (e.g., Kanter, Stein, & Jick, 1992), we suggest that the traditional technical nature of office design (being typically led by architects, engineers, or facilities managers) makes it especially comparable to IT-led change programs. A socio-technical approach (e.g., Clegg, 2000; Mumford, 1983) provides a framework which is well suited to the specific problem of managing workspace change, as its emphasis is upon not only user involvement and ownership, but also on finding ways of managing and coping with the competing interests and needs of various stakeholders. Approaches that maximize the involvement of staff and other stakeholders, focus upon the functional and human needs of the office occupants, and are open and transparent, appear more likely to result in successful workspace design than do traditional expert-led push-based approaches to design and change. We return to this issue below.

OPPORTUNITIES AND FUTURE DIRECTIONS

Within this chapter we have taken a broad approach to the design of office environments, from the benefits and pitfalls of open-plan offices, through the continuing optimization of the office, to issues concerning the management of change. These three areas present distinct opportunities for I/O psychology scholars aiming to contribute to better office design and implementation. In this final section, we outline the opportunities for future research into office design, offer suggestions for theory development, and consider practical and methodological issues.

New Opportunities

The prevalence and continuing evolution of office working (e.g., Brill, Weidemann, & BOSTI Associates, 2001; Duffy, 1997; Vischer, 1996) points to the potential impact that I/O psychology researchers and practitioners can achieve through offering advice regarding the design and implementation of physical environments. Although a significant body of work on the effects of the introduction of office concepts, such as new IT systems (Clegg, 2000; Mumford, 1983), open-plan offices and adjustments in spatial features (e.g., Brennan, Chugh, & Kline, 2002; Brookes & Kaplan, 1972; May, Oldham, & Rathert, 2005; Oldham, 1988; Sundstrom, Herbert, & Brown, 1982; Sundstrom & Sundstrom, 1986; Sutton & Rafaeli, 1987) has been already amassed, there is now an opportunity for an acceleration of studies that look to guide designers' and stakeholders' decision-making in selecting and optimizing office design.

Given that the prevailing business mindset on office design is that it represents in large part a technical issue (Duffy, 2000), behavioral research is now required to provide users, managers, practitioners, and designers with meaningful data that can be used to help undertake system design, including weighing up the various trade-offs that need to be negotiated (cf. Elsbach & Pratt, 2007). This will involve the generation of further, nuanced, research, and the presentation of analyses regarding the contextual, individual, and organizational contingencies that may affect the efficacy of office designs, especially their layout or spatial features. There remains a need for advice and insight concerning the effectiveness of differing types of offices for various groups of staff, with an emphasis upon the nature of the tasks performed and the organizational structures within which they operate.

There is an opportunity not only to reflect the changing nature of the office in future research, but also to influence the form that these redesigns take and to promote consideration of the effects on individuals, organizational cultures, and processes. Innovative offices and workplaces are often being designed and optimized without the support of professional architects or designers (Laing, 2006) and this represents a real danger for our discipline, too, as new developments pass by without our effective engagement and impact. Just as in the

period when open-plan working became prominent, we are at risk of failing to evaluate the impact of evolving office forms or to help guide their design to maximize the positive effects on both staff and organizations. There is a need for further work that explores the interaction between evolving office design, new technology, and changing work patterns. The literature would benefit in particular from research examining the effects of new working practices that may accompany redesigned or highly flexible open-plan office space, such as hot-desking, home or tele-working (e.g., Baruch, 2001; Chapman, Sheehy, Heywood, *et al*., 1995; Daniels, Lamond, & Standen, 2001; De Croon, Sluiter, Kuijer, *et al*., 2005; Ng, in press; Vos & van der Voordt, 2001).

To date, there has only been limited examination of how the introduction of new or redesigned offices may be successfully managed. As others have recently noted (e.g., McElroy & Morrow, 2010), research that recognizes the potential for workspace to support or initiate change in general is very much in its infancy, with as yet limited mainstream consideration. Research in this area, thus far, has been driven largely by case studies and programs of work that have arisen more often from the architectural or environmental psychology disciplines (e.g., Allen, Bell, Graham, *et al*., 2004; Turner & Myerson, 1998) than from the traditional I/O psychology literatures. There is clearly a need for more empirical exploration in relation to the management of new or redesigned offices, in order to validate present case study findings, in addition to testing associated propositions more extensively.

A further timely extension relating to the design of the physical office environment concerns research to support the design, implementation, and operation of sustainable buildings. The activities of private and public sector organizations generate a significant proportion of world carbon emissions, waste generation, and water usage (Davis & Challenger, 2009). The build and operation of work facilities is an important contributor to an organization's environmental impact, and there is an increasing awareness of the role that new technologies and improved design may have in improving building performance (e.g., Natsu, 2008; Yudelson, 2009). However, technology or innovative design on its own is unlikely to be able to bring the required environmental gains – gaining an understanding of staff behaviors and needs is also massively important. Wener and Carmalt (2006: 158) have noted that "Some of the oft-cited ecological benefits of green buildings are dependent on the ability to correctly predict user behavior." Appreciating how individuals respond to different work environments and conditions will be critical in ensuring that new technology or design features are used appropriately, so as to avoid counterproductive behaviors. For example, failing to provide adequate storage facilities for staff may lead to shelving being added after the building is built, obstructing efficient ventilation systems and necessitating less efficient "work-arounds" (e.g., opening external windows and doors) (for further discussion see Wener & Carmalt, 2006). The configuration of offices and other workspaces can affect staff uptake of sustainable activities, for example by making sustainable behaviors more convenient and reducing perceived

behavioral barriers. The location of recycling receptacles is a good illustration of this principle in practice, with the placement of recycling bins having been found to influence recycling rates in academic buildings (Ludwig, Gray, & Rowell, 1998). Currently, there are only limited indicative studies that can help guide designers and organizations in using design to support more sustainable behaviors or improve the efficiency of ecologically inspired work buildings. Exploring and understanding the linkages between design and sustainable behaviors thus represents a major opportunity and priority for future research.

Theory Development, and Extensions

The literature on workspace design and its impact can be characterized by an absence of a unifying theoretical approach. Theories and frameworks have been drawn from social relations, cognitive psychology, systems thinking, symbolic, and physiological standpoints to investigate relationships between workers and their physical environment (e.g., Altman, 1975; Baum & Paulus, 1987; Becker, 1981; Carnevale, 1992; Cohen, 1980; Cummings, 1978; Davis, 1984; De Croon, Sluiter, J., Kuijer, *et al*., 2005; Desor, 1972; Duffy, 1997; Elsbach & Pratt, 2007; Ferguson & Weisman, 1986; Festinger, Schachter, & Back, 1950; Geen & Gange, 1977; Oldham, Cummings, & Zhou, 1995; Paciuk, 1990; Paulus, 1980; Schuler, 1980; Steele, 1973; Stokols, Smith, & Prostor, 1975; Sundstrom, Burt, & Kamp, 1980; Sutton & Rafaeli, 1987; Vischer, 1989, 2007). However, as discussed by several previous reviewers (e.g., Baron, 1994; Elsbach & Pratt, 2007; Oldham, Cummings, & Zhou, 1995), none of these approaches has received overwhelming empirical support. Although use of a diverse range of theoretical stances has enabled a broad view to be taken of the topic, it has also meant that there has been a lack of consistency in terms of outcome evaluation (i.e., a range of outcomes have been measured), making it difficult to assess theoretical efficacy and consistency. In effect, the variety of approaches has meant that research attention has been spread relatively thinly. The field requires greater direct empirical testing of competing theories to allow informed and incremental theorization to progress (Oldham & Brass, 1979; Zalesny & Farace, 1987).

Previous reviewers have also noted that it is unlikely that there will be a single mechanism explaining the interaction of workers and their workspace (e.g., Elsbach & Pratt, 2007). The complexity of the physical office and its constituent parts may partly explain this, but we propose that greater effort is required to integrate successful aspects of these competing theories. While we do not necessarily argue for a single meta-theory, for such an exercise would in all probability yield a cumbersome outcome, integration within congruent theoretical approaches would be welcome (cf. Hodgkinson & Healey, 2008; Locke & Latham, 2004).

For example, the ability to exert control over one's environment is explicit within social interference theory (e.g., Baum & Paulus, 1987; Oldham,

Cummings, & Zhou, 1995) and the environmental comfort model (Vischer, 1989), in addition to being implicit in cognitive theories, such as overload (e.g., Cohen, 1980). Although direct testing of control as a mechanism involved in the interaction of individuals with their environment is still in its infancy (e.g., Huang, Robertson, & Chang, 2004; Lee & Brand, 2005, 2010; O'Neill, 1994), this is an area to be capitalized upon. Indeed, the importance of being able to move and act with freedom and control has been suggested as being intimately related not only to individuals' well-being, but also to their creativity at work (Csikszentmihalyi, 2003). Becker (1991) argues that an ability to adjust the workspace may be significant in influencing how individuals feel about and behave in all aspects of their work life.

Our review has demonstrated that knowledge workers often engage in a variety of tasks during the course of the day (e.g., Becker & Sims, 2001; Craig, 2010) and that the space individuals utilize can vary on a daily, weekly, or monthly basis (e.g., Laing, 2006; Ridgway, Cerulli, Davis, *et al.*, 2008). Unfortunately, to date there has been limited theoretical acknowledgement that worker demands and interaction with workspaces are dynamic (but for a notable exception see Duffy, 1997). Clearly, therefore, this issue warrants greater attention. Such an approach would be in line with the progression occurring within other established areas of organizational theory, not least job design, which have sought to incorporate the dynamic nature of the work practices into contemporary models (e.g., Clegg & Spencer, 2007); indeed, activities such as job crafting require temporality to be dealt with explicitly (e.g., Wrzesniewski & Dutton, 2001).

It is clear there are opportunities to link areas of theory-building and expertise that are currently treated as separate and distinct domains. Thus, extending the argument above about the job design and job crafting, to date there have been few attempts either theoretically or empirically to examine the extent to which physical spaces and environments shape and influence job designs and the opportunities for job crafting. Hence, although it is clear that physical layouts and proximity to other staff influence patterns of social interaction (Oldham & Brass, 1979; Zalesny & Farace, 1987) and thereby shape the social and relational aspects of work (see Grant & Parker, 2009; Kilduff & Brass, 2010), we need to explore further the constraints that workspaces place on job design and, looking at it in the opposite direction, the ways in which people may craft their jobs to shape and change their environments.

Finally, we have made use earlier of a socio-technical systems framework to inform the design of a new building (see p. XXX). We believe this has real merit and potential, both theoretically and as a practical approach. But this approach cannot, in our view, remain static. It is thus clear that the underlying principles of socio-technical design were developed and articulated primarily with a focus on the links between new technologies and the social systems around them (see e.g., Cherns, 1976, 1987; Clegg, 2000; Mumford, 1983; Trist & Bamforth, 1951). To the best of our knowledge, these principles and ways of thinking have

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rarely been used to support the design, implementation, and evaluation of new buildings, new workspaces, and the issues that arise there from, including sustainability and so-called "green issues." One major theoretical challenge for people working in this area is to apply existing socio-technical principles to this new domain of application and to use these experiences to update and improve the principles. This is entirely consistent with an action research philosophy (e.g., Cassell & Johnson, 2006; Susman & Evered, 1978).

Practical and Methodological Considerations for Researchers

A number of practical and methodological suggestions can be made to aid researchers in designing studies that are better able to exploit and examine the opportunities and challenges of this field.

Analysis of tipping points

The literature is rife with examples of where compromises need to be made in the design of offices, for instance between providing a workspace that is open and one that provides too many distractions. We believe that there is an opportunity to explore these trade-offs through looking for tipping points that occur within these relationships. The issue of potential tipping points is not something that has received noticeable attention amongst field studies in the literature. However, identifying specific points of inflexion at which aspects of the physical environment (e.g., the proximity of co-workers, the amount of available meeting space) are likely to produce greater detrimental effects than benefits would be of real value. In addition to advancing understanding of the relative effects of such workspace factors, more meaningful advice and guidance could be offered to designers, managers, and staff who have to resolve competing demands in this area. Evidence from specific areas of the workspace literature, however, indicates that an appreciation of tipping points will require systematic analysis. For example, multiple factors (e.g., job complexity, screening ability, gender, and tenure) have been found to affect reactions to density (Epstein & Karlin, 1975; Fried, Slowik, Ben-David, *et al*., 2001; Oldham, Kulik, & Stepina, 1991). Understanding the complex nature of tipping points will be a challenge for future research but such inquiry should yield information of both practical and theoretical interest.

Adopting quasi-experimental approaches

Observations of changes to the physical environment provide researchers with an ideal opportunity to utilize quasi-experimental methodology. Quasi-experiments are similar to traditional experiments in that they involve the study of a change in an independent variable (e.g., the removal of partition walls); however, they occur in field settings, and do not require the experimenter to either directly control the manipulation of the independent variable nor to

randomly assign participants to treatment groups (for an extensive description and discussion of quasi-experimental methodology see Grant & Wall, 2009). This means that interventions such as the introduction of open-plan working can be studied opportunistically, that is without the researcher necessarily having to control how or to whom it is introduced (for an example of a classic open-plan office quasi-experiment see Oldham & Brass, 1979). To date the use of quasi-experiments has been one of the great strengths of the literature on the design of workspaces, as the technique provides the opportunity to achieve high levels of external validity and strengthen causal inferences (Cook & Campbell, 1979). Indeed, as discussed by Grant and Wall (2009), the Hawthorne experiments can be considered one of the earliest exemplars of the quasi-experimental method in use in this particular context.

Quasi-experimental designs have been successfully employed in a number of studies in this area. For instance, Oldham (1988) surveyed three open-plan offices of the same company to examine the effects of change. Occupants of the first moved to a new office which incorporated partitions whereas those of the second moved to a new, lower density office. The third office acted as a non-equivalent control (i.e., where no change occurred). Surveys were administered prior to the office moves and again after occupancy. The quasi-experimental design allowed comparisons to be made between times one and two for all three groups. The findings showed that both the introduction of lower density open-plan workspace and the use of partitions were accompanied by increased perceptions of privacy and environmental satisfaction, together with reduced crowding in office occupants, in comparison with the control group. Workers in the lower density open-plan office also reported increased work satisfaction. An inference of these finding is that the presence of physical screens or a lower density of workers within an open office configuration reduces excessive stimulation from the surrounding environment.

Temporal/real-time data collection

Research has demonstrated that the nature of tasks and the space that workers utilize to fulfill them vary over time and between individuals (e.g., Becker & Sims, 2001; Craig, 2010). Capturing the temporality of such interactions, and the potentially changing experience, requires techniques that are more sophisticated than those generally employed in the domain of workspace evaluation and employee–environment interaction; cross-sectional surveys or questionnaires administered months apart. Two related techniques, the Experience Sampling Method (ESM) and Work Sampling Method (WSM) are examples of tools that may suit such purposes (e.g., Ayoko, Ashkanasy, & Jehn, 2010). ESM captures within-person, temporal experiences within natural settings, which is achieved through asking participants to provide information regarding their subjective experience on multiple occasions (often at frequent points each day over a period of time) (Totterdell, 2006). WSM is similar and requires

participants to identify and record the tasks they are involved in at any given point in a similar fashion (e.g., Robinson, 2010). Although diaries and online surveys have often been used to collect data of this kind in the past, Personal Digital Assistants (PDAs) are being recognized as providing advantages to collecting data in this regard. PDAs allow efficiency of data processing, fast input of responses, and portability (Robinson, 2010; Totterdell, 2006). These techniques can be extended to the study of the physical workspace (Ayoko Ashkanasy, & Jehn, 2010), allowing researchers to capture what tasks employees are engaged in, where they are performing them, and the related psychological experience. The collection of such rich real-time data can help inform how knowledge workers use office space in practice and guide the development of new theory and more sophisticated techniques for the optimization of existing office space.

Incorporating physiological data

Research concerning the evaluation and effects of open-plan offices within field settings has been dominated by perceptual and self-report measurements, with the inherent dangers of common method bias (e.g., Podsakoff, MacKenzie, Lee, *et al*., 2003; Spector, 1992). The collection of physiological data would allow objective insights to be gained into the effects that an office change, for example the introduction of more workers, might elicit in individuals (Elsbach & Pratt, 2007). Ayoko, Ashkanasy, and Jehn (2010) suggest electrocardiograph (ECG) and blood pressure monitoring as techniques that researchers might utilize to assess physiological reactions to working in open-plan space. We contend that serum cortisol (a prominent stress hormone) sampling would also yield valuable information with which to appraise such reactions. Collecting data of this kind would enable a more direct integration of findings with related literatures (e.g., occupational stress), and would also provide another source of "hard" data for designers and other stakeholders (cf. Ganster, Fox, & Dwyer, 2001).

Moving beyond basic productivity/business outcomes

Design and redesign of working space require compromises and trade-offs (Elsbach & Pratt, 2007; Ridgway, Cerulli, Davis, *et al*., 2008). The above review has shown that the basis upon which to make these decisions is currently weighted towards technical or operational considerations, with data readily available regarding financial implications of pursuing different office strategies (e.g., the financial savings of reducing an office floor plan or minimizing build costs is easily calculable). However, when considering the costs of such changes on human behavior and reactions to redesign, objective evaluations are much harder to calculate due to a paucity of measurement of explicit organizational outcomes in current research. Although self-report evaluations (e.g., individual

productivity) are typically available (e.g., Leaman & Bordass, 2005), future studies that utilize measurements of time use (e.g., Craig, 2010) or higher level organizational outcomes such as project completion times (Foland, Rowlen, & Watson, 1995) would provide designers and practitioners with more robust data on which to determine the effects of office design on individuals and organizations. Overall, the provision of bottom line indicators would enable I/O psychology researchers to offer a credible argument in favor of design choices that may not be the most financially attractive in the short run, but which deliver longer term human and organizational benefits.

Enhancing the precision of our measures through greater cross-disciplinary collaboration

A lack of standardization of definition and operationalization, both within the behavioral literature and in relation to standards and practices used in other disciplines (e.g., architecture and facilities management), hampers comparison across studies, thereby limiting generalizability. There is a need for researchers to adopt more closely defined constructs when considering office space, in addition to being aware of measurements and norms commonly used by other disciplines. To illustrate this problem, we can consider studies that have specifically explored office density. Although Net Indoor Area (NIA) is an industry standard for measuring the density of employees in a given office space (being the total internal area of an office building, excluding unusable areas such as stairways, corridors, or entrance halls, divided by the number of occupants), two different conceptualizations – setting density or workspace density – have been generally employed by I/O psychology scholars (Oldham, Cummings, & Zhou, 1995). Furthermore, there have been differences in the measurement of the office space used in the workspace density calculations. For instance, Sutton and Rafaeli (1987) used the dimensions of the whole office to calculate the square footage, while researchers have excluded areas covered by furniture from this calculation (e.g., May, Oldham, & Rathert, 2005).

At a broader level, offices are inherently difficult to classify due to the sheer differences in building types, structures, nature of the physical services, and furniture systems, together with the variance that organizational structures and cultures bring to bear on office design. The task of classifying such concepts is undoubtedly more difficult for I/O psychology researchers than for those from more design-led professions and disciplines, whose expertise lie in understanding such physical forms (Veitch, Charles, Farley, *et al*., 2007). Although it is probably unrealistic to expect researchers to adopt a single classification for office types, future research that seeks to understand differences between traditional enclosed space, open-plan office concepts, and new flexible offices, would benefit from paying reference to the distinctions made by Duffy (1997), Brennan, Chugh, and Kline (2002) and Danielsson and Bodin (2008). These classification systems distinguish between variations in open-plan concepts;

however, Danielsson and Bodin (2008) use a more comprehensive categorization which allows future office concepts to be more precisely defined and studied. As illustrated earlier, their typology incorporates architectural thinking to classify seven office types: cell office, shared room office, small open-plan office, medium-sized open-plan office, large open-plan office, flex office, and combi office. A standardized approach to recognizing, recording, and reporting differing types of office designs will enable researchers to make more stable judgments between and within competing concepts, reducing some of the current inconsistencies. For example, the term open-plan has often been applied generally within the literature, based upon relatively loose criteria (Brennan, Chugh, & Kline, 2002; Danielsson & Bodin, 2008; Ferguson & Weisman, 1986; Oldham, Cummings, & Zhou, 1995) which has resulted in noisy data. For instance, some offices defined as traditional enclosed offices contain sections of open-plan (e.g., Brookes & Kaplan, 1972; Zalesny & Farace, 1987).

One way of enabling and encouraging the adoption of more sophisticated and useful typologies will be for I/O psychologists to work together in projects with designers and architects – as with other domains, there is much to be gained from inter-disciplinary working. It is also clear that architects and other designers may have much to gain by working with I/O psychologists. One of the authors, for example, is heavily engaged with a leading global architectural practice which is actively developing what it calls a "people-centered approach to design." The method integrates the complexities of the organization, people, processes, and technology with the construction and architectural aspects of design by taking a systems view to generate performance and sustainability benefits. The approach includes a flexible framework and a toolkit to support each stage of design. We believe that theory-based practical methods and toolkits developed through such people-centered multidisciplinary working will ultimately provide a real way forward for improving building design.

CONCLUSIONS

Our review has shown how the physical environment of the office has developed over the past decades, with the open-plan office becoming and remaining the most popular office design (Brill, Weidemann, & BOSTI Associates, 2001). As information technologies continue to advance, with the growing proportion of knowledge workers within the economy showing no sign of abating (e.g., Davenport, 2005), we can be confident that the evolution of office working is set to continue, throwing up an ever-increasing range of environments in which individuals and groups will work. As in many areas of organizational evolution, there is a real danger that our professional capabilities and offerings will lag behind practice. As I/O psychologists we have a professional duty to understand the complex interactions between employees, their ways of working, and the environments within which they work. We also have a responsibility to try to influence the design of these inter-dependent systems and this will make heavy

demands of our empirical and theoretical work and of our capability to make it available to the stakeholders involved. But we do believe the opportunities are enormous and we have tried to identify some of the specific ways in which we believe this potential might be realized. Not least amongst these are the needs for more joined-up and systemic approaches to theory building, the development of theory-based practical approaches and toolkits, and the need for multidisciplinary work.

REFERENCES

Allen, T., Bell, A., Graham, R., Hardy, B., & Swaffer, F. (2004). *Working without walls: An insight into the transforming government workplace*. DEGW.

Allen, T., & Henn, G.W. (2007). *The organization and architecture of innovation: Managing the flow of technology*. Oxford: Elsevier.

Altman, I. (1975). *The environment and social behavior: Privacy, personal space, territory, and crowding*. Monterey, CA: Brookes.

Armenakis, A.A., & Bedeian, A.G. (1999). Organizational change: A review of theory and research in the 1990s. *Journal of Management*, **25**(3), 293–315.

Ayoko, O.B., Ashkanasy, N.M., & Jehn, K.A. (2010). Issues and methods in studying territoriality and the physical workspace. Paper presented at the Annual Meeting of the Academy of Management, Montréal, Canada.

Baron, R.A. (1994). The physical environment of work settings: Effects on task performance, interpersonal relations, and job satisfaction. In B.M. Straw & L.L. Cummings (Eds), *Research in Organizational Behavior* (volume 16), (pp. 1–46). Greenwich, CT: JAI Press.

Baruch, Y. (2001). The status of research on teleworking and an agenda for future research. *International Journal of Management Reviews*, **3**(2), 113–29.

Baum, A., & Paulus, P.B. (1987). Crowding. In D. Stokols & I. Altman (Eds), *Handbook of Environmental Psychology* (pp. 533–70). New York: Wiley.

Becker, F.D. (1981). *Workspace: Creating Environments in Organizations*. New York: Praeger Publishers.

Becker, F.D. (1991). Workplace planning, design, and management. In E.H. Zube & G.T. Moore (Eds), *Advances in Environment, Behavior and Design* (volume 3), (pp. 115–51). London: Plenum Press.

Becker, F.D., & Sims, W. (2001). *Offices That Work: Balancing Communication, Flexibility and Cost*: Cornell University.

Becker, F.D., & Steele, F. (1995). *Workplace by Besign: Mapping the High-Performance Workscape*. San Francisco, CA: Jossey-Bass.

Bell, B.F., & Kozlowski, S.W.J. (2002). A typology of virtual teams: Implications for effective leadership. *Group and Organization Management*, **27**, 14–49.

Block, L.K., & Stokes, G.S. (1989). Performance and satisfaction in private versus nonprivate work settings. *Environment and Behavior*, **21**, 277–92.

Blundell-Jones, P., Petrescu, D., & Till, J. (2005). *Archeticture and Participation.* London, UK: Spon Press.

Blyth, A., & Worthington, J. (2001). *Managing the Brief for Better Design*. London: Taylor & Francis Group.

Boyce, P.R. (1974). User's assessments of a landscaped office. *Journal of Architectural Research*, **3**, 44–62.

Brennan, A., Chugh, J.S., & Kline, T. (2002). Traditional versus open office design: A longitudinal study. *Environment and Behavior*, **34**(3), 279–99.

Brill, M., Weidemann, S., & BOSTI Associates. (2001). *Disproving Widespread Myths about Workplace Design*. Jasper, IN: Kimball International.

British Council of Offices (2009). Sharp increase in office density reveals today's changing working environment. http://www.bco.org.uk/news/detail.cfm?rid=118 (accessed 3 November 2009).

Brookes, M.J., & Kaplan, A. (1972). The office environment: Space planning and affective behavior. *Human Factors and Ergonomics in Manufacturing*, **14**(5), 373–91.

Brown, G., Lawrence, T.B., & Robinson, S.L. (2005). Territoriality in organizations. *Academy of Management Review*, **30**(3), 577–94.

Brown, S.L., & Eisenhardt, K.M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, **42**, 1–34.

Burnes, B. (1996). No such thing as ... A "one best way" to manage organizational change. *Management Decision*, **34**(10), 11–8.

Burnes, B. (2004). *Managing Change: A Strategic Approach to Organizational Dynamics*. Harlow, UK: FT/Prentice Hall.

Business Week (1978) The trouble with open offices. *Business Week* (7 August 1978), **88**, 84–5.

By, R.T. (2005). Organisational change management: A critical review. *Journal of Change Management*, **5**(4), 369–80.

Carlopio, J.R. (1996). Construct validity of a physical work environment satisfaction questionnaire. *Journal of Occupational Health Psychology*, **1**(3), 330–44.

Carlopio, J.R., & Gardner, D. (1992). Direct and interactive effects of the physical work environment on attitudes. *Environment and Behavior*, **24**(5), 579–601.

Carnevale, D.G. (1992). Physical settings of work: A theory of the effects of environmental form. *Public Productivity & Management Review*, **15**(4), 423–36.

Cascio, W.F. (2000). Managing a virtual workplace. *Academy of Management Executive*, **14**(3), 81–90.

Cassell, C., & Johnson, P. (2006). Action research: Explaining the diversity. *Human Relations*, **59**(6), 783–814.

Challenger, R., Clegg, C.W., & Robinson, M.A. (2010). *Understanding Crowd Behaviours (volume 1) Practical Guidance and Lessons Identified*. London: The Stationary Office.

Chapman, A.J., Sheehy, N.P., Heywood, S., Dooley, B., & Collins, S.C. (1995). The organizational implications of teleworking. In C.L. Cooper & I.T. Robertson (Eds), *International Review of Industrial and Organizational Psychology* (volume 10), (pp. 229–48). Chichester, UK: John Wiley & Sons Ltd.

Charles, K.E., & Veitch, J. (2002). *Environmental Satisfaction in Open-Plan Environments: 2. Effects of Workstation Size, Partition Height and Windows*. Institute for Research in Construction, National Research Council Canada.

Cherns, A. (1976). The principles of sociotechnical design. *Human Relations*, **29**(8), 783–92.

Cherns, A. (1987). Principles of sociotechnical design revisited. *Human Relations*, **40**(3), 153–61.

Clegg, C.W. (2000). Sociotechnical principles for system design. *Applied Ergonomics*, **31**(5), 463–77.

Clegg, C.W., Cooch, P., Hornby, P., Maclaren, R., Robson, J.I., Symon, G.J., & Carey, N. (1996). Tools to incorporate some psychological and organizational issues during the development of computer-based systems. *Ergonomics*, **39**(3), 482–511.

Clegg, C.W., & Shepherd, C. (2007). The biggest computer programme in the world ever!: Time for a change in mindset? *Journal of Information Technology*, **22**, 212–21.

Clegg, C.W., & Spencer, C. (2007). A circular and dynamic model of the process of job design. *Journal of Occupational and Organizational Psychology*, **80**, 321–339.
Clegg, C.W., & Walsh, S. (2004). Change management: Time for a change! *European Journal of Work and Organizational Psychology*, **13**(2), 217–39.
Cohen, S. (1980). After effects of stress on human performance and social behavior: A review of research and theory. *Psychological Bulletin*, **88**, 82–108.
Cook, T.D., & Campbell, D.T. (1979). *Quasi-experimentation: Design and analysis issues for field settings*. Chicago, IL: Rand McNally.
Craig, D. (2010). The workplace's impact on time use and time loss. Paper presented at the Annual Meeting of the Academy of Management, Montréal, Canada.
Csikszentmihalyi, M. (2003). *Good Business: Leadership, Flow, and the Making of Meaning*. New York: Penguin Group.
Cummings, T.G. (1978). Self-regulating work groups: A socio-technical synthesis. *Academy of Management Review*, **3**(3), 625–34.
Daniels, K., Lamond, D., & Standen, P. (2001). Teleworking: Frameworks for organizational research. *Journal of Management Studies*, **38**(8), 1151–85.
Danielsson, C.B., & Bodin, L. (2008). Office type in relation to health, well-being, and job satisfaction among employees. *Environment and Behavior*, **40**(5), 636–68.
Davenport, T.H. (2005). *Thinking for a Living: How to Get Better Performance and Results from Knowledge Workers*. Boston, MA: Harvard Business School Press.
Davis, M.C., & Challenger, R. (2009). Climate change: Warming to the task. *Psychologist*, **22**(2), 112–4.
Davis, M.C., Leach, D.J., & Clegg, C.W. (2010). The physical environment: An evolving topic. Paper presented at the Annual Meeting of the Academy of Management, Montreal.
Davis, T.R.V. (1984). The influence of the physical environment in offices. *Academy of Management Review*, **9**(2), 271–83.
De Croon, E., Sluiter, J., Kuijer, P.P., & Frings-Dresen, M. (2005). The effect of office concepts on worker health and performance: A systematic review of the literature. *Ergonomics*, **48**(2), 119–34.
Desor, J.A. (1972). Toward a psychological theory of crowding. *Journal of Personality and Social Psychology*, **21**, 79–83.
Duffy, F. (1997). *The New Office*. London: Conran Octopus.
Duffy, F. (2000). Design and facilities management in a time of change. *Facilities*, **18**, 371–75.
Duffy, F., McMahan, J., & Pringle, J. (1999). Offices. In D. Adler (Ed.), *Metric Handbook: Planning and Design Data* (2nd edn). Oxford: Architectural Press.
Elsbach, K.D., & Pratt, M.G. (2007). The physical environment in organizations. *Academy of Management Annals*, **1**, 181–224.
Epstein, Y.M., & Karlin, R.A. (1975). Effects of acute experimental crowding. *Journal of Applied Social Psychology*, **5**, 34–53.
Evans, G.W., & Johnson, D. (2000). Stress and open-office noise. *Journal of Applied Psychology*, **85**(5), 779–83.
Evans, G.W., Johansson, G., & Carrere, S. (1994). Psychosocial factors and the physical environment: Inter-relations in the workplace. In C.L. Cooper, & I.T. Robertson (Eds), *International Review of Industrial and Organizational Psychology*. New York: John Wiley.
Felstead, A., Jewson, N., & Walters, S. (2005). The shifting locations of work: New statistical evidence on the spaces and places of employment. *Work, Employment and Society*, **19**(2), 415–31.
Ferguson, G.S., & Weisman, G.D. (1986). Alternative approaches to the assessment of employee satisfaction with the environment. In J.D. Wineman (Ed.), *Behavioral Issues in Office Design* (pp. 85–108). New York: Van Nostrand Reinhold Company.

Festinger, L., Schachter, S., & Back, K. (1950). *Social Pressure in Informal Groups*. Stanford, CA: Stanford University Press.

Foland, S.S., Rowlen, S., & Watson, S. (1995). Team space and empowerment: A formula for success. Paper presented at the World Workplace '95, IFMA Annual Conference, Miami, FL.

Fried, Y. (1990). Workspace characteristics, behavioral interferences, and screening ability as joint predictors of employee reactions: An examination of the intensification approach. *Journal of Organizational Behavior*, **11**(4), 267–80.

Fried, Y., Slowik, L.H., Ben-David, H.A., & Tiegs, R.B. (2001). Exploring the relationship between workspace density and employee attitudinal reactions: An integrative model. *Journal of Occupational and Organizational Psychology*, **74**, 359–72.

Fritz, M.E.W., Higa, K., & Narasimhan, S. (1995). Toward a telework taxonomy and test for suitability: A synthesis of the literature. *Group Decision and Negotiation*, **4**, 311–34.

Gannon, T. (2006). *Zaha Hadid: BMW Central Building, Leipzig, Germany*. New York: Princeton Architectural Press.

Ganster, D.C., Fox, M.L., & Dwyer, D.J. (2001). Explaining employees' health care costs: A prospective examination of stressful job demands, personal control, and physiological reactivity. *Journal of Applied Psychology*, **86**, 954–64.

Geen, R.G., & Gange, J.J. (1977). Drive theory of social facilitation: Twelve years of theory and research. *Psychological Bulletin* **84**(6), 1267–88.

Gillen, N.M. (2006). The future workplace, opportunities, realities and myths: A practical approach to creating meaningful environments. In J. Worthington (Ed.), *Reinventing the Workplace* (2nd edn), (pp. 61–78). Oxford: Architectural Press.

Glass, D.C., & Singer, J.E. (1972). *Urban Stress: Experiments on Noise and Social Stressors*. New York: Academic Press.

Grant, A.M., & Parker, S.K. (2009). Redesigning work design theories: The rise of relational and proactive perspectives. *Academy of Management Annals*, **3**, 317–75.

Grant, A.M., & Wall, T.D. (2009). The neglected science and art of quasi-experimentation: Why-to, when-to, and how-to advice for organizational researchers. *Organizational Research Methods*, **12**, 653–86.

Hall, D.J., & Ford, T.Q. (1998). A quality approach to factory design. *Industrial Management and Data Systems*, **6**, 241–5.

Haynes, B.P. (2007). Office productivity: A theoretical framework. *Journal of Corporate Real Estate*, **9**(2), 97–110.

Hedge, A. (1982). The open-plan office: A systematic investigation of employee reactions to their work environment. *Environment and Behavior*, **14**(5), 519–42.

Hendrick, H. (1997). Organizational design and macroergonomics. In G. Salvendy (Ed.), *Handbook of Human Factors and Ergonomics* (pp. 594–637). New York: John Wiley & Sons.

Higgins, J.M., & McAllaster, C. (2004). If you want strategic change, don't forget to change your cultural artifacts. *Journal of Change Management*, **4**, 63–74.

Hodgkinson, G.P., & Healey, M.P. (2008). Cognition in organizations. *Annual Review of Psychology*, **59**, 387–417.

Holman, D., Axtell, C., Clegg, C., Pepper, K., Waterson, P., Cantista, I., *et al.* (2000). Change and innovation in modern manufacturing practices: An expert panel survey of UK Companies. *Human Factors and Ergonomics in Manufacturing*, **10**(2), 121–37.

Huang, Y.H., Robertson, M.M., & Chang, K.I. (2004). The role of environmental control on environmental satisfaction, communication, and psychological stress: effects of office ergonomics training. *Environment and Behavior*, **36**(5), 617–37.

Hundert, A.T., & Greenfield, N. (1969). Physical space and organizational behavior: A study of office landscape. Paper presented at the 77th Annual Convention of the American Psychological Association, Washington, D.C.

Ives, R.S., & Ferdinands, R. (1974). Working in a landscaped office. *Personnel Practice Bulletin*, **30**, 126–41.

Kanter, R.M., Stein, B.A., & Jick, T.D. (1992). *The Challenge of Organizational Change*. New York, NY: Free Press.

Kilduff, M., & Brass, D.J. (2010). Job design: A social network perspective *Journal of Organizational Behavior*, **31**, 309–18.

Konar, E., Sundstrom, E., Brady, C., Mandel, D., & Rice, R. (1982). Status demarcation in the office. *Environment and Behavior*, **14**, 561–80.

Kotter, J.P. (1996). *Leading change*. Boston, MA: Harvard Business School Press.

Kupritz, V.W. (1998). Privacy in the work place: The impact of building design. *Journal of Environmental Psychology*, **18**(4), 341–56.

Laing, A. (2006). New patterns of work: The design of the office. In J. Worthington (Ed.), *Reinventing the Workplace* (2nd edn). Oxford: Architectural Press.

Laing, A., Duffy, F., Jaunzens, D., & Willis, S. (1998). *New Environments for Working: The Redesign of Offices and Environmental Systems for New Ways of Working* (pp. 29–49). London: Construction Research Communications Ltd.

Lawler, E.E.I., & Worley, C.G. (2006). *Built to Change: How to Achieve Sustained Organizational Effectiveness* San Francisco, CA: Jossey-Bass.

Lawson, B. (2004). *What Designers Know*. Oxford: Architectural Press.

Lawson, B.R., & Phiri, M. (2003). *The Architectural Healthcare Environment and its Effects on Patient Health Outcomes*. London: The Stationery Office.

Leaman, A., & Bordass, W. (2005). *Productivity in Buildings: The Killer Variables*. The Usable Buildings Trust.

Lee, S.Y., & Brand, J.L. (2005). Effects of control over office workspace on perceptions of the work environment and work outcomes. *Journal of Environmental Psychology*, **25**(3), 323–33.

Lee, S.Y., & Brand, J.L. (2010). Can personal control over the physical environment ease distractions in office workplaces? *Ergonomics*, **53**(3), 324–35.

Locke, E.A., & Latham, G.P. (2004). What should we do about motivation theory? Six recommendations for the twenty-first century. *Academy of Management Review*, **29**(3), 388–403.

Ludwig, T.D., Gray, T.W., & Rowell, A. (1998). Increasing recycling in academic buildings: A systematic replication. *Journal of Applied Behavior Analysis*, **31**(4), 683–6.

Luecke, R. (2003). *Managing Change and Transition*. Boston, MA: Harvard Business School Press.

Markland, M. (1995). The future of the office building. *Facilities*, **13**(3), 15–22.

Marquardt, C.J.G., Veitch, J.A., & Charles, K.E. (2002). *Environmental Satisfaction with Open-Plan Office Furniture Design and Layout*. Institute for Research in Construction, National Research Council Canada.

May, D.R., Oldham, G.R., & Rathert, C. (2005). Employee affective and behavioral reactions to the spatial density of physical work environments. *Human Resource Management*, **44**(1), 21–33.

McCoy, J.M. (2005). Linking the physical work environment to creative context. *Journal of Creative Behavior*, **39**(3), 169–91.

McElroy, J.C., & Morrow, P.C. (2010). Employee reactions to office redesign: A naturally occurring quasi-field experiment in a multi-generational setting. *Human Relations*, **63**(5), 609–39.

McGourlay, J., Ridgway, K., Davis, M., Challenger, R., & Clegg, C. (2009). Designing the factory of the future. Paper presented at the Design for Human Performance, a one-day conference organized by Arup, London, UK.

Mehrabian, A. (1977). A questionnaire measure of individual differences in stimulus screening and associated differences in arousability. *Environmental Psychology and Nonverbal Behavior*, **1**, 89–103.

Millward, L.J., Haslam, S.A., & Postmes, T. (2007). Putting employees in their place: The impact of hot desking on organizational and team identification. *Organization Science*, **18**(4), 547–59.

Morgan, J.J. (1916). The overcoming of distraction and other resistances. *Archives of Psychology*, **28**, 191–208.

Mumford, E. (1983). *Designing Secretaries: The Participative Design of a Word Processing System*. Manchester, UK: Manchester Business School.

Mumford, E. (1995). *Effective Systems Design and Requirements Analysis: The ETHICS Approach*. Basingstoke, UK: Macmillan.

Mumford, E., & Weir, M. (1979). *Computer Systems Work Design: The Ethics Method*. London: Associated Business Press.

Nadin, S.J., Waterson, P.E., & Parker, S.K. (2001). Participation in job redesign: An evaluation of the use of a sociotechnical tool and its impact. *Human Factors and Ergonomics in Manufacturing*, **11**(1), 53–69.

Natsu, P. (2008). US Companies embrace green technology [electronic version]. *eJournal USA*, **13**, 4–6.

Navai, M., & Veitch, J.A. (2003). *Acoustic Satisfaction in Open-Plan Offices: Review and Recommendations*. Institute for Research in Construction, National Research Council Canada.

Ng, C.F. (in press). Teleworker's home office: An extension of corporate office? *Facilities*.

O'Neill, M.J. (1994). Work space adjustability, storage, and enclosure as predictors of employee reactions and performance. *Environment and Behavior*, **26**(4), 504–26.

Oldham, G.R. (1988). Effects of changes in workspace partitions and spatial density on employee reactions: A quasi-experiment. *Journal of Applied Psychology*, **73**(2), 253–8.

Oldham, G.R., & Brass, D.J. (1979). Employee reactions to an open-plan office: A naturally occurring quasi-experiment. *Administrative Science Quarterly*, **24**(2), 267–84.

Oldham, G.R., Cummings, A., & Zhou, J. (1995). The spatial conguration of organizations. In G. Ferris (Ed.), *Research in Personnel and Human Resources Management* (volume 13), (pp. 1–37). Greenwich, USA: JAI Press.

Oldham, G.R., Kulik, C.T., & Stepina, L.P. (1991). Physical environments and employee reactions: Effects of stimulus-screening skills and job complexity. *Academy of Management Journal*, **34**(4), 929–38.

Oldham, G.R., & Rotchford, N.L. (1983). Relationships between office characteristics and employee reactions: A study of the physical environment. *Administrative Science Quarterly*, **28**(4), 542–56.

Osmond, H. (1959). The relationship between architect and psychiatrist. In C. Goshen (Ed.), *Psychiatric Architecture* (pp. 16–20). Washington, DC: American Psychiatric Association.

Paciuk, M. (1990). The role of personal control of the environmental control on office worker perceptions of air quality. Paper presented at the EDRA Annual Conference, Edmond, OK.

Parker, S.K., Wall, T.D., & Cordery, J.L. (2001). Future work design research and practice: Towards an elaborated model of work design. *Journal of Occupational and Organizational Psychology*, **74**, 413–40.

Paulus, P.B. (1980). Crowding. In P.B. Paulus (Ed.), *Psychology of Group Influence* (pp. 245–89). Hillsdale, NJ: Erlbaum.

Paulus, P.B., Annis, A.B., Seta, J.J., Schkade, J.K. & Matthews, R.W. (1976). Density does affect task performance. *Journal of Personality and Social Psychology*, **34**, 248–53.

Peponis, J., Bafna, S., Bajaj, R., Bromberg, J., Congdon, C., Rashid, M., *et al.* (2007). Designing space to support knowledge work. *Environment and Behavior*, **39**(6), 815–40.

Perham, N., Banbury, S., & Jones, D.M. (2007). Do realistic reverberation levels reduce auditory distraction? *Applied Cognitive Psychology*, **21**(7), 839–47.

Pettigrew, A.M. (1985). *The Awakening Giant: Continuity and Change in Imperial Chemical Industries*. Oxford, UK: Blackwell.

Pettigrew, A.M., Woodman, R.W., & Cameron, K.S. (2001). Studying organizational change and development: Challenges for future research. *Academy of Management Journal*, **44**(4), 697–713.

Pile, J. (1976). *Interiors: Third Book of Offices*. Whitney Library of Design, NY: Watson-Guptill.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y., & Podsakoff, N.P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, **88**(5), 879–903.

Preiser, W.F.E. (1994). Built environment evaluation: Conceptual basis, benefits and uses. *Journal of Architectural and Planning Research*, **11**(2), 91–107.

Rashid, M., & Zimring, C. (2008). A review of the empirical literature on the relationships between indoor environment and stress in health care and office settings: Problems and prospects of sharing evidence. *Environment and Behavior*, **40**(2), 151–90.

Redman, T., Snape, E., & Ashurst, C. (2009). Location, location, location: Does place of work really matter? *British Journal of Management*, **20**(1), 171–81.

Ridgway, K., Cerulli, C., Davis, M., Challenger, R., Wiseall, S., Hill, P., *et al.* (2008). Designing the factory of the future. Paper presented at the International Conference on Applied Human Factors and Ergonomics (AHFEI), Las Vegas, NV.

Robinson, M. (2010). An empirical analysis of engineers' information behaviors. *Journal of the American Society for Information Science and Technology*, **61**(4), 640–58.

Roethlisberger, F.J., & Dickson, W.J. (1939). *Management and the Worker: An Account of a Research Program Conducted by the Western Electric Company, Hawthorne Works, Chicago*. Cambridge, MA: Harvard University Press.

Schuler, R.S. (1980). Definition and conceptualization of stress in organizations. *Organizational Behavior and Human Performance*, **25**, 184–215.

Smith-Jackson, T.L., & Klein, K.W. (2009). Open-plan offices: Task performance and mental workload. *Journal of Environmental Psychology*, **29**(2), 279–89.

Sommer, R. (1959). Studies in personal space. *Sociometry*, **22**, 246–60.

Spector, P.E. (1992). A consideration of the validity and meaning of self-report measures of job conditions. In C.L. Cooper & I.T. Robertson (Eds), *International Review of Industrial and Organizational Psychology* (volume 7), (pp. 123–51). Chichester, UK: John Wiley & Sons Ltd.

Steele, F.I. (1973). *Physical Settings and Organizational Development*. Reading, MA: Addison Wesley.

Stokols, D., Smith, T.E., & Prostor, J.J. (1975). Partitioning and perceived crowding in a public space. *American Behavioral Scientist*, **18**, 792–814.

Sundstrom, E., Burt, R.E., & Kamp, D. (1980). Privacy at work: Architectural correlates of job satisfaction and job performance. *Academy of Management Journal*, **23**(1), 101–17.

Sundstrom, E., Herbert, R.K., & Brown, D.W. (1982). Privacy and communication in an open-plan office: A case study. *Environment and Behavior*, **14**(3), 379–92.

Sundstrom, E., & Sundstrom, M.G. (1986). *Work Places: The Psychology of the Physical Environment in Offices and Factories*. New York, NY: Cambridge University Press.

Sundstrom, E., Town, J.P., Rice, R.W., & Osborn, D.P. (1994). Office noise, satisfaction, and performance. *Environment and Behavior*, **26**(2), 195–222.
Susman, G.I., & Evered, R.D. (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly*, **23**(4), 582–603.
Sutton, R.I., & Rafaeli, A. (1987). Characteristics of work stations as potential occupational stressors. *Academy of Management Journal*, **30**, 260–76.
Totterdell, P.A. (2006). Longitudinal research/experience sampling technique. In S. G. Rogelberg (Ed.), *Encyclopedia of Industrial/Organizational Psychology*. Thousand Oaks: Sage.
Trist, E.L., & Bamforth, K.W. (1951). Some social and psychological consequences of the longwall method of coal-getting: An examination of the psychological situation and defences of a work group in relation to the social structure and technological content of the work system. *Human Relations*, **4**(1), 3–38.
Turner, G., & Myerson, J. (1998). *New Workspace New Culture: Office Design as a Catalyst for Change*. Aldershot: Gower Publishing.
van Eijnatten, F.M. (1997). Development in socio-technical systems design (STSD). In P.J.D. Drenth, H. Thierry, & C.J. de Wolff (Eds), *Handbook of Work and Organizational Psychology. (volume 4) Organizational psychology* (pp. 61–88). Sussex, UK: Lawrence.
Van de Ven, A.H., & Poole, M.S. (1995). Explaining development and change in organizations. *Academy of Management Review*, **20**, 510–40.
Veitch, J.A., Charles, K.E., Farley, K.M.J., & Newsham, G.R. (2007). A model of satisfaction with open-plan office conditions: Cope field findings. *Journal of Environmental Psychology*, **27**(3), 177–89.
Vernon, H.M. (1919). *The Influence of Hours of Work and of Ventilation on Output in Tinplate Manufacture*. London: HMSO.
Vernon, H.M. (1921). *Industrial Fatigue and Efficiency*. London: Routledge.
Vilnai-Yavetz, I., Rafaeli, A., & Yaacov, C.S. (2005). Instrumentality, aesthetics, and symbolism of office design. *Environment and Behavior*, **37**(4), 533–51.
Vischer, J.C. (1989). *Environmental Quality in Offices*. New York: Van Nostrand Reinhold.
Vischer, J.C. (1996). *Workspace Strategies: Environment as a Tool for Work*. New York: Chapman and Hall.
Vischer, J.C. (2005). *Space Meets Status: Designing Workplace Performance*. Oxon: Routledge.
Vischer, J.C. (2007). The effects of the physical environment on job performance: Towards a theoretical model of workplace stress. *Stress and Health*, **23**, 175–84.
Vos, P., & van der Voordt, T. (2001). Tomorrow's offices through today's eyes: Effects of innovation in the working environment. *Journal of Corporate Real Estate*, **4**(1), 48–65.
Warr, P.B., Cook, J., & Wall, T.D. (1979). Scales for the measurement of some work attitudes and aspects of psychological well-being. *Journal of Occupational Psychology*, **52**(2), 129–48.
Weick, K.E. (1979). *The Social Psychology of Organizing* (2nd edn). Reading, MA: Addison-Wesley.
Wener, R., & Carmalt, H. (2006). Environmental psychology and sustainability in high-rise structures. *Technology in Society*, **28**, 157–67.
Woodman, R.W. (1989). Organizational change and development: New arenas for inquiry and action. *Journal of Management*, **15**, 205–28.
Wrzesniewski, A., & Dutton, J. (2001). Crafting a job: Employees as active crafters of their work. *Academy of Management Review*, **26**(2), 179–201.
Yudelson, J. (2009). *Green Building Trends: Europe*. Washington, DC: Island Press.
Zalesny, M.D., & Farace, R.V. (1987). Traditional versus open offices: A comparison

of sociotechnical, social relations, and symbolic meaning perspectives. *Academy of Management Journal*, **30**(2), 240–59.

Zalesny, M.D., Farace, R.V., & Kurchner-Hawkins, R. (1985). Determinants of employee work perceptions and attitudes: Perceived work environment and organizational level. *Environment and Behavior*, **17**(5), 567–92.

Zeitlin, L.R. (1969). *A Comparison of Employee Attitudes Towards the Conventional and the Landscaped Office*. Organization and Procedures Department, Port of New York Authority.