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Executive Summary

Open-plan offices became popular in the 1970's because they were believed to lead to improved communication and productivity. Anecdotal evidence suggests that many employees find some aspects of open-plan offices to be unsatisfactory. A literature review was completed in an attempt to clarify the relationship between the effects of open-plan office furniture design features and layout on ratings of environmental satisfaction. A search of the literature from 1975 to 2002 in over 20 major databases resulted in very little directly relevant material. Therefore, the indirect findings from sources that included environmental satisfaction measures and examined furniture aspects of enclosed private offices and bull-pen layouts, and studies comparing enclosed or bull-pen layout to open-plan office environments were also included in the review. Studies directly related to density, noise, temperature, ventilation, and lighting conditions were excluded because other COPE project reports address these topics specifically.

Features of furniture design and layout affect occupants by addressing their physical and task needs, privacy needs, and need for recognition. The degree of fulfilment of these needs influences environmental satisfaction.

Physical and Task Needs

- Location
- Furnishings
- Chairs
- Storage
- Adjustability

Privacy Needs

- Partition shape and height
- Degree of enclosure
- Low noise levels
- Workstation size

Need for Recognition

- Space for display of personal items
- Space, furnishings, and equipment suited to one's status

The literature did not conclusively demonstrate general relationships in which specific furnishings or layouts were superior to others in fulfilling these needs. However, it is clear that when occupants experience their needs as fulfilled, their environmental satisfaction is improved. Meeting individual needs – which vary by job type, individual characteristics, and from one task to another – leads to improved satisfaction, but there is no universal way of doing this.

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1.0 Introduction

With only about 16.5 waking hours available daily, many people spend over 50% of their lives at work, within indoor physical settings that influence their thoughts, emotions and actions (Gallagher, 1993; Gifford, 2002; Sundstrom, 1986). The most popular form of office design is the open-plan office, characterised by moveable partitions that separate individual workspaces. Over 70 % of office workers occupy some form of open-plan office space (Brill, Weidemann, & BOSTI Associates, 2001).

Open-plan offices offer organizations more flexibility in spatial configuration and occupy less space per occupant, thereby reducing real estate expenses. In addition, many believe that open-plan spaces enhance communication by increasing proximity and better reflect a more egalitarian working culture (Sundstrom, 1986). However, studies have demonstrated that environmental satisfaction levels are lower for people occupying open-plan offices than for people occupying enclosed private offices (Block & Stokes, 1989; Bradshaw, 1984; Hedge, 1982; Marans & Yan, 1989; Oldham & Brass, 1979; Oldham & Rotchford, 1983).

Given the financial imperatives that make open-plan offices attractive to organizations, their use is unlikely to cease. It is therefore important to ascertain how furniture design and layout features of the open-plan office contribute to environmental satisfaction and to develop design recommendations for the most satisfactory conditions.

1.1 Environmental Satisfaction

Operationally defined, general or overall environmental satisfaction refers to how contented a person feels with respect to the physical setting in question. Environmental satisfaction has been divided into many sub-dimensions. These include, but are not limited to, satisfaction with floor space (Sundstrom, 1986); satisfaction with the workstation and office building, satisfaction with control over visual and noise distractions, and satisfaction with filing/storage space (Dressel & Francis, 1987); and satisfaction with temperature and air-quality (O'Neill, 1992). Comfort is positively correlated with environmental satisfaction (Brill, Margulis, Konar., & BOSTI, 1984) and can be considered a sub-dimension of environmental satisfaction. General subjective impressions of office comfort (Brill et al., 1984) and specific measures of comfort (Paul, Morrow, & Helander, 1996) have been used.

The sub-dimensions of environmental satisfaction measure the degree to which specific human needs are being fulfilled. For example, satisfaction with floor space measures the degree to which a person's need for adequate space is being met and measurements of general comfort indicate the degree to which a person's need for personal comfort is being met.

Environmental satisfaction has been addressed circuitously by questions such as "How do you like the office you are working in here?" (Kraemer, Sieverts & Partners, 1977); and "All things considered, how satisfied are you with your primary work space?", and loosely defined as liking or disliking the working conditions (Finnegan & Solomon, 1981). Questions and definitions such as these have been incorporated into a number of environmental satisfaction questionnaires. For example, the Physical Work Environment Satisfaction Questionnaire (PWESQ), also known as the Human Factors Satisfaction Questionnaire (HFSQ), measures satisfaction with environmental factors related to health and safety, work and systems, equipment, environment, and facilities (Carlopio, 1986). This 37 item self-report questionnaire can provide a measure of environmental satisfaction among its many sub-dimensions. The device has demonstrated construct validity (Carlopio, 1996).

User or tenant satisfaction is another way of conceptualising environmental satisfaction. With the User or Tenant Questionnaire Survey Assessment Method, user satisfaction is derived from ratings of 24 items measuring nine sub-dimensions of environmental satisfaction: thermal comfort, air quality, office noise control, spatial comfort, privacy, lighting, building noise control, overall satisfaction, and ability to do your work (Dillon & Vischer, 1987; Leifer & Gumbaketi, 1999).

In addition, large comprehensive workplace assessment devices often measure environmental satisfaction as a sub-scale of such constructs as self-reported productivity and worker satisfaction. The Office Environment User's Survey measures the perceived physical environment, job characteristics and activities, demographic characteristics and issues related to satisfaction and performance: satisfaction with the work space or overall environmental satisfaction (Sundstrom, Town, Brown, Forman, & McGee, 1982). Modified versions of flexible questionnaires such as the method proposed by Moos (1973) and the Environmental Satisfaction Questionnaire (ESQ) (Corazzini, Wilson, & Huebner, 1977) can also permit the measurement of environmental satisfaction. The methodology of these questionnaires allows the researcher to measure independent variables according to the research setting by changing the items in the questionnaires.

In spite of the availability of these measurement devices, they were not widely or consistently employed in the literature. Due to the ambiguity and inconsistent definitions of environmental satisfaction, we operationally defined environmental satisfaction as a general construct or overall rating of environmental satisfaction. Environmental or workplace satisfaction is distinct from work satisfaction, job satisfaction, and satisfaction with performance, constructs that other authors have discussed (Oldham & Brass, 1979; Oldham & Fried, 1987; Oldham, Kulik, & Stepina, 1991; Stone, 2001). Work and job satisfaction refer to measures of contentment with the one's duties or with the organisation and one's role in it, while satisfaction with performance generally refers to measures of contentment with one's ability to perform the work tasks.

1.2 Study Selection Criteria

Open-plan office furniture design features and layout effects on environmental satisfaction, as reported in the scientific literature (i.e., publicly-available books, book chapters, journal articles and conference proceedings) between 1975 and 2002, were the targets of this review. Studies directly related to density, noise, temperature, ventilation, and lighting conditions were excluded because other COPE project reports address these topics specifically. In addition, studies focussing on micro-design issues such as ergonomics were not discussed because they lie outside the scope of the COPE project.

In spite of an exhaustive search of over 20 major databases with more than 75 search terms (over 460 individual searches were performed, see Appendix A) and a study of the reference lists of every relevant article, little directly relevant material was found. Studies of open-plan office environments where environmental satisfaction measures were the dependent variable and aspects of the physical environment (e.g., partition height) were the independent measures were considered directly relevant (O'Neill, 1994).

Because there were not many directly relevant studies, the focus of the review was broadened to include indirectly relevant material. These studies examined furniture aspects of offices in general, including enclosed private offices, bull-pen (no walls or partitions) and open-plan layouts. Measures of environmental satisfaction were not usually the main focus of these studies (Brill et al., 1984).

In all sources of information, aspects of furniture design and layout were discussed. Items such as chairs, desks, tables, work surfaces, filing cabinets, partitions or panels, and storage units were considered furniture; as opposed to equipment (e.g., fax machines, computers, printers). The term *layout* referred to the spatial organisation of various furniture configurations.

1.3 Need Fulfilment and Environmental Satisfaction

A popular means of analyzing behaviour is to consider it as directed towards fulfilling individual needs (Maslow, 1943). Although research has not confirmed a hierarchical order, evidence for various classifications of needs has been acknowledged (Sundstrom, 1987). The classification of work related needs has included Maslow's (1) physiological, (2) safety, (3) social, (4) esteem, and (5) self-actualization needs (Maslow, 1943) and needs for (6) achievement, (7) power, and (8) affiliation (Medcof & Hausdorf, 1995). For the purposes of this review, the scheme was simplified to three levels: physical and task needs, privacy needs, and need for recognition. Specific needs will depend on the individual and on the work. The degree to which these needs are fulfilled is reflected in occupants' experiences of environmental satisfaction.

2.0 Physical and Task Needs

Workers require a certain level of physical accommodation from the environment in order to accomplish their work. Open-plan offices might support task needs to a lesser degree than enclosed offices (Bradshaw, 1984). Specific requirements depend on the physical characteristics of the individual (e.g., height, reach), their individual preferences and expectations, and the work they do.

2.1 Location

Environmental satisfaction might be affected by one's workstation location relative to the entire space and facilities. Lack of clearly defined boundaries and adjacency to entranceways or machinery were associated with decreased environmental satisfaction (Goodrich, 1982) as was the inability to freely move around one's workstation, independent of total floor space (Lantrip, 1993). In contrast, accessibility to equipment and reference material was rated as influencing personal comfort a great deal by 67% of workers (Louis Harris & Associates, Inc. 1980).

These influences on environmental satisfaction might be related to the space's positive or negative ability to fulfil worker's task needs due to such things as well situated equipment (positive influence), or machinery noise and chairs without wheels (negative influence). By placing a worker in a less practical location within a group of offices the worker might not be able to perform her or his work efficiently or effectively.

2.2 Furnishings

The key to suitability is the fit between what is provided, and what is needed for the job. Work space comfort can be increased by increasing work surface height, width, and depth, overall room to manoeuvre, subjective measures of size of work space, and enclosure (usually measured by the number of walls or partitions per office), but only if the layout suits the work tasks (Brill et al., 1984).

A configuration including two work surfaces, one or two chairs, and one to five filing or storage drawers was rated high in suitability for managers, professional/technical, and clerical employees alike (Brill et al., 1984). Ergonomic furniture – a general phrase usually applied to furnishings that can be adapted to individual physical characteristics, and that is designed to

reduce muscular strain – improved satisfaction with the work environment (Carlopio & Gardner, 1992).

2.3 Chairs

Chair comfort in particular is important in any office configuration; 73% of office workers reported that it influenced their personal comfort a great deal (Louis Harris & Associates, Inc. 1980). As chair comfort increases, so does environmental satisfaction (Brill et al., 1984). Chair comfort can be increased by adjustability. The ability to adjust chairs and other furniture to meet the physical needs of the worker was also related to environmental satisfaction in O'Neill's (1994) directly relevant study, discussed below. It is interesting to note that although chair comfort might be related to adjustability, a more recent study found that chair comfort was also related to a sense of well-being and aesthetics (Helander & Zhang, 1997). Chair discomfort was independent of chair comfort and was positively related to accumulated fatigue and poor biomechanics (chair –person fit). No studies related to chair discomfort and environmental satisfaction were found.

2.4 Storage

General findings indicate that environmental satisfaction ratings of most workers are affected by their ability to store personal items such as coats and boots. Professional and technical workers' ratings of environmental satisfaction are affected by their ability to store items such as paper, books, binders, briefcases, and purses more so than clerical workers and managers (Brill et al., 1984).

The fulfilment of storage needs might directly influence environmental satisfaction (O'Neill, 1994). These results are not straightforward because the storage ratings might have actually been satisfaction ratings. Items one and two of the storage index were: (1) How satisfied are you with the amount of storage you have in your work space? and (2) How satisfied are you with the amount of space you have for displaying things on tack boards and other vertical surfaces? On the surface this implies only that environmental satisfaction is related to its sub-dimension: satisfaction with storage. In addition, no objective measurements of storage capacity were obtained; the final storage questionnaire item was "The storage units in my work space are appropriate for the kind of work materials I need to store".

While it is clear that storage might be related to environmental satisfaction, the type and actual quantity of storage capacity must be studied more thoroughly in open-plan office configurations. In addition, the effect of location of the storage units on environmental satisfaction must be studied; accessibility to equipment and reference material was rated as influencing personal comfort a great deal by 67% of the surveyed workers (Louis Harris & Associates, Inc., 1980).

2.5 Adjustability

Providing adjustable furniture is a means to provide for physical needs in relation to individual characteristics and task-specific demands. If the furniture can be adjusted to be more physically comfortable given the stature, size, and preferences of the individual, environmental satisfaction might increase. Assessing subjective impressions of general comfort is one method of assessing the degree to which workers' physical needs are being met. General findings from studies such as the BOSTI studies of the early 1980's (Brill et al., 1984), indicate that as overall comfort increases, so does environmental satisfaction.

Furniture adjustments also allow individuals to adapt to specific task demands. The most frequently moved and reconfigured (e.g., adjusted shelf heights, added shelves etc.) piece of furniture in all office configurations is the storage unit (e.g., filing cabinet, cabinets with doors). The second to fifth most frequently reconfigured pieces of furniture are work surfaces, telephone and electrical components, partitions, and major equipment (Brill et al., 1984). In general, easily reconfigurable office furniture is positively correlated to environmental satisfaction (Brill et al., 1984; Francis & Dressel, 1990).

Similarly, a field study of open-plan offices found that adjustability was highly correlated with environmental satisfaction (r = .68) (O'Neill, 1994). This relationship was confirmed through path analysis, results of which suggested that no other factors influenced this relationship. This strong result might be an overestimate, however: Adjustability was not objectively verified or quantified, and some of the items used to assess adjustability might have actually measured satisfaction with adjustability. The exact questionnaire items used to address adjustability were (1) "How frequently do you adjust the position of storage units?" (2) "How satisfied are you with how well your work space lets you organise your materials?" and (3) How satisfied are you with the ease of rearranging the furniture in your work space?" This could have inflated the relationship to overall environmental satisfaction.

Contrasting direct evidence suggests that adjustable workstations might not always improve environmental satisfaction. The introduction of sit-stand adjustable computer workstations did not significantly change workers' perceptions of satisfaction with their work environments (Paul, 1995). One possibility is that the option of standing, rather than sitting, was not an option that employees wanted. In addition, the office layouts were also changed when the new furniture was installed. The initial office configurations were comprised of 64" high panels on each of four sides, with a 30" wide opening on one side acting as an entranceway. In the new office configuration only three panels were provided. Although not measured, the change in layout might have introduced decreases in perceived privacy that might have counteracted any increases in environmental satisfaction.

The ability to adjust furniture to suit individual differences in work styles might increase environmental satisfaction. Seven behaviour patterns in office workers have been noted, each with different furniture demands: horizontal organisers, vertical organisers, intense organisers, relaxed organisers, packrats, neatrats, and territorial workers (Goodrich, 1982). Horizontal organisers require large surface areas to organise their work laterally while vertical organisers require shelves and wall tack-boards for their work. Intense organisers require a combination of shelves, files, and drawers to compartmentalise their items and keep their space uncluttered. In contrast, relaxed organisers prefer a cluttered work area with all their items within sight; they are unique in their approaches to organisation and would benefit from large desk covers to seal their work area when not in use. Packrats find it difficult to throw things away and therefore require an abundance of storage, and neatrats require very little storage as they do not like to keep things. Lastly, territorial workers require clearly demarcated personal workspaces and their own storage areas. Providing the ability to adjust furniture to suit the specific needs of each behaviour pattern might increase environmental satisfaction.

3.0 Privacy Needs

Privacy can be defined as the degree to which one's social interactions are regulated. It can be sub-divided into categories such as acoustic privacy, visual privacy (O'Neill & Carayon, 1993), and privacy from distractions (O'Neill, 1994). Perceived privacy has been measured by

assessing control over accessibility, isolation from intrusions, speech privacy, degree of being on display to others, auditory privacy, visual privacy, reduction in intrusions due to increased way-finding, and overall subjective privacy (Brill et al., 1984; Carlopio & Gardner, 1995; Hedge, 1982; O'Neill, 1994; Sundstrom, Herbert, & Brown, 1982). In addition, satisfaction with privacy has been measured (Veitch, Farley, & Newsham, 2002).

A positive relationship appears to exist between general satisfaction with the environment and perceived privacy (Sundstrom, Burt, & Kamp, 1980a) and this is supported by the findings specific to open-plan offices (O'Neill & Carayon, 1993; O'Neill, 1994). The prevailing finding from indirect studies indicates that open-plan offices are associated with lower privacy than enclosed offices (Block & Stokes, 1989; Brookes, 1978; Hedge, 1982; Louis Harris & Associates, Inc., 1978; Sanoff, 1985; Sundstrom et al., 1980; Sundstrom, Town, et al., 1982; Zalesny & Farace, 1987).

Quantitatively speaking, the relationship between visual and acoustic privacy sub-types and environmental satisfaction is strong. O'Neill (1994) found a significant negative correlation ($r = -.4$) between subjective ratings of visual and acoustic distractions and environmental satisfaction. In addition, open-plan offices are associated with higher degrees of distraction (Block & Stokes, 1989; Burgess, Lai, Eisner, & Taylor, 1989; Cangelosi & Lemoine, 1988; Hedge, 1982; Marans & Spreckelmeyer, 1982). Partition shape and height, degree of enclosure, and workstation size might contribute to the fulfilment of privacy needs and influence environmental satisfaction.

3.1 Partition Shape and Height

O'Neill (1994) studied the influence of partition type (single piece versus stackable frame and tile) and partition height on environmental satisfaction. No significant relationship was found. This study did not provide the range of partition heights that were assessed and it is quite possible that a relationship does exist but only after a certain minimum height, most likely about 4 - 5ft, has been attained (Bradshaw, 1984). Previous studies demonstrated that average panel height was somewhat correlated with perceptions of privacy (O'Neill & Carayon, 1993) and privacy was related to environmental satisfaction (Sundstrom, Town et al., 1982).

In a separate COPE field study of three workstation characteristics (workstation area, minimum partition height, and windows) researchers found that minimum partition height was negatively related to overall environmental satisfaction (Charles & Veitch, 2002), although it did not predict satisfaction with privacy specifically. The data from 419 government office workstations and their occupants demonstrated that as the minimum partition height decreased, overall environmental satisfaction increased. However, most partitions in this sample were quite high, between 60-76 inches; which is a limited range for multiple regression analysis. It is also possible that these partitions were too isolating, providing more privacy than desired; alternatively, lower partitions might have permitted better ambient conditions through such things as improved airflow. Further examinations of this issue with a larger, more variable, sample, should help to clarify these relationships.

3.2 Degree of Enclosure

Although the need for some degree of privacy is strong, in general, most people prefer to work with other people in the vicinity, rather than totally alone (Brill et al., 1984). Moving workers from enclosed offices to a bull-pen layout would provide the desired company; unfortunately, this might also increase interruptions and disturbances and lead to decreases in perceived global privacy and conversational privacy (Sundstrom, 1986). Providing any

enclosure where none existed prior, as in the bull-pen layout, can improve environmental satisfaction (Dressel & Francis, 1987; Oldham, 1988; Sullivan, 1990). Enclosure can be provided by floor to ceiling permanent walls, movable partitions, or office furniture such as cabinets and closets.

The amount of enclosure is tenuously related to privacy ratings (Oldham, 1988; Oldham & Rotchford, 1983; Sanoff, 1985) and in general, the evidence suggests that as the degree of enclosure decreases, less privacy is experienced, and environmental satisfaction levels drop (Brill et al., 1984). For example, Ferguson (1983) demonstrated a strong relationship between the degree of openness and satisfaction with the work space, from traditional enclosed offices to varying degrees of open-plan and bull-pen layouts. Openness was inversely related to satisfaction with the work space in this study. The relationship was strongly influenced by aural distractions and perceived privacy. The degree of openness was positively correlated with aural distractions which, in turn, were negatively correlated to perceived privacy. Aural distractions were also negatively correlated with satisfaction with the workspace and perceived privacy was positively correlated with satisfaction with the workspace.

In a directly relevant study, researchers compared the relationships between objective and subjective measures of enclosure, perceived privacy, and environmental satisfaction (O'Neill & Carayon, 1993). They found that objective indicators of enclosure, such as square footage of work space, average panel height, and number of panels, were significantly correlated with perceptions of privacy and accounted for 8% of the variance in perceived privacy. The relationship between subjective measures of enclosure (i.e. perceived enclosure) and perceived privacy was much stronger and accounted for 43% of the variance in perceived privacy. Subjective measures also had strong effects on environmental satisfaction; perceived enclosure accounted for 7% of the variance in environmental satisfaction and perceived privacy accounted for 50% of the variance in environmental satisfaction. No regression statistics were reported for the objective measures of enclosure and environmental satisfaction.

A subsequent study did report on objective measures of enclosure and environmental satisfaction (O'Neill, 1994). The actual number of partitions or sides in an open-plan office was not related to privacy or environmental satisfaction. This study used objective measures of enclosure only, including partition type, heights of lowest and highest partition, square footage of the work space, and the number of panels surrounding the work space.

Although the correlations and predictive functions of the regression analysis of the O'Neill and Carayon (1993) and O'Neill (1994) studies are interesting, they appear somewhat contradictory. The construct validity of the variables might have contributed to the inconsistency between subjective and objective variables. For example, only one of the three items defining perceived enclosure in O'Neill and Carayon (1993) actually referred to a subjective perception: "amount of enclosure felt from the panels or walls surrounding work space." The other two items addressed actual objective measures of panel height and number of panels. In addition, both studies relied on occupant self-reports to two different questionnaires and the objective measures were not verified by the researchers. Therefore, measurement error might also have contributed to the disparate results.

Studies with better construct validity appear to confirm the inconsistency between objective and subjective measures. For example, in Marans and Yan's (1989) study of lighting quality, the relationship between actual enclosure levels, subjective and objective measures of space, conversational privacy, and environmental satisfaction were examined. The objective degree of enclosure was divided into 14 categories with varying numbers of fixed floor to ceiling

walls and non-permanent partitions. A complex pattern of environmental satisfaction emerged. For example, the highest rate of "very satisfied" responses occurred not with the traditional enclosed office (27%) but with a relatively open office with three floor-to-ceiling walls (30%). In addition, when only the offices with partitions were considered, four partitions, two partitions, one partition and bull-pen style with no partitions produced higher rates of "very satisfied" responses (all 12%) than offices with three partitions (only 4%). Although no subjective measures of enclosure were recorded, Marans and Yan found that subjective assessments of floor area correlated highly with work space satisfaction ($r = .46$ to $r = .62$) while objective measures of floor area were only moderately correlated ($r = .08$ to $r = .29$) with work space satisfaction.

Marans and Yan (1989) also found that conversational privacy was correlated with environmental satisfaction for occupants of open-plan offices although the strength of the relationship decreased along with decreases in the degree of enclosure. Environmental satisfaction was only moderately correlated to conversational privacy for occupants in totally open offices or offices with only two walls or partitions. Furthermore, although environmental satisfaction was only moderately related to visual privacy for occupants of open-plan offices, it was more strongly related to visual privacy for workers in offices with four partitions. In other words, privacy influenced environmental satisfaction more for people in enclosed offices than for people in offices with less enclosure. This relationship is interesting because one would expect privacy to influence environmental satisfaction to a stronger degree for people in open-plan offices. The difference may be a statistical artifact related to a restricted range of privacy scores; if all of the open-plan occupants reported low privacy then a lower correlation would result. Alternatively, perhaps people in open-plan spaces do not miss what they cannot have.

Partition height provides second illustration of the complex relationship between privacy and degree of enclosure. Privacy might be increased more by adding a fourth side to an open-plan office with three relatively low partitions than by adding a fourth side to an open-plan office with three relatively high partitions (Brill et al., 1984). Therefore, simply adding another side or partition might not be the only solution to satisfying the need for privacy and increasing environmental satisfaction; this relationship has not been empirically explored.

3.3 Workstation Size

Very large open-plan workstations might result in feeling a lack of enclosure and privacy that could decrease environmental satisfaction (Dressel & Francis, 1987). However, workstations between 42 and 209 ft^2 (M=108 ft^2) positively predicted satisfaction with privacy (Charles & Veitch, 2002). These results support findings from O'Neill and Carayon (1993) who reported that square footage of work space was positively correlated with perceptions of privacy. In addition, Oldham and Rotchford (1983) found that perceptions of privacy were positively related to satisfaction with the office. Interestingly, however, neither Charles and Veitch (2002) nor Oldham and Rotchford (1983) reported a direct relationship between measures of workstation size and overall environmental satisfaction. Workstation size effects on other aspects of overall environmental satisfaction might be contrary to the benefits of larger workstations on satisfaction with privacy specifically.

3.4 Moderator Variables

3.4.1 Job type.

Concerns about privacy might be related to the type of infringement experienced by various job levels. In Sundstrom (1982), the requisite privacy sub-type varied across job types. For example, managers rated speech privacy as being strongly related to environmental satisfaction,

while professional-technical workers rated isolation from intrusions as being strongly related to environmental satisfaction.

3.4.2 Task difficulty.

Indirect evidence suggests that the relationship between degree of enclosure and environmental satisfaction might be influenced by task difficulty in conjunction with privacy issues. Block and Stokes (1989) found that people performing difficult tasks preferred working in private offices, probably to prevent unwanted intrusions. Workers in the higher status positions with more difficult tasks might be more sensitive to their office configurations. They might be more detrimentally affected by the disturbances and lack of privacy associated with open-plan offices (Hedge, 1982) and they might react more strongly when moving from enclosed offices to open-plan offices.

3.4.3 Adjustability.

Logically, if there are panels or doors, or changes in position, that individuals can use to limit visual access, this adjustability should improve privacy and environmental satisfaction. The BOSTI studies found that privacy control (control over accessibility, distractions, interruptions, and unwanted telephone calls) positively correlated with environmental satisfaction (Brill et al., 1984).

However, one study found that the degree of personal control (privacy adjustability) in limiting visual access to others in open-plan offices did not have any predictive ability in determining environmental satisfaction (O'Neill & Carayon, 1993), although it did predict privacy (9% of the variance). One reason for the absence of a relationship to environmental satisfaction could be the measurement scale. Two of four items concerned acoustic privacy; the other two concerned the fit of the accommodation to the job status. Alternatively, the adjustments could have been too small to provide a meaningful benefit.

3.5 Summary

Increasing partition height, increasing enclosure, and larger workstation sizes help to provide adequate privacy and improve environmental satisfaction. At present, however, it is not possible to state exactly which values are optimal. Needs for privacy, in any case, vary in relation to job requirements; thus different partition heights and workstation size choices might be appropriate for different job types. Providing individuals with ways to modify their exposure to others, to increase visual or acoustic privacy, might also improve environmental satisfaction.

4.0 Need for Recognition

Through personalization of work spaces, one expresses one's individuality. The work space provided by the employer might also confirm one’s identity and communicate one's position within the organisation. Self-expression and recognition are related to environmental satisfaction. Organizations also communicate their attitudes about the worth of employees through their accommodation practices and policies.

4.1 Personalization

Personalization is the process whereby workers publicly display personally meaningful items. Examining all enclosed, bull-pen and open-plan offices, the amount of room to display personal items was positively related to overall satisfaction with the environment (Brill et al., 1984). This relationship, however, could be confounded by differences in status associated with office type (lower status people are more likely to be in bull-pen areas with less display space). Looking more closely at open-plan layouts only, perceived amount of wall space available for

hanging items was only moderately related to environmental satisfaction (r = .24 to r = .33) (Marans & Yan, 1989).

Personalization might be construed as a compensatory mechanism for dealing with unsatisfactory environments: Those who personalize their space the most might be the least pleased with their environments and those who personalize the least might be most pleased with their environments (Goodrich, 1982). This is a difficult hypothesis to test with a correlational design; whether one personalized or not, the result should be satisfaction with the resultant environment at the time of measurement. This is reflected in the inconclusiveness of the literature: One study found no relationship between the degree of personalization and environmental satisfaction in any open-plan office configuration (Marans & Yan, 1989) and one study did demonstrate a positive relationship (Wells, 2000). In the latter study, individuals whose workstations showed greater personalization reported higher environmental satisfaction; higher environmental satisfaction predicted overall well-being.

The amount of space available for personalization depends strongly on the space (either horizontal or vertical) provided in total. Ratings of the adequacy of the space for personalization are equally dependent on the adequacy of the space overall. Although one could establish a relationship between objective measures of the space for personalization and environmental satisfaction, it is unlikely to be a large one. Organisational policies need to be in place to permit personalization; even if space is available in a physical sense, it is unavailable if policy prohibits its use.

4.2 Job Status Markers

Office accommodations- their type, size, and finishes - have always reflected the status of the individual. For example, enclosed offices have always been associated with managerial, higher-status positions (Sundstrom, 1986). Environmental satisfaction, therefore, should depend in part on the degree to which one's office accords with one's expectations given one's status. Interestingly as few as 50% of workers, independent of office configuration, feel that their work space reflects their job-status (Brill et al., 1984). The relationship also seems to indicate that higher status individuals feel that their space reflects their job-status the least.

Perceptions of work space – job-status congruency might influence environmental satisfaction to a stronger degree for supervisory level individuals and this in turn might be related to having an enclosed office (Konar, Sundstrom, Brady, Mandel, & Rice, 1982). In other words, supervisors rate environmental satisfaction lower if they are in open-plan offices and feel that they should be in enclosed offices in comparison to general office workers occupying open-plan offices who feel they should be in enclosed offices.

The workstation – job-status relationship might be explained by Mazumdar's notion of *environmental deprivation* (Mazumdar, 1992). This qualitative study examined the hypothesis that the intensity of workers' reactions to their workspaces is dependent upon the degree to which they feel they are being deprived of an architectural element. When workers experience the loss or lack of provision of some aspect of the physical environment which they consider their own, they experience environmental deprivation. For example, a worker can experience environmental deprivation when he or she must occupy an open-plan office despite feeling the job requires (or deserves) an enclosed office. A sense of loss and grief can result when the symbolic connection between the office space and job-status is strong. The emotional reactions can vary from embarrassment and shame to anxiety and panic. The behaviours resulting from environmental deprivation range from self-imposed isolation within the inferior space to taking legal action against the organisation. Because the symbolic connection between superior office

space and higher status jobs is strong, it is quite possible that supervisory workers experience a greater degree of environmental deprivation when they feel their office space is not congruent with their job-status than when clerical workers must occupy an incongruent office space.

The location of specific workers might also influence environmental satisfaction through job-status congruency. For example, the distance between a particular worker and a key decision maker in the organisation might decrease environmental satisfaction if the individual feels that she or he is too far away (or too close) to the key decision maker relative to her or his job-status, so that communication quality has diminished (Brill et al., 1984). Although no clear evidence supporting this hypothesis was found, other studies have demonstrated changes in communication dependent upon office type (Oldham & Brass, 1979), distance from supervisors, and inter-office distances (Zahn, 1991). For example, greater distances between supervisors and their workers resulted in less face-to-face communication (Zahn, 1991) and moving from enclosed offices to open-plan offices resulted in less supervisor feedback and fewer friendship opportunities (Oldham & Brass, 1979).

4.3 Furnishing Quality and Maintenance Levels

There is scant literature concerning the effects of furnishing quality and maintenance levels, although these considerations bear obvious relations to environmental satisfaction. In general, quality, durability, new furnishings, and visual aspects of office furnishings positively influence comfort and general satisfaction with the office environment (Brill et al., 1984; Francis & Dressel, 1990; Marans & Yan, 1989; Sullivan, 1990). Interestingly, wall or partition sturdiness did not correlate well with environmental satisfaction (Brill et al., 1984). In addition, a survey of 18 organizations demonstrated that buildings with better maintenance of services (e.g., restrooms, elevators) and office equipment (e.g., typewriters, photocopiers) were associated with higher environmental satisfaction as well as comfort and health of the office workers (Foju, 1993).

5.0 Meeting Individual Needs: Control

The ability to control aspects of the environment is one means to meet individually different needs, or needs that change from time to time. For example, if a worker finds it too cold, the ability to adjust the temperature is a means to achieve a satisfactory temperature. An important distinction exists between perceived control, which is the perception that one can influence events; and, actual control, or the availability of behavioural responses to change environmental conditions. Actual control might require the provision of adjustability (discussed earlier), or could be provided by involving individuals in the design and outfitting of their offices.

5.1 Control through Adjustability

Perceived control over stressful environmental conditions can be beneficial (Thompson, 1981). The classic example of this is the reduction in adverse noise-related after effects (on proof-reading performance and frustration tolerance) in participants who were given a switch to turn off annoying noise, but who did not use it, in comparison to participants who had no means to stop the noise (Glass & Singer, 1972). However, perceived control over non-stressful lighting conditions was not associated with improved performance, frustration tolerance, or mood (Veitch

& Gifford, 1996). One possibility for this result is that perceived control is not salient if the conditions are good enough not to highlight a need to change or escape them.

Exercising meaningful control over environmental conditions allows the individual to tailor them to one's needs and preferences. By definition, the conditions one prefers should be those that produce high environmental satisfaction. The environmental conditions that one prefers, such as the presence of a pleasant fragrance, can improve cognitive performance, creativity, and social behaviour, apparently through the mediation of positive affect (Baron, 1990; Baron & Thomley, 1994).

This is one possible explanation for the results of a field investigation in which individual workstation control over six environmental conditions (temperature, velocity and direction of ventilation air, radiant heat, lighting, and sound masking equipment) was given through environmentally responsive workstations (ERWs). The productivity of these insurance industry workers increased by 2.8% when they moved into a new space with ERWs (Kroner & Stark-Martin, 1994). When three of the six controls were disabled (air temperature, air velocity, and radiant heat), productivity dropped 12.8% below the new baseline. The productivity effects positively correlated with overall satisfaction of the office workplace. The change in environmental satisfaction was 33% higher for workers whose productivity increased than for those whose productivity decreased. However, the introduction of the ERWS coincided with a move to a new building and other changes; therefore, it is impossible to be certain that either the availability of controls, or a better fit of work conditions to employees' preferences, caused the productivity changes or the improved satisfaction.

One study found that although exercised control and perceived control were inversely correlated with perceptions of temperature comfort in open and enclosed offices, they were not correlated with satisfaction with air temperature (O'Neill, 1992). In other words, workers who made changes to the temperature or who felt they could change the temperature also felt less comfortable with the temperature, but this had no bearing on their satisfaction with air temperature. These results are somewhat difficult to interpret because comfort can be considered a sub-scale of environmental satisfaction. One would expect that if a worker feels that the thermal conditions are poor enough to merit an adjustment, then actually changing the temperature should be related to low environmental satisfaction.

5.2 Participation in Office Design

Although it is possible to create an office environment that will satisfy the average person, the average person is not a frequent occurrence. Individuals respond differently to their environments and demonstrate different levels of each need. Influential control in the design process might increase environmental satisfaction by fulfilling the need to demonstrate environmental competence or by resulting in offices that better satisfy task needs (Aronoff & Kaplan, 1995). Environmental competence is “people’s ability to deal with their immediate surroundings in an effective and stimulating manner” (Steele, 1980).

Some field studies support this hypothesis. For example, 72% of office workers felt that if they were allowed to influence the design of their own office space (i.e. demonstrate the ability to effectively design one’s own office configuration), it would result in a more satisfactory work environment (Louis Harris & Associates, Inc., 1978) and actual participation in the office design process is positively correlated with overall satisfaction with the resulting work environment (Brill et al., 1984). Participation in the design process can account for as much as 6% of the variance in environmental satisfaction according to the BOSTI studies of the early 1980’s,

independent of gender, age, job-type, and government versus private sector organizations (Sundstrom, Town, et al., 1982a).

6.0 Discussion

6.1 Research Limitations

The extensive search revealed comparatively few investigations of environmental satisfaction in relation to open-plan office furnishings. Those that were found also had several limitations in research design, reporting, and analysis, that prevented clear recommendations from emerging.

6.1.1 History.

Comparisons of studies before and after the mid-1980s are complicated by dramatic technological changes, specifically the introduction of personal computers, which have resulted in different task demands. For example, stenography and typing by clerical workers has given way to individual knowledge workers typing their own documents. Physical and task needs have changed dramatically and the older literature is therefore less applicable to today's open-plan offices.

6.1.2 Research design.

Relatively few studies cited here used strong research designs that allowed causal attributions about the effects of furniture design or layout on environmental satisfaction. Strong research designs would set testable hypotheses, and eliminate alternative explanations (Cook & Campbell, 1979).

Attempting to clarify specific issues regarding the effects of open-plan office furniture design features and layout on the fulfilment of needs and environmental satisfaction is difficult because open-plan offices were rarely studied in isolation. More often than not, they were studied in comparison to enclosed offices or bull-pen offices in a categorical comparison of office types, without objective measurements of physical conditions that could allow specific parameters to be compared across the groups (e.g., Brill et al., 1984; Oldham & Rotchford, 1983).

Studies that were cross-sectional-correlational investigations only measured one group at one time point. This research design greatly limited the strength of causal inferences about the origins of environmental satisfaction (e.g., Foju, 1993; Goodrich, 1982).

Some researchers also did not report results in sufficient detail to support detailed recommendations, even if they compared pre and post measures of environmental satisfaction, and did not attempt to attribute differences to specific environmental changes (e.g., Anderson, Weidemann, Heinen, Adeoye, & Beazly, 1994). Based on these reports, all one may say is that workers were more satisfied with the new or old environment.

6.1.3 Construct validity.

Most of the studies employed their own questionnaires or surveys, developed for the one study and not rigorously established as valid or reliable measures. This practice made comparisons across studies problematic.

Many investigations lacked objective measurements of the physical environment, relying instead on self-reports by participants (O'Neill, 1992). The self-reports could have been subject to bias or error, but more importantly this is a logical error, treating the subjective experience of individuals as identical to the objective reality of the spaces in which they worked. It is valuable

to understand subjective experience, but practical recommendations about how to design or configure a workplace require knowledge about how objective conditions influence occupants.

Moreover, many of the purported measures of independent variables (e.g., privacy) were actually measures of the dependent variables (e.g., sub-dimensions of environmental satisfaction). For example, privacy was measured by a questionnaire item assessing satisfaction with privacy in at least one study (O'Neill, 1994). The confounded variables might have artificially increased the strength of the correlations, while adding little to our understanding of the effects of office design on environmental satisfaction.

6.1.4 Inadequate theory development.

Basic psychological processes occur in people at work just as in any other setting. They are scarcely considered in the literature concerning environmental satisfaction, but might explain the relatively weak results in some of the investigations cited here. Prior experiences influence subsequent behaviours. Thus, previous office space experiences might influence subsequent environmental satisfaction assessments. Four aspects of prior experience deserve more attention.

Adaptation is a process whereby the strength of sensory response to a stimulus decreases with prolonged exposure (Wolman, 1989). Thus, conditions that might initially provoke strong discomfort might become less uncomfortable over time. Similarly, *habituation* describes the process whereby learned responses to a specific stimulus stop after a continuous exposure to the stimulus (Wolman, 1989). In workplaces, this would be demonstrated by an individual who learns to ignore the chat of people in other cubicles, instead focusing on the task. *Sensitization*, by contrast, is the process whereby the nervous system becomes more susceptible to a given stimulus (Wolman, 1989). The employee who reports increasing annoyance with the draught from overhead, when the draught itself is constant, demonstrates sensitization. *Expectation*, a state of anticipation associated with a stimulus or event, develops through both direct experience and observation. Thus, by having observed that managers occupy private offices, we come to expect that as managers, we too would have private offices.

The importance of understanding these theoretical issues becomes apparent when one considers results such as the observation that workers who moved from enclosed to open offices reported lower privacy than individuals who had only experienced open-plan offices (Hedge, 1982). This might have been a result of adaptation or habituation on the part of the long-time open-office occupants, in which case any dissatisfaction might be predicted to decline in the new open-plan occupants as they undergo these processes. Alternatively, the move from closed to open offices might have been perceived as a loss of status by those employees, and the resultant conditions might therefore have been less satisfactory to them. Positive steps to improve their environmental satisfaction would likely be needed, particularly if the perceived loss of status led to their being more sensitive to other environmental changes.

6.2 Future Research Directions

The literature demonstrates a trend of positive influence of office furnishings and layout on environmental satisfaction through the satisfaction of workers' needs. In no case did the literature suggest that the independent variables or the satisfaction of workers' needs influenced environmental satisfaction in a negative fashion (unless of course they were measured inversely [e.g., lack of privacy, lack of storage, etc.]).

A logical first step towards clarification would be to specify an operational definition of environmental satisfaction and its sub-dimensions, and to use a standard measurement device with demonstrated reliability and validity. This could be completed through revisiting an existing questionnaire or by creating, testing and validating a new measurement device.

The second step would be to identify the processes that influence environmental satisfaction, making predictions about how furniture and layout features might act on those processes. Specific hypotheses about these processes and variables should be tested, using appropriate research methods and statistical analyses. In addition, the literature points to potential moderator variables such as individual differences, job type, and prior experience, that are worthy of further attention. Wherever possible actual objective measures of independent variables (e.g., storage capacity in cubic meters) should be augmented by subjective evaluations (e.g., perceived amount of storage).

7.0 Conclusions

The lack of findings directly relevant to the influence of open-plan office furniture design and layout on environmental satisfaction makes it difficult to specify furniture choices or layouts for optimal environmental satisfaction. The methodology, measurement techniques, and lack of replication of most studies contribute to the difficult interpretations and comparisons of the findings. In spite of these challenging issues, a few principles can be extracted from the current review.

Features of furniture design and layout affect occupants by addressing their physical and task needs, privacy needs, and need for recognition. The degree of fulfilment of these needs influences environmental satisfaction. The furniture and layout features relating to each need are summarised thus:

Physical and Task Needs

- Location
- Furnishings
- Chairs
- Storage
- Adjustability

Privacy Needs

- Partition shape and height
- Degree of enclosure
- Low noise levels
- Workstation size

Need for Recognition

- Space for display of personal items
- Space, furnishings, and equipment suited to one's status

The literature did not conclusively demonstrate general relationships in which specific furnishings or layouts were superior to others in fulfilling these needs. However, it is clear that when occupants experience their needs as fulfilled, their environmental satisfaction is improved. Meeting individual needs – which vary by job type, individual characteristics, and from one task to another – leads to improved satisfaction, but there is no universal way of doing this. Designers of open-plan office space should take the fulfilment of these needs as a goal of the design process, seeking the best available evidence (as it accumulates) to determine the best practical implementation for the given circumstance. Some of the outstanding research questions revealed by this review will be addressed in analyses of COPE field data.

8.0 References

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Appendix A: List of Databases and Search Terms

Databases
Chapters Online
CISTI Articles, Journals, Catalogue
CISTI Source (e-journals & EDRA proceedings in catalogue)
Current Contents
Dissertation Abstracts
EBM Cochrane Reviews
EI Compendex Plus
Ergonomics in Design
Health Star '75-2002
Human Factors
Human Factors and Ergonomics Society Annual Meeting Proceedings
Inspec
Medline/Pubmed
PAIS
PsychCrawler
PsychInfo
SocioFile
Sociological Abstracts
www.google.com
www.hfes.com

Search Terms (1975-2002) [* = wildcard substitution]
alternative office
communication in the workplace
cubicle
cubicle and satisfaction
enclosure and satisfaction
enclosure space
environment and satisfaction
environmental satisfaction
furniture design
grouping
interior design and working conditions and environmental satisfaction
layout and design
office and comfort
office and cubicle
office and environment
office and environment and satisfaction
office and furniture
office and layout
office and layout and satisfaction
office and partition
office and partition*

office and privacy
office and satisfaction
office comfort
office communication
office cubicle
office cubicles
office cubicle*
office décor
office environment
office environment and satisfaction
office furniture
office and furniture and design and layout and environmental and satisfaction
office furniture design features and layout and environmental satisfaction
office grouping
office happiness
office layout
office layout and design
office layout and environmental satisfaction
office partitions
office partition*
office performance
office privacy
office proximity
open and plan and office and layout and environmental and satisfaction
open plan and office
open plan offices
open plan office*
open plan office layout and environmental satisfaction
physical environment
physical environment and satisfaction
post-occupancy evaluation
storage
storage and satisfaction
work and environmental and satisfaction
work and environmental satisfaction
work environment and satisfaction
workplace and environment
workplace and environmental and satisfaction
workplace and layout
workplace and satisfaction
workplace and environmental satisfaction
workplace and comfort
workplace comfort
workplace décor
workplace grouping
workplace happiness

workplace layout
workplace performance
workplace satisfaction
workplace surface area
workplace territoriality
workstation
workstation and environmental satisfaction
workstation and storage
workstation and storage and satisfaction