

# Effects of Office Layout and Sit-Stand Adjustable Furniture: A Field Study

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In a controlled field study, twelve office employees with computer-intensive jobs were monitored during the redesign of their work environment. Before office redesign, they worked in closed offices with four walls and sitting height, non-adjustable workstations. Then they worked in more open offices with three walls and sit-stand adjustable VDT workstations. The effects of this office redesign were evaluated three months post-occupancy. During the three months, employees worked standing for two hours every day. The results suggest that change in the office layout, i.e. open versus closed, increased the interaction and communication between employees. However, it significantly decreased employees' perceived privacy, and increased the amount of visual and noise distractions. In the offices with sit-stand adjustable furniture, subjects felt more energetic and less tired by the end of the workday.

## Effects of Office Layout and Sit-Stand Adjustable Furniture: A Field Study

Using open offices to create interactive and team-oriented environments is one of the major trends in office design. Open office layouts are generally viewed as developing greater solidarity among employees and offering greater personal contact (Sanders and McCormick, 1993). Mercer (1979) and Nemecek and Grandjean (1973) reported that in such open office designs, visual distractions and acoustic disturbances are greater than the same in cellular offices. Such distractions can hinder employees' ability to concentrate on their job tasks. Closed offices, on the other hand, prevent disruptive distractions but also tend to isolate employees.

Office design can affect employee health and performance. Hedge (1984) reported that the complaints of frequent headaches were almost twice as prevalent among employees working in open-plan offices than those in walled offices. In VDT offices, the furniture layout can influence end-users' comfort levels and the work organization (Lu and Aghazadeh, 1994). Francis and Dressel (1990) reported that the type of furniture and office layout significantly affected employee performance and their satisfaction with the work environment. Adjustable workstations that allow the occupants to work in more comfortable postures have been shown to improve comfort, environmental satisfaction and productivity (Dainoff, 1990; Dressel and Francis, 1987; Gahramani, 1992; Nerhood and Thompson, 1994; Sullivan, 1990).

The concept of closed or open offices focuses on boundaries – interpersonal and interdepartmental. Boundaries can either integrate teams into a larger organization, or differentiate them from the rest of the organization. The interdepartmental boundaries should facilitate the desired activity and dynamics between the incumbent departments. Gladstein (1984) suggested that the way teams manage interaction across their organizational boundaries influences their effectiveness. O'Neil and Carayon (1993) reported that perceived enclosure, which is influenced by the number of walls,

was an important predictor of privacy and environmental satisfaction. Boundaries and office layouts impact the pace and timing of information exchanges with other departments. They can be reinforced or made permeable through the design and selection of proper office furniture, and should be integrative or differentiative as needed. A comprehensive macroergonomic approach to such issues has been suggested by Hendrick (1986, 1994).

Today, the majority of office jobs are sedentary. The long-term risk of low back pain is greater in such jobs (Magora, 1972). Sitting in any posture, no matter how comfortable, loses its merit over time and it is desirable to promote body activity in sedentary jobs. Even moderate level of activity can reduce foot swelling (Winkel and Jorgensen, 1986). One approach to promote activity is to work periodically in a standing position. Paul and Helander (1995) reported that office employees who stood for two out of the eight working hours shrank significantly less than those who sat all eight hours. Paul (1995) reported that standing intermittently reduced foot swelling. Helander and Quance (1990) reported that use of a sit-stand chair (stool), compared to a regular chair, reduced spinal shrinkage.

This paper reports the results of a controlled field study on the effects of office layout and sit-stand adjustable furniture on group dynamics and employee satisfaction. A group of office employees with computer-intensive tasks was monitored during the redesign of their offices. Prior to redesign, their offices were 8' x 8' cellular offices with 64" high panels on all four sides, except a 30" wide entrance on one side. Within these offices, work surfaces were mounted on panels in an L-shaped layout. The work surfaces were mounted on panels at heights according to generally accepted ergonomic principles. The computer screen and keyboard were placed on the work surface. The offices were similar to the experimental systems furniture described by Francis and Dressel (1990). The employees had substantial control over their job activities and the pace of their work.

After redesign, the offices were still cellular and panel-based, but were different in two respects: (1) The new offices had three walls. The open side served as the entrance; and (2) Subjects were provided with a sit-stand adjustable workstation for VDT work. The VDT workstation was instant user-adjustable using an electronic touch-keypad. Next to the sit-stand workstation, additional work surfaces were mounted on panels to create an L-shaped layout. In both settings, employees used the same highly adjustable chairs and computers were placed in a corner. Since the location of new offices was adjacent to the old offices, the physical environment was the same in both settings.

**EXPERIMENTAL PROCEDURE**

**Subjects**

Twelve healthy office employees, nine female and three male, voluntarily participated in this study. The demographic characteristics of these employees are shown in Table 1. The demographic and medical history of the subjects was scrutinized to screen out employees with either medical or physical conditions that might affect assessment of office layout and furniture adjustability.

**Procedure**

Before Office redesign, the offices of twelve employees were videotaped for analysis. They also filled surveys on demographic characteristics, job content, and environmental satisfaction, perceived group interaction and stress level. Additional surveys for mood states were filled at the start of the workday, before lunch, after lunch, and at the end of the workday, i.e., at 8:00 a.m., 12:00 p.m., 1:00 p.m., and 5:00 p.m. In the redesigned offices, employees

were surveyed and videotaped three months post-occupancy. During the three months, subjects stood for two hours every day, either for 15 minutes every hour or 30 minutes every two hours. Three months were believed to be adequate to settle in the new environment.

**Statistical Method**

This is a before-after study without mutually exclusive samples. Therefore, the pairwise t-test was used for statistical analysis of the results.

**RESULTS**

The results of employee perceptions about the work environment are illustrated in Figure 1 [Scale: 1 – Poor; 2 – Adequate; 3 – Good; 4 – Excellent]. Figure 2 shows the changes in employees’ mood states [Scale: 1 = Hardly at all; 2 = A little; 3 = Some; 4 = A Lot; 5 = A great deal]. The change is shown with respect to the scores recorded in offices with closed layout and non-adjustable furniture.

**Figure 1. Employee satisfaction with the work environment**

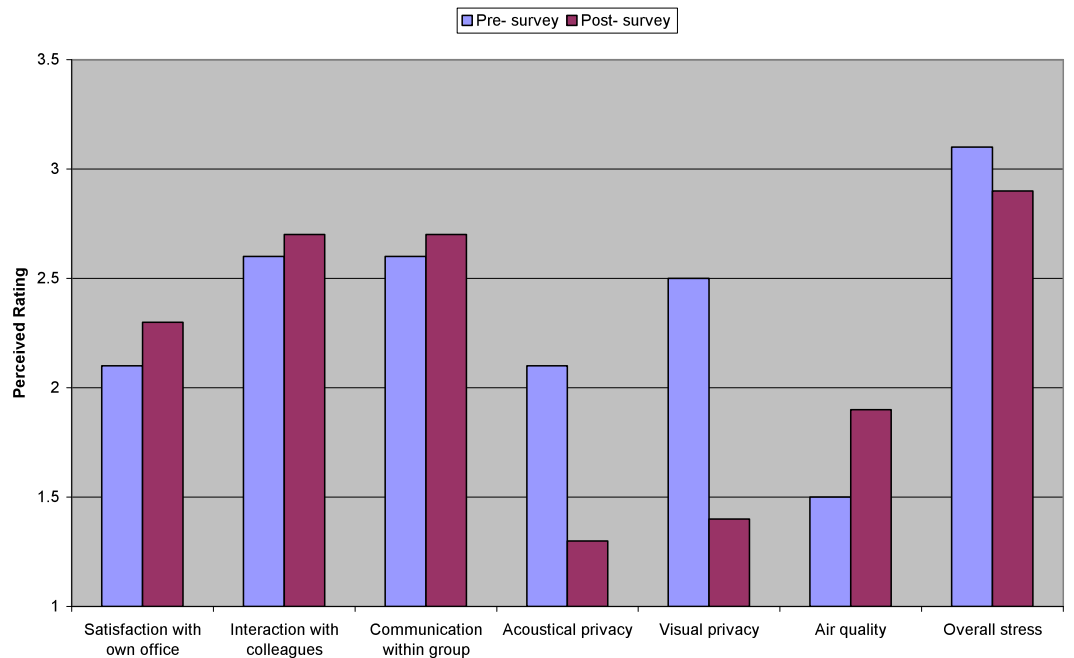
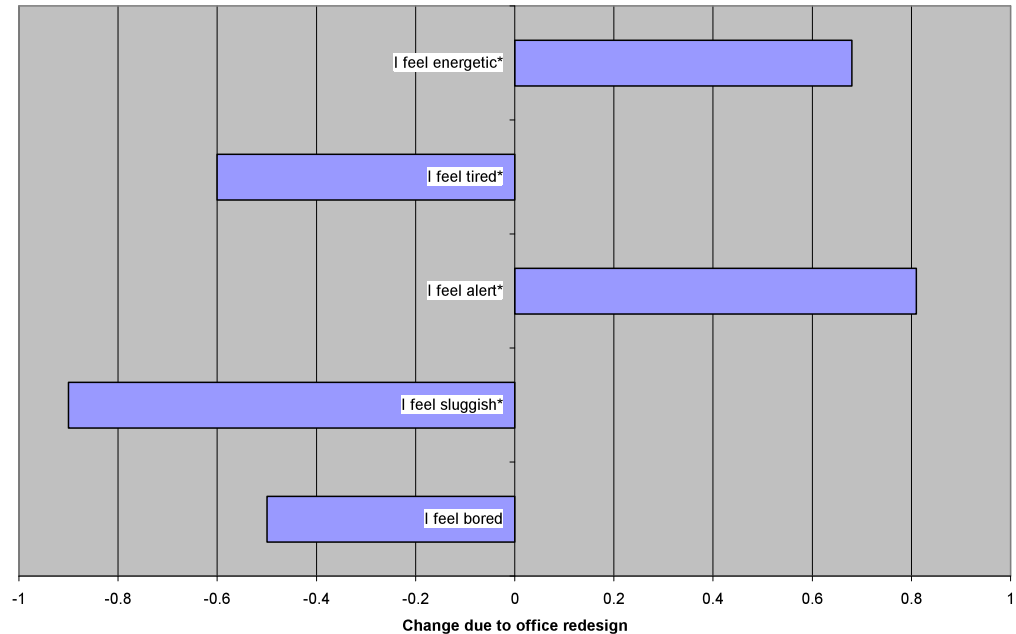


Figure 2. Change in employee perceptions due to office redesign



**DISCUSSION**

Since the late eighties, open office layouts that promote a team environment are becoming more popular. The interaction and communication between the members of a work group are generally considered a good indicator of the level of teamwork. The open office layout examined in this study increased the communication and interaction between employees somewhat (not significant at  $p=0.05$ ). Field evidence suggests that interaction and communication patterns develop over several months before they stabilize.

Therefore, long-term observations are necessary to verify the lasting changes. The increase in visual and noise distractions concurs with the results of previous studies. The implications of distractions for employees' ability to concentrate on their work and their productivity are difficult to quantify. The increase in air quality is an indicator of improved air circulation in open offices. Overall, this study and other studies to-date indicate that open and closed office designs have individual both benefits and drawbacks. Even in team areas where open layouts seem appropriate, employees occasionally need a closed space where they can concentrate on the task at hand or conduct confidential conversations. Since employee and organizational needs change over time, a flexible work environment that allows employees to "open" or "close"

their work areas to the desired degree is perhaps the most effective solution. O'Neil (1994) hypothesized that such flexibility and control over the physical environment might enhance worker effectiveness and satisfaction.

Employees' perceived satisfaction with their work environment did not change significantly, despite provision of ergonomically advanced furniture. The possible reason could be employees working in closed offices found the openness disadvantageous to their sense of privacy. Decreased level of privacy adversely affects satisfaction ratings (O'Neil and Carayon, 1993). These results cannot be generalized, since they are task-dependent and influenced by group dynamics, supervisory relationships, and personal preferences.

When working in offices with sit-stand adjustable furniture, employees felt more energetic and less tired by the end of the workday compared to when working in closed offices with non-adjustable furniture. The likely reason is the increase in body activity and postural changes due to intermittent standing.

It is difficult to precisely differentiate the influence of office layout from that of the adjustable furniture, since they were implemented together. However, in post-installation surveys, the subjects attributed increase in distractions to open layout and improvements in

mood states to adjustable furniture. Further research, preferably in laboratory settings, is needed to discern the influences of such compounding factors. High cost of creating experimental settings in laboratories prohibits such efforts, and less controlled field studies, such as this, are more common.

## CONCLUSIONS

1. Previous studies have documented that open office layouts increase interaction and communication between employees. However, such layouts can also increase visual and noise distractions, reduce perceived privacy and hinder employees' ability to concentrate on their job tasks when needed. It appears that the open and closed offices have benefits and drawbacks. An assessment of the organizational goals, group objectives and individual responsibilities is needed to decide the right mix of open and closed spaces for a given work area.

2. Sit-stand adjustable furniture that promotes postural changes and body activity can improve employees' perceived energy level and mood state after a day's work.

## REFERENCES

- Dainoff, M.J. (1990). Ergonomic improvements in VDT workstations: health and performance benefits. In S.L. Sauter, M.J. Dainoff and M.J. Smith (Eds.), *Promoting health and productivity in the computerized office: Models of successful ergonomic interventions* (pp. 49-67). London: Taylor & Francis.
- Dressel, D.L. and Francis, J., 1987, Office productivity: contributions of the workstation. *Behavior and Information Technology*, 6, 279-284.
- Francis, J. and Dressel, D.L. (1990). Workspace influence on worker performance and satisfaction: an experimental field study. In S.L. Sauter, M.J. Dainoff and M.J. Smith (Eds.), *Promoting health and productivity in the computerized office: Models of successful ergonomic interventions* (pp. 3-16). London: Taylor & Francis.
- Gahramani, B. (1992). Significant improvements from providing ergonomically designed furniture to AT&T corporate managers. In S. Kumar (Ed.), *Advances in Industrial Ergonomics and Safety IV* (pp. 455-462). London: Taylor & Francis.
- Gladstein, D. (1984). Groups in context: A model of task group effectiveness. *Administrative Science Quarterly*, 29, 499-517.
- Hedge, A. (1984). Ill health among office workers: An examination of the relationship between office design and employee well-being. In E. Grandjean (Ed.) *Ergonomics and Health in Modern Offices*. London: Taylor & Francis.
- Hendrick, H.W. (1986). Macroergonomics: A conceptual model for integrating human factors with organizational design. In O. Brown, Jr. and H.W. Hendrick (Eds.), *Human Factors in Organizational Design and Management – II* (pp. 467-478). Amsterdam: North-Holland.
- Hendrick, N.w. (1994). Work system and job design factors in preventing WMSDs in VDT operators. In *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting* (pp. 419-423). Santa Monica, CA: Human Factors and Ergonomics Society.
- Lu, H. and Aghazadeh, F. (1994). The perceived discomfort and musculoskeletal complaints associated with varying positions of VDT and keyboard, in F. Aghazadeh (Ed.), *Advances in Industrial Ergonomics and Safety VI*, (pp. 475-481). London: Taylor & Francis.
- Magora, A. (1972). Investigation of the relation between low back pain and occupation, 3 physical requirements: sitting, standing, and weight lifting. *Industrial medicine*, 41, 5-9.
- Mercer, A. (1979). Office environments and clerical behavior, *Environment and Planning*, 6, 29-29.
- Nemecek, J. and Grandjean, e. (1973). Results of an ergonomic investigation of large-space offices. *Human Factors*, 15, 111-124.
- Nerhood, H.L. and Thompson, S.W. (1994). Adjustable sit-stand workstations in the office. In *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting* (pp. 668-672). Santa Monica, CA: Human Factors and Ergonomics Society.
- O'Neil, M.J. (1994). Environmental design and worker control for preventing WMSDs. In *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting* (pp. 424-427). Santa Monica, CA: Human Factors and Ergonomics Society.

O'Neil, M.J. and Carayon, P. (1993). The relationships between privacy, control, and stress responses in office workers. In Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting (pp. 479-483). Santa Monica, CA: Human Factors and Ergonomics Society.

Paul, R.D. (1995). Foot swelling in VDT Operators with sitting and sit-stand workstations. In Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting (in press). Santa Monica, CA: Human Factors and Ergonomics Society.

Paul, R.D. and Helander, M.G. (1995). Spinal shrinkage in sedentary and non-sedentary VDT jobs. In A.C. Bittner and P.C. Champney (Ed.), *Advances in Industrial Ergonomics and Safety VII* (pp. 631-637). London: Taylor & Francis.

Paul, R.D. and Helander, M.G. (1995a). Effect of sit-stand schedules on spinal shrinkage in VDT operators. In Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting (in press). Santa Monica, CA: Human Factors and Ergonomics Society.

Sanders, M.S. and McCormick, E.J. (1993). *Human Factors in Engineering and Design*. New York: McGraw Hill.

Smith, M.J., Cohen, B.G., Stammerjohn, L.W.Jr., and Happ, A. (1981). An investigation of health complaints and job stress in video display terminals. *Human Factors*, 23, 387-400.

Sullivan, C. (1990). Employee comfort, satisfaction, and productivity: Recent efforts at Aetna. In S.L. Sauter, M.J. Dainoff and M.J. Smith (Ed.), *Promoting health and productivity in the computerized office: Models of successful ergonomic interventions* (pp. 28-48). London: Taylor and Francis.

Tyrell, A.R., Reilly, T. and Troup, J.D.G. (1985). Circadian variation in stature and the effects of spinal loading, *Spine*, 10, 161-164.

Winkel, J. and Jorgensen, K. (1986). Evaluation of foot swelling and lower-limb temperatures in relation to leg activity during long-term seated office work. *Ergonomics*, 29, 313-328.