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A CASE STUDY: INTEGRATED WORK ENVIRONMENT AND ORGANIZATIONAL CHANGE

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The failure to integrate environmental and organizational interventions may help explain the lack of success of many change efforts. The high rate of failure for change efforts (50% to 90% failure rates) has been noted by many writers (Majchrzak, 1988; Nadler and Tushman, 1977). While specific causes of failure are diverse, a common theme has been failure to consider the organization as a system. That is, either significant aspects of the organization were ignored during the intervention or potential impacts of changes on the elements were overlooked or underestimated.

Perhaps, as in the fable where a group of blind men reach very different conclusions when describing an elephant, our own training, technical literature, and professional culture lead us to limited understandings of complex organizations. Change agents must consider all relevant components of organizational performance if interventions are to be meaningful and successful.

It is our contention that, as a significant part of the organizational system, the physical environment must be elevated to the role of an active or independent variable and treated as an important component of any change effort. Failure to adequately attend to the physical environment is likely to contribute to the failure of otherwise well-conceived organizational interventions. Unfortunately, organizational effectiveness programs and facilities projects usually remain separate and distinct and thus fail to achieve the synergy that comes from an integrated intervention.

In support of this opinion, Harris (1988) found that managers were aware of the need to link work environment improvement to their overall organizational plans: 98% of those polled said this linkage was "very important." Yet less than a third said such linkages occurred in their own organization. A key purpose of the present research is to study the effects of integrating the work environment with other interventions.

INTEGRATED CHANGE STUDY

An integrated environmental/ organizational intervention was conducted in the Production Planning and Control (PP&C) department of the Analytical Chemistry Laboratory at Pacific Northwest Laboratory in Richland, Washington. The intervention included changes in three areas: the redesign and renovation of offices, an organizational development effort, and the development and implementation of a computerized Laboratory Information Management System. The hypothesis upon which these actions were based was that the integrated environmental/ organizational intervention would result in significant improvements in productivity, job satisfaction, and organizational culture, as well as more positive perceptions of the work environment and reduced absenteeism and turnover.

METHOD

Subjects

The participants in this study were 23 employees who worked in administrative

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and managerial roles in an underground office area (Mean age = 43.4, SD = 12.3). The participants work in line management, facilities improvement management, project management, quality engineering, quality control, quality assurance, industrial engineering, administrative data management-Laboratory Support Office (LSO), and secretarial support. The primary role of the LSO is to track samples through the laboratory and to manage and produce the reports presenting the findings resulting from analytical chemistry projects performed in nearby laboratory areas. Interventions were carried out in the physical work environment, in organizational development, and in an information system.

Physical Work Environment Intervention

Extensive changes in the office work environment were initiated in response to a high level of health problems, which were attributed to poor air quality and a substandard work environment. Interviews with management and employees, data collection, and direct observations of the workplace by the research team resulted in the identification of the following additional problems: high employee turnover and absenteeism, conflict between similar work groups, low morale, poor workflow, and a substandard work environment. Employees also played an important role in the workplace design. They described the work processes, reviewed workflow layout, and reviewed initial and final drawings. Staff input was incorporated into the design.

Prior to renovation, the work environment was a windowless underground space located in a 40-year-old Department of Energy analytical chemistry laboratory. The workplace contained private offices, small multiple-person offices, a small unused conference room, and a mismatched assemblage of food preparation and storage areas located in the central hallway. There were exposed utilities low enough to pose a safety hazard, overhead sanitary drains and water pipes (some leaking), poor lighting, poor temperature control, poor acoustics, and ergonomically inappropriate furniture. Occupants described the work area as "an embarrassing office space," "archaic, even when compared to the back room of a large grocery store," and the "catacombs."

The renovation dramatically changed the mezzanine workplace. The LSO office area was arranged in an open space to improve the workflow and job task demands described by the staff. In addition, storage space was increased to accommodate work-in-process that had previously accumulated at workstations. The storage of work-in-process materials substantially increased the amount of available work surface and more than doubled the number of people who could work comfortably in the work area. The new arrangement was also designed to encourage group cohesion and cooperation, increase efficiency of operations, ensure easy access to the extensive file cabinets, restrict access to interior areas by visitors to the area, create a sense of spaciousness, differentiate between workstations, and maintain the easy verbal interactions cited as necessary by the staff.

Other changes were also introduced in the work environment: two fully equipped conference rooms and an attractive lunchroom, adjustable energy-efficient lighting, consolidation of utilities into runs hidden behind high-sheen metallic paneling, a renovated heating, ventilation, and air conditioning (HVAC) system fitted with an electronic air filter, and acoustical wall treatment and carpeting. In addition, a set of "performance enhancement" features were incorporated in the design: interior (3 x 6 ft) windows adjacent to each office

door, an "indoor street" created by a glass-block wall lighted with fiber optics to create a sense of the outdoors behind the wall, plants, and an updated color scheme. These "beyond government norm" features accounted for less than 5% of the renovation budget.

Organization Development Intervention

Prior to the renovation, line management established an organization development process to be led by a human resources (HR) specialist. The HR representative conducted extensive interviews (one hour or more in length) with each PP&C staff member to assess their perceptions of the mezzanine organization. Following the interviews, the HR specialist facilitated meetings in which interview comments were discussed, roles and responsibilities were clarified, career development plans were outlined, and staff-management relationships were processed. The intervention effort has continued to the present date (a period of two years), with strong support from the participating staff.

Information System Intervention

Shortly after completion of the renovation, the new information system, known as the Laboratory Information Management System (LIMS), was introduced and replaced an outdated system. Prior to implementing LIMS, two different sections of the administrative staff were entering information into two incompatible software systems. This resulted in increased and redundant work, created friction between staff, and caused much lost productivity. The new LIMS system allows multiple users to access sample information and carries much more information about each sample than did its predecessor. Staff were trained in the use of LIMS and began to use it on a regular basis.

Data and Data Collection Procedures

Data were collected via questionnaires completed by mezzanine staff; archival records of productivity, absenteeism, and turnover; and focused group interviews. Development of the questionnaire was based upon a review of the literature on environmental interventions, a review of several instruments used by researchers in previous studies, discussions with PP&C management about the key issues, and from the goals of the renovation. The workplace characteristics, work process/ work environment fit, and overall satisfaction items were rated on a five-point Likert-type scale. The survey was pilot-tested and revised in response to comments.

The resulting questionnaire asked for ratings of satisfaction with the work environment in the mezzanine before and after the renovation, ratings of the validity of various statements about work processes before and after the renovation, and overall ratings of the work environment and its importance to the respondent. In addition, four open-ended questions asked for a discussion of work environment features that participants like most and those that should be changed.

The survey was administered to the 23 mezzanine area employees. Several members were absent at the time of the initial survey administration. These members completed the questionnaires individually and returned them to the research team anonymously through plant mail.

In addition to the questionnaire data, the research team also gathered archival, behaviorally based information from pre- and post-renovation time periods. These measures included 1) staff turnover, 2) absenteeism, 3) number of laboratory

tasks performed, 4) number of work procedures revised before and after renovation, 5) number of project files actively maintained by the mezzanine staff, and 6) number of data entries required for the information management system before and after the interventions.

RESULTS

Survey Results

The survey addressed both work environment characteristics, work process/work environment fit, and overall satisfaction. Pre- and post-renovation comparative results are based on the subset of 13 respondents present before and after the renovation. A total of 23 surveys was completed. It was found that shows that pre-ratings were consistently lower than post-ratings.

Paired t-tests were performed on the pre- and post-renovation ratings for each environmental characteristic and work process item. However, the use of multiple t-tests posed problems in interpretation of findings since, by chance, 5% of the t-tests would likely prove to be significant even if there were no true differences in perceptions. Consequently, an adjustment in the alpha value was used, based on a procedure described in Hays et al. (1988). The alpha value was recalculated using the formula

$$\text{adjusted alpha} = \text{alpha}/J$$

where alpha is the probability of a Type I error on a single t-test and J is the number of independent t-tests being conducted (J=41). The adjusted alpha level was thus calculated to be

$$\text{alpha (adj.)} = 0.05/41 = 0.0012.$$

Table 1 shows the results of performing the paired t-tests on the pre- and post-renovation environmental characteristics ratings. The 11 items shown with an asterisk indicate improvements that are significant at the adjusted alpha level. (Note that all but two of these items would show significantly higher ratings after renovation, based on an alpha of 0.05). The greatest increases from pre- to post-renovation were found for attractiveness of the work area (t =-25.74, p<0.001), meeting space (t =-20.04, p<0.001), interior design/decor (t = -16.08, p<0.001), and food preparation area (t = -8.83, p<0.001).

The pre- and post-renovation ratings of work process issues also showed a pattern of significant increases in post-renovation (see Table 2). All but two items showed a significant increase at the .05-level, with 7 of 17 items showing a significant increase at the .001-level. The greatest increases were found for "The layout encourages team cohesion" (t = -7.12, p<.001), "Reports can be readily assembled" (t = -6.40 p<.001), "The copying area is conveniently located" (t =-4.63, p <.001), and "The files are conveniently located" (t = -4.62, p<.001).

The survey also requested a rating of work environment importance, using a five-point Likert scale (with anchors of 1 = "not important at all" to 5 = "extremely important"). The 23 respondents indicated that the work environment was very important (M = 4.0, SD = 0.91). They were also asked to grade their current work environment on a 13-point scale (13=A+ to 1=F). The current work environment received an "A" (M = 11.62, SD = 1.04).

Overall, the survey results indicated that, compared with perceptions before the renovation, worker perceptions following the renovation showed an extremely consistent and statistically significant pattern of improvements regarding the work

environment, work process effectiveness, and satisfaction with various aspects of work.

Changes in Productivity and Staff Performance Due to Interventions

The following sections present indices of performance of the mezzanine staff before and after the interventions. Some indices may be used to infer gains in total staff productivity (e.g., reduced absenteeism and turnover); other indices simply indicate that the laboratory support staff took on expanded roles or increased the amount of time spent on certain activities. Taken together, these indices provide a picture of performance improvements at both the individual and group level in the mezzanine following the interventions.

Turnover

Between April 1991 and April 1992 (the year prior to the renovation), 10 out of 16 employees left the mezzanine area for other positions, for a 63% turnover rate. After the renovation, the size of the work group was increased to 24. From November 1992 to November 1993, only one employee was replaced (a 4% turnover), indicating a dramatic decrease in staff turnover following the renovation. In the following year, employee replacement remained at 4%.

Absenteeism

Human resource records were used to provide information about absenteeism in the mezzanine area. Prior to the renovation, the mean time lost from work due to illness was 95 hours per person per year (April 1991 through April 1992). After the renovation (November 1992 through November 1993), the average time lost due to illness dropped to 45 hours per person per year, a decrease of 47% from the previous year.

Number of Tasks Performed

Interviews with mezzanine management and staff revealed that the number of tasks being performed increased following the renovation. Before the renovation, the primary responsibilities of the staff were 1) entering data into data management systems, 2) preparing data reports, 3) filing and maintaining technical data materials, and 4) maintaining procedures. After the renovation, which included introduction of the LIMS information system, the following additional tasks were reported:
5) supporting management travel,
6) supporting information systems maintenance, 7) maintaining the library,
8) supporting the equipment center,
9) managing the job board (to provide help to technical staff in locating assistance for projects), and 10) maintaining procedures. The post-renovation activities not only reflected more than double the original number of tasks performed, but also (according to management and staff) represented a significant qualitative increase in scope of effort, releasing analytical chemistry laboratory technical and scientific staff from administrative tasks to allow them to focus on technical activities.

Number of Procedures

Laboratory technical staff use documented procedures to perform analytical processes in compliance with government guidelines on health and safety. These procedures are updated periodically to comply with federal and state regulations. Before the renovation, laboratory staff had primary responsibility for procedures maintenance and the mezzanine staff provided some support on an as-needed basis. After the renovation, procedure maintenance became a defined role for the administrative clerks. In the year prior to the renovation, 104 procedures were revised or updated by the mezzanine staff. In the year after the

Table 1. Item Difference Scores - Pre-Renovation Versus Post-Renovation Ratings

	Item Number	Difference Score	Student's t
1.	Position of your workstation	-1.62	-4.20*
2.	Arrangement of furniture	-0.83	-2.28
3.	Amount of work surface	-0.83	-2.00
4.	Quality of furniture	-0.69	-1.81
5.	Amount of storage	-1.33	-0.42
6.	Degree of privacy	-0.92	-2.30
7.	"Functionality"	-1.31	-3.42
8.	Opportunity to personalize	-0.69	-3.32
9.	The opportunity to socialize	-0.54	-2.01
10.	The food preparation area	-3.08	-8.83*
11.	Interior decor	-3.46	-16.08*
12.	Quality of air	-2.08	-7.22*
13.	Noise level	-1.69	-6.32*
14.	Temperature	-1.69	-7.14*
15.	Lighting	-1.85	-5.82*
16.	Meeting space	-3.62	-20.04*
17.	Ability to see others	-0.85	-2.86
18.	Others see you	-0.92	-2.52
19.	Interact with coworkers	-1.31	-4.57*
20.	Control over work station	-0.69	-1.90
21.	Distractions from work	-1.62	-4.03
22.	Space around work station	-1.62	-3.27
23.	Attractiveness of work area	-3.62	-25.74*
24.	The feeling of spaciousness	-1.92	-5.84*

*P<.0012

Table 2. Item Difference Scores - Pre-Renovation Versus Post-Renovation Ratings
Work Processes

	Item Number	Difference Score	Student's t
1.	Layout helps accomplish work	-1.31	-4.57*
2.	Restricted access to files/records	-0.92	-3.21
3.	Analysts know where to log samples	-1.33	-4.00
4.	Copiers conveniently located	-2.15	-4.63*
5.	Files conveniently located	-1.62	-4.62*
6.	Log-in book, documents accesible	-1.16	-3.63
7.	Reports readily assembled	-2.15	-6.40*
8.	Outsiders easily monitored	-1.54	-4.63*
9.	"Traffic" is a problem	-1.77	-4.15
10.	Layout encourages teamwork	-2.00	-5.10*
11.	Analysts stay in public area	-0.54	-2.50
12.	Layout encourages team cohesion	-2.62	-7.12*
13.	Design encourages interaction	-1.96	-3.38
14.	Enough variety in the work	-0.77	-2.38
15.	I am doing important work	-0.46	-2.14
16.	I feel valued for what I do	-0.62	-2.89
17.	I like my job	-0.34	-1.44

*P<.0012

renovation, 246 procedures were revised or updated--a 236% increase.

Maintenance of File Storage Cabinets

File cabinets in the mezzanine area contain all technical records for the analytical chemistry laboratory. These project files require regular maintenance and review to update the records. Prior to renovation, 19 five-drawer file cabinets were actively maintained and updated by the mezzanine staff. After renovation, the number of file cabinets maintained grew to 30, a 157% increase in file maintenance activity.

Number of Data Entries

One of the main functions of administrative clerks is to track the progress of the samples being analyzed in the laboratory using the LIMS. When samples are brought into the laboratory for analysis, sample data are entered into a database. This information is updated and expanded upon as the sample passes through various phases of the analysis process. Prior to the introduction of the LIMS, eight data entries were made for each sample. Upon activation of the LIMS, a total of 24 data entries were made for each sample, a 362% increase in entry requirements.

Organizational Culture

The research team met with the mezzanine staff and management to present the survey results. In this context, the employees were asked to discuss changes in the organizational culture that had accompanied the renovation, organization development, and LIMS implementation efforts. The resulting discussion reflected a strong consensus that a major cultural change had occurred. The culture prior to renovation was characterized by poor communications between staff members and with management, lack of teamwork, strong conflicts over "turf" issues, and an unwillingness to provide support for other staff members. Recruiting new staff members was virtually an impossible task for management and HR. According to mezzanine employees, new recruits often decided to leave within days of arriving for their first day's work.

The current culture (June 1994) was described as one in which status differences have virtually disappeared and everyone works together for the group goals, regardless of whether they have a high school education or a Ph.D. The employees feel valued and are able to voice their opinions freely. Management was seen as being willing to listen and as genuinely caring about the staff. Several employee comments directly expressed appreciation to management for their commitment to the improvements. Communications between staff members and between the staff and management were described as excellent. Several members commented on the fact that morale is much higher than before and that staff members are now willing to volunteer for various process improvement efforts being undertaken. Other members expressed their feeling that the group now feels ownership and responsibility for its tasks and is committed to high levels of performance. Staff were seen as working hard to complete their tasks and achieve group goals. Recruiting was described as much easier. One newer member mentioned hearing excellent reports of the mezzanine staff and the management

"through the grapevine" and had actively sought a transfer to the mezzanine.

DISCUSSION

This study examined the effects of integrating environmental, organizational, and information systems interventions. The

findings included a strong pattern of improvements in employee attitudes and productivity, coupled with reduced turnover and absenteeism. Perceptions about various aspects of the work environment shifted from being extremely negative to being highly positive after the interventions. The organizational culture changed from being one characterized by low morale, territoriality, and mistrust to one of cooperation, satisfaction, good communications, and motivation to perform well. Measures of absenteeism and turnover showed marked decreases following the renovation. Various measures of productivity all indicated improvements. After the renovation more tasks were performed, more data were entered on each sample, more file cabinets and procedures were maintained, and less time was needed to complete large data reports. Spinoff effects helped other organizational units as well. For example, the increased number of tasks assumed by the mezzanine administrative staff released analytical chemical laboratory staff to focus on more technical and analytical tasks. The increased ease of recruitment simplified the efforts and reduced the time commitments of both management and HR staff in finding new staff.

Several methodological issues need to be considered in the context of the present study. First, the population size was very small, with an N of only 13 employees present before and after the renovation. This resulted in low statistical power associated with the pre-renovation/post-renovation t-tests. The power of the t-tests assuming low, moderate, or large effect sizes ranged from roughly 0.10 to 0.45 (based on the computation procedure described in Hays et al., 1988). Even with a large effect size, the likelihood of detecting significant differences was less than 50%. Thus, obtaining significant findings (even if an effect was present) was unlikely. The fact that such consistently significant findings were obtained serves only to enhance appreciation for the changes that were detected. Clearly, however, it would be desirable to conduct follow-up research using larger samples.

A second potential area of concern arises from the focus group discussion of culture, since two managers were present. However, it was the view of the HR facilitator that the discussion represented honest perceptions of changes that had occurred. Finally, the study relies on a number of data types other than self-report: absenteeism and turnover data, productivity data, and job analytic data. These forms of data are not easily subject to biases, and in all cases, served to confirm and support the survey findings.

One area for improvement in the study would be to collect more comprehensive performance data. In this case, many aspects of performance were simply not amenable to quantification without extensive costs being incurred. Measures of customer satisfaction, response time, product quality, total cycle time, and other measures associated with a Total Quality Management paradigm would be very useful. In addition, it would be useful to track these data over multiple years.

Another area for improvement in this study would be to use a true pre-renovation/post-renovation data collection approach, including the use of a control group which would help eliminate alternative explanations for the results.

CONCLUSION

This study demonstrated the value of an integrated organizational intervention involving redesign of the physical environment, introduction of a new information system, work process

improvement, and extended organizational development intervention. The outcomes were extremely positive. Unlike many interventions reported in the literature, in which failure and disappointment are a common theme, workers and management were both delighted with the results. Further, the cost of the improvement efforts was found to be recaptured within a short time, easily justifying the expenditures.

One conclusion from the study is that integrated interventions are very powerful. Integrating improvement of the physical environment with organizational development and technological innovation greatly enhances the likelihood of achieving a successful intervention. The synergy that results from an integrated improvement approach may also, as in the present study, result in the recapture of intervention costs within a fairly short time. Given the high risk of failure associated with more limited, single-approach interventions, the use of an integrated intervention strategy that incorporates improvements to the physical environment simply makes good organizational and economic sense.

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BIOGRAPHICAL SKETCH

Dr. Janet Heubach, Senior Research Scientist, works in the Operational Effectiveness Research Group for the Pacific Northwest Laboratory, a research and development national laboratory operated for the Department of Energy. Dr. Heubach is currently the principal investigator of a multi-year Laboratory Work Environment Productivity Project. She has recently completed research on work environment and organizational effectiveness, developed human performance-based functional design criteria for office and laboratory settings, directed laboratory facility programming projects, and conducted post-occupancy evaluations.