

The following is an article as it appeared in “*Environmental Design and Construction*”. The magazine featured the article in the July/August 2000 issue.

Do Green Buildings Enhance the Well Being of Workers? Yes.

Or

Linking Worker Well Being to Green Buildings – The Evidence is In

Abstract: A recent study conducted on the workers at the new Herman Miller Greenhouse building in Holland, MI provides strong evidence that enhanced habitability is associated with increases in psychological and social well being.

By: Judi Heerwagen, Ph.D

Nowhere is the absence of sensory experience more vivid than in modern buildings that minimize contact with anything natural – whether it is air, daylight, views, green vegetation, materials, patterns, or color. Our modern workplaces are seas of bland cubicles that isolate rather than integrate people – not unlike the cages in the old style zoos. Fortunately, the old style cages are disappearing in favor of more naturalistic habitats in an effort to improve the psychological and behavioral well being of animals.

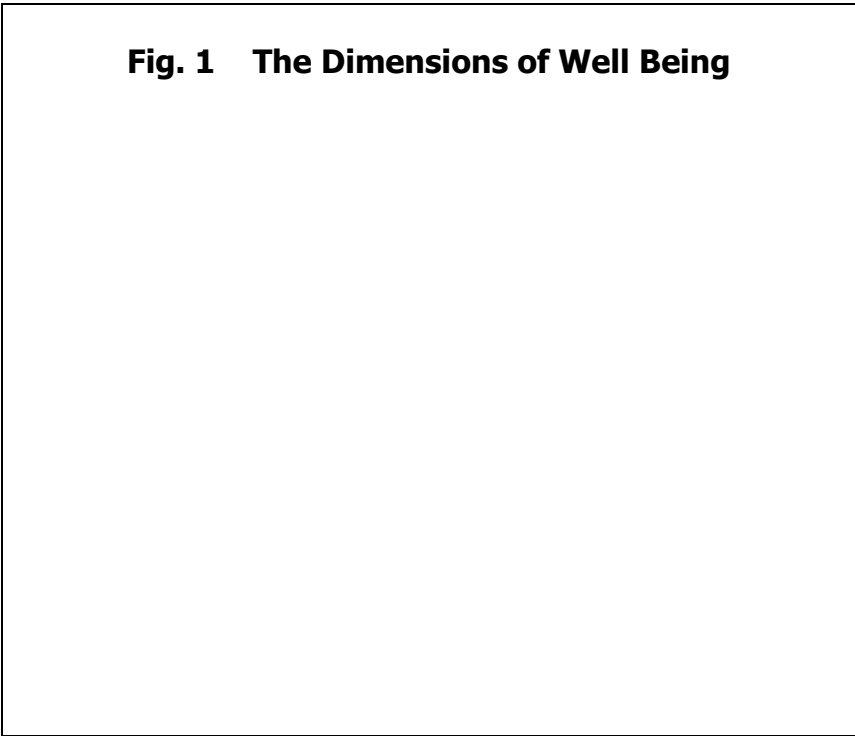
Is there a lesson for us here? Can we enhance human psychological and behavioral experience by revolutionizing building design? By increasing contact with natural processes and by incorporating nature into buildings? By reducing the use of hazardous materials and chemicals? By saying people matter? If we were to think this way, we would look at buildings as an employee benefit – not just as a way to house an organization.

At its core, green building philosophy aims to provide this transformation, and, in doing so, to enhance human well-being and performance in work settings. However, the evidence for these positive impacts is slim due, in part, to the lack of a compelling conceptual framework for measuring human outcomes and linking them to design features.

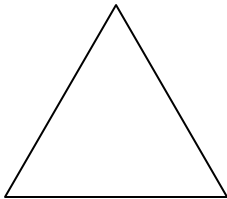
There is some evidence of reduced absenteeism and increased productivity in green buildings, but little understanding of the links between design features and human outcomes. Of particular interest to many is the potential impact of sustainable building design on worker productivity. However, there is little explanation of how productivity benefits might accrue, beyond reduced absenteeism associated with reduced illness (especially Sick Building syndrome and Building Related Illness). A more comprehensive view of health and well-being begins to suggest additional indicators that fall broadly under the topic of “human resource sustainability”¹. The Figure below illustrates this integrated view of well being.

¹ I borrow this wonderful term from a presentation by Bob Berkebile and Kath Williams at EnvironDesign3 in Baltimore, May, 1999.

Fig. 1 The Dimensions of Well Being



Neuro-Cognitive
Attention
Memory
Mental clarity
Flow



Psycho-Social
Communications
Emotional functioning
Belonging
Motivation
Satisfaction

Accidents
Sick Building Syndrome
Stress
Physical

Medical models of health integrate behavioral, social, psychological, and mental processes. So too should building models of health and well being. At the present time, however, much of the green building literature focuses on air quality and physical health, thereby ignoring the other dimensions that are equally important. Ironically, many of the prominent features of green buildings are likely to have their greatest impact on cognitive and psycho-social well being. For instance, contact with nature and sunlight penetration has been found to enhance emotional functioning. Positive emotions, in turn, are associated with creativity and cognitive “flow,” a state of high task engagement. Other green building features, such as indoor and outdoor relaxation areas with vegetation and views are likely to enhance social interactions and sense of belonging – both of which are associated with organizational attachment, a topic of enormous interest among organizations today.

Drawing on research from a variety of studies in the US and Europe, it is possible to more fully identify links between these well being outcomes and building features, as shown in Table 2. As can be seen, several design features affect more than one dimension of well being. Personal control over ambient conditions, temperatures, ventilation, materials selection affect both physical and neuro-cognitive well being, including performance outcomes. For instance, research by David Wyon has found consistent connections between temperatures, ventilation, air quality and performance on cognitive tasks requiring high levels of focus attention.² Each of the links shown in the Table has been identified in at least one field or laboratory study.³ However, most of these studies have been conducted in traditional buildings, and often in buildings with serious health problems associated with high levels of reported illness symptoms or discomforts.

Until recently, there was no evidence that proved green buildings led to the well being of its occupants.

Table 2. Links between Well Being and Building Features	
Health Dimension	Building Design Features
<i>Physical Well Being</i>	Interior cleaning/maintenance HVAC operation and maintenance Ventilation conditions Materials selection Temperature conditions Personal control of ambient conditions
<i>Psycho-social Well-Being</i>	Daylight Sunlight penetration Window views Contact with nature Social spaces Crowding Acoustical privacy Personal control of ambient conditions
	Temperature conditions Ventilation conditions Interior cleaning/maintenance

²D. Wyon, 1996. Indoor environmental effects on productivity. In Proceedings of IAQ '96, Paths to Better Building Environments, Oct. 6-8, Baltimore, MD.

³ J. Heerwagen, forthcoming, Green buildings, organizational success and occupant productivity. *Building Research and Information*, 28(4): 1-15.

<i>Neuro-cognitive Well-Being</i>	Materials selection Personal control of ambient conditions Light levels appropriate for task Lack of glare from ceiling lights/windows Window views Perceived visual distance Contact with nature
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Testing the Theory

The links between worker well being and building features of a green building were tested in a case study of the Miller SQA building in Holland, Michigan.⁴ Miller SQA, a wholly owned subsidiary of Herman Miller, Inc., remanufactures Herman Miller office furniture.

The overall goal of the study was to develop a conceptual framework and methodology for assessing the benefits of green buildings.⁵

Designed by William McDonough + Partners out of Charlottesville,VA, the 290,000 sq ft building houses a manufacturing plant and office/show room for Herman Miller, Inc., a manufacturer of office furniture. The building houses approximately 700 people (600 in the manufacturing plant across three shifts, and 100 in the office.) It contains fitness center with a full-length basketball court and exercise machines adjacent to windows that overlooking the countryside landscape. At the time of data collection, the building also had break areas at each end of the building and a centrally located cafeteria. Since then, the central cafeteria was replaced by smaller, more easily accessed cafes at each end of the building, with coffee bars and enclosed sitting areas.

Prior to its move into the new green facility in 1996, Miller SQA was housed in a smaller industrial type building several miles away. The old building was also divided into manufacturing and office areas. The building had ribbon windows lining the perimeter walls in both the manufacturing and office areas. The office areas in both the old and new building were air conditioned, but the manufacturing plant was not.

Key green building features in the new building included good energy efficiency, indoor air quality, and daylighting. The site included a restored wetlands and prairie landscape.

The Results: Productivity and Quality

Studies have shown that most organizations take weeks to months to regain lost efficiency associated with moving. In fact, using the Total Quality Metrics data that Herman Miller uses to evaluate its overall performance, in the nine month-period after

⁴ SQA stands for “Simple, Quick, Affordable” .

⁵ The research was conducted by the Battelle Pacific Northwest Laboratories with funding from the U.S. Department of Energy. Team members included J. Heerwagen, J. Wise, M. Ivanovich, and D. Lantrip.

their move, there was an overall increase in productivity of 0.22%. On time delivery also increased from 98.54% to 99.53% and product quality increased from 98.97% to 99.23%. The increases are small because there is relatively little room for improvement – an indicator of Herman Miller’s overall high level of near perfect operation. In addition, while the increase is small, it is possible that the pattern would change with a longer period of study. Nine months is probably an insufficient time-period to capture long-term productivity benefits.

Notably, however, there was no productivity “dip” with the move to the new facility. The move to the new facility took place over a weekend, with the work picking up immediately as if there had not been a move. This suggests that the space was very easy to adapt to and that the move was very efficient. In contrast, a pre and post occupancy study of the West Bend Mutual Insurance Company found a 32% drop in median productivity of the office workers.⁶ Although Herman Miller SQA and West Bend Mutual are two very different companies, the temporary dip experienced by West Bend is more typical of moves to new buildings.

Further, the new facility accommodated a growth in manufacturing plant staff. Again, it is notable that there was no “dip” in productivity despite new staff needing to acclimate. In the old building, the plant staff worked more overtime to complete the work.

The only Total Quality Metrics performance measure that showed a significant decrease in the year following the move to the new building was the decrease in performance bonuses for the workers. Funds that would normally go into worker bonuses were going instead to help pay for the new building. This was a temporary condition that was expected by the workers. However, given that bonus pay is a significant performance motivator, it is worth noting that work output remained high, despite the rather significant loss to workers’ total income. It would not have been surprising to see a dip in the organizational measures associated with reduced effort or motivation.

The Results: Worker Well Being

Prior to the move to the new building and again nine months after the building was occupied, workers were asked to complete extensive surveys. Data were gathered in the new building nine months after it was occupied in order to allow occupants to adjust to the space, thereby minimizing the potential impact of “newness” on outcome measures. The data were analyzed separately for office and manufacturing workers because of the difference in both their environments and their work. Initial plans to gather data on turnover and absenteeism were abandoned because turnover rates were so low, and absenteeism data had not been kept in a database that enabled easy analysis. (More detailed data are available in reports cited at the end of this article).

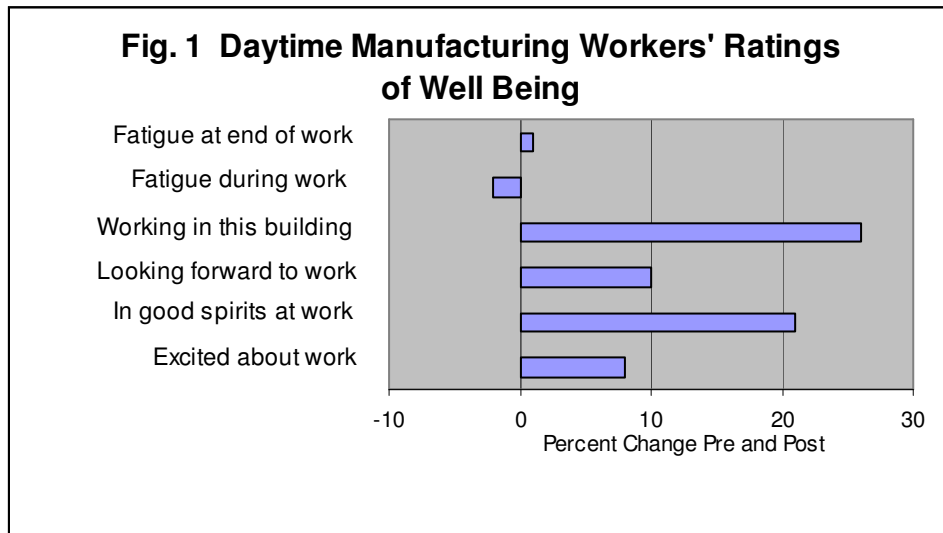
Well Being increased for daytime manufacturing workers

Three key indicators of motivation and emotional well being increased for daytime manufacturing workers in the new building. These workers indicated that in terms of

⁶ W. Kroner, J.A. Stark-Martin, and T. Willemain, 1992. Using Advanced Technology to Increase Productivity. Rensselaer Polytechnic Institute, Center for Architectural Research.

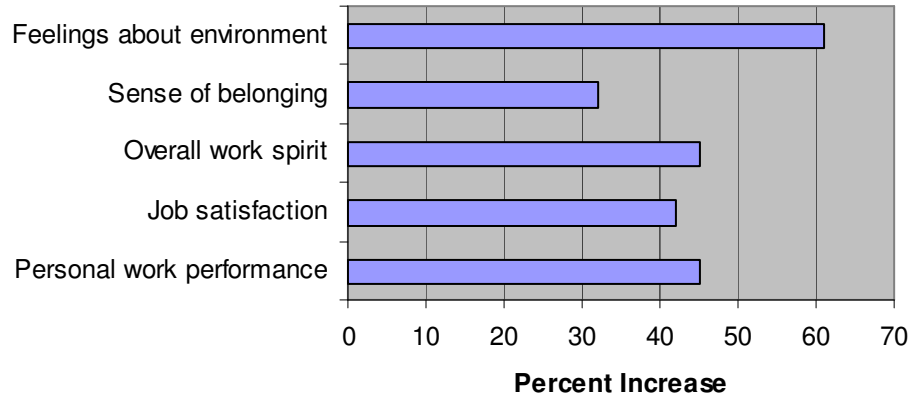
“looking forward to work,” being “in good spirits at work,” and being “excited about work,” overall, they were happier in the new building. Over 20% expressed an increased sense of being in good spirits while at work.

Fig. 1 compares the pre-post occupancy survey outcomes for the daytime manufacturing workers. As can be seen, there was a positive change on all measures, except fatigue at the end of the day, which showed a slight increase. Interestingly, however, fatigue *during* work showed a modest decrease.

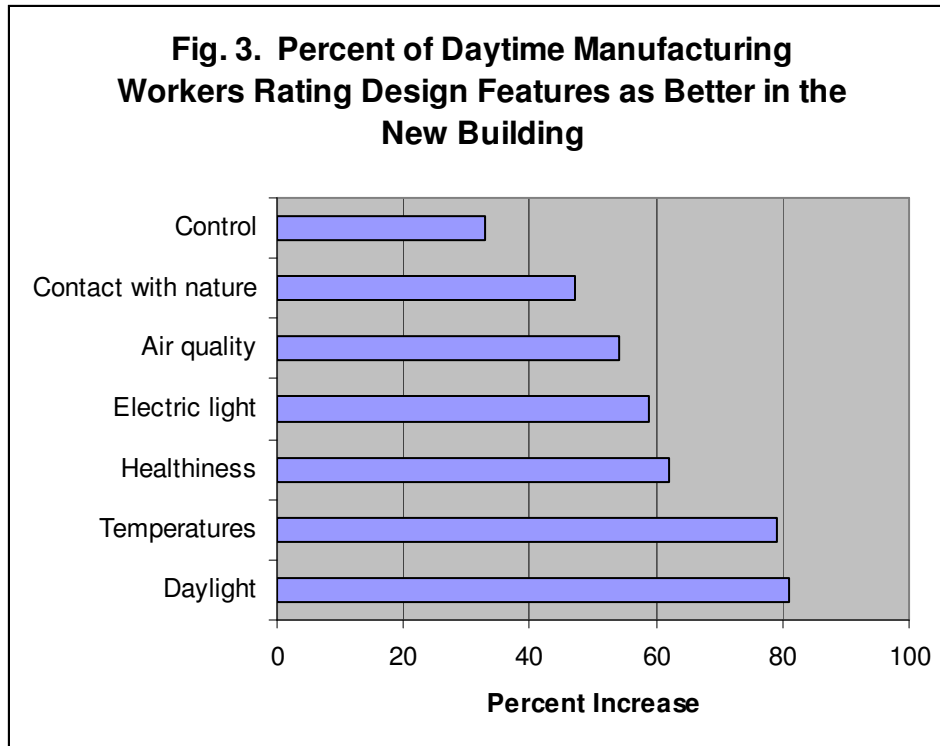


When asked to directly compare the old and new facilities on a number of well being outcomes, the daytime workers rated the new building as more positive for all measures. There was a 60% increase in worker’s “overall feeling about the environment” and over 30% said the new building was better for social well-being, as indicated by increases in ratings of sense of belonging and overall work spirit. Job satisfaction was also higher in the new building, as were self-ratings of work performance. (See Fig. 2.)

Fig. 2. Percent of Daytime Manufacturing Workers Rating the New Building as Better for Selected Well Being Measures



Direct comparisons of environmental features in the new and old buildings show a similar pattern, with daytime workers rating the new building as better across a range of features. The data in Fig. 3 shows the percentage of workers in each shift that rated the new building as better than the old one. A significant 80% of daytime workers rated temperatures and daylight as better in the new building and 60% perceived the new building as healthier. Over 40% rated contact with nature, electric light and air quality as better. Almost 30% also rated control over the environment as better – an important factor in psychological and physical comfort.



Interestingly, there were strong differences in perceptions and experiences across the three manufacturing shifts, with daytime workers, in general, more satisfied with the building than those in the second shift and night shift. The data presented here focused on the daytime workers only. An extensive discussion of the differences between the manufacturing shifts appears in *HPAC Magazine*, November, 1998.

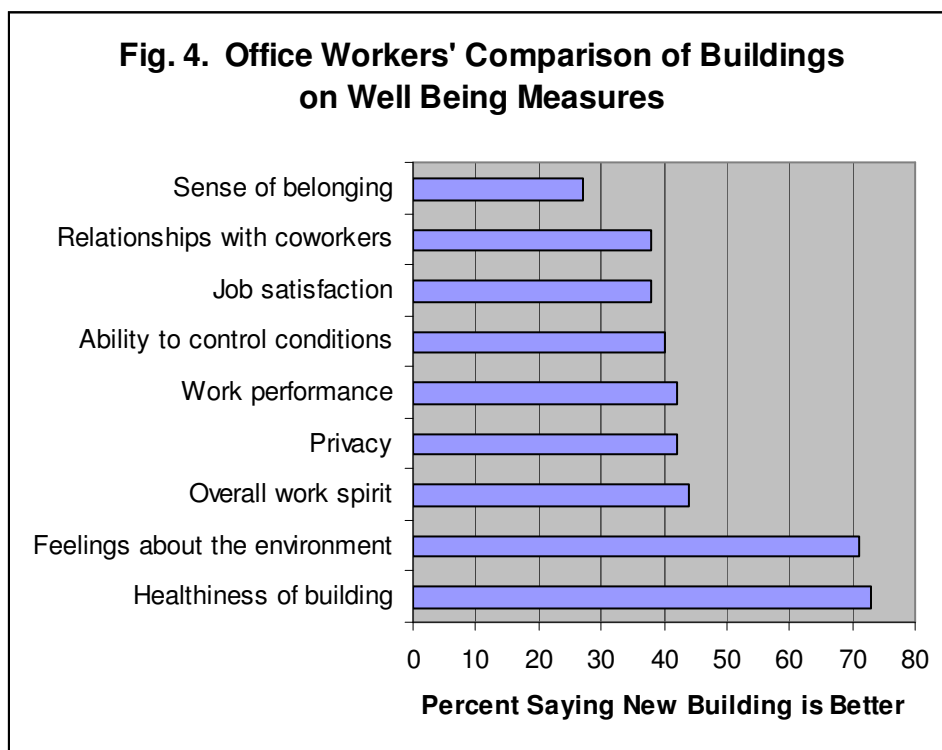
Office workers rated the new building more positively overall than the combined shifts of manufacturing workers. However, there were fewer differences in the well being measures for office workers pre and post occupancy. For instance, there were no differences on ratings of feeling excited about work, looking forward to work, and being in good spirits at work. There were, however, increases in ratings of fatigue, both during work and at the end of the day. This is likely to be due to an increased workload, as shown in the increased ratings of “feeling overworked” in the new building. In the old building, only 12% of the office workers said they often or always felt overworked, compared to 33% in the new building.

The fact that they felt overworked, but still had high ratings on the well being measures may indicate a buffering effect of the building environment. Although we cannot verify this conjecture, it is entirely consistent with research on the negative effects of feeling overworked. Work stress has been found to have a negative impact on motivation and emotional functioning, but that was not the case for the SQA office workers.⁷

⁷ See M. Frankenhauser, M. and G. Johansson, 1986. “Stress at Work: Psychobiological and Psychosocial Aspects”, *International Review of Applied Psychology*, 35: 287-299.

There was also a large increase in the percentage of office workers who said they looked forward to working in the building. In the old building, 45% said they looked forward to working in the building, while 70% responded this way for the new building – an increase of 25%.

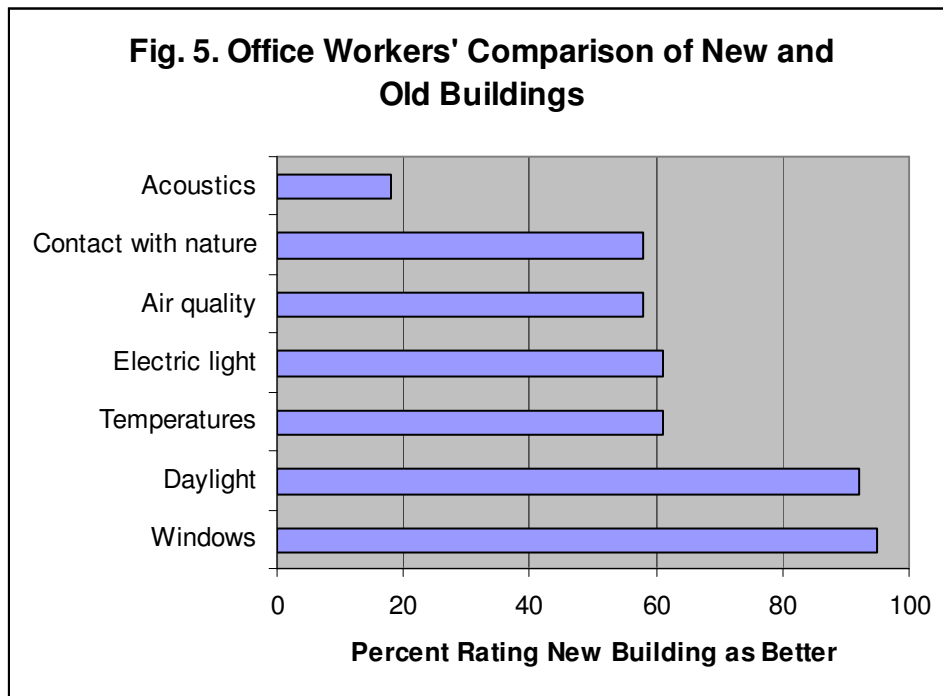
In direct comparisons of the old and new buildings, office workers perceived the new building more positively for a number of well-being outcomes. As shown in Fig. 4, the most positive ratings were for perceived healthiness of the building and overall feelings about the environment. Furthermore, 40% or more said the new building was better for their work performance, privacy, and overall work spirit. Workers also rated the social environment as better, with 37% saying the new building was better for relationships with coworkers and 28% saying the sense of belonging was better.



It is worth noting, however, that 40% or more of the workers said there was no difference between the buildings on these outcomes. Although we cannot say for certain why there is such a large percent that did not experience a difference between the two work settings, it is possible that the interior spatial variability may be a factor. Office workers do not have equal access to daylight, views (either internal or external), and other building amenities. Those in interior spaces with high cubicle partitions essentially work in windowless offices without daylight. And if they worked under the same conditions in the old building, it is hardly surprising that they would perceive the environment as unchanged. Unfortunately, we were not able to gather locational data due to the need to keep survey responses confidential. However, other work by the author for a California office building plotted survey responses on floor plans using a Geographical Information

System application. This technique clearly illustrated the spatial effects of environmental satisfaction. Those in the most interior partitioned spaces were the least satisfied with all design features. Similar results were found in a study of seven energy efficient buildings in the Pacific Northwest.⁸

As seen in Fig. 5, ratings of building design features shows that over 90% of the office workers said daylight and windows were better in the new SQA building, and more than 50% said air quality, contact with nature, electric light, and temperatures were also better. Only acoustics stands out as being more negative. This is largely due to the increased openness between the manufacturing plant and office area.



Summary and conclusions

To return to the issues raised at the beginning of this article, the real appeal of green buildings lies in their potential to create better building habitats, and to do so by incorporating design features that address health and well being in an integrated manner. How does the SQA building fare, overall, as a human habitat? Has it created a more pleasing, more supportive space?

The answer is yes – at least for the daytime workers. There is overwhelming evidence that office workers and daytime manufacturing workers perceived the new building as more positive across design features. The fact that workers in the 2nd and night shifts had

⁸ J. Heerwagen, R. Diamond, and J. Loveland, 1992. Post Occupancy Evaluation of Energy Edge Buildings, University of Washington, Center for Planning and Design.

less positive ratings across almost all dimensions lends further support to the human value of increased daylight, views, fresh air, and contact with nature.

Furthermore, there is strong evidence that the enhanced habitability is associated with increases in psychological and social well-being. The effects were particularly evident for the daytime manufacturing workers for whom the environment changed the most dramatically. The impact for the office workers was weaker, but, as noted above, this may have been due to an increased work load. Nonetheless, the fact that there was no *decrease* in psycho-social well being suggests that the building may have buffered the stress normally associated with increased work pressures. Furthermore, on measures less likely to be affected by increased workload (e.g., sense of belonging, overall work spirit), the outcomes were more positive.

The SQA building clearly lends credence to the “green building hypothesis.” The hypothesis states that green buildings are better for people because they generate higher quality, healthier, more habitable spaces than comparable standard practice buildings. However, one building cannot prove the hypothesis. It is merely one case study. The evaluation of green buildings should become more common until a convincing case can be made. To this end, the City of Seattle is implementing “human factors commissioning” of all its new and renovated municipal buildings that will be designed to meet or exceed the LEED™ Silver level. Other cities and organizations should join Seattle in establishing a comparative database from which all will benefit in the future.