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# A workplace design that reduces employee stress and increases employee productivity using environmentally responsible materials

Limor Gutnick

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A Workplace Design That Reduces Employee Stress and Increases Employee  
Productivity Using Environmentally Responsible Materials

By

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Thesis

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## Abstract

In today's competitive global environment, employee productivity is an essential element of a company's success. Employee productivity can be significantly hindered by high levels of stress experienced in the work environment. In addition, poor indoor air quality contributes to deterioration of employee health and well-being, which further reduces productivity.

The object of this study was to explore interior design techniques that may reduce employee stress and enhance productivity while using environmentally responsible materials and furnishings. The design paradigm was qualitative, and the research method used was a case study. Specifically, this was an action-research project consisting of a design proposal for an advertising firm in Michigan. The design solution includes elements that increase collaboration and enable teamwork among employees, combined with flexible and ergonomic furniture as a means to enhance productivity.

Environmentally responsible material and furnishings were selected to protect the health and well-being of both employees and global ecosystems.

The study discusses limitations as to the wider applicability of the approach described herein and proposes recommendations for future works in this area.

## TABLE OF CONTENTS

Acknowledgements.....	ii
Abstract.....	iii
List of Figures.....	vi
CHAPTER ONE.....	1
Introduction.....	1
Stress in the Work Environment.....	1
Employee Stress Drivers.....	1
Workplaces Today.....	2
Research Problem.....	3
Contribution to the Discipline.....	3
CHAPTER TWO.....	4
Literature Review.....	4
Productivity in the Work Environment.....	4
Stress in the Work Environment.....	6
Indoor Air Quality in the Work Environment as it Relates to Employee Stress and Productivity.....	6
The Evolution of the Awareness of Employee Productivity and Stress with Relation to Office Design.....	8
Evolution of the Awareness of the Importance of Environmentally Responsible Design.....	11
Conceptual Framework and Current Perspective.....	13
Environmentally Responsible Design Solutions.....	27
Future Projections.....	36
CHAPTER THREE.....	41
Research Design.....	41
Overview.....	41
Research Problem.....	41
Data collection and Analysis.....	42
Limitations.....	42
Scope of Work.....	43

CHAPTER FOUR.....	44
Design Discussion.....	44
Evaluation of existing building.....	44
Design Plan.....	46
Design Techniques.....	54
Proposed Environmentally Responsible Materials.....	66
CHAPTER FIVE .....	86
Summary, Recommendations, and Conclusions.....	86
Summary.....	86
Limitations of Study .....	88
Recommendations for Future Work.....	89
Conclusions.....	90
REFERENCE LIST .....	91
APPENDIX A: FINLITE SERIES 7 CUT SHEET .....	99
APPENDIX B: FINLITE SERIES 9 CUT SHEET .....	100
APPENDIX C: LUTRON RECESSED COMPACT FLUORESCENT DOWNLIGHTS CUT SHEET .....	101

## LIST OF FIGURES

Figure 1.	Figure 1: BI- Existing floor furniture plan.....	49
Figure 2.	BI- Reflected ceilings plan .....	50
Figure 3:	Proposed conceptual demolition plan.....	51
Figure 4:	Proposed conceptual new floor plan.....	52
Figure 5:	Proposed furniture floor plan.....	53
Figure 6:	Resolve System by Herman Miller.....	55
Figure 7.	Resolve System by Herman Miller; account mangers workstations.....	55
Figure 8.	Resolve System by Herman Miller; account team member workstations.....	56
Figure 9.	Resolve System by Herman Miller; administrative staff workstations.....	56
Figure 10.	Perspective view looking toward workstations in the open space.....	57
Figure 11.	Elective Element 6 by Steelcase.....	58
Figure 12.	The Think Chair by Steelcase.....	59
Figure 13.	Meditation room perspective view.....	63
Figure 14.	Exercise room perspective view.....	63
Figure 15:	Proposed Reflected Ceiling Plan.....	67
Figure 16:	Proposed furniture schedule.....	73
Figure 17.	Proposed furniture board A.....	74

Figure 18.	Proposed furniture board B.....	75
Figure 19.	Proposed finishes schedule.....	78
Figure 20.	Proposed finishes plan .....	79
Figure 21.	Finishes board A.....	80
Figure 22.	Finishes board B.....	81
Figure 23:	Finishes board C.....	82
Figure 24.	Finishes board D.....	83
Figure 25:	Rendered finishes plan.....	84



## CHAPTER ONE Introduction

### *Stress in the Work Environment*

“Today’s business environment in America is highly competitive, global, technologically enhanced, and rapidly changing” (Marilyn, 2001, p.1). To deal with these trends, businesses have been changing their internal operations and focusing on essentials such as teamwork, collaboration, sharing of resources, flexibility, modularity, expanded functionality, and productivity. In addition, there is a growing understanding among major global businesses that one of the key components for competitive advantage is the human capital assets – the employees and the intellectual value they bring to the table. This is leading employers to continually seek new and creative ways to maximize their employees’ productivity and provide the most effective work environment (Marilyn, 2001). Companies have come to realize the importance of comfort in the workplace environment in order to retain quality personnel, increase productivity, and maintain a competitive edge (Luparello, 2004).

With the increased focus on employee productivity, there is a corresponding increase in employee stress. The enhanced pressure to be productive, and the associated stress many employees are experiencing, is proving to be a major source of risk for many businesses. The National Safety Council found that on an average workday, one million employees will be absent from work due to job stress. The estimated annual cost to the employers is \$200 billion a year, which includes medical costs, worker’s compensation, and productivity losses (Caudron, 1998).

### *Employee Stress Drivers*

On an individual level, most people experience some degree of stress in their daily lives and in their workplaces (Ernesto, 1997). Excessive work-related stress can damage the physical and emotional well-being of the employee (Allie, 1996). Given the aforementioned changes undertaken by most major organizations, employees are suffering from the increasing complexity of the workplace, the rapidly changing work environments, the increased information and responsibility load, the increases in intrusions on employee privacy, and the pressure to be productive, which is especially stressful considering the global competition that reduces job security. Consequently, employers are faced with increased absenteeism and productivity losses (Aldred, 2001).

To deal with this growing problem of work-related stress, employers must identify the specific sources of stress and take clear measures to address them (Allie, 1996). One of the major areas to address is the office workspace design. Vangen (1999) notes that the design of the workplace may be a significant driver in reducing employee stress. Consequently, by addressing such issues as poor acoustics, poor lighting, and poor indoor air quality, employers can go a long way towards reducing workplace stress.

### *Workplaces Today*

According to a study by Hixon (n.d), a Cincinnati -based a workspace design and architecture firm, managers today are not satisfied with their workplace facilities. Furthermore, many managers have indicated that much or some of the workspace inhibits, rather than promotes, teamwork and flexibility, which are key factors in productivity (Laabs, 2000). Karen (2004, p. 52) adds: “Companies this year will look toward designs that will provide, open, technologically advanced, flexible, comfortable,

and secure spaces—all the necessary components to attract and retain high caliber employees and maximize productivity.”

To address stress reduction issues, there are numerous, well-studied strategies that employers can apply, including anti-stress seating zones (Welch, 1996), ergonomic furniture, physical fitness centers (DiNubile & Sherman, 1999), appropriate colors (Luparello 2004), natural lighting, materials, and finishes (Karen, 2004), and individual workstation control of the lighting level and the thermal comfort (Knisley, 2005). However, it is important to note that this area of study is still in its relative infancy, and there is much research to be done on the subject (Beehr, 1998).

#### *Research Problem*

The objective of this conceptual design will be to build on the earlier research to design the interior space of an advertising agency in the Midwestern US. This company operates in a stressful environment, and the employees work under extreme deadlines. The purpose of this study, therefore, will be to explore the design elements that will best contribute to employee stress reduction, and subsequent enhanced productivity, using environmentally responsible materials as part of the solution.

#### *Contribution to the Discipline*

This study is intended to help both employers and employees learn about and understand the relationship between workplace design and employee stress and productivity. The study will provide both sides with tools to reduce employee stress and will identify the importance of using environmentally responsible materials. In addition, this study is intended to inform both non-residential designers and architects who seek to address their clients’ needs for stress-reducing designs and productivity enhancers.

## CHAPTER TWO

### Literature Review

#### *Productivity in the Work Environment*

U.S. industries lose nearly \$300 billion a year—or \$7,500 per worker—in employee absenteeism, diminished productivity, employee turnover, and direct medical, legal, and insurance fees related to workplace stress, according to the American Institute of Stress (Stambor, 2006). According to the architecture and design firm's Gensler 2006 U.S. Workplace Survey, “Office design has a direct correlation with optimal job performance, not to mention a company’s competitive advantage. Businesses that ignore the design and layout of their workplaces are failing to optimize the full value of their human capital” (Beautyman, 2006).

Good workplace design can make a big difference in staff satisfaction, attraction, motivation, and retention. It can also affect the level of knowledge and skills of workers, how innovative and creating they are, and how they respond to business and technological change. Poor workplace design, by contrast, is linked to lower business performance and higher level of stress experienced by employees (Amble, 2005).

This trend among employers has led to a growing recognition of the importance of designing a work environment that meets the physical and emotional needs of workers, so that they may be most productive (Proper, 1998). Proper (1998) emphasizes that an effective work environment should provide positive sensory stimulation through the proper use of color, lighting, aroma, space, and furnishings. These elements are seen as critical to effective work activities and workplaces, and they lead to increased productivity of employees.

A fundamental element in increasing productivity is the physical work environment. According to a report by the Rocky Mountain Institute in Boulder (Training, 1997), employees could do a much better job if employers paid attention to the work environment. This question is posed in the article: “You have held contests, you offered bonuses, and you have given out t-shirts to employees who meet their productivity goals. Still, productivity could be better. What else can you do? How about changing the office or plant’s lighting? Most people are working under the glare of florescent lighting without even noticing it. How about the heating and cooling systems? Are employees as comfortable as they might be?” (Training, 1997, p. 15). However, these are only some of the considerations that must be taken into an account when examining the work environment for maximum productivity.

In addition, a study conducted by the Commission for Architecture & the Built Environment and the British Council for Offices found that even simple things such as good lighting and adequate daylight can reduce absenteeism by 15 per cent and increase productivity by between 2.8 per cent and 20 per cent (Amble, 2005).

Fischer (2000) notes that the effect of the workplace on individual productivity, team productivity, job satisfaction, and, therefore, the bottom line of the company, are significant. To many, work space design may seem trivial, but environmental factors can greatly affect an employee’s performance. Since most of the employees in corporate America spend their days doing brain-intensive work, work spaces must reflect the employees’ need for an environment that enhances productivity (Laabs, 2000).

### *Stress in the Work Environment*

There has been an increasing focus on employee productivity, which has led to a corresponding increase in employee stress. Miles (2000) notes that employee stress in the workplace manifests itself in poor physical and mental health and is associated with organizational symptoms such as low productivity, low job satisfaction, absenteeism, and high employee turn-over.

According to research conducted by Integra Reality Resources, New York, and Opinion Research Corp. International of Princeton, New Jersey, 23% of today's workforce has actually been driven to tears as a result of workplace anxiety. One of eight workers (12%) has called in sick because of workplace stress, and one of five American workers (19%) has left a company in the past because of stress (Gilhooley, 2002).

### *Indoor Air Quality in the Work Environment as it Relates to Employee Stress and Productivity*

A substantial portion of the US population suffers from communicable respiratory illness, allergy, asthma symptoms, and symptoms of sick building syndrome. There is evidence that changes in the building design, operation, and maintenance can significantly reduce these illnesses. A decrease in these health problems would lead to lower health costs: a reduction in sick leave, and shorter periods of illness, which might increase work productivity. These benefits can be economically translated into billions of dollars (Fisk, 2000). RSMMeans (2002) adds that environmentally responsible (i.e., green or sustainable) building design is increasingly recognized as the answer to these health, economic, and environmental challenges. Environmentally responsible (ER) design not only uses energy-efficient recyclable materials and products, but also creates a

healthier and more comfortable indoor environment. The benefits have been demonstrated: higher property values, higher productivity among the building users, and an enhanced ability to attract and retain employees.

RSMMeans (2002) emphasizes that there are several major factors that can enhance productivity and health while reducing absenteeism and stress. Some of these factors include higher quality lighting, positioning fixtures to avoid glare and reflection, higher levels of daylight, increased individual control of the workplace in matters of heating and cooling, improved acoustics, improved air quality, and views of nature.

An ER building can go a long way toward safeguarding the environment and improving productivity. Verifone, a subdivision of Hewlett Packard, invested in an ER building in 1992. In addition to replacing the heating, cooling, and ventilation systems, Verifone used environmentally responsible materials, such as office furniture that was made without endangered woods or glues that emits formaldehyde or other toxic gases. In addition, minimally toxic carpeting that had not been treated with an excessive amount of pesticide and fungicides was selected (which would be unacceptable today, but was the best available in 1992). Natural light, a key component, was provided by skylights, clerestories, and an atrium with four live trees. Larger cubicles and a ceiling that hovered more than 17 feet above the workspace created an open, airy atmosphere. As a result, during the year following the completion of the building, absences from work fell from an average 14.5 hours per employee to 7.5 hours, and finally settled at 9.6 hours by 1994. In a survey conducted by Verifone of 135 employees, their most common response was that they enjoyed being in the new facility and that they felt much more energetic (Reese, 2000).

Today's design community is moving toward using more environmentally friendly components as part of the office design. The focus is to create healthier conditions for the employees and the global ecosystems through the use of environmentally responsible materials and finishes that do not contribute to poor indoor air quality or negatively affect occupant health (Luparello, 2004).

*The Evolution of the Awareness of Employee Productivity and Stress with Relation to Office Design*

At the end of the 19th century, workers were treated as if they were machines. The office model was a business that manufactured a product. Offices were planned for hundreds of unskilled clerks, each performing specialized and highly routine tasks. Their desks were aligned in a grid structure on open office floors and were seen as a model for efficiency and control (Asirvatham, 1999). Later on, the concept of office organization developed; filing systems were introduced, the presence of office machinery increased, and women entered the workforce. At this time, employers started to look for ways to humanize the workplace to increase employee satisfaction and morale, which in turn was viewed as important for increasing their productivity (Klein, 1982).

Creating an inviting workspace was one of the ideas behind the design of the Larkin Building in Ohio in 1906, designed by Frank Lloyd Wright. The building had amenities such as air conditioning, an employee library, a music lounge, and a fitness center. Today these amenities are widely recognized as mechanisms that reduce employee stress and increase both morale and productivity (Cole, 2001). However, at the time, they were quite revolutionary.



Office management became a science in the second decade of the twentieth century, and the National Association of Office Managers was formed under the direction of Fredrick Taylor (Klein, 1982). As a result, office managers acquired an awareness of both cost efficiency and time-saving devices in terms of design and materials. Office machines were placed where their noises would be least distracting; central file rooms were situated where they would be easily accessible. Office managers also measured cost efficiency by calculating costs such as the time it would take to sharpen a pencil or dictate and type a letter. They could then compare productivity to the hourly wage (Klein, 1982).

Klein (1982) notes that in 1925, Leffingweel suggested that desk and chair designs needed to integrate concepts of human physiology and psychology. He suggested that the desk, for example, should be simple and light. The surface should not be too polished so as to prevent glare, yet it should not be too dark either, since the contrast of white paper on a dark table could cause fatigue, a factor that could lead to increased stress levels and reduce productivity.

When Frank Lloyd Wright designed the S. C. Johnson & Son company building in Racine, Wisconsin, in 1936, he was thinking about the employees (Pelegri-Genel, 1996). Everything in the building was designed for the comfort of the user. For example, the desk had three different heights for ergonomic reasons.

After World War II, office interiors were generally standardized and systemized according to employee status in the corporation. Top executives generally used top floors, and office sizes reflected rank—larger offices, windows, and chairs—style became

status symbols. In this environment, there was little emphasis on the individual and his/her feelings or physical requirements (Klein, 1982).

Only later did the mood and morale of employees become factors again, and the influence of these factors on productivity was noted. For example, in the 1960s it was discovered that well-designed lighting had the effect of putting employees into a good mood, which in turn increased their productivity (Pelegri-Genel, 1996).

According to Klein (1982), by 1960 the status of the white-collar worker rose, along with increased office automation and improvements in office design. In the 1960s Robert Propst, then with the Herman Miller Furniture Company, developed a new concept of furniture design that underscored the relevance of individual motivation and work expression. Rather than merely designing open work areas, Propst tried to balance the ability to achieve privacy and control acoustics, while creating open access between managers and employees. Many companies applied these philosophies, combining both an open space and a friendly network of spaces that allowed communication between the employees (Klein, 1982).

In the 1970s, the cubical structure was established with the intention of improving communication among employees and thereby increasing productivity. In many cases the cubicle had the opposite effect, when employees became more concerned about their privacy (Bencivenga, 1998).

In 1982, the architect Michael Brill completed a study of the Office Environment on Productivity and Quality of Working Life (a BOSTI Study). He discovered that among office workers, there was a strong desire to be with others – that led further credence to the idea that satisfaction with the working environment has a direct

relationship with job performance. Performance in this case was measured by several factors: the quantity and quality of the work, meeting deadlines, taking responsibility, creativity, getting along with others, and dependability (Klein, 1982).

More research has been done since then to examine what influences employees' morale and stress levels. For example, in 1988, Kaplan and Talbot found that access to nearby nature sites was associated with lower levels of perceived job stress, as well as higher levels of job satisfaction. This was particularly true for employees who had a direct view of natural elements such as trees and flowers (Leather & Di Beals, 1998).

Important research on workplace stress in the 1990s was conducted by Northwestern National Life Insurance Co. of Minneapolis. This nationwide study found that one in three workers considered quitting because of stress (Ward, 1995).

#### *Evolution of the Awareness of the Importance of Environmentally Responsible Design*

Design for the environment strategies are often considered an innovation of the 21st century. But its history reaches back to pre-industrial building types such as tents, igloos, and icehouses, which control their interior climates through simple means and respond to a specific climate and site. Only with the industrial age did buildings become isolated from their environment, using mechanical and electrical means to control ventilation, temperature, and lighting, and relying on manmade building materials – decisions that were not always best for the environment (Nyren, 2003).

Simpson (2003) reports that much has happened since the first Earth Day took place in 1970. Our awareness and knowledge about environmental issues have increased dramatically. As Steele (1997) describes it, in the 1970s Congress enacted a remarkable series of new laws—including the Clean Air Act, the Clean Water Act, and the

Endangered Species Act—that established regulatory safeguards and enabled environmentalists to use the courts, the bargaining table, and even the marketplace to clean up air and water, protect wilderness and wildlife, and improve the safety of the food and water (Natural Resources Defense Council, n.d). Steele (1997) elaborated that the basic environmental issues were first raised as part of the Earth Day in June of 1970. These included resource degradation; population growth; agricultural limits leading to global food shortages; pollution of air and water; and the disastrous potential climatic effect of the concentration of greenhouse and ozone-depleting gases in the atmosphere. Since that day, the concept of environmental responsibility in order to protect the well-being of both people and the planet on which they live, work, and play has gained momentum.

In 1977 the Commission on International Development was established by Robert MacNamara. In 1980 the Committee published the report “North-South: A Program for Survival.” The report contained recommendations for changes in the operational procedures and policies of the International Monetary Fund and the World Bank. At the same time, the Brandt Commission, focusing on the oil-producing countries, was established. The Commission managed to initiate an awareness of the need for “global negotiations” to be carried out in the United Nations. Through emphasis on trade, finance, and the development of the Third World, the Commission managed to increase the focus on the search for rapprochement between economics and ecology (Steele, 1997).

The World Commission on Environment and Development, which was established by the United Nations, published the “One Common Future” report, also

known as the Brundtland report, in 1987. The report dealt with the concept of sustainability, which the Commission defined as managing natural resources in such a way that the quality of life of future generations is ensured. Sustainable development involved “those paths of social economic and political progress that meet the needs of the present without compromising the ability of future generations to meet their own needs” (Steele, 1997, p. 5).

According to Steele (1997), the concept of sustainability was further emphasized and explored at the Earth Summit held in Serrado Mar, Brazil, in 1992, which produced Agenda 21 document. The Agenda discussed the quality of life on Earth, efficient use of the Earth’s materials, the management of human settlements, chemicals, the management of waste, and sustainable economic growth. As a result of the publicity regarding Agenda 21, the International Institute of Architects issued an addendum that encouraged, among other things, a reduction of construction processes that damage the environments in favor of those that restore it, use of recycled materials, and a return to well- established methods of design that conserve energy and natural resources. In addition, the Agenda 21 report established the three E's of "sustainable development": Environment, Economy and Equity referring to the UN blueprint for environmental regulations, economic controls, and social equity. Sustainable development is a process of bringing these three development processes into balance with each other. Most important, the Agenda 21 report managed to establish firmly the term “sustainability” in relation to ecology in the public consciousness. As Putten (1997) emphasizes, global and local citizen activists are applying the principles of sustainable development to solving their local problems. In areas like transportation, energy efficiency, and waste reduction, enormous if uneven

progress is being made towards a better integration of environmental protection and economic growth.

### *Conceptual Framework and Current Perspective*

#### *Design components that increase employees' productivity and decrease their stress*

According to Asirvatham (1999), the work environment model of the 1960s still exists today, although there is much more emphasis on the connection between productivity and the work environment. Today, the key is to integrate the physical environment with technology, management practices, and work practices. In many of today's businesses, the focus is on trying to be creative and innovative rather than on demanding standardized results. On the other hand, Allie (1996) argues that today's employees are especially vulnerable to workplace stress. There is more automation, fewer staff, heavier workloads, and tighter deadlines. Given these stress-inducing factors, it is imperative to create a healthy office environment and eliminate the inherent sources of the problem.

The following factors will reveal the way in which the physical, technological, and logical systems work together to promote work process and increase employee productivity while decreasing their stress:

*Open space and productivity.* Nowadays, there is a blurring of the hierarchy in the organization, and people are working in a more collaborative environment. Evidence abounds that a more open environment can facilitate team members' contributions to productivity. Work spaces are designed to increase informal interaction, not just to save cost and space (Wah, 1998).

One of the ways to enhance an open environment and increase interaction between employees is by using the cubicle, which was introduced in the 1970s. However, one problem with using a cubicle is that employees may feel some level of stress due to lack of privacy (Bencivenga, 1998). Wallace (2001) indicated that the cubicle will not disappear and that employers, together with designers, are increasingly looking for ways to use the cubicle concept to increase productivity.

Open and flexible spaces are key concepts according to Asirvatham (1999). Asirvatham also adds that openness has at least two advantages: it allows management to oversee their employees, and it allows for encounters in public spaces. Managers who previously might have discouraged water cooler chats find themselves encouraging such casual interactions, because they recognize the built-in opportunities in such encounters for quick and easy problem-solving. At the same time, the need for occasional privacy can be accommodated in a variety of ways: separate telephone rooms, conference rooms, and glass walls that can be shaded if necessary (Asirvatham, 1999).

*Teamwork.* The competitive pressures on today's business are tremendous, and employees can no longer just work together; they must think together (Monroe, 1999). Since teamwork has become a major component in today's work environment, creating a workspace that will support it is very important. Monroe (1999) emphasizes that a physical environment that fosters interaction, whether in formal conference areas or in casual "collisions" in corridors or break areas, is important for communication.

According to Hower (1995), an employee's comfort level corresponds to the amount of space that surrounds him or her. Excessively large spaces can often be disorienting and can make the employee feel vulnerable. It is therefore important to have

a variety of spaces that take into account the individuals' work styles and personalities and offer possibilities for promoting individual and group interaction.

Asirvatham (1999) and Umlauf-Garneau (2001) describe the future office as a place with few fixed wall systems, a great deal of furniture on wheels, more laptops, and a generously distributed array of electronics and telephone outlets. It is not just the open environment that is important, but also giving employees recreational areas to talk about projects and learn more from each other. This feature may enhance learning and support team concepts that enhance employees' productivity (Arend, 2000).

*Ergonomics.* A recent survey of 350 major corporations, both professional services and small businesses, found that 82.5% believe that good ergonomics makes employees more productive (Danner, 2001). Miles (2000) adds that ergonomics is becoming a very important issue in the work place. Ergonomics involves adapting jobs and workspaces to the worker. By applying ergonomic principles, the employer can reduce medical costs, decrease absenteeism, and positively affect the employees, both physically and psychologically. Ergonomics reduces strains such as physical discomfort, fatigue, and tension. As a result, employees' stress can be reduced.

Promoting good posture, for example, can play an important role in reducing worker fatigue and improving productivity. Poor posture, stress on the muscles, unnatural setting of hands and arms, static loading of the neck, and pressure on the upper back and lower body all contribute to pain and illness. These symptoms not only reduce productivity, but they increase medical costs and absenteeism (Shihadeh-Gomaa, 1998).

According to the Kensington Stress Survey, 60% of American workers experience musculoskeletal pain on a regular basis. Experts say that this happens because the



employees are not getting the support they need from their office environment. Factors such as poor lighting, repetitive movement, stiff chairs, and inflexible workstations contribute to the strain (Parrish, 1999). Miles (2000) adds that ergonomic designs that include such things as adjustable chairs, wall color, and work area design have shown positive effects on stress reduction. For example, the city of Portland, Oregon, studied the issue and installed new adjustable furniture. As a result, 85% of the employees reported an increase in their comfort levels, 64% reported decreased fatigue, 72% reported an improvement in their ability to focus on work, and 66% reported a reduction in pain associated with their work (Shihadeh-Gomaa, 1998).

Karen (2004) concluded that ergonomic chairs continue to be in demand due to reduction in employees stress and injury, as well as enhanced comfort and good posture, which can significantly impact a company's productivity.

*Lighting.* According to Frank (2000), lighting is a critical element in creating a comfortable work environment. Depending on the situation, the lighting around individuals and groups can either help or hinder productivity. Frank adds that employees are more comfortable working in lower light levels. In instances where companies do lower lighting levels, experts recommend providing employees with individual task lighting with adjustable controls for greater comfort and flexibility.

According to the Steelcase Workplace Index survey (released Dec. 1, 1999), 56% of the office workers responding said that poor lighting in the workplace caused them tired or watery eyes, while another 30% said it caused headaches. Furthermore, improved lighting in the workplace could reduce eyestrain and headaches for 86% for

those surveyed. According to the survey, improved lighting would increase efficiency and productivity for three out of four office workers (“Poor Lighting Dims,” 1999).

Hower (1995) emphasized that light influences the endocrine system, the cardiac rhythm, Seasonal Affective Disorder and the “body clock,” and regulates fatigue and stress. He determined that it is important to pay attention to the quantity as well as the quality of the illumination in the workplace:

- Lighting level: high levels of light enhance the employee’s attention. Lower levels of light can enhance memory and focus and are thus more suitable for tasks that require concentration and decision-making.
- Source of daylight: daylight from windows, atriums, or ceilings brings natural light indoors and provides improved comfort levels. Welch (1996) noted that sunlight-deprivation syndrome, caused by lack of adequate natural light, is becoming recognized as a form of depression among employees.
- Placement of lights: workers tend to perform best in well-lit areas. Yet it is important to have a balance of direct, task-oriented light, and indirect light. The key is providing light that appears natural and is consistent with the workspace.
- Surface reflection: interior colors and work surfaces should be chosen to minimize the incidence of reflective light from VDT screen glare and other surface reflections.

In addition, there are problems with indirect glare - VDT screen reflections and surface reflections can cause visual problems and increase the risk of stress and fatigue. Barton (1998) adds that in the modern working environment, electric lighting is essential, but that significant exposure to electrical lighting can be a cause for stress. Indirect, softer

lighting sources avoid glare and create an environment of comfort in the workplace, which in turn can increase employees' possessive tense task performance (Luparello, 2004).

Indirect, softer lighting sources create an environment of comfort in the workplace, which in tune can increase employees' task performance (Luparello, 2004).

Knisley (2005) found that in today's dynamic workplace, employees are shifting among a variety of tasks during a typical day. A high light level is needed for reading documents with small text, a medium light is more appropriate for meetings, and an even lower level is required for keyboard tasks on a computer. In addition, each employee's personal light requirements may differ based on age, vision, or preference.

Windows have also been found to play an important role in employee stress. There is a relationship between lack of windows in the workplace and employees' feelings of job dissatisfaction, depression, and tension. A view of natural elements such as trees, vegetation, plants, and foliage was found to buffer the negative impact of job stress (Leather & Di Beals, 1998).

*Color.* Color plays an important role in employees' emotional and physiological responses. Color can be soothing, invigorating, jarring, or stress-inducing. Red, for example, has been shown to stimulate a sympathetic response. On the other hand, red has also been shown to increase stress when compared to blue, which is more relaxing and tends to reduce stress (Pelegri-Genel, 1996). Rooms that are painted in cool hues tend to look large, and time is often underestimated in these rooms. People may also feel cooler. In today's offices it is important to select colors based on the activity or activities that will take place in a given room (Hower, 1995).

*Noise and Acoustics.* Cooper, Dewe, and O’Driscoll (2001) suggest that poor noise conditions can have a severe impact on a worker’s physical health and psychological well-being. This statement confirms Hower’s (1995) findings that high noise levels can cause irritation, increase stress, and reduce productivity, especially in an open space. Therefore, it is important to select interior finishes and furnishings that do not reflect sound waves. Another effective solution is to scatter sound waves by creating wall surfaces with niches and ceilings with irregularly recessed sections (Hower, 1995).

Smith (2001) found that a worker who sits near enough to other co-workers to hear them typing may need few extra sick days. In addition, employees working in a noisy office have shown increased levels of adrenaline while working in the noisy office that might reduced their productivity.

*Aroma.* According to Welch (1996), unpleasant odors increase the heart rate and that, in turn, might increase stress levels and result in a loss of productivity. One solution is to install a good HVAC system that exudes a lavender aroma, which has been shown to promote relaxation (Welch, 1996). Some Japanese companies are beginning to manipulate smells in the workplace, arguing that greater alertness is as much a function of olfactory factors as it is of visual ones. As an example, the Kajima Corporation in Tokyo has applied the ancient tenets of aromatherapy to the workplace. Studies that analyzed how the brain coped with prolonged periods of concentration helped explain the process by which aromas can be used in the workplace. Termed the “curve of arousal,” the first phase was marked by initial interest, followed by a period of clear concentration. After a while, brain activity tapered off into a phase of less productive thoughts (Welch, 1996). Companies can exploit these findings by pumping various fragrances through the

air conditioning systems. Refreshing citrus aromas, for instance, are useful at the beginning of the concentration cycle, followed by another fragrance to aid concentration. Woody scents are then introduced to encourage a short period of mental relaxation, before the process starts again (Welch, 1996). Although it sounds very tempting to apply the aforementioned mechanism, it is important to note that this might be a problem due to employees' allergies and indoor air quality sustainable design guidelines.

*Additional luxuries to increase productivity.* In today's companies there are often additional facilities to increase employees' productivity: exercise rooms, video game rooms, recreational areas, meditation rooms, and libraries with armchairs. Break rooms are less utilitarian and instead feature a variety of colors and more comfortable furniture. In some facilities, employees have access to outdoor space and break areas as well (Umalauf-Garneau, 2001).

*The ability to control the workplace environment.* Vangen (1999) points out that workplace stress is affected by a person's inability to control his/her office environment. Clinical research has shown that ordinary office activities, such as ringing telephones, voice levels, temperature, and so on, lead to a chemical reaction that increases stress. Therefore, greater attention to workplace design elements that provide the employees with a certain degree of control over their environment may help reduce the stress.

*Privacy.* Allie (1996) found that lack of privacy can be a major cause of stress among employees. Not only do many tasks require a total absence of distraction, each individual has a different level of tolerance when it comes to privacy. Therefore, there should be a variety of design solutions to address the privacy issue.

## *Design Solutions*

*Light and Daylight.* Cartwright and Cooper (1997) determined that physical surroundings, such as noise, lighting, and scents, can affect mood and our overall mental functioning. Each occupation has its own potential environmental sources of stress. For example, in jobs that require close detailed work, poor lighting or glare can create eyestrain. With respect to electrical light, Barton (1998) notes that employees need to take into consideration several aspects of artificial lighting solutions.

- The quantity of light. A footcandle is defined as the amount of illumination falling on the area where the visual task is being performed. The recommended number of footcandles is based on the visual difficulty of the task, the age of the worker (older eyes require more light), the reflection of the task surface, and the background color.
- The quality of the lighting system. Quality factors include the color of the light source; the color of the objects viewed under it; the amount of glare, shadows, and brightness patterns produced by the lighting system; the amount of audible noise; and visible flicker.

Some solutions according to Barton (1998) might include:

- Higher luminance values, which can be achieved through a combination of supplementary and general lighting.
- Low mounted luminaries, which deliver uniform, balanced illumination with pleasing brightness.

- Glare reduction by the use of fixture shields or louvers; positioning of fixtures; repainting of walls and ceiling in light, high-reflectance colors; and wider-distribution fixtures to provide a uniform light pattern.
- Reduction of flicker sound by using fluorescent lamps operating on electronic ballasts. These exhibit the least noticeable flicker. Karen (2004) adds that when using other sources of lighting, HID and LED lighting are popular because they are more energy efficient and last much more longer than standard fluorescent lamps.

Leather and Di Beals (1998) mention that basic lighting design of offices must take into account the amount of natural light, proper windows design, and access to a natural vegetation area. An example of this approach can be viewed in a Chicago-based company, Tribune Interactive. There, the designer suspended the light fixtures so the employees could have a skyline view and enjoy penetration of daylight (Jevens, 2001). Another example is a Detroit area Ford automotive facility, where the architect designed a roof garden that provides aesthetics, energy use reduction, and run-off water management benefits. Employees can look at the garden from the cafeteria and can use these outdoor spaces for their breaks (Umlauf-Garneau, 2001). Both of these are examples of important contributions office design makes to employees' morale and stress reduction.

*Ergonomics.* According to Parrish (1999), employers should be concerned about ergonomics, since ignoring these principles will result in reduced productivity and increased medical costs. The following are some of the suggestions that the employer should consider when seeking to improve the ergonomic aspects of their work space:

- Provide chairs with range of motion. These include vertical, horizontal, and back adjustments.
- Give employees options in furniture shapes, sizes, and arrangements, based on their height and the task that they will be required to do, such as lifting, filing, word-processing, talking on the phone, and so on.
- Encourage moderate exercise during the work day.
- For computer users, consider buying large monitors, footrests, ergonomic keyboards, and wrist support devices.
- For heavy phone users, provide headsets for hands-free talking.

*Noise and acoustics.* Brown (1997) identified several strategies that employers can apply to reduce noise:

- High-performance acoustical ceiling systems. The materials in the ceiling should be able to absorb sounds striking at angles of incidence of 45 to 55 degrees (the angles that allow sound to bounce over cubical walls rather than entering the cubicle).
- Carpeting or other sound-damping flooring.
- Furniture should be higher than 53" to provide seating acoustical privacy with a Sound Transmission Class (STC) performance rating of 20 or greater.
- Brown (1997) also suggests including designated "quiet rooms" where employees can work quietly if they need to concentrate.

*Color.* Ward (1995) determined that colors provide a dependable, predictable, and economical approach for employers to deal with stress:



- Violet is considered to be the most restful color, since it causes a decrease in blood pressure. However, it is not viewed favorably by most people as a wall color, so an employer might use it as an accent color to reduce employee stress.
- Blue is the best color for break areas since it promotes relaxation, and it is also a favorite color of most people. A blue environment can also help reduce headaches and hypertension.
- Green is considered to be in the middle of the spectrum of stress reduction colors. One of the problems with green, however, is that it is used frequently in hospitals, schools, and government buildings, which hold unpleasant associations for many people.
- Using yellow on walls and floors might increase overall frustration. It tends to conflict with people's natural inclination for earth tones and forest tones.
- Orange and red colors can increase the heart rate. Therefore, these colors should not be used in break rooms and relaxation areas.
- Splashes of red in a conference room might increase the "good stress," since it will increase the heart rate and the energy level that is required for a productive meeting.

Luparello (2004) found that color influences attitude and comfort level for the employees. Currently, blues are taking on a sea glass-type hue that is very calm and cooling. Skin tones, much like colors that can be viewed on a make-up counter, are being used in varying combinations to create soothing warmth.

Ward (1995) also added that it is important to remember that no single color stands alone in an overall stress management program. Colors must be mixed, blended,

and matched. Most importantly, color combinations must be kept simple, since too many colors can be overwhelming and may actually increase the stress levels.

*Personalization and control of the workplace.* Allie (1996) states that allowing the employees to have a say in the design of their immediate work environment increases the employees' morale and reduces their tension. Today's employees expect to have more control over their immediate office environment with key elements like temperature, lighting, ventilation, and noise. Today, companies such as Hubbel Lighting, Lutrona, and Johnson Controls offer personal environment controls that allow workers to control the balance between ambient and natural light sources and diffuse background noise with the use of sound masking systems (Vangen, 1999).

*Relaxation centers.* Ernesto (1997) suggested that an important component of stress management programs is relaxation centers that are analogous to fitness centers. The purpose of these facilities is to provide employees with an area, equipment, and qualified staff to encourage learning and practicing stress management and relaxation techniques. These rooms include several items that promote relaxation, such as light-sound machines, massage chairs, VCR monitors, stereo systems, reclining lounge chairs, and an audio, video, and text lending library. Ernesto viewed this as a holistic approach to dealing with employee stress. The light-sounds machines are used with the assistance of special glasses and headphones. These machines expose the employee to flashing lights and repetitive sounds at specific frequencies. The result is a brainwave activity that facilitates relaxation (Ernesto, 1997).

Special relaxation rooms are also mentioned by Stevens (2001). These rooms are totally enclosed and soundproof. They are available to any employee and serve as a

refuge area from the normal intrusions into the workspace. The employee can relax in the room, work quietly, take a break, meditate to the sound and sight of a room-high water wall, listen to music on a three dimensional virtual sound system, or doze off in a reclining chair. All of these features help the employee relax and ultimately be more productive.

Welch (1996) described the Freeman Catalog Company's approach to stress: The offices have anti-stress zones that incorporate futons, vibrating relaxation chairs, low level lighting, garden elements, and water features. Their purpose is to create a completely stress-free environment.

*Fitness centers.* According to the Society of Human Resource Management, in 1999, about 20% of companies had in-house fitness centers, up from 16% in 1997. This was important, since physical fitness can be promoted in the workplace for the benefit of everyone, both employers and employees. Consequently, employers are being encouraged to establish exercise facilities and programs in the work place. The employers who offer exercise facilities will be more likely to benefit from a more relaxed employee, reduced health care costs, and reduced absenteeism, as well as improved job performance, productivity, and morale (DiNubile & Sherman, 1999).

#### *Environmentally Responsible Design Solutions*

According to Katz (1997), the risk of becoming sick from indoor air is potentially very great, as Americans spend 80-90% of their time indoors. Yet as widespread as this risk is, it appears to have come into focus only recently for risk managers and underwriters.

Katz (1997) also mentioned that there is a growing public awareness of the fact that there are diseases that are related to indoor air pollution such as asthma and various lung disease including Legionnaire's Disease and pneumonia. There are also the less well defined symptoms of "Sick Building Syndrome," including eye, ear, and nose irritation; headaches; dizziness; difficulty in concentrating; and mental fatigue. It is important to mention that even the mildest complaint may cause lost productivity. As industrial hygienist John Tiffany says: "If you have somebody at a computer who's going to zone out because of stale, stuffy air, you've got your cost right there" (Katz, 1997, p. 1).

The following are environmentally responsible design elements that should be taken into consideration in order to increase productivity and reduce stress:

#### *Indoor Environmental Quality*

*Lighting.* Good indoor environmental quality starts with a well-designed lighting system, which involves more than just providing windows and incandescent lighting. Lighting has an enormous potential for influencing occupant perception of the interior space. A variety of factors contribute to the lighting experience, including the amount and color of light, glare, variations in light levels, and use of daylighting (RSMeans, 2002).

*Daylighting.* Turning off or dimming electrical lighting when there is sufficient daylight reduces operational energy costs. Daylight also provides important occupant benefits, including better visual acuity, a connection to nature, enhanced productivity (which has been documented), and well-being (RSMeans, 2002). A recent study examined the relationship of daylight to students' performance. The results indicated that in the classrooms with daylighting, the scores for math and reading performance were

16% to 26% higher than in classrooms with only electrical lighting (Fisk, 2000). Quality of lighting starts with well-designed daylighting, which involves more than just providing windows.

In order to balance the lighting, daylight must be introduced or reflected deep into the building. Direct beam sunlight (such as from standard skylights) should be diffused or reflected deeper into the room cavity. It is important to reflect the light primarily onto walls and ceilings to provide indirect lighting. Direct beam sunlight should not strike floors or worksurfaces to avoid creating glare (RSMMeans, 2002). These goals can be accomplished by using light monitors, clerestories, light shelves, advanced skylight systems, or a courtyard. (RSMMeans, 2002).

Daylight, even when reflected, should not be expected to penetrate more than 15-20 feet into a room from a perimeter window (RSMMeans, 2002). An overhead skylight can provide light in areas farther from walls. There are additional devices that can project daylight deep into the core of a building, including window reflectors, light pipes, and fiber optics. In addition, choosing light colored finishes greatly enhances the ambient brightness of the room.

Soleau and Ross (2002) offer additional daylighting solutions for reducing energy consumption. Using tinted or reflected glass for southern and western exposures helps minimize heat absorption from direct sunlight, while low-e glass can be used for all glazing in order to maximize daylight without fading interior finishes and furnishings.

*Electrical lighting.* Fixtures that provide mainly indirect, but also some direct, light will create an even, glare-free ambiance, to which task lighting can be added to

accommodate specific activities and individual preferences. Accent lighting can be added to create sparkle and to draw people into the space (RSMMeans, 2002).

When daylight and electric lighting are designed as an integrated system, the amount of electric lighting needed during most of the day can be minimized for additional energy savings. Automatic lighting controls can greatly reduce lighting energy consumption. They include occupancy sensors that turn lights off when a room is not in use and photosensitive dimmers that dim lights when daylight is ample (RSMMeans, 2002).

Today's fluorescent lighting is efficient, has excellent color rendition, and is appropriate for most applications. Soleau and Ross (2002) suggested that it is important to include a daylight harvesting system, which senses the amount of the daylight in the space and adjusts the light as needed. Lighting sensors tied to dimming ballasts create effective energy cost savings. When there is sufficient ceiling height, high intensity discharge lighting can be used for additional energy consumption reductions.

*Indoor Air Quality (IAQ).* According to Lees-Haley (1993), complaints of building-related illnesses are estimated to affect 20-30% of buildings in the U.S. and to cause as many as 500,000 lost workdays each year. The problem of IAQ is further complicated by the fact that sick building syndrome seems to emanate from a complex mix of actual physical pollutants, individual psychological forces such as workplace stress, and the social environment of the office (Lees-Haley, 1993). Axley (1993) adds that sick building syndrome is caused by organic solvents emitted from structural materials and finishes and by by-products of the human occupants, such as carbon dioxide, tobacco smoke, and vapors from hair sprays, deodorants, perfumes, and food. To solve these problem arising from sick building syndrom, some building owners have

resorted to using expensive cleaning procedures to reduce the symptoms as well as installed carbon-dioxide detectors that control ventilation systems (Axley, 1993).

According to Krause (n.d.), the typical indoor workplace environment contains high levels of contaminants and chemicals. Standard latex or alkyd paint emits volatile organic compounds (VOCs), which the Environmental Protection Agency has found to be carcinogenic. Other sources of IAQ pollution are carpeting, foam insulation, varnishes, adhesives, and pressed wood. Fungi (including yeast, mold, mildew, etc.), can cause a range of health problems from skin irritation and immunity disorders to cancer. They will grow any place where there is a sufficient amount of moisture, a growth substrate, and an organic nutrient base. Therefore, it is important to control indoor humidity year-round to 40-45% relative humidity (RSMMeans, 2002).

*Individual environment controls.* Operable windows, furniture with adjustable ergonomic features, dimmable lighting, and task lighting are different types of individual environmental control. Such benefits allow employees to maximize their personal comfort (RSMMeans, 2002). There is a strong link between the thermal environment and job performance. The results of many studies indicate that changes in temperature of a few degrees Celsius (within 18 to 30 degrees Celsius) can significantly influence performance in a number of tasks including typewriting, factory work, signal recognition, time to respond to signals, learning performance, reading and speed comprehension, and word memory (Fisk, 2000). An adjustable thermostat or, even better, under-floor air distribution with an airflow diffuser for each occupant can provide individuals with temperature control.

## *Furnishings and Finishes*

*Interior wall systems.* Interior wall systems should be made from agricultural materials, such as straw. Some products use 100% agricultural waste products, avoid toxic binders, are fire resistant (with a fire rating from one-to two hours), and do not require structural studs.

If gypsum board needs to be used, recycled content product should be specified. Using locally available materials avoids use of carbon-based fuels for transportation of materials (RSMMeans, 2002).

*Acoustical panels.* The acoustical panels and fabric should be durable, made from recycled materials, and recyclable. Neither the panel nor the fabric should have toxic emissions that contribute to poor indoor air quality (RSMMeans, 2002).

*Windows.* When selecting windows, the goal is to specify windows that will provide the climatically appropriate insulating value, while also allowing for a high percentage of visible light to enter the space. Today, there are many options to choose from, and it is possible to “tune” the glazing carefully for the particular orientation and desired conditions (RSMMeans, 2002).

*Doors.* Glass doors should be designed with all the same considerations as windows. In addition, door frames must be carefully detailed, with door sweeps and weatherproofing, to prevent infiltration of outside air. Non-glazed doors should be insulated, preferably with no-ozone depleting Expanded Polystyrene (EPS) (RSMMeans, 2002).

*Paints, coatings, and adhesives.* Most paints, coatings, and adhesives for finishes such as flooring and wall coverings emit such toxic chemicals such as VOCs and



formaldehyde, among others, which negatively affect the builders as well as the building's occupants (RSMMeans, 2002). Therefore, it is important to specify products that protect IAQ.

*Wall covering.* The best wall coverings from environmental and air quality standpoints are non-toxic gas-emitting paints or textiles that are installed with no -VOC adhesives. Vinyl wall covering poses the environmental problems associated with chlorine compounds. In addition, vinyl poses an additional health hazard if it is subjected to high temperatures, as it releases toxic fumes (RSMMeans, 2002).

*Carpet.* Traditional synthetic carpets emit hundreds of chemicals, and as they age, they become prime breeding ground for microorganisms (Ulness, 1997). Carpet underlayment should have recycled content, be non-toxic (no formaldehyde or VOC off-gassing), and provide both insulation value and sound barrier properties. Carpet made out of wool is a safer natural choice, along with area rugs made from wool, only for residential applications, which can be removed for cleaning and airing (RSMMeans, 2002). Polyester carpets are available that are manufactured from recycled soda pop bottles (PET plastic). Most carpet manufacturers have reclamation programs and closed loop manufacturing keeps nylon carpeting out of landfills.

*Resilient flooring.* Like all other vinyl products, vinyl flooring is an environmentally sound choice. Several other types of resilient flooring can be used, such as cork, linoleum, recycled-content rubber, or chlorine-free polymer resin tile (RSMMeans, 2002).

*Ceramic and porcelain tile.* There are many manufacturers that offer products with up to 70% recycled content. Adding recycled glass makes use of a post-consumer product and can also add an interesting texture and colors to the tile (RSMMeans, 2002).

*Wood flooring.* Certified wood should be specified, and locally or regionally grown and processed products are preferable to those that require transportation in excess of 500 miles (USGBC, 2006). Rare species of tropical woods should be avoided, to protect tropical rain forests, unless certified by the Forest Stewardship Council (FSC). Bamboo is becoming a popular flooring option. It is exceptionally strong and rapidly renewable (RSMMeans, 2002).

According to Ulness (1997), health-conscious builders prefer wood, preferably raw wood that is nailed, not glued, to the subfloor and protected with water-based, polyurethane finishes that are low in volatile organic compounds (VOCs). Solvent-based floor finishes can cause indoor air quality problems, especially during and immediately following installation.

*Walk-off mats.* Much of the dust and dirt in a typical building comes from pedestrian traffic. The simple provision of a walk-off mat in the building entryway can improve indoor air quality by greatly reducing dust and dirt (RSMMeans, 2002).

*Furnishings.* The furniture should provide adjustable ergonomic features and be made without toxic gas emitting dyes, finishes, foams, or adhesives. Upholstery fabrics should be composed of natural, organic fibers or recycled materials and should be recyclable. Metals should be recycled with powder-coated paint finishes. Woods should be FSC certified to avoid unsustainably harvested woods, such as those from clear-cut rainforests (RSMMeans, 2002).

The furniture should be extremely durable to avoid early replacement. Solid wood, rather than veneer, which can be refinished if necessary, is another option, although this requires more wood than does veneer and is less dimensionally stable. Selecting light-colored finishes reduces the lighting level required. It is important to avoid using furniture made out of endangered tropical woods, particleboard containing urea or formaldehyde glue, PVC, nylon, or other petroleum-based plastics (unless they are recycled plastic, such as PET). Additional features not recommended for furniture are finishes with high levels of VOCs or other toxic chemicals, laminated veneer finishes (which may eventually show wear and have to be replaced), plastics, foams with CFCs, upholstered surfaces that cannot be easily cleaned and therefore have a shorter lifetime, and any materials that cannot be easily recycled. Office furniture should include such items as reupholstered chairs, refinished tables, office partitions made with gypsum core or recycled cellulose, recycled aluminum or steel frames, and upholstery from recycled soda bottles (RSMMeans, 2002).

*Indoor plants.* Plants in the workplace have shown to improve employee productivity and reduce stress. In a study conducted by Virginia Lohr of Washington State University, 12% of employees who worked in a plant-filled environment were more productive and less stressed than those who worked in an environment with no plants (Gilhooley, 2002).

There are other advantages to plants. A recent Washington State University study demonstrated that plant transpiration in office environment releases moisture, creating a humidity level that matches the recommended human comfort range of 30-60% (Gilhooley, 2002). As Susan Odiseos, vice president of U.S. Energy Systems Inc., in

White Plains, New York, says: “Interior plants are a solid return on investment and a must for any corporation concerned with sustainable, ‘green building’ solutions.” She adds; ” We practice what we teach and find that our investment in interior plants services has had the expected outcome of improving indoor air quality, supporting positive outlook in the workplace and increasing employee productivity” (Gilhooley, 2002. p. 2).

In several research studies done by Dr. Billy Wolverton and his aides in the Environmental Research Laboratory of John C. Stennis Space Center, in Mississippi, it was found that plant-filled rooms contain 50-60% fewer airborne molds and bacteria than rooms without plants. In addition, the plants absorb office pollutants through their leaves and transmit the toxins to their roots, where they are transformed into a source of food for the plant (Gilhooley, 2002).

Research has shown that indoor plants have a beneficial effect on indoor air quality by increasing oxygen and humidity and by absorbing off-gassing chemicals. At least one plant should be provided for each ten square yards of floor space with ceiling heights between eight and ten feet. Proper watering and care of plants is required to ensure that the pots themselves do not become a source of molds. Some varieties of plants recommended for their particular effectiveness in improving air quality are areca, reeds, dwarf date palms, Boston and Australian sword ferns, English ivy, peace lilies and rubber plants (RSMMeans, 2002).

### *Future Projections*

The U.S. Office of Technology Assessment (Workplace Stress, 2000) predicts that stress-related illness may become the greatest public health problem faced by office workers. Research that was done by the Industrial Society in London found that 74% of

the employers surveyed predicted that employee stress would become their greatest health and safety concern in the next few years. Furthermore, 53% said that stress is an issue that employers can and should address proactively (Alder, 2001). The subject of employer responsibility is also acknowledged by Ernesto (1997), who stated that a commitment by the employer to reduce work related stress will be very important and will demonstrate the employer's concern for the lives and well-being of his/her employees.

As for the employees, they are demanding more control over their immediate office environment, such as temperature, lighting, ventilation, and noise (Allie, 1996). Welch (1996) foresaw the need to give employees increased control over their work environment. Technology is available to allow employees to change temperature or lighting levels through a control panel on their computer screens.

Companies are using creative ways to reduce stress, such as company pets, or yoga and Tai Chi classes in the office (USA Today, 1998). Ergonomics equipment, appropriate lighting, and built-in flexibility will continue to be important factors for improving the work environments (Proper, 1998).

In order to maximize productivity, managers will need to create project-team environments and activity-based settings (Proper, 1998). According to Kupritz (1999), teamwork, open space, and flexibility will continue to be important trends in office design, although privacy will be a primary concern for employees. Stevens (2001) predicted that offices would be more open, with even fewer or no doors, so that employees will be able to interact easily, share ideas, and solve problems in an informal fashion. Stevens also addresses privacy concerns by designing special privacy locations in

the office, which he defines as “your room.” These rooms have doors, are enclosed and soundproofed, and are available for all employees on an as-needed basis.

Wah (1998) acknowledged that flexibility and open space were growing trends, but he noted that mass customization would not work. According to Wah, no office design concept can be blindly applied to every type of business and work function. Customization would be key. He predicted that the workplace of the future will demand more flexible and customized solutions.

Wah (1998) emphasized that although employers and employees understand the importance of design in increasing productivity, top management will still require a cost/benefit analysis to justify any investment in office design. Consequently, the designers’ role would be twofold: to base the design on sound principles and established research and to present quantitative returns on the investment. This approach would assist designers in convincing business leaders of the value in these types of investments. Laabs (2000) emphasized that the designer can play an important role in helping the company achieve productivity goals.

Laabs (2000) found that 61% of managers (of 650 from the Fortune 1000 companies) indicated that they would be willing to sacrifice as much as one-half of their bonuses to improve the workplace. These managers also indicated that they believed that the office space of the future will have to do a much better job of supporting teamwork, telecommunication, and productivity-enhancing activities.

Improving the indoor environments will be a major factor in increasing productivity and reducing stress. Fisk (2000) found that in most non-industrial workplaces, the costs of salaries and benefits exceed energy, maintenance, and

annualized construction costs and rent. Consequently, demonstrably quantified improvements in health and productivity from better indoor environments could substantially change attitudes and practices related to building design and operation. Businesses should be strongly motivated to invest in changes in building design that improve worker performance or reduce absenteeism. Fisk (2000) predicted that in the long term, as more research and communication is published, employers' uncertainty regarding the benefits of improved indoor environment will diminish, and employers will invest more readily in improving indoor environments to increase productivity.

Petrakis (2002) reported that the real estate industry had never been a strong proponent of going green unless "green" referred to dollars, but he found a growing awareness among developers and architects regarding the inherent bottom-line benefits of environmentally responsible design, which is reflected in the design of the next generation of office buildings.

Petrakis (2002) summarized the current environment by saying that today businesses are maximizing efficiency and using every inch of office space to do so. He predicted that the next generation of office buildings will emulate many features of older loft buildings; the ideal workspace will resemble a long, clear shell that allows maximum flexibility.

High ceilings, improved access to exterior walls, more daylight, and airy plans with few interior walls are becoming the standard. The ways in which interior design can boost productivity, enhance communication, improve morale, foster creativity, and reduce absenteeism are based on sound scientific research. As companies strive to compete effectively in the global market, they will continually seek avenues not only to

attract and retain talent, but also to provide their employees with a comfortable, productivity-enhancing environment. Thus, the trend toward evidence-based design will play an increasingly important role in office design.



## CHAPTER THREE

### Research Design

#### *Overview*

The design paradigm for this research project is qualitative, and the research method is a case study. Specifically, the case study will be an action-based project consisting of a conceptual design proposal for an existing commercial building in a northern Midwestern town in the United States. The facility is a one-floor building in an industrial area of the city. It is an open space surrounded with windows (see floorplan, Figure 1). The facility is occupied by an advertising agency that specializes in managing digital advertising campaigns for Fortune 500 companies.

Information obtained in the literature review suggested that employees' productivity is essential to company success and that their stress is an important factor. In addition, the literature documented that using specific interior design techniques can increase employees' productivity and reduce their stress. Being an employee of an advertising agency in the past made me familiar with the type of work environments and demands that exist in the field. The employees are expected to work under extreme deadlines with high expectation from clients on a daily basis. These increase their stress and decrease their productivity.

#### *Research Problem*

The goal for this conceptual design project was to research ways to reduce employees' stress and increase their productivity using interior design techniques and environmentally responsible materials.

### *Data collection and Analysis*

The original architectural floor plans for the facility were collected from the CEO of the company. The plan for this design project was to use the existing open space and redesign it using new space planning, furniture, finishes, and lighting. The design was based on the literature review that described the different interior design techniques used to increase employees' productivity and to reduce their stress. The materials were chosen from companies whose products are considered environmentally responsible.

During the design process, the Delphi technique was used. Input and feedback were provided by design professionals as well as by the thesis committee members. The feedback was analyzed to provide guidance for further design development. This review process was repeated until the final plan was approved.

### *Limitations*

This research-based, conceptual design was based on a literature review and was completed without a budget limitation. In addition, the design was not implemented, so the variables that included employees' productivity and stress were not measured pre- and post-design. Therefore, there was not a way to prove that the design techniques that were used would actually influence employees' stress and productivity. However, the purpose of this study was to review the literature to identify research that demonstrates that appropriate design of the interior can increase employees' productivity and decrease their stress level and then implement those theories in the conceptual redesign of an existing space, using a research-based design method. This goal was met.

### *Scope of Work*

The conceptual design project included the following components:

- Evaluation of the existing building floor plan and implementation of a new space plan that incorporated open and flexible spaces that would encourage teamwork and collaboration combined with solutions that would provide privacy when desired.
- Ergonomics was an important factor, and new furniture was used to promote employees' physical health and ensure their comfort.
- New lighting was added to increase energy efficiency and employees' productivity.
- Daylight issues were examined and additional windows were added where needed.
- New colors and finishes were selected. The challenge was to keep the environment vibrant and energetic in certain areas, as a digital advertising agency should be, while promoting a relaxed and soothing environment that would reduce employees' stress.
- Noise reductions infrastructure was developed and implemented.
- Individual control devices for the employees were provided.
- Environmentally friendly materials and furniture were specified wherever possible to decrease air pollution, promote a healthy environment, and protect global eco-systems.

## CHAPTER FOUR

### Design Discussion

#### *Evaluation of existing building*

##### *Space plan evaluation*

The 18,000 square foot (SF) space, which is leased by the advertising firm, includes a large open space surrounded by private offices. The open space includes cubicles that are positioned in straight linear rows (see Figure 1). Each row is associated with a specific department within the company, such as the Media department, Account Supervisors department, Art department, and others. Account directors and managers are usually located in the private offices, but not necessarily next to their account teams.

Team work is an essential element of working in an advertising environment. Typically, when a client hires an advertising company, the company assembles a team of professionals that includes an account manager, media buyer, marketing coordinator, creative and data management coordinators, and perhaps other personnel, depending on the needs of the account. To be successful, this team must work collaboratively in a close-knit setting, as it must coordinate activities and decisions in real-time.

At the advertising firm, teams also need to work together in a collaborative setting. However, the existing space plan is not conducive to teamwork:

- The employees' cubicles' location is determined by which department they "belong" to, as opposed to their account team association. Thus, for example, when a creative coordinator needs to talk to an account supervisor or a marketing coordinator he or she has to walk 80-90 feet, which is not efficient.

- There are only two available conference rooms. The large conference room can be divided into two rooms if needed; however, it serves the entire company and is not sufficient. Consequently, teams often find themselves without an adequate place to meet and brainstorm ideas.
- The open area lacks privacy and there is no alternative place to have private discussions or phone conversations, unless one of the managers' offices is not assigned to anyone and so can serve as an ad hoc meeting room.
- The existing furniture is not flexible or mobile and is not conducive to teamwork and cooperation.

#### *Lighting evaluation*

Windows surround the perimeter but they primarily serve the employees located in the private offices. To bring light into the open area, each office has an interior window that provides penetration of daylight into the cubical area. Unfortunately, most of the time the windows are covered with shades to create privacy for the managers. This greatly diminishes the amount of daylight in the center area and the space appears dark, thus defeating the purpose of the day lighting option provided by the interior windows.

The ambient lighting is primarily recessed 2'x4' fluorescent fixtures (see Figure 2) that provide direct lighting.

#### *Furniture evaluation*

Each employee has a worksurface and storage cabinets. However, none of them is flexible. The cubicles are installed using 65-inch-high dark green panels, which block and absorb the minimal available light.

### *Color scheme evaluation*

The primary color scheme includes a combination of dark green and black. The color choice evolved from the company's desire to match the furniture and finishes with the colors of its logo, which is dark green and black. Only the work-surfaces are in a light maple shade, which provides contrast and helps to reflect the lighting within the workstations.

### *Design Plan*

#### *Proposed space plan*

Given the aforementioned deficiencies in the existing space plan, the proposed floor plan was designed with the intention to improve team work, collaboration, efficiency, and productivity. The following design solutions are the key elements of the new space layout:

- As part of the demolition plan (see Figure 3) some of the private offices would be removed to allow for more daylight penetration.
- Of the offices that remain, some will be converted to smaller offices (see Figure 4). These will serve as “designated quiet rooms” to allow private phone conversation or meetings for two to three people. Other offices will serve as either conference rooms or gathering places for teams of up to four people.
- The center area would remain open space with cubicles. The cubicle configuration (see Figure 5), however, would change and would be based on team collaboration as opposed to its current configuration, which is based on department affiliation. This new configuration would support more frequent interaction, discussions, and spontaneous team meetings.

- The cubicles would be organized around a team-client association, where a director, supervisor, media person, and creative coordinator would be located in the same cluster of workstations (see Figure 5). As suggested by Buhler (2000), teams are often cross-functional and non-linear. Therefore, each team member would be located in proximity to others on the team to facilitate their interaction; team members could pull chairs to the meeting table near the cubicle for a short discussion or brainstorming session. If there is a need for a longer or larger meeting, one of the conference rooms could be utilized as well.
- Private offices would be provided only for the CEO and the CFO (see Figure 5), while the account directors and managers will receive larger cubicles closer to their teams in the open space. This layout would enhance the perception that these individuals are approachable, thereby supporting Buhler's (2000) suggestion that the traditional hierarchical pyramid is being replaced with a more fluid organization. Hand-in-hand with the demise of the traditional hierarchical pyramid is the move toward teamwork.
- The furniture would be flexible, with chairs and tables on casters. Small conference tables would be provided among every few cubicles (see Figure 5).
- Administrative personnel would be located in the middle of the open area to allow easy access to their services from every location and distance within the employees' working space (see Figure 5).
- Meditation, relaxation, and exercise rooms would be added (see Figure 5) to enhance productivity by providing these facilities to minimize stress as suggested by Stevens (2001).

- Several lounge areas with comfortable seating would be added to provide alternative meeting space (see Figure 5).
- The kitchen area and the cafeteria would be refinished using vibrant colors to temporarily increase adrenaline levels. As suggested by Hart (2004), red, for example, is warm and stimulating. Orange is considered warm and exciting, which may even help boost productivity.
- Plants will be added in different areas (see Figure 5) to establish a natural setting that would support an ambience of stress reduction and overall well-being. As suggested by the AIA (2005), indoor plants increase worker productivity and workplace satisfaction. In addition, interior plants have been shown to reduce air quality-related absenteeism by 14% (AIA, 2005). Other research studies have also shown that people tend to be less stressed and more productive around plants and are generally more innovative and creative when surrounded by leafy plants and flowers (AIA, 2005). Consequently, according to the AIA (2005), it is important to educate management on the significance of investing in plants and to establish a live plants policy.
- The restrooms and the lounge area across from it will be separated by special inspiring art panels from floor to ceiling. The panels have preserved green reeds and branches incorporated in them to promote a natural, relaxing look.
- The existing space is able to accommodate more than 100 employees. However, there were no more than 60 employees, so many cubicles were empty. The new design plan would accommodate approximately 60-plus employees.





Figure 1: BI Existing floor furniture plan

Note. Blueprint was provided to the former CEO of BI. Drawing was made by AFD, 88 West End Ave, New York, NY . Permission to used drawings granted by J.B, the CEO of BI.

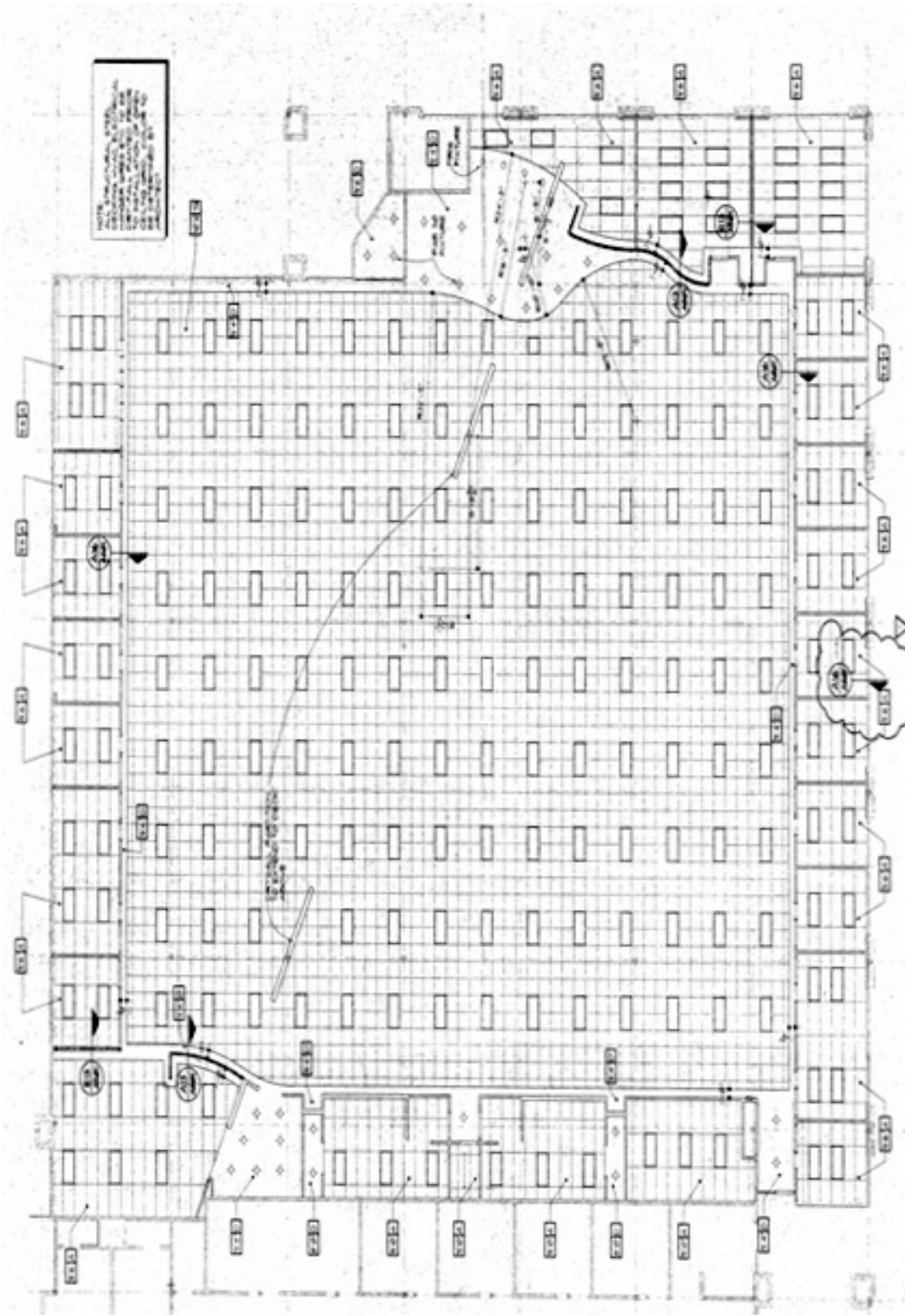


Figure 2: BI- Reflected ceilings plan

Note. Blueprint was provided to the CEO of BI. Drawing were made by The Heil Partnership Inc, 26400 Labster Rd, Southfield, MI. Permission to used drawings granted by J.B, the CEO of BI.

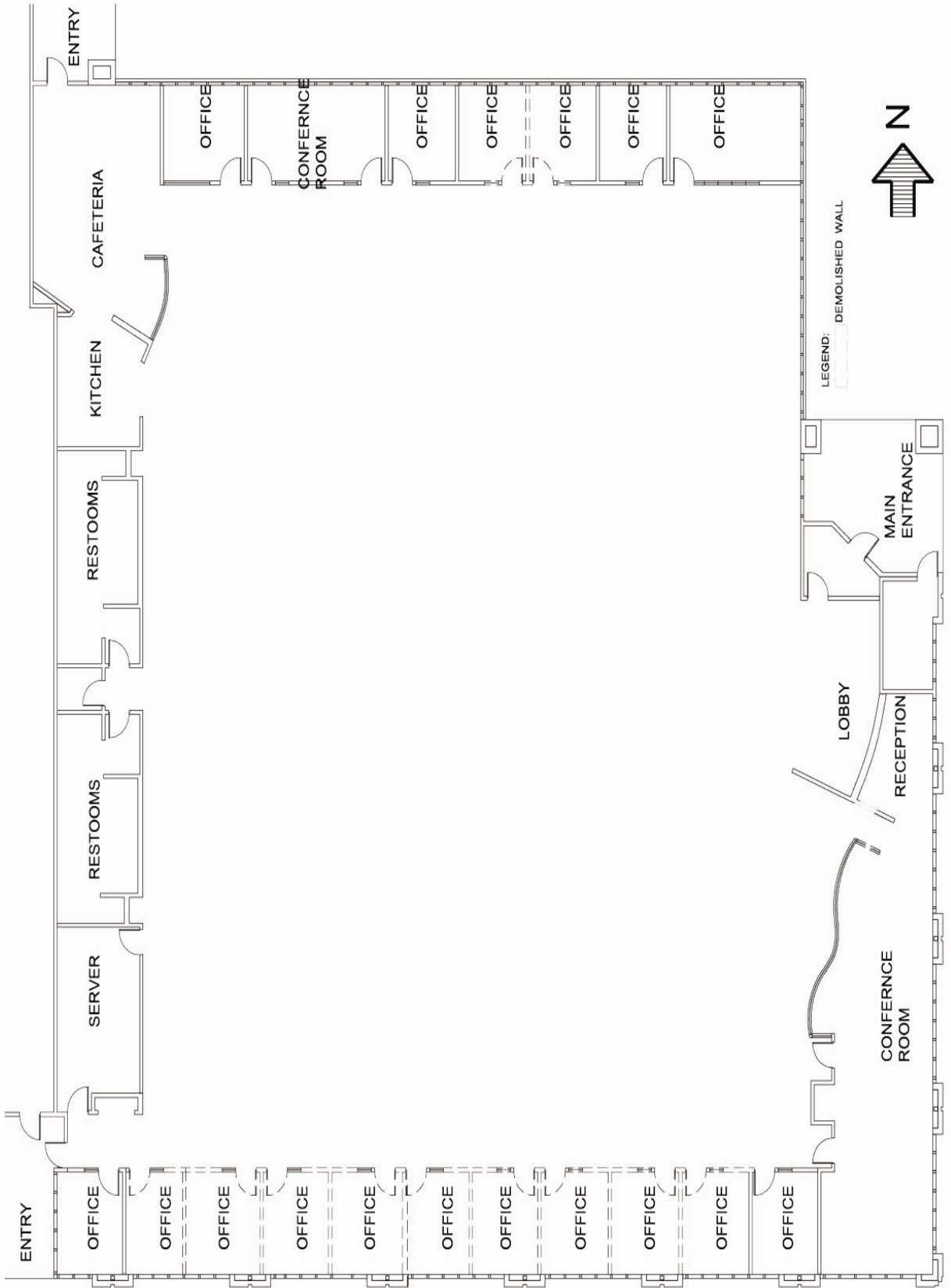


Figure 3: Proposed conceptual demolition plan

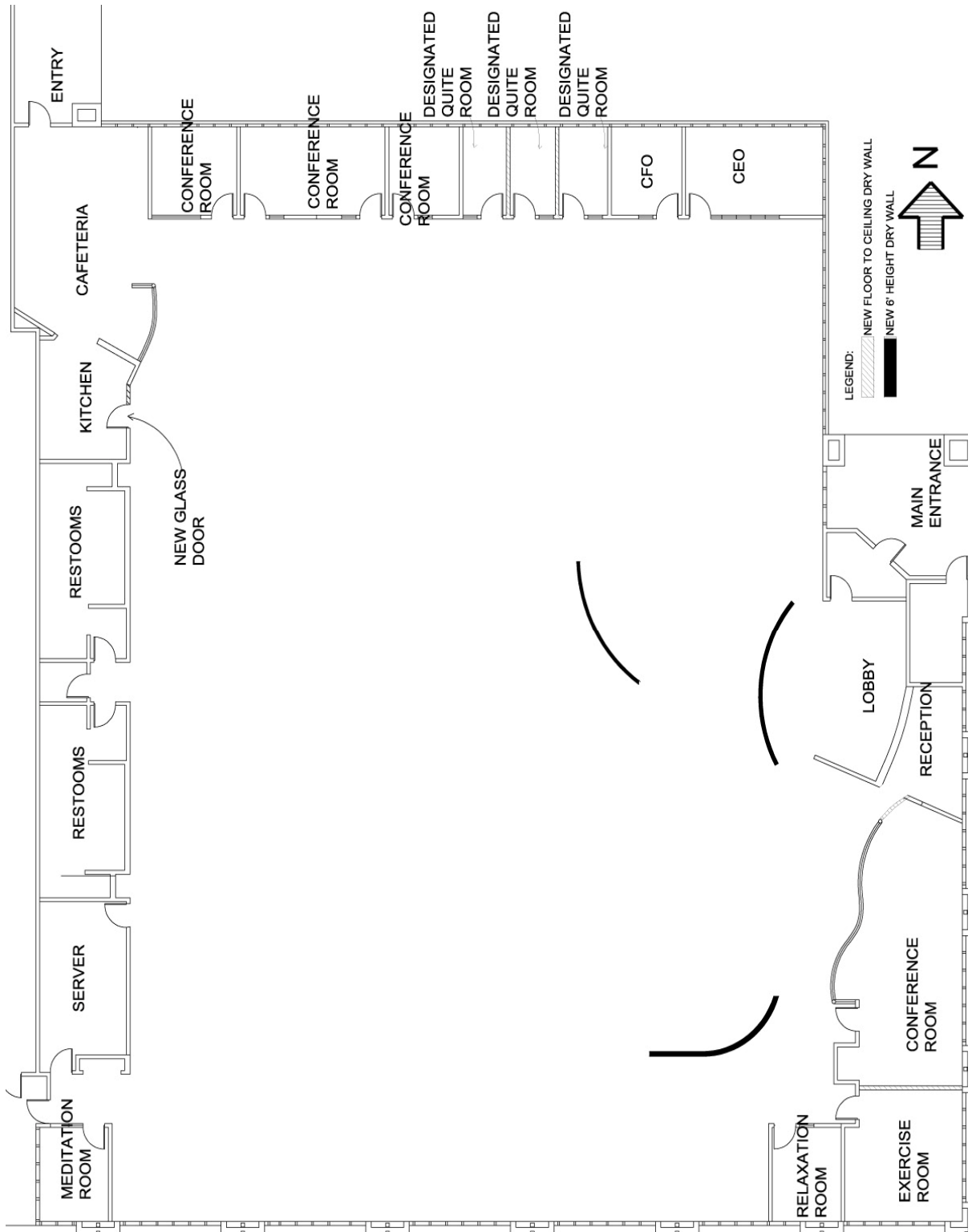


Figure 4: Proposed conceptual new floor plan.

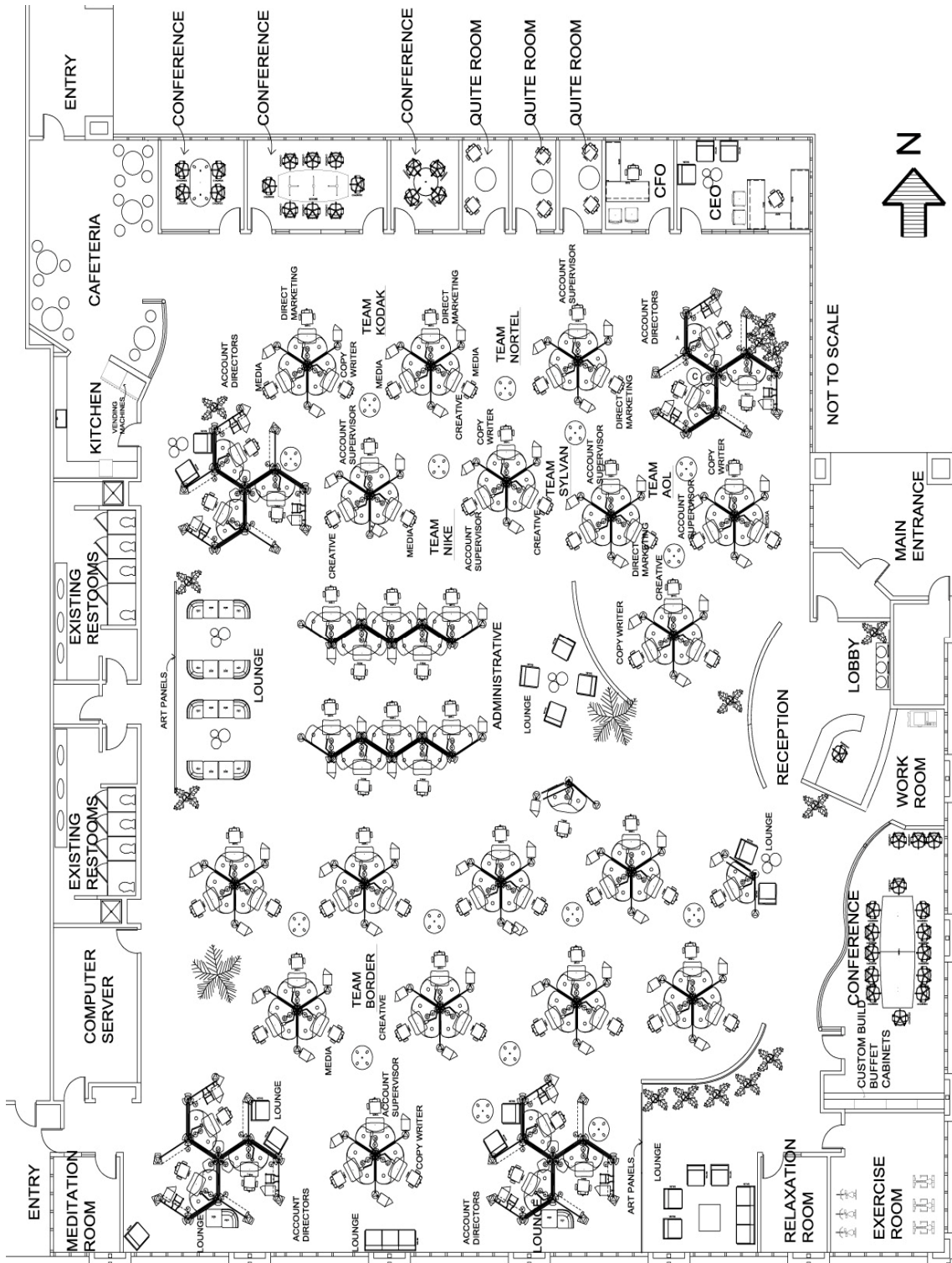


Figure 5: Proposed furniture floor plan.

## *Design Techniques*

### *Proposed office system furniture design*

The primary furniture system that will be used for the open office area is the Resolve system by Herman Miller (see Figure 6). This system is defined by open, friendly work spaces that encourage employees to connect. In addition, air and light pass through the panels so employees can perceive much broader spaces and don't feel confined. This enhanced visibility creates a challenge with privacy. To overcome this issue, screens and canopies will be installed. The screens can be rolled up or down to enable users to control privacy (see Herman Miller web page: <http://www.hermanmiller.com/CDA/SSA/Product/1,1592,a10-c440-p150,00.html> for more information regarding the Resolve furniture system).

The account team directors will be housed in a cluster of cubicles close to their team members (see Figure 7), while the other account team members will be clustered in a smaller group of cubicles (see Figure 8). Team members for each account will be located in close proximity to allow them to pull together their chairs and tables, which are on casters, for quick discussions. The administration team (see Figure 9) will be clustered in the middle of the space to allow easier accessibility to account members. The Resolve furniture system is organized in a way that encourages team work and collaboration by the team members by easily allowing them to congregate in common seating areas (see Figure 10).

To supply electrical outlets to the workstations, overhead pathways will be used. These trusses carry power and data independent of the workspace below so workstations can be light, open, and easy to plan and reconfigure: features that address the need for

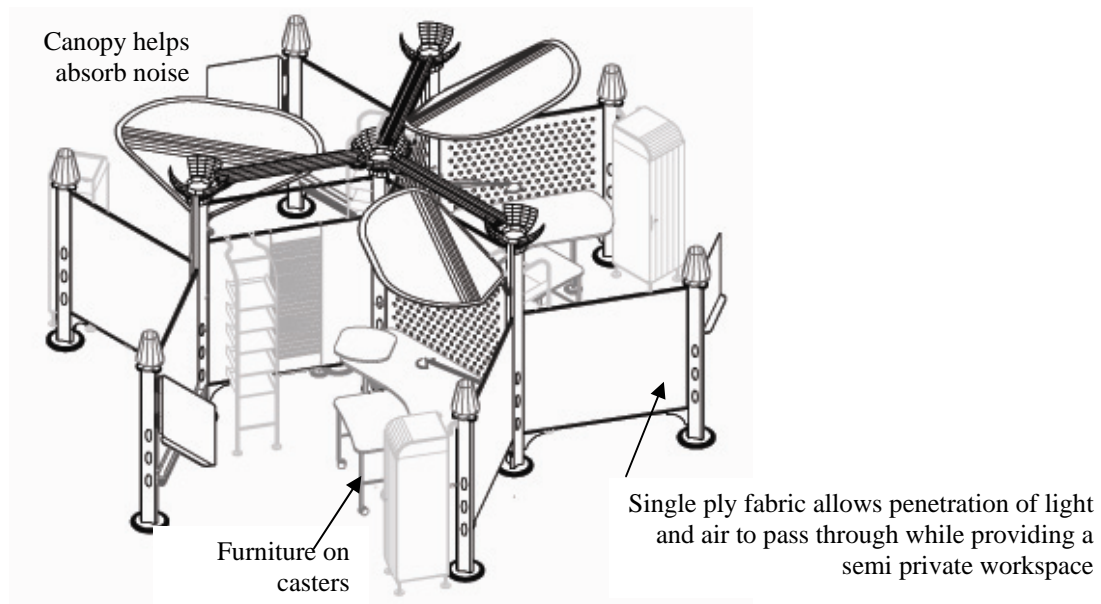
flexibility. If there is a need for further reconfiguration, Resolve is designed for smooth changes that control churn costs and minimize work disruption.



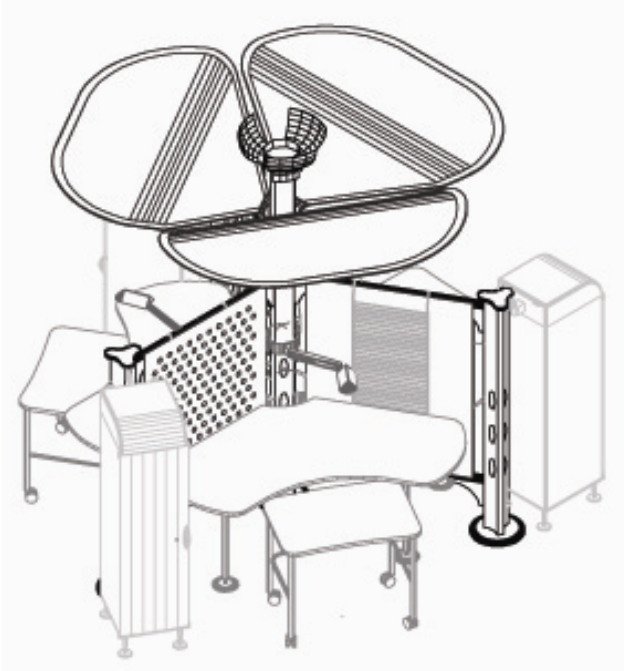
*Figure 6: Resolve System by Herman Miller.*

Picture provided by Herman Miller from

<http://www.hermanmiller.com/CDA/SSA/Product/1,1592,a10-c440-p150,00.html>



*Figure 7. Resolve System by Herman Miller: account managers workstations.*



*Figure 8.* Resolve System by Herman Miller: account team member workstations.



*Figure 9.* Resolve System by Herman Miller: administrative staff workstations.



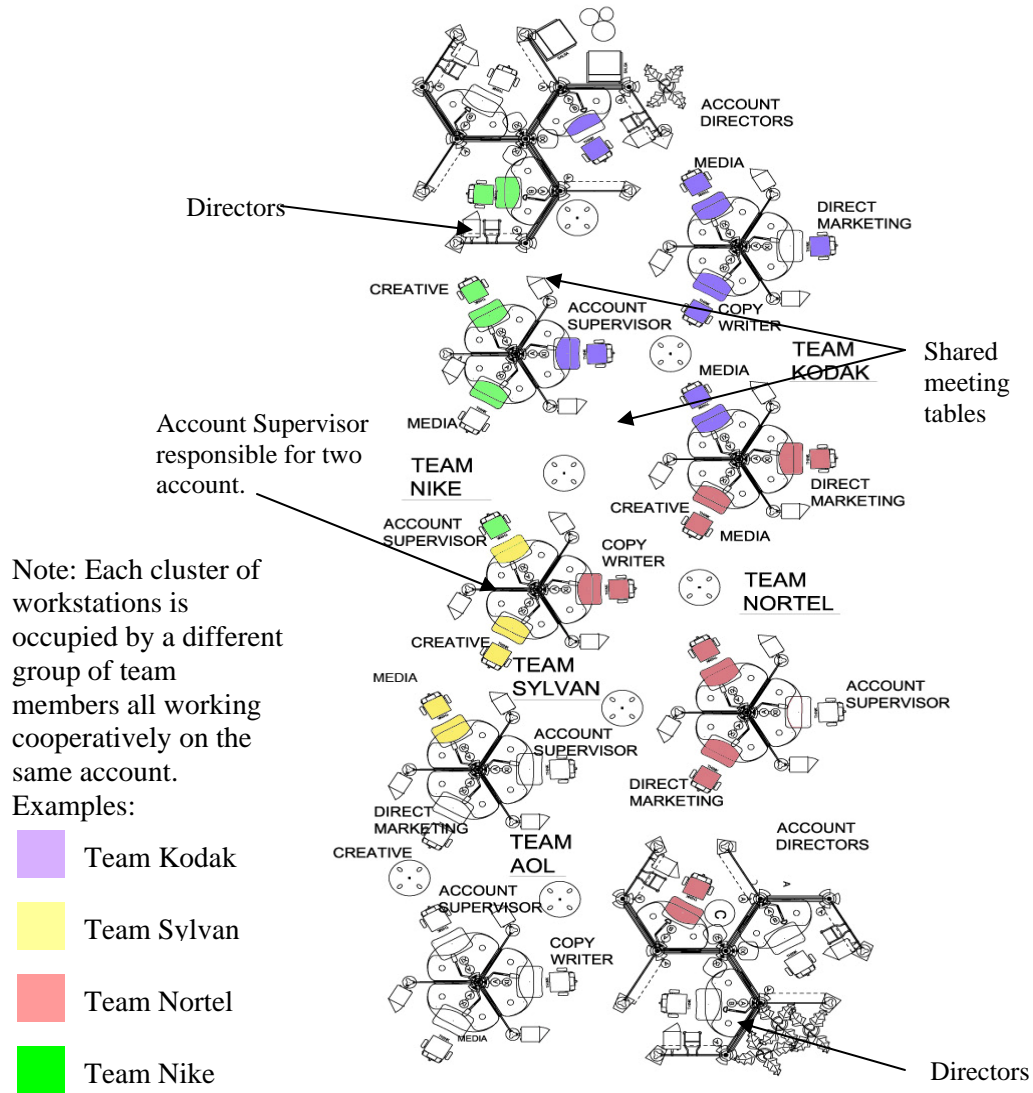


Figure 10. Teamwork in the open space.

*Proposed lounge area furniture design*

Several lounge areas would be used to provide the employees with alternative workplaces when they need to change their working environment in order to enhance their creativity. These areas would use comfortable upholstered sofas and chairs and would be surrounded by plants. The configuration of the lounge area furniture would support team discussions when needed. One of the lounge areas would face the window to promote a more natural, relaxing ambience as suggested by Leather & Di Beals

(1998); natural scenes have been found to be more desirable by employees and can enhance stress recovery.

*Proposed private office furniture design*

The furniture that would be located in the private offices would be Elective Elements by Steelcase (See Figure 11). The style is designed to balance the need for privacy and interaction, concentration as well as collaboration. Elective Elements 6 meshes clean aesthetics with a flexible, freestanding furniture system that can be easily tailored to meet individual needs. Application flexibility includes a clean, simple technology interface that allows users to customize their workspace to their individual needs. Mobile workers are accommodated with convenient plug-and-play capabilities (see Steelcase web page:

[http://www.steelcase.com/na/elective\\_elements\\_6\\_products.aspx?f=15904](http://www.steelcase.com/na/elective_elements_6_products.aspx?f=15904) for more information regarding Elective Elements 6 system).



*Figure 11.* Elective Element 6 by Steelcase.

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Picture provided by Steelcase from

[http://www.steelcase.com/na/elective\\_elements\\_6\\_products.aspx?f=15904](http://www.steelcase.com/na/elective_elements_6_products.aspx?f=15904)

### *Proposed ergonomic solutions*

To enhance employees' comfort and well-being, adjustable worksurfaces, keyboard trays, and ergonomic chairs would be specified. The task chair that would be used is the Think chair by Steelcase (see Figure 12). It includes back flexors that track the individual movement of the spine and pelvis. The back flexors are individually shaped to the human body to provide optimum support for each area of the back. The chair provides reclining support in proportion to the individual body weight. It has adjustable arms that retract up to three inches upon contact with the worksurface, allowing the employee to get closer to his or her work. These chairs can also pivot and move up and down to provide natural support (see Steelcase web page [http://www.steelcase.com/na/environmental\\_think\\_products.aspx?f=11845&c=18820](http://www.steelcase.com/na/environmental_think_products.aspx?f=11845&c=18820)) for more information regarding the Think chair).



*Figure 12.* The Think Chair by Steelcase.

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Picture provided by Steelcase from

[http://www.steelcase.com/na/environmental\\_think\\_products.aspx?f=11845&c=18820](http://www.steelcase.com/na/environmental_think_products.aspx?f=11845&c=18820))

### *Proposed noise and acoustics solutions*

Allie (1996) notes that extremely loud and unpredictable noises can cause an increase in blood pressure. Brown (1997) adds that noise can be a significant factor; according to a study that was done by Armstrong World Industries in Pennsylvania, noisy offices were found that they reduced employee productivity and increased stress levels. The type of task is also important when it comes to noise level. If the job demands a greater need for concentration, a disruptive noise will likely increase the stress level much more than a task that requires less focus and concentration.

According to Tom Koenig, president of Dynasound Inc., a Norcross, GA-based manufacturer of sound-masking systems, proper carpeting, high-performance ceilings, appropriate systems furniture, and an effective sound-masking system can recapture lost productivity by up to 30% (Smith, 2000).

In order to reduce noise, the following solutions are proposed:

- Installation of carpet throughout the open office area as well as inside enclosed offices to absorb noise.
- The Herman Miller Resolve system includes fabric panels that are 60 inches wide and 48 inches on the sides, thereby allowing for the absorption of some of the noise while not disturbing light penetration. The system also has acoustical inserts in the screen and canopies to absorb and block sound. This is Herman Miller's proprietary technology to reduce noise and distractions.
- The designated "quiet rooms" would provide the employees with a quiet space when concentration or privacy is required. Additional insulation will be added to the walls to increase noise reduction.

### *Proposed colors solutions*

The overall theme of the space would focus on simplicity using earthy, natural, light colors that promote relaxation and help reflect the daylight coming into the office area. The color choices were based on research by Ward (1995) that suggested that colors can influence emotions and can serve as tools to help employees manage their stress. Certain colors can increase the “bad” stress that reduces employees’ productivity, while other colors can increase “good stress” that promotes productivity by increasing the adrenalin and energy levels.

Therefore, in certain areas, such as the kitchen and the cafeteria, more vibrant colors would be used to enhance energy and, ultimately, productivity. In other areas, such as the offices, meditation, and relaxation rooms a combination of light blue and green colors will be used to promote a relaxing ambiance as suggested by Hower (1995).

The following are specific color solutions:

- The carpets would have a combination of light greens and cream to reduce stress.
- The floors and tiles of the restrooms would be a light shade of blue to promote a relaxing environment.
- The kitchen wall color will be red to increase appetite and energy levels while having breakfast or lunch.
- The majority of the walls in the corridors, private offices and quite rooms will be painted with Zolatone paint colors which would allow a combination of light cream color with flecks of green pigment in it to promote relaxation.
- Accent walls in the large open space would be cream with flecks of blue pigment in it to promote natural relaxing environment with limited distraction.

- Accent walls in the different conference rooms and the exercise room would have splashes of orange and red to increase productivity.
- Workstation and cabinets will have a light wood maple color to increase light reflection.

### *Meditation, relaxation, and exercise rooms*

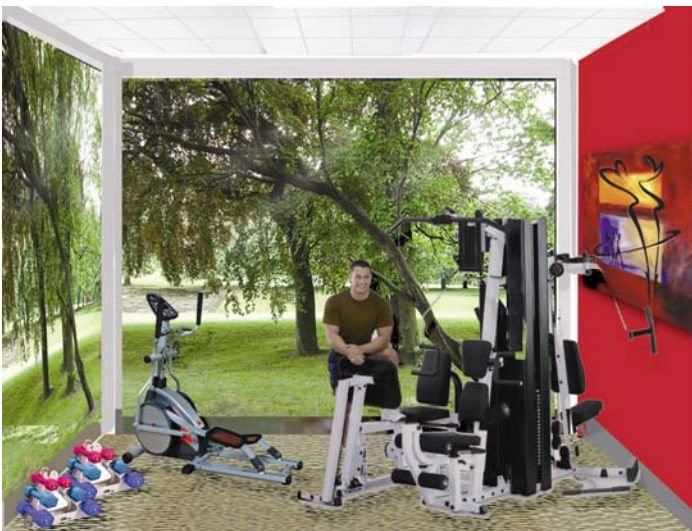
The meditation room would have a view to the outside landscaping as suggested by Leather & Di Beals (1998), who found that a view of natural elements such as trees, plants, and foliage could buffer the negative impact of job stress.

Both the meditation and relaxation rooms would also be insulated and sound-proof to limit noise distractions. The meditation room would include chair massages that provide a comfortable setting to meditate or read (see Figure 13). As suggested by Higley (2003), on-site chair massage is a cost-effective way of enhancing and improving employee performance. A chair massage program demonstrates an employer's proactive commitment to the health and well-being of his/her employees. Chair massage techniques significantly lower the day-to-day stress of the competitive workplace. Relaxed workers are more likely to cooperate with each other, and lowering stress reduces both anxiety and hostility, thereby improving the work environment for everyone. Therefore, in both the relaxation and meditation rooms, reclining lounge chairs with massage capabilities would be added to promote more relaxation. A small bookcase with magazines and books will be added to imply that it is OK to linger in the meditation and relaxation rooms.



*Figure 13.* Meditation room perspective view.

The exercise room would include several elliptical machines as well as weights. Corner window would have a view to the outside landscaping.



*Figure 14.* Exercise room perspective view.

#### *Lighting design proposal*

The open office area would have pendant ambient lighting that would provide primarily indirect lighting but also some direct lighting to create an even, glare-free

environment (see Figure 15). In addition, task lighting will be added to each desk as needed. Lighting in conference rooms would be manually dimmable to provide light adjustment that supports different activities. Accent lighting will be installed to emphasize certain decorative features on the walls. In addition, daylight sensors would be installed to control electrical lighting level based on daylight contribution and thereby maximize efficiency. The following discusses some specific solutions for the lighting:

- For the open space, the ambient lighting would be created using Series 7 from Finelite (see Appendix A). This series distributes approximately 97% uplight and 3% downlight. It uses T5 lamps that can supply sufficient foot candles and save energy at the same time. According to IES (Illuminating Engineering Society) standards (Steffy, 2002), an office environment needs an average of 45 foot candles to perform visual tasks. Product specifications for a typical open office area indicate that fixture spacing of 15 feet would produce, on average, 48 foot candles.
- For the conference rooms, the following pendant luminaries would be installed:
  - Conference rooms will use Series 9 from Finelite (see Appendix B), for both indirect and direct lighting. The fixtures would provide 80% uplight and 20% downlight for optimum performance when used in conference/training rooms or other areas requiring high light output with an average of 45-50 foot candles. When using a VDT (Visual Display Terminals), there is an option at the switch to use only one lamp, thereby creating 97% indirect lighting and 3% direct lighting. Based on the conference room measurement of 12' x 11.5', with 50 foot candles



required, one 8' row with three lamps per fixtures will be used. For conference room measurements of 11'x20', with 50 foot candles required, two 8' rows with three lamps per fixture will be used. For a conference room of 35'x14', three 8' rows with three lamps per fixtures will be used.

- For a private office, which measures approximately 8'x11', one Finelite Series 7, 8' fixture, with three T5 lamps would be used to create approximately 45-50 foot candles as recommended by IES (Steffy, 2002).
- In the meditation and relaxation room, low light levels are required. Therefore, to create 30 foot candles, Series 7 from Finelite would be used with only one lamp that would operate as 97% indirect and 3% direct lighting.
- For the workstation worksurface, an additional free standing task light would be provided to supplement the general lighting and supply the approximately 50 foot candles that are required for reading black print on white paper, according to IES standards (Steffy, 2002).
- In the lobby, meditation and relaxation rooms, large conference room, and the open space perimeters, Lutron Recessed Compact Fluorescent Downlights (see Appendix C) would be installed. This lighting dims smoothly and continuously from 100% to 5% and creates low brightness to reduce glare. Using the dimmable option will create a warm ambience and enable adjustment of light levels as needed.

Automatic lighting controls would be added to reduce energy consumption for lighting. These occupancy sensors would turn the lights off in the private offices,

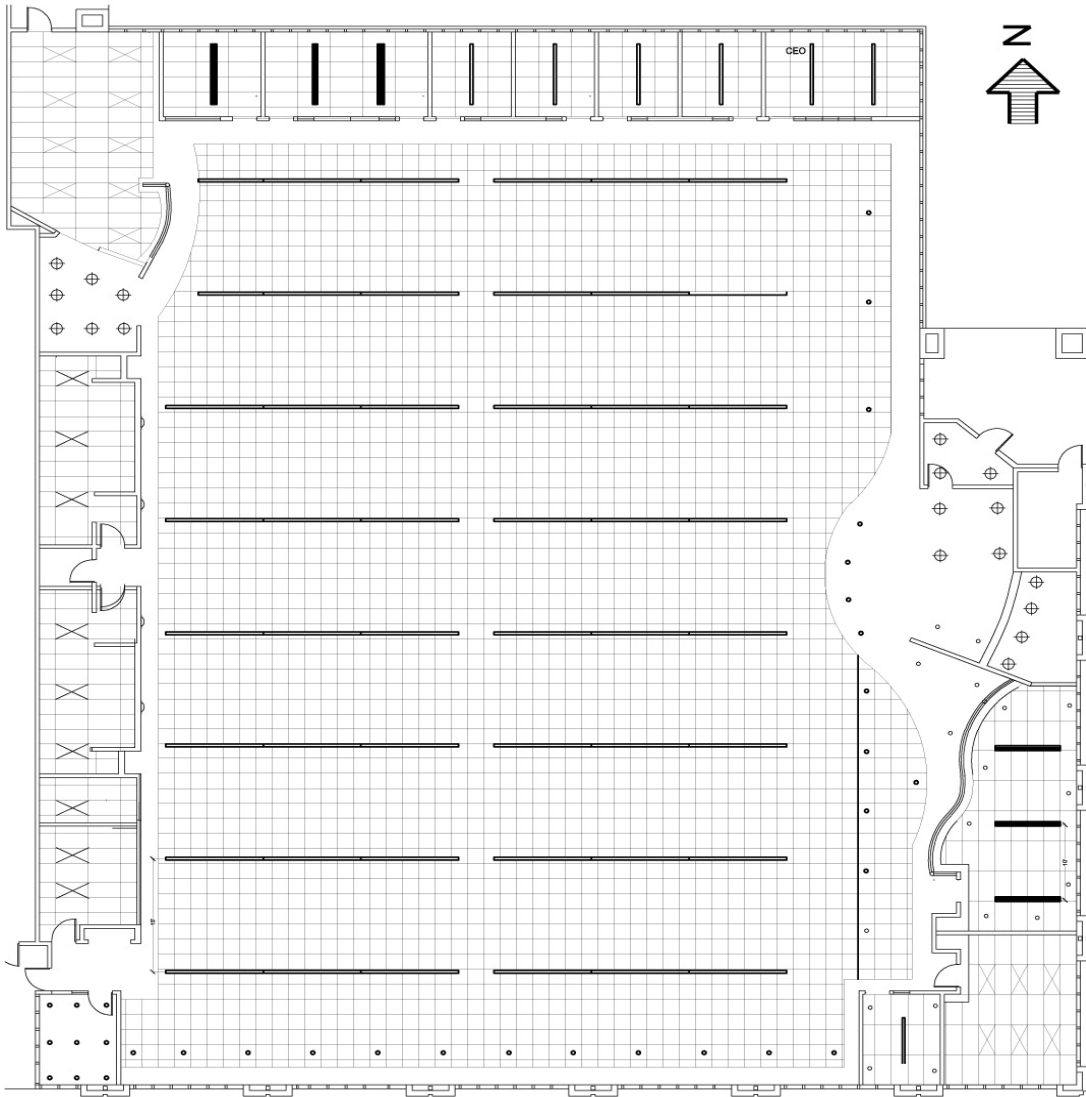
conference rooms, and exercise or mediation rooms when the room is not occupied for a specified amount of time.

### *Proposed Environmentally Responsible Materials*

Furniture and finishes selections would be based on using environmentally responsible materials to enhance employees' well-being, reduce their stress, and increase their productivity. As noted by Lockwood (2006), numerous studies demonstrate that green workplaces can raise employee productivity by up to 15% annually. A mere 1% increase in productivity can be worth as much as \$3 per square foot to a company annually, or \$600 to \$700 per employee per year.

#### *Furniture (See Figure 16)*

- Workstation furniture system: Resolve by Herman Miller. It is GREENGUARD™ certified as a low-emitting product that meets current indoor air quality standards. The Resolve system may contribute to LEED® credits due to its returnable/reusable packaging, durability, pre-consumer and post-consumer recycled content, and GREENGUARD™ certification. (See web page for more information: <http://www.hermanmiller.com/CDA/SSA/Product/1,1592,a10-c440-p150,00.html>)
- Private office furniture: Elective Elements 6 is made using water-based glues, stains, and topcoats, as well as UV finishes to significantly reduce VOC emissions. Water from the finishing process is cleaned and recycled in a



LIGHTING LEGEND	
⊕	EXISTING LIGHTING TO REMAIN
○	6" DIAMETER RECESSED DOWNLIGHT FMG: LUTRON LAMP: COMPACT FLUORESCENT
⌋	WALL SCONCE
⊗	2'x4' EXISTING FLUORESCENT
—	PENDANT FLUORESCENT FMG: FINELITE STYLE: SERIES 7 LENGTH: 8' LAMP: T5
—	PENDANT FLUORESCENT FMG: FINELITE STYLE: SERIES 7 LENGTH: 12' LAMP: T5
—	PENDANT FLUORESCENT FMG: FINELITE STYLE: SERIES 9 LENGTH: 8' LAMP: T5

Figure 15: Proposed Reflected Ceiling Plan

continuous loop. The particleboard found in Elective Elements 6 products is 100% recycled wood fiber. FSC (Forest Stewardship Council) and SFI (Sustainable Forestry Initiative) certified woods are available. The packing materials used for shipping are reusable and/or recyclable. (See web page for more information:

[http://www.steelcase.com/na/environmental\\_elective\\_elements\\_6\\_products.aspx?f=15904&c=21145](http://www.steelcase.com/na/environmental_elective_elements_6_products.aspx?f=15904&c=21145))

- Task chairs: Think chair by Steelcase (see Figure 17, A) receives Cradle to Cradle™ Product Certification from MBDC. The chair is up to 99% recyclable by weight and has about 44% recycled material. It holds the NF Environment Label in France for environmental quality and is GREENGUARD™ Indoor Air Quality Certified. (See web page for more information:  
[http://www.steelcase.com/na/think\\_products.aspx?f=11845](http://www.steelcase.com/na/think_products.aspx?f=11845))
- Conference chair: Chadwick by Knoll (see Figure 17, B) uses technologies such as integral coloring on plastic components and zero VOC paints. The chair is designed for durability and ease of disassembly so that parts can be removed and be replaced effortlessly. Raw materials with a recycled materials content of 41% are used. Chadwick™ provides solutions that contribute to earned LEED® credits. (See web page for more information:  
[http://www.knoll.com/products/product.jsp?prod\\_id=623](http://www.knoll.com/products/product.jsp?prod_id=623))
- Lounge seating: Salsa lounge chair and sofa by Knoll Studio (see Figure 17, C & D) are GREENGUARD™ Indoor Air Quality Certified® for low-emitting

- products. (See web page for more information:  
[http://www.knoll.com/products/product.jsp?prod\\_id=586](http://www.knoll.com/products/product.jsp?prod_id=586))
- Lounge team seating: Meet and Greet seating by Gunlocke (see Figure 17, E) has versatile components that can stand alone or form engaging groups. Wedge-shaped and rectangular seats and ottomans create configurations suitable for the different locations such as a reception area, the executive office, or the teaming room and can be easily changed, thus supporting design for flexibility, an environmentally responsible concept. (See web page for more information:  
[http://www.gunlocke.com/public\\_html/products/lounge/meetGreet.html](http://www.gunlocke.com/public_html/products/lounge/meetGreet.html))
  - Entry lounge bench: Lollipop Bench by J. Persing (see Figure 17, F) was created with sturdy plate steel plate and plywood-bent construction, which requires less than one-eighth the amount of lumber needed for conventional wood furniture. Non-toxic water-based adhesives are used. (See web page for more information:  
[http://www.vivavi.com/catalog/product\\_info.php?products\\_id=283](http://www.vivavi.com/catalog/product_info.php?products_id=283)).
  - Cafeteria or meeting tables: Tables by Scrapile (see Figure 18, G). Scraps are collected from a growing number of local woodshops, which prevents usable wood from ending up in landfills. (See web page for more information:  
[http://www.velocityartanddesign.com/scrapile\\_roundtable.html](http://www.velocityartanddesign.com/scrapile_roundtable.html))
  - Conference table: Ellipse table by John Wiggers (see Figure 18, H) is handcrafted from FSC (Forest Stewardship Council) certified sustainable wood. (See web page for more information:  
[http://www.vivavi.com/catalog/product\\_info.php?products\\_id=802](http://www.vivavi.com/catalog/product_info.php?products_id=802))

- Conference table: Kddo table by Material Furniture (see Figure 18, I) is handcrafted from FSC certified sustainable wood (See web page for more information:  
[http://www.vivavi.com/catalog/product\\_info.php?cPath=31\\_113\\_159&products\\_id=54](http://www.vivavi.com/catalog/product_info.php?cPath=31_113_159&products_id=54)).
- Coffee table for lounge area: Plyboo Square Table by Bettencourt (see Figure 18, K) is made from bamboo with non-toxic adhesives and finished with non-VOC Danish Oil. (See web page for more information:  
[http://www.vivavi.com/catalog/product\\_info.php?cPath=31\\_113\\_159&products\\_id=862](http://www.vivavi.com/catalog/product_info.php?cPath=31_113_159&products_id=862))
- Lounge tables: Island table by John Wiggers (see Figure 18, L) is constructed from FSC certified sustainable wood. The tables also feature a small inlay of rare Amboyna, a hardwood taken from the remaining board of the first sustainably harvested wood on the Solomon Islands. (See web page for more information:  
[http://www.vivavi.com/catalog/product\\_info.php?products\\_id=803](http://www.vivavi.com/catalog/product_info.php?products_id=803))
- Cafeteria stools: Xox Stools by Reform (see Figure 18, M) are constructed from bamboo, a rapidly renewable material. (See web page for more information:  
[http://www.vivavi.com/catalog/product\\_info.php?cPath=31\\_130\\_212&products\\_id=994](http://www.vivavi.com/catalog/product_info.php?cPath=31_130_212&products_id=994))
- Sconce lighting fixtures: Lulu by David Bergman of Fire & Water (see Figure 18, N) features a shade made of recycled plastic content with steel connectors. (See web page for more information:

[http://www.vivavi.com/catalog/product\\_info.php?cPath=31\\_82\\_175&products\\_id=841](http://www.vivavi.com/catalog/product_info.php?cPath=31_82_175&products_id=841))

- Task lighting: Leaf Personal Light by Herman Miller (see Figure 18, O) is up to 95% recyclable at the end of its useful life. Leaf may contribute to LEED credits due to its returnable/reusable packaging, durability, and pre-consumer and post-consumer content recycled content. (See web page for more information: <http://www.hermanmiller.com/CDA/SSA/Product/0,,a10-c440-p225,00.html>)
- Storage and filing systems: Meridian filing by Herman Miller (see Figure 18, P) is GREENGUARD™ certified as a low-emitting product that meets current indoor air quality standards. (See web page for more information: <http://www.hermanmiller.com/CDA/SSA/Product/1,1592,a10-c440-p111,00.html>).
- Lighting fixtures: Finelite: The fixture finish is an electrostatically, dry-applied epoxy powder coat that is thermo-fused at over 100°C to maintain indoor air quality during manufacturing and to produce durable product. No VOCs are emitted during finishing. (See web page for more information: <http://www.finelite.com/content/productset.html>)
- Lamps: GE Consumer & Industrial Ecolux® lamps. These lamps are low in mercury and feature outstanding performance and reliability, reducing waste disposal. All Ecolux® products pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test. This TCLP test characterizes fluorescent lamp waste as either hazardous or non-hazardous for the purpose of disposal. (See web page for more information:

[http://www.gelighting.com/na/business\\_lighting/education\\_resources/environmental/tclp\\_results.htm](http://www.gelighting.com/na/business_lighting/education_resources/environmental/tclp_results.htm))

*Proposed material and finishes*

The materials being proposed are environmentally responsible:

- Flooring: Bamboo by Sustainable Flooring has the lowest levels of formaldehyde in the industry (0.0127 ppm for “traditional,” 0.02 ppm for Strandwoven). In addition, this flooring uses only sustainably harvested, six-to eight-year old bamboo (see Figure 21.1). (See web page for more information: <http://www.sustainableflooring.com/bamboo-millwork.htm>)
- Flooring: Standard broadloom carpet product by Bentley Prince Street achieved certification through the new SCS (Scientific Certification System) Sustainable Choice™ carpet certification program. This new certification replaces the Environmentally Preferable Product (EPP) Standard to which Bentley Prince Street previously certified its products (see Figure 21.2). (See web page for more information: [http://www.bentleyprincestreet.com/cultures/en-us/bpc/responsibly\\_made/sustainable\\_choice.htm](http://www.bentleyprincestreet.com/cultures/en-us/bpc/responsibly_made/sustainable_choice.htm))
- Flooring: Carpet backing: High PerformancePC™ by Bentley is a post-consumer recycled content backing system that uses state-of-the art technology to recover mineral residuals from the global paper recycling industry in an environmentally friendly fashion for use in carpet backing. (See web page for more information: [http://www.bentleyprincestreet.com/cultures/en-us/bpc/responsibly\\_made/sustainable\\_choice.htm](http://www.bentleyprincestreet.com/cultures/en-us/bpc/responsibly_made/sustainable_choice.htm))



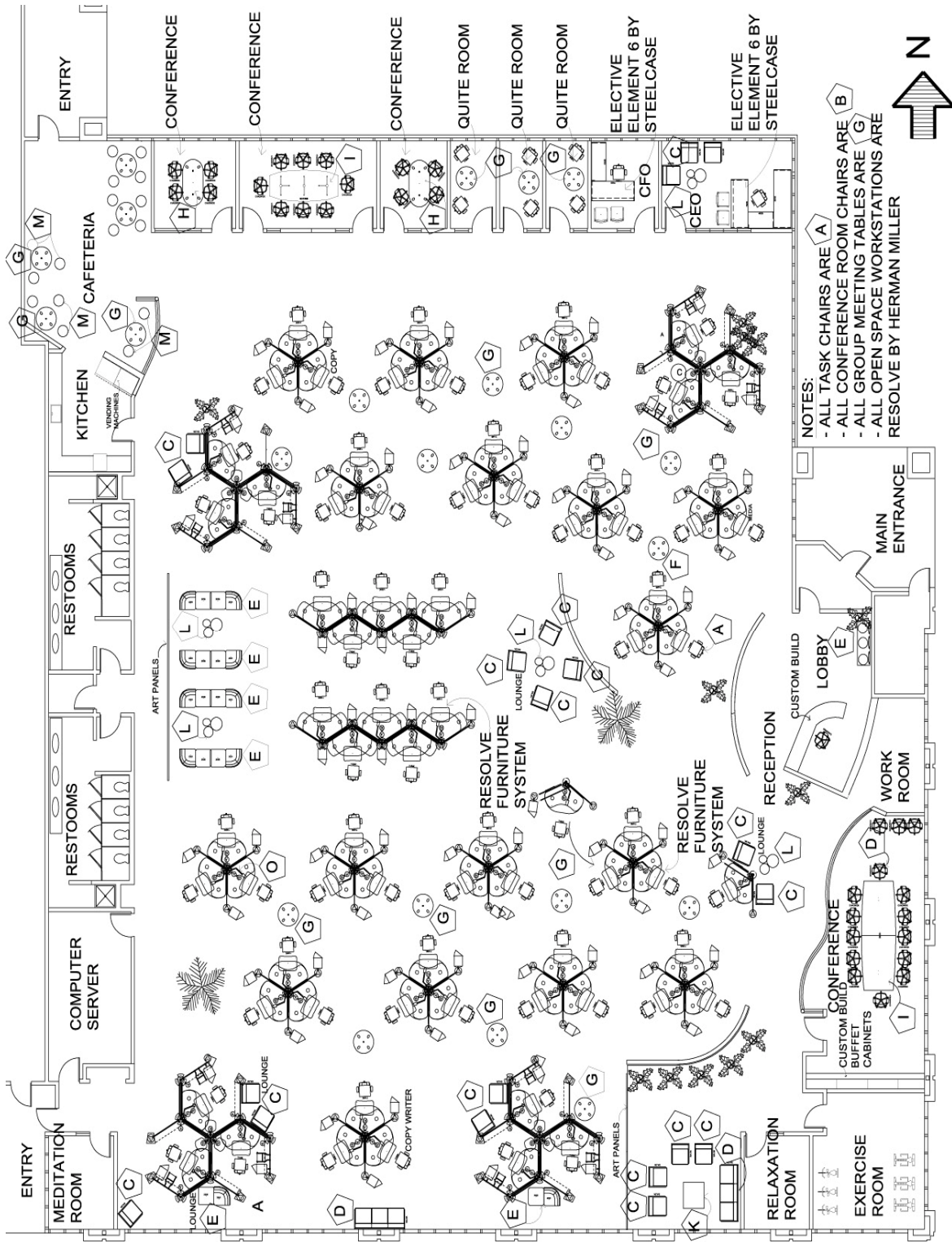


Figure 16: Proposed furniture schedule.



Figure 17. Proposed furniture board A

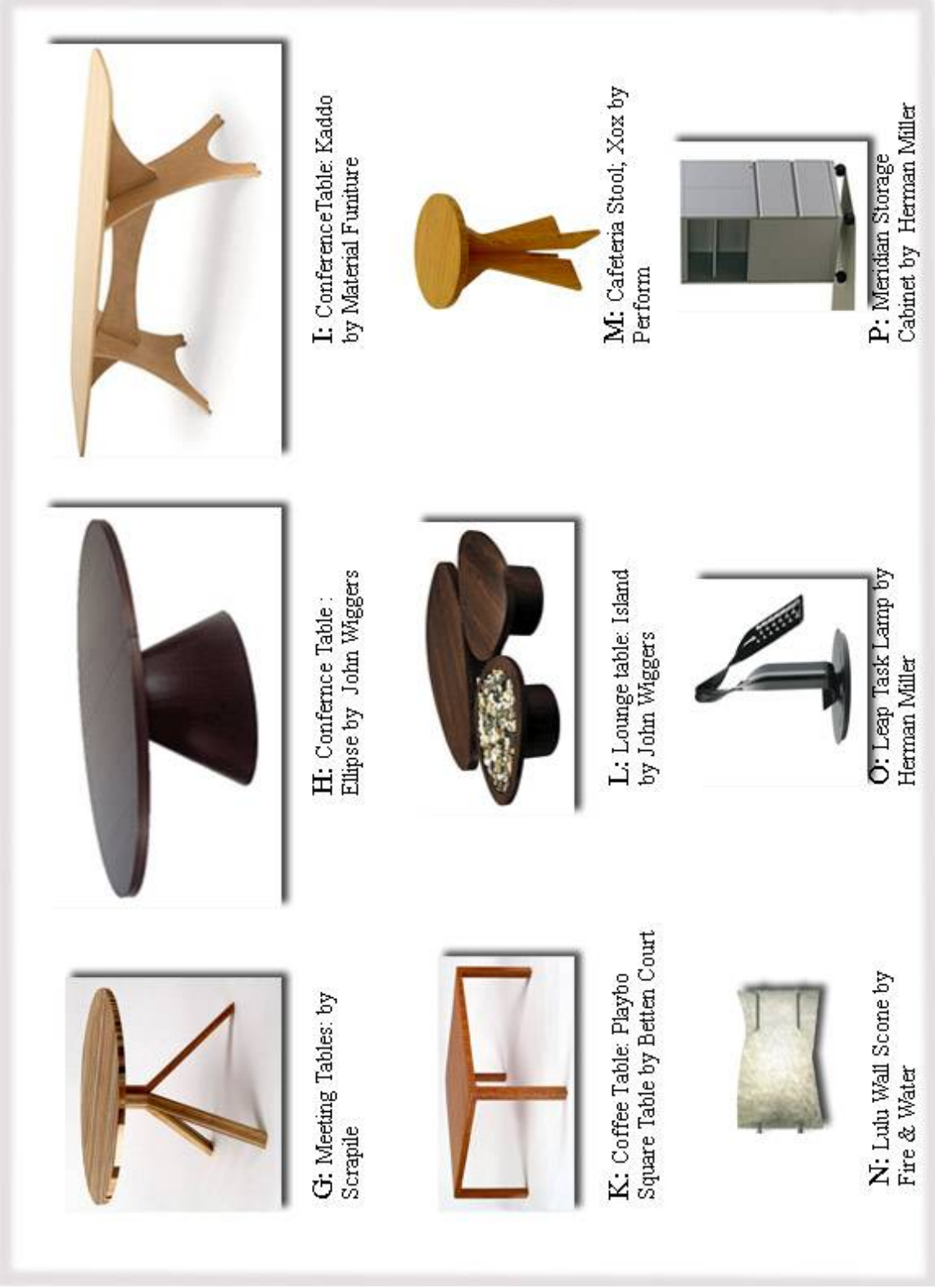


Figure 18. Proposed furniture board B

- Flooring: Cork by Unicork is a green, renewable, and natural resource. It is manufactured from cork tree bark that is harvested by hand. No trees are destroyed in the manufacturing of this product; the bark regenerates, making it a rapidly renewable product. It is resistant to mold and mildew and naturally hypo-allergenic. It is also acoustically superior in its performance and serves as a natural thermal insulator (see Figure 21.4). (See web page for more information: <http://www.tomkt.com/unicork/unicorkspecs.html#>)
- Flooring: Linoleum by Forbo is made from solidified linseed oil (linoxyn) and pine rosin in combination with cork dust over burlap backing. Linoleum also has naturally inherent anti-bacterial and anti-static properties. (see Figures 21.5, 21.6). (See web page for more information: <http://www.forbo-flooring.com/default.aspx?menuid=1596>)
- Worksurface: Wood veneer by Herman Miller. 90% of the wood fiber in the worksurfaces comes from a recycled or reclaimed material source (see Figures 22.1). (See web page for more information: <http://www.hermanmiller.com/CDA/SSA/Category/0,1564,a10-c689,00.html>)
- Restrooms tiles: Tiles by Sandhill Industries are composed of 100% recycled glass that is otherwise destined for landfills (see Figures 22.2). (See web page for more information: <http://sandhillind.com/productgallery.asp>)
- Art panels: by Veritas™ ResinArt™ Panels. These panels are made with an environmentally-friendly proprietary polyester-based resin. The panels are made without using hazardous substances such as halogens, sulfur compounds, nitrogen

- compounds or asbestos (see Figure 22.3). (See web page for more information: <http://www.veritasideas.com/Environmental.aspx>)
- Cabinets: Meridian with Powder Coat finishes by Herman Miller. The powder coat painting is more durable than other painted finishes, eliminates VOCs, makes product renewal and recycling easier, and allows for a more streamlined manufacturing process (see Figure 22.4). (See web page for more information: <http://www.hermanmiller.com/CDA/SSA/Category/0,1564,a10-c688,00.html>)
  - Kitchen tiles: Tiles by Sandhill Industries are composed of 100% recycled glass (see Figures 22.5). (See web page for more information: <http://sandhillind.com/productgallery.asp>)
  - Vertical Surface fabrics: DesignTex with 100% Recycled Polyester (see Figure 23.1). (See web page for more information: [http://www.360steelcase.com/e\\_article000154668.cfm](http://www.360steelcase.com/e_article000154668.cfm))
  - Upholstery (see figure 23):
    - DesignTex: Seating upholstery fabrics from the Environmental Impact collection with 100% recycled polyester. (See web page for more information: [http://www.360steelcase.com/e\\_article000154668.cfm](http://www.360steelcase.com/e_article000154668.cfm))
    - KnollTextile: Seating upholstery fabrics with recycled content or natural fiber. Included are fabrics with 100% recycled upholstery fabrics that have no added backing or finish, and are also recyclable at the end of their use. All KnollTextiles upholstery fabrics are GREENGUARD™ certified for low chemical emissions. (See web page for more information: [http://www.knoll.com/products/textileCatProducts.jsp?cat\\_id=161](http://www.knoll.com/products/textileCatProducts.jsp?cat_id=161))

- Paint (see Figure 24): Zolatone Polomyx. This all acrylic paint is extremely low in VOCs, is breathable, and contains active biocides to resist the growth of mold and mildew on the paint film. In addition, the water base finish is formulated for low odor. The pigment formulation produces a durable finish to avoid the need to frequent repainting (See web page for more information: [http://www.zolatone.com/content\\_polomyx\\_2\\_trad.html](http://www.zolatone.com/content_polomyx_2_trad.html))

FINISH PLAN /SCHEDULE	
<b>FLOORING</b> <input type="checkbox"/>	<b>WALL COVERING</b> <input type="checkbox"/>
<b>F-1</b> BAMBOO FLOORING MFG:SUSTAINABLE FLOORINS TYPE: BAMBOO VERTICAL NATURAL SIZE: 5/8" x 3-5/8" x RANDOM LENGTH	<b>W-1</b> MFG: ZOLATONE STYLE : POLOMYX TYPE: Star 4 COLOR: P2L-C1125
<b>F-2</b> CARPET MFG: BENTLEY PRINCE CARPET STYLE:SANSOVINO NUMBER: 8SV28 COLOR: BIANCO, 6475 BACKING: PRESTIGE PlusRC	<b>W-2</b> MFG: ZOLATONE STYLE : POLOMYX TYPE: Star 6 COLOR: P2L-C1222
<b>F-3</b> CARPET MFG: BENTLEY PRINCE CARPET STYLE: SISAL TWIST NUMBER: 4ST32 COLOR: BERSEK, 404383 BACKING: PRESTIGE PlusRC	<b>W-3</b> MFG: ZOLATONE STYLE : POLOMYX TYPE: Star 4 COLOR: P4M-C1112
<b>F-4</b> CORK MFG:UNICORK TYPE; NATURAL COLOR: LAVA TMU 2005	<b>W-4</b> MFG: ZOLATONE STYLE : POLOMYX TYPE: Star 4 COLOR: P4M-C1241
<b>F-5</b> LINOLEUM MFG: FORBO TYPE: MARMULEUM COLOR: DOVE BLUE 3053	<b>W-5</b> MFG: SANDHILL GLASS TILE SIZE: 4"X4" COLOR: WINTER GREEN FINISH: GLOSSY
<b>F-6</b> LINOLEUM MFG: FORBO TYPE: MARMULEUM COLOR: HIMALAYA 3141	<b>W-6</b> MFG: SANDHILL GLASS TILE SIZE: 4"X4" COLOR: PAPAYA FINISH: GLOSSY

Figure 19: Proposed finishes schedule. 3

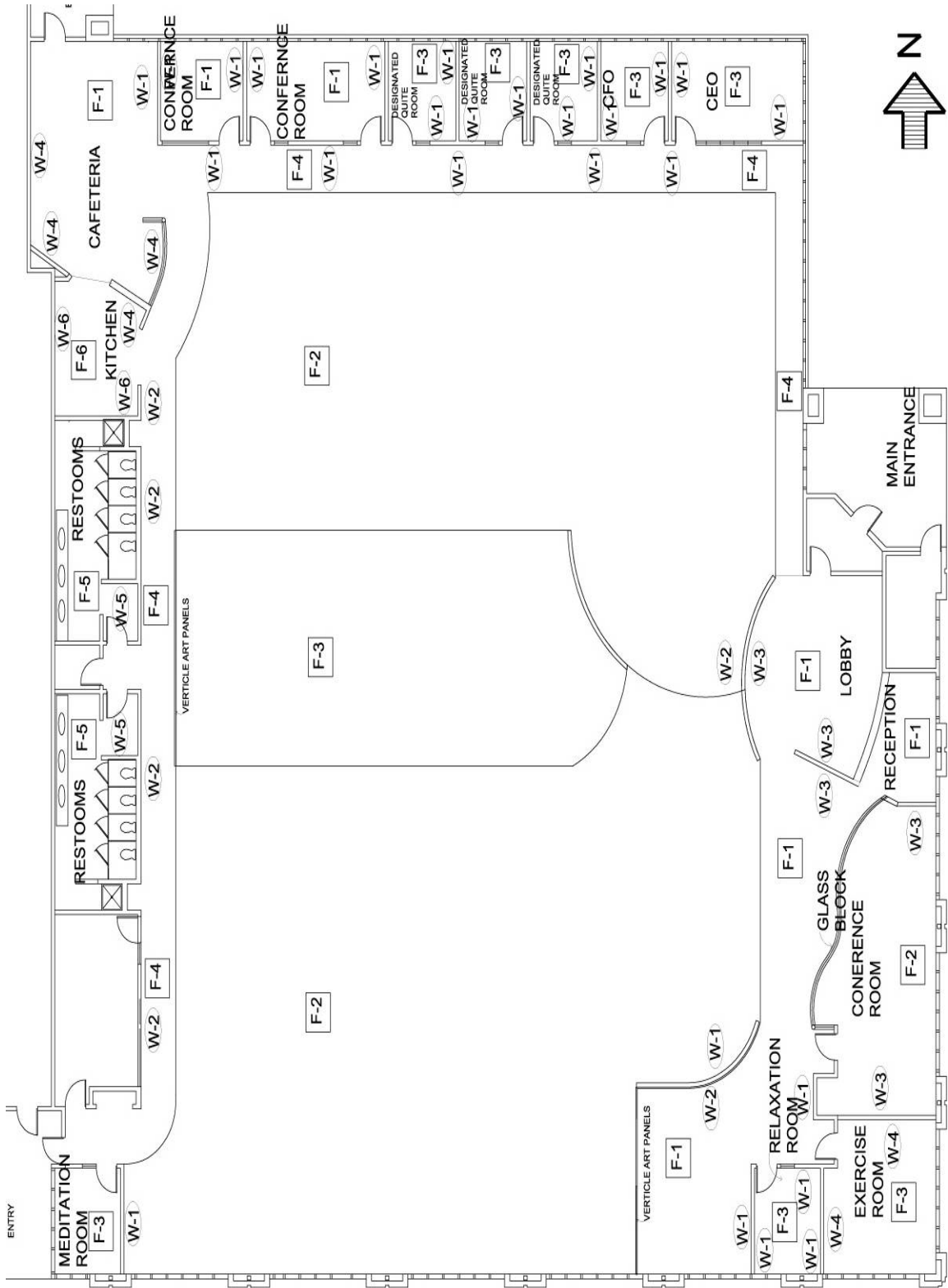


Figure 20. Proposed finishes plan



**1:** Floor: Bamboo Vertical Natural by Sustainable Flooring



**2:** Carpet: Sisal Twist, 4ST32, Berserk, by Bentley Prince Street



**3:** Carpet: Sansovino, 8SV28, Bianco, by Bentley Prince Street



**4:** Floor: Cork, Naturals, Lava Blond TMU 2005 by Unicork.



**5:** Floor: Linoleum, Marmoleum Real, Dove Blue, by Forbo.



**6:** Floor: Linoleum, Real Classic, Himalaya 3141, By Forbo.

*Figure 21. Finishes board A*





Figure 22. Finishes board B



Figure 23: Finishes board C

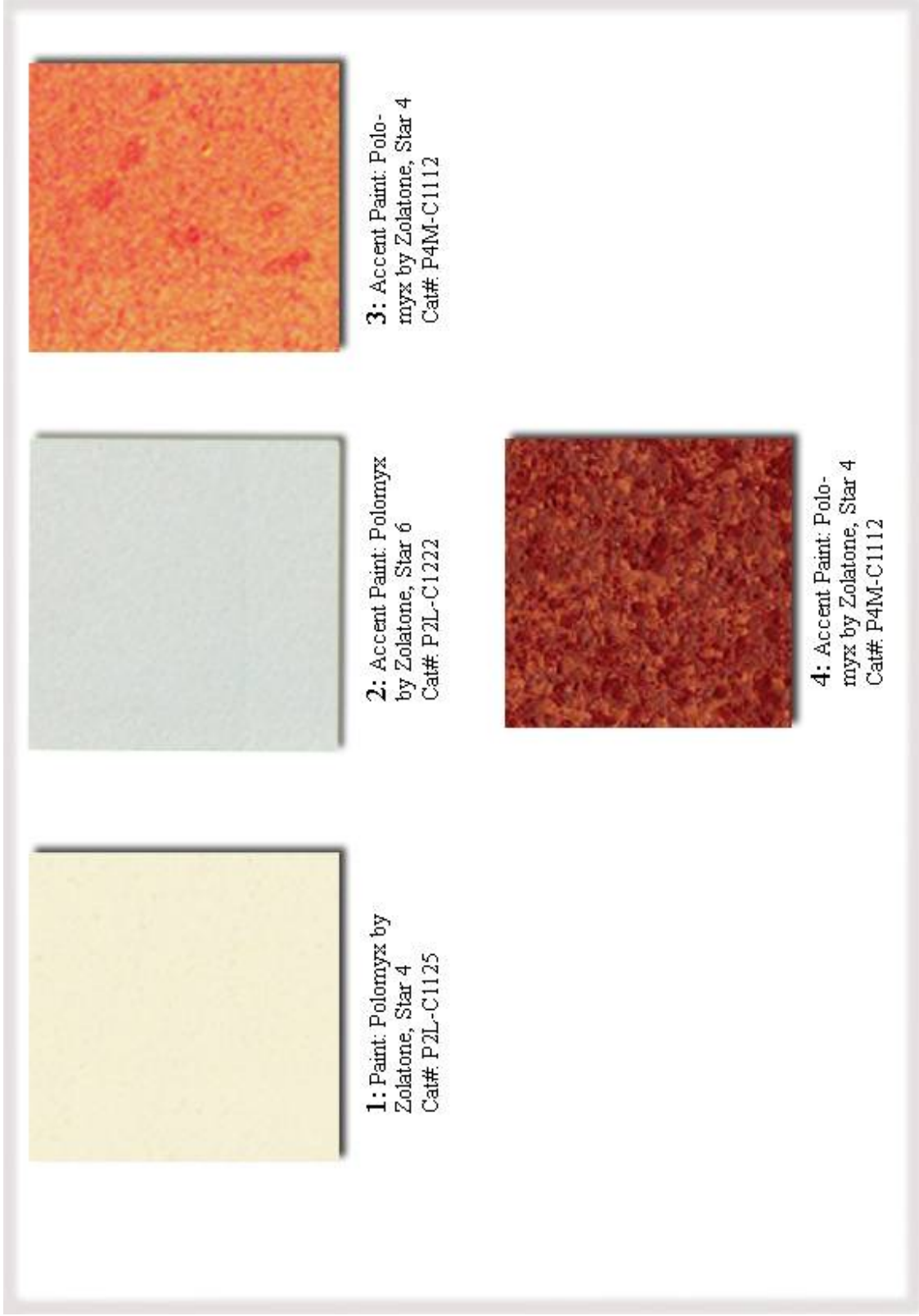


Figure 24. Finishes board D

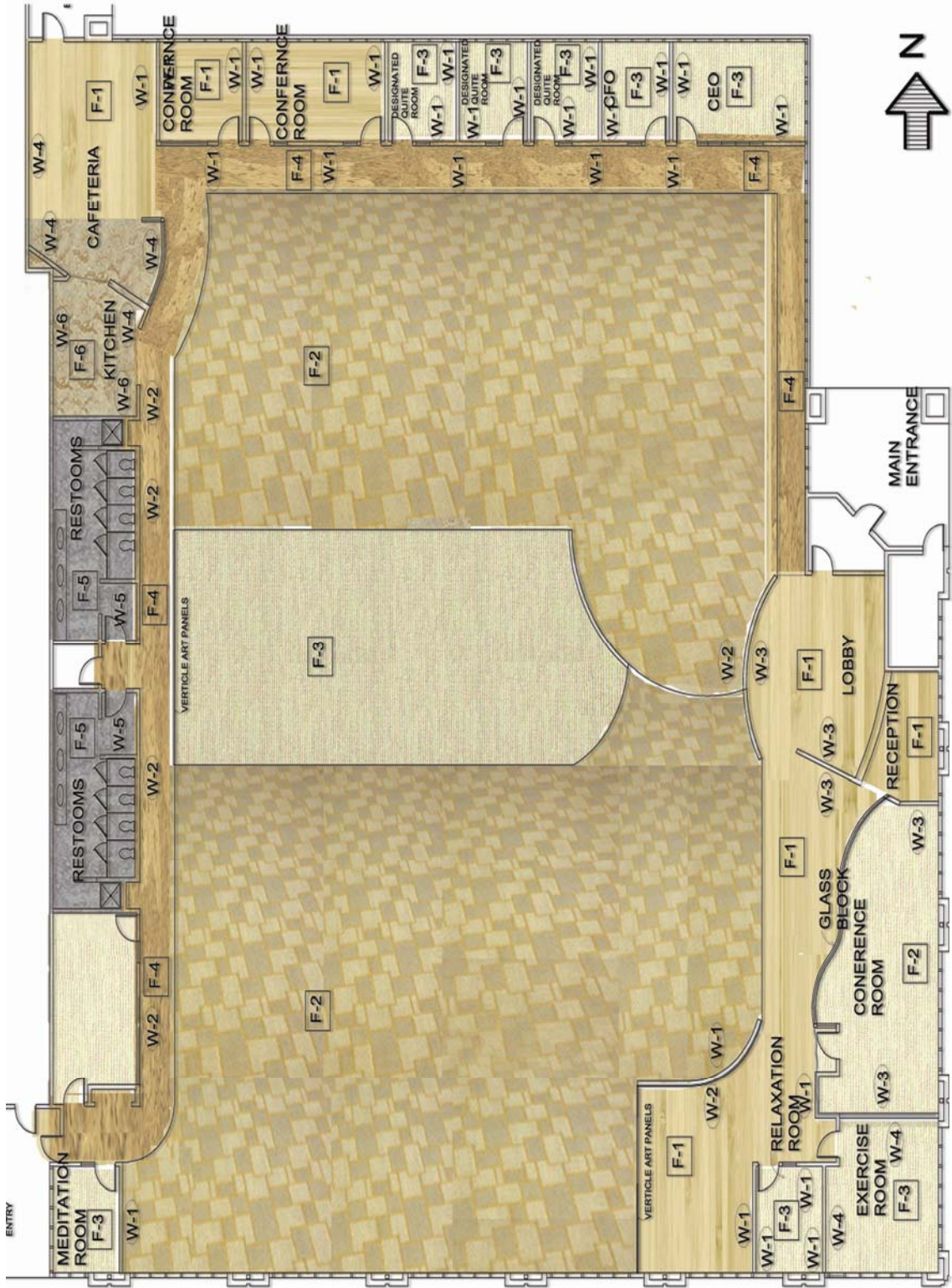


Figure 25: Rendered finishes plan.

## *Summary*

The space was evaluated and planned based on research that describes design techniques that can contribute to an increase in employee productivity and a decrease in stress. An important aspect of the conceptual design was the use of environmentally responsible materials, furnishings, and finishes as a means to enhance the quality of indoor air as well as to promote employees' well-being.

The new space was designed to accommodate teamwork and collaboration by using flexible furniture and an open configuration, where employees' workspace allocation would be based on team orientation. Private offices were reconfigured to be used as conference rooms and designated "quiet rooms." Alternative spaces were added to enhance productivity and creativity when needed. Meditation, relaxation, and exercise rooms were designed to promote a relaxing atmosphere. Increased daylight was used in addition to electrical lighting to increase employees' ability to perform their tasks while contributing to their overall morale. Environmentally responsible materials were specified to encourage a healthy environment.

## CHAPTER FIVE

### Summary, Recommendations, and Conclusions

#### *Summary*

This study was conceptualized to explore ways to increase employee productivity by reducing stress and providing a healthier indoor environment through implementation of interior design research and use of environmentally responsible finishes and furnishings to protect the health and well-being of both employees and global ecosystems.

The final office layout was designed to promote teamwork and collaboration, consistent with the business goals and strategic needs of the company. Labbs (2000) found that teamwork and flexibility are key factors in productivity (Labbs, 2000). This need is also emphasized by Monroe (1999, p. 12): “A physical environment that fosters interaction, whether in formal conference areas or in casual ‘collisions’ in corridors or break areas, is an important first step in team communication.”

In addition to the design strategy that promotes collaboration, additional areas were added to address the need for privacy and quiet, where employees could perform tasks requiring concentration. Mobile furniture was selected to provide flexibility in accommodating team meetings and gatherings of different sizes and to adjust more easily to future changes (Sterk, 2005). The furniture selected was ergonomic and adjustable for individual comfort levels.

Daylight provides important benefits to workers, including better visual acuity, a connection to nature, and enhanced productivity (Means, 2002). Therefore, daylight was used throughout the office to promote productivity. In addition, a combination of indirect

and direct electrical lighting was used to provide an even, glare-free ambience, while task lighting was added to increase light levels for specific tasks (Steffy, 2002). The colors selected were light and comforting to promote a relaxing ambience. An efficient integration of outside light from the windows and the light from the electrical lighting fixtures was encouraged to respond to research that shows higher productivity in daylight environments (Fisk, 2000). Where possible, plants were added to support and further the impression of a healthy environment in the work place.

An important component of stress management programs is relaxation centers that are analogous to fitness centers (Ernesto, 1997). Therefore, the design strategy included support spaces such as meditation, exercise, and relaxation rooms. These rooms would provide employees with comfortable, stress-free venues to enhance creativity and productivity.

The finishes and furnishings proposed were environmentally responsible in that they were free of VOCs, CFCs, formaldehyde, mold, and fungi. The decisions as to which materials and furnishings to choose were based on the US Green Building Council (USGBC) LEED rating system (2006). The primary evaluation criteria for the products were (see web page for further information

<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=145>):

- Low-emitting materials for adhesives and sealants, paints and coatings, carpet systems and composite wood.
- Daylight & views, with at least 75% day lit space.
- Recycled content, 10% minimum.
- Rapidly renewable materials.

- Certified wood.

In addition, materials and finishes that received environmental recognition and certification were chosen. The certifications included Cradle to Cradle™ Product Certification (manufacturing process), GREENGUARD Indoor Air Quality Certified®, contribution to LEED® credits, EPA Toxicity Characteristic Leaching Procedure (TCLP) test (fluorescent lamps), Environmentally Preferable Product (EPP), and SCS Sustainable Choice™ (carpet organization).

#### *Limitations of Study*

The design of this study was based on extensive research regarding design of the office work environment as well as personal experience working in advertising. One of the primary limitations of the conceptual design proposed herein is that no budget limitations were assumed, and it was never implemented. Therefore there is no empirical way to measure the success or failure of the interior design proposals to determine if, in fact, there was a reduction in stress and/or increase in productivity as a result of the proposed solutions. Another significant limitation of the study was the practical inability to receive input and feedback from employees who might actually work in this space. One can assume that an improved indoor environment would have a positive outcome, but this assumption could not be tested within the scope of this study.

Finally, it was assumed in the design of the concept presented herein that builders, contractors, and various craftsmen who would be involved in the renovation would all be familiar with issues of environmental responsibility and possesses the necessary experience, training, and background to carry out the project.



### *Recommendations for Future Work*

In the future it will be necessary to carry out a more rigorous quantitative analysis that will examine whether indeed there is a positive correlation between a workspace design that uses the space planning theory and employs the environmentally responsible materials and furnishing presented in this study and a reduction of employee stress and an increase in employee productivity. This will require research in a number of different buildings, each with different business goals and tasks. Such studies are likely to shed light on the extent to which the principles described herein are suitable for large variations in work groups with different skills, training, and jobs. It will be necessary to examine the cost of implementing the design solutions developed for this study. Ultimately, the primary goal in each case will be to enhance worker productivity by reducing stress and enhancing the employee's well-being.

This research should also include detailed surveys to obtain feedback from workers, administrators, builders, and designers. This feedback will include their views towards development of new ideas and solutions to existing problems while working within a budget. In order to enhance the importance of the finding, a national study with a random sample would be required so that the conclusions could be generalized from the sample of office environments involved in the study to the general population of offices in the United State. This kind of study should involve a multidisciplinary approach involving inputs not only from a designer who is schooled in environmentally responsible interior design, but also the participation of a statistician, a psychologist, and possibly an expert in personnel management.

## *Conclusions*

Based on the research cited in this study, it is clear that the stress levels, health, and productivity of people in their workplace can be greatly influenced by the environment and physical work space they occupy on a daily basis. It is important to continue to educate the business community regarding the direct benefits of providing an improved work environment. Good working environments can help employers recruit and retain well-qualified employees, and any improvements in the well-being of employees are in the best interests of the employers themselves.

Before embarking on a design project, the designers must review the literature to identify the design theories and research that will guide design decisions (i.e. research-based design). In this project there were two areas of interest: 1). reducing stress among employees and 2). creating greater productivity for the company. Of equal importance is the need to educate the community about the benefits of using environmentally responsible furnishing and finishing materials, which are now widely available. Increased use of these materials not only benefits the individuals in the workplace, it contributes to protection of global ecosystems. The research that supports this study suggests that a company that provides a well-designed work environment not only enhances the well-being of its employees but also increases productivity and may ultimately reduce its healthcare costs. Furthermore, it will set an example in the community as an environmentally responsible employer and member of that community.

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## APPENDIX A: FINLITE SERIES 7 CUT SHEET

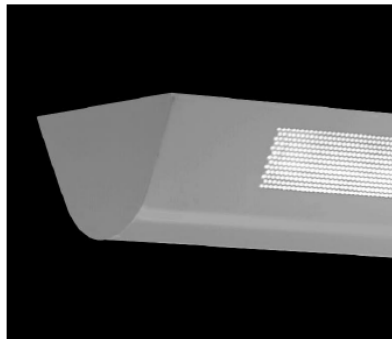
# AppGuide™

## Finelite Series 7

Specular Reflector

### OPEN OFFICE AND SMALL OFFICE

Start with this information to see how Series 7 can be used to light a open office or small office. Many other layouts are possible and we would be glad to calculate the results for you.



Actual field results may vary. Finelite recommends that design professionals be consulted when planning how to integrate lighting into the overall design of a project. See the Series 7 Technical Sheet in the Finelite Catalog for complete ordering information.

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HOT5 OPEN OFFICE APPLICATION TABLE								
Ceiling reflectance: 80%								
Avg. Footcandle = (initial level) * (.65 light loss factor)								
Area greater than 32' by 40', Ceiling height 8' to 10'								
Target Level	Row Centers	# of Lamps	Suspension					
			12"	15"	18"	21"	24"	
50 Fc	10'	1 HOT5	Avg. Maintained Footcandles	59	59	59	58	58
			Ceiling Uniformity	14:1	10:1	7:1	6:1	4:1
			Ceiling Brightness (cd/m <sup>2</sup> )	611	545	491	444	403
			Avg. Maintained Footcandles	48	48	48	48	48
			Ceiling Uniformity	15:1	12:1	9:1	7:1	6:1
			Ceiling Brightness (cd/m <sup>2</sup> )	460	439	411	384	359
	12'	1 HOT5	Avg. Maintained Footcandles	44	44	44	43	43
			Ceiling Uniformity	15:1	13:1	11:1	9:1	7:1
			Ceiling Brightness (cd/m <sup>2</sup> )	348	345	340	323	309

TABLE DATA IS BASED ON THE FOLLOWING CRITERIA:

Fixture Length 36"	Light Loss Factor .77
Ceiling Height 9'6"	Latmp Lumens 5,000
Reflectance 80/50/20	Room Size (10' row center) 40' by 40'
Ballast Factor 1.0	Room Size (12' row center) 48' by 40'
	Room Size (15' row center) 60' by 40'
	1 latmp ITL test #48495

○ = meets IESNA recommendation of ceiling uniformity for open plan office with intensive VDT use.

T5 SMALL OFFICE APPLICATION TABLE						
Room Size	Target Fc Level	Fixture Length	# of Fixtures	# of Lamps		T5 Specular
8' by 10'	30	4'	1	3	Avg. Maintained Footcandle	31
	50	8'	1	3	Avg. Maintained Footcandle	57
8' by 12'	30	4'	1	3	Avg. Maintained Footcandle	27
	50	8'	1	3	Avg. Maintained Footcandle	51
10' by 12'	30	6'	1	3	Avg. Maintained Footcandle	33
	50	8'	1	3	Avg. Maintained Footcandle	46
10' by 14'	30	8'	1	3	Avg. Maintained Footcandle	44
	50	12'	1	3	Avg. Maintained Footcandle	60
12' by 12'	30	6'	1	3	Avg. Maintained Footcandle	31
	50	8'	1	3	Avg. Maintained Footcandle	43
12' by 15'	30	8'	1	3	Avg. Maintained Footcandle	37
	50	12'	1	3	Avg. Maintained Footcandle	54

SMALL OFFICE TABLE DATA IS BASED ON:

Ceiling Height: 9'0"	Ballast Factor 1.0
Suspension 15"	Latmp Lumens 2,900
Reflectance 80/50/20	3 lamp ITL test #48497

IESD 750-249

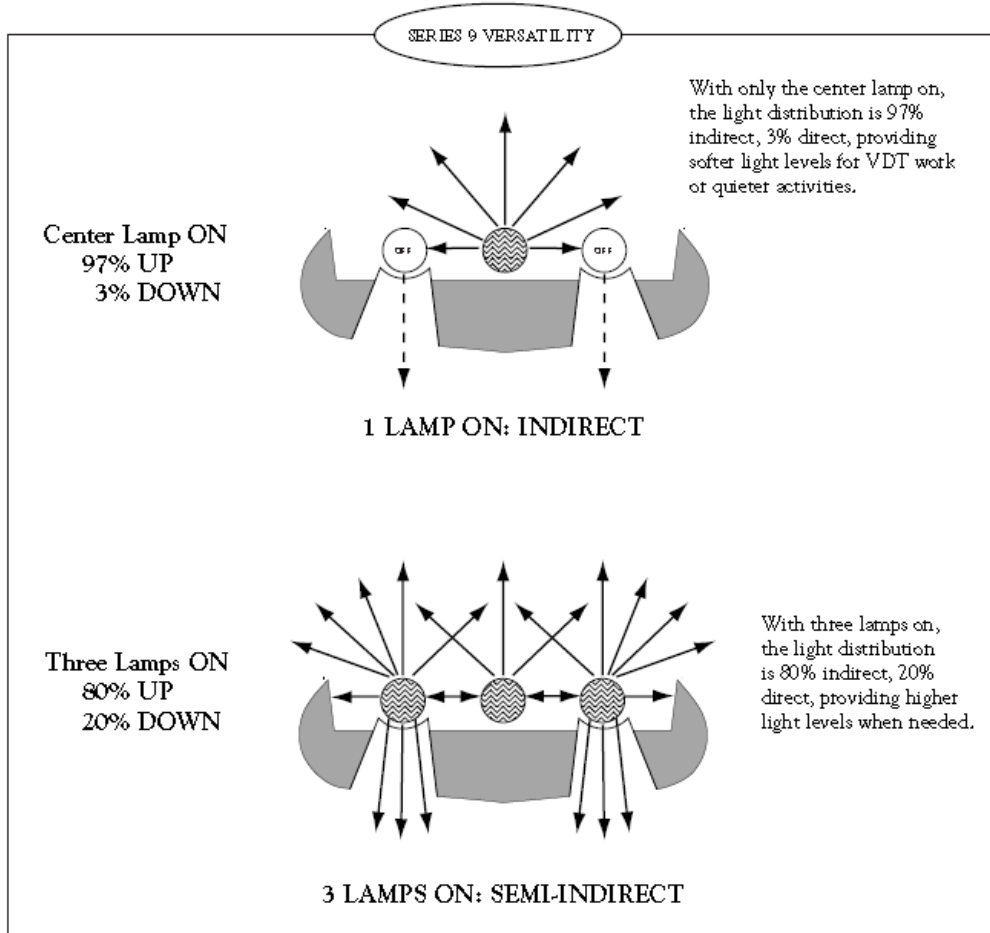
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APPENDIX B: FINLITE SERIES 9 CUT SHEET

AppGuide™

Finelite Series 9 - EP

Lighting Application Guide



Use this guide to evaluate how **Finelite Series 9** may perform in your application. On the pages which follow, projects have been grouped into 3 categories:

**OPEN OFFICE:** area greater than 32' by 40', ceiling height 8' to 10';

**CONFERENCE ROOM & CLASSROOM:** area 16' by 20' to 30' by 30', ceiling height of 8' to 10';

**SMALL OFFICE:** area smaller than 15' by 12', ceiling height of 8' to 10'.

Finelite strongly recommends that professionals such as architects, interior designers, electrical engineers, or lighting designers be consulted when planning how to integrate lighting into the overall design of each project.

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## APPENDIX C: LUTRON RECESSED COMPACT FLUORESCENT DOWNLIGHTS

### CUT SHEET



DIMMABLE FIXTURES

**Recessed Compact  
Fluorescent Downlight**

## Recessed Compact Fluorescent Dimmable Downlight



### FEATURES

- Low brightness 6" downlight.
- Dims smoothly and continuously from 100% to 5% measured light.
- Includes a pair of mounting bars for use in T bar ceilings.
- Models for 120 and 277 volts.
- Removal of reflector allows access to the ballast and junction box.
- UL listed for damp locations, Class P thermally protected ballast.

### FINISH

- Reflector is a clear aluminum finish.
- Trim ring is a clear aluminum finish.

### DIMMING PERFORMANCE

- Dimming range – 100% to 5%
- Power factor greater than .95
- Total harmonic distortion less than 10%
- Designed to withstand surge voltages of 4000 volts as specified in ANSI C62.41
- Better than Class A sound rating
- Ballast meets FCC Part 18 regulations for RFI/EMI
- No visible lamp flicker
- Ballasts strike lamps at any light level without first flashing to full light

### CONTROLS

The following controls are available for use with Lutron dimmable fixtures.

- RadioTouch™
- Nova T☆™
- Ariadni™
- GRAFIK Eye™
- Nova™
- Vareo™
- Spacer™ System™
- Diva™
- microWATT™
- PerSONNA™
- Skylark™
- Digital microWATT™

### LAMPS

- Requires one 32-watt, 4-pin, triple tube compact fluorescent lamp by GE, OSRAM/Sylvania or Philips.
- Lamps must be run at full intensity for 100 hours before dimming
- Lamps are not included with the fixture