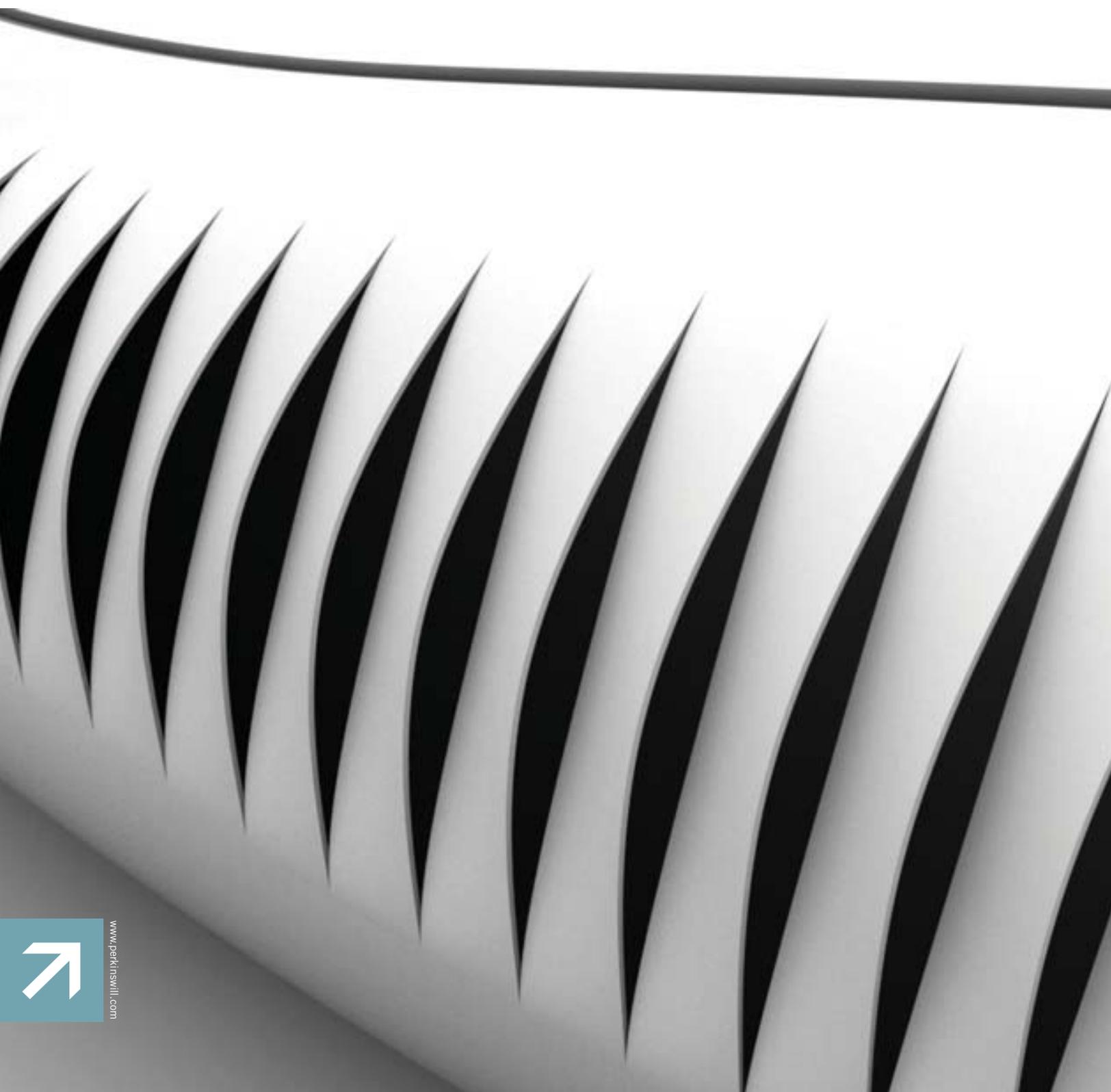


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## 05.

### TRANSCENDING PROJECT TYPE – PRINCIPLES FOR HIGH PERFORMANCE

#### INTERIOR DESIGN: *High Performance Interiors + Evidence-Based Design*

**Joan Blumenfeld, FAIA, LEED® AP,** *joan.blumenfeld@perkinswill.com*

**Carolyn BaRoss, ASID, IIDA, LEED® AP,** *carolyn.baross@perkinswill.com*

**Sonya Dufner, ASID, LEED® AP,** *sonya.dufner@perkinswill.com*

#### ABSTRACT

In a diverse design practice such as Perkins+Will, we have found recent trends in interior design that reach across market sectors that appear to link aspects of environmental design to improvements in productivity, health and learning capacity. Several common attributes or trends are found to occur in all project types, regardless of the particular functionalities of the spaces under consideration. Are there actually metrics that will link these attributes to improved performance or health? Does research within any particular market sector relating to the discrete parameters for success within that project type support the importance of these attributes in a high performance interior?

**KEYWORDS:** evidence based design, higher education, healthcare, corporate, office, civic, cultural, and research

#### 1.0 INTRODUCTION

“Evidence-based design” has used research to tie principles of design to fulfilled business, learning and wellness goals. This has become possible through an examination of successfully realized projects and the aspects of those projects that can be linked back to gains in wellness, productivity or satisfaction in finite metrics. For the purpose of this paper, we have chosen to focus on a few of these aspects that reverberate through all high performance interior design regardless of market sector: collaborative spaces, modularity/flexibility, sustainability/wellness and daylighting. There are many other ways to parse high performance design, but these four have become some of the mainstays of design for modern interiors and are easy markers for the cultural movements that are motivating environmental change, regardless of environmental function. Over the past ten to fifteen years, these trends have become dominant for a number of reasons that have not necessarily been proven, but have become the prevailing wisdom. Is there research across market sectors that can tie these prevalent trends to improvements in performance, health and well-being? In this paper we will survey the literature regarding these attributes in each one of the market sectors separately, in an attempt to determine whether there are metrics to prove out the efficacy of these trends from the standpoint of the user.

#### 2.0 TRENDS IN MODERN HIGH PERFORMANCE INTERIOR DESIGN: COLLABORATIVE SPACES, MODULARITY/FLEXIBILITY, SUSTAINABILITY AND DAYLIGHTING

##### 2.1 Collaborative Spaces

As perspectives on office culture, pedagogy and healing methods change, environments increasingly provide spaces for people to gather, collaborate and connect in both formal and informal ways. Modern workplaces often provide open workspaces and a range of meeting areas for employees to interact and exchange ideas, from small teaming areas to larger, reconfigurable conference rooms. In response to contemporary approaches to pedagogy, schools have started to accommodate the varying ways students learn in and out of the classroom. Healthcare facilities have also begun to rethink their facilities as both collaborative workplaces and places for patients to heal through personal connections to others. The common thread is a revived belief in the value of human interaction in daily life.

##### Healthcare

Two comprehensive studies “A Review of the Research Literature on Evidence-Based Healthcare Design” and

“The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity” by Ulrich et al., and additional publications from The Advisory Board Company; “Taking Note Noise, Hospitals Making Facility and Unit Changes to Lower Noise Volume” by Oncology Insights are less specific about studies on collaboration spaces per se, but point more to aspects of collaborative experiences that lead to positive results, through enhanced communication, social support and acoustical control. Examples of this include unit configuration to reduce walking and maintain continuity of patient information between staff, by minimizing patient bed transfers through single-occupancy, acuity adaptable rooms<sup>1</sup>. In private emergency treatment rooms and in private inpatient rooms, the confidential setting leads to perceived improved communication between patients and caregivers<sup>2</sup>. To create environments that allow quality sleep and minimize staff and patient stress, dedicated areas for conferencing and collaboration help in controlling noise and maintaining patient privacy by reducing corridor conversations<sup>1,3</sup>. Hybrid models of decentralized and centralized nursing care alleviate stress and burnout in nursing by providing social support and reducing a sense of isolation<sup>1</sup>. Dedicated family areas in patient care settings lead to improved outcomes by encouraging social support and helping to reduce stress levels<sup>1</sup>.

From these examples it is apparent that, whether designed for intentional or opportunistic and serendipitous collaboration, caregivers need places where they can comfortably work and collaborate and communicate with patients and families to lead to better patient outcomes.

In addition, teaching hospitals generally require dedicated team conference and work areas to facilitate the teaching process. In certain cases, institutions such as Mayo Clinic organize care delivery through a multidisciplinary team approach and the physical environment must support this.

**Workplace**

For years, designers have struggled with a client’s request to provide visual access among employees that need to share knowledge and interact, balanced by the requirement to work effectively by oneself. The necessity to go back and forth between focused and collaborative work is supported by workplace studies that suggest collaborative work environments are linked to productivity. One of those studies in the international journal, Building and Research Information, found that co-location of teams in the same general area can provide a balance that allows individuals to work for periods of time undisturbed by positioning themselves to signal



Figure 1: Mayo Hospital, Jacksonville, Florida plan with features that support teaching program and collaboration.

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different levels of concentration and interaction. Other solutions, such as 'co-location' stimulate areas of practice and promote spontaneous encounters as well as 'heads down' work. Allowing staff the flexibility to work from home or in the field and then connect back with other team members in the office at designated times has also been found to have positive correlations with productivity through user choice of workplace environment<sup>4</sup>.

Evidence in the article, "Designing Space to Support Knowledge Work", suggests that the layout of the physical environment can influence social- and task-based interactions in the work experience and that both of these interactions have an impact on achievement, worker productivity and morale. Designing space to reduce perceived worker distance from team members and to foster interaction and collaboration has been shown to improve the flow of communication in groups<sup>5</sup>. A study at Cornell University International Workplace Studies Program suggests that the typical high-paneled cubicles made famous by Dilbert cartoons are generally dysfunctional and that more team-oriented spaces provide opportunities to increase efficiency both in space and work product.



Figures 2 and 3: New York office of Perkins+Will collaborative workspace images.

Research by O'Neill, "Measuring Workplace Performance", examines human resources, procurement, finance as well as other functional areas and confirms that designing workspace to foster group work and collaboration has a positive impact on business process time and cost. Workers who moved from private offices to a collaborative, open work environment realized performance increases in speed and accuracy of work<sup>6</sup>.

### Education

While there is not much literature showing measurable productivity gains through the provision of collaborative space, educational learning theory has focused on the necessity for schools to provide many different types of environments for learning. The classroom has become only a single unit in an overall network of opportunities for "productive collisions". The internet provides an essential tool for students, a tool that can be accessed any time and any place. Settings such as lounges and touchdown areas provide the physical environment where this access can be afforded<sup>7</sup>.

There has, however, been literature in psychology journals such as *Environment and Behavior* that generally ties the physical environment to quality of learning in a quantitative way<sup>8</sup>. This relationship is being explored in a long term (30-month) study, commissioned by the Department for Children, Schools and Families (DCSF) in Great Britain. The study will examine how space that has been "personalized" into more collaborative and diverse environments improves learning and student morale.

There is also a body of work available on the topic of collaborative space on the website for EDUCAUSE, an organization that is predicated on the development of innovative learning environments. The website contains

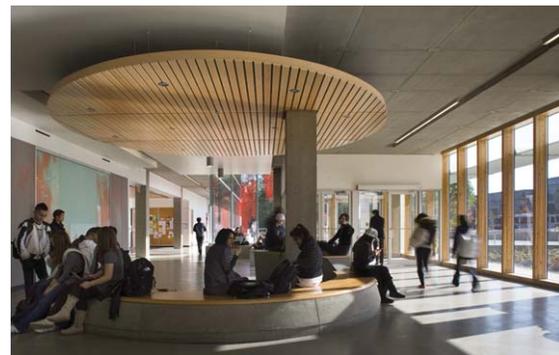


Figure 4: Students meet and study at Simon Frazier University in circulation zones.

links to articles regarding the development and necessity for innovative and collaborative approaches, given the high degree of technology integration within student life, with the personal and the academic intertwined through the internet and other electronic connectivity<sup>7</sup>. The classroom thus has become only one element in institutional learning patterns, particularly at the level of higher education. Public space has now taken on a function of learning space through social and technological interplay and the spaces “in between” become instrumental in supporting this type of learning. These spaces also serve as branding, displaying the open and transparent nature of the institution through the encouragement of student interaction. There is general recognition by educators, such as Chris Johnson at the University of Arizona or Kenneth Bruffee at Johns Hopkins, that open space is necessary for group identity to occur at a large scale, allowing students to participate in a community setting<sup>7,9</sup>.

## 2.2 Modularity and Flexibility

The flexibility of physical spaces has become a critical criteria for performance from economic, environmental and social sustainability perspectives. The ability for an organization to adapt its facilities according to increasingly faster changes in technology, philosophy and business has been a design driver, only balanced by financial concerns. Designers have used many different strategies for accommodating future change within the design of a physical typology as well as in infrastructure and technology.

### Healthcare

Planning for change in anticipation of future care models and technologies to provide long-term economic value has become standard practice. One strategy for addressing this is through standards and modularity, which can accommodate future growth and allow flexibility in use via scheduling or without disruptive renovation in occupied spaces.

In the hospital setting, research by Ulrich et al., focuses on inpatient environment, specifically patient rooms, and conclude that patient rooms be private, and acuity adaptable with standardized room design and same-handed layout<sup>1</sup>.

One important aspect of standards for private patient rooms has a relationship to human health. In the United States, hospital acquired infections are one of the leading causes of death<sup>10,11</sup>. In a report by the Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention (CDC) “Preventing Healthcare

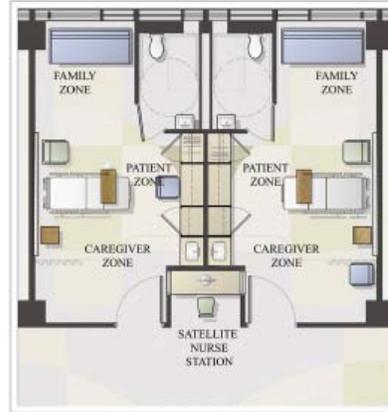


Figure 5: Mayo Hospital acute care room.

Associated Infections” to the Council of State and Territorial Epidemiologists on June 7, 2009, cited Klevens, et al. Public Health Report, 2007, that there are 1.7 infections acquired in US hospitals annually, or 1 in 20 patients. Of these cases, 99,000 people die<sup>12</sup>. There are complex procedural recommendations to help curb this problem, including hand washing and contact precautions and research investigated by Ulrich et al. has demonstrated that an architectural solution of single patient rooms can also contribute to reducing the spread of infection, and this recommendation has been endorsed and is now recommended by the AIA Guidelines for Healthcare Design<sup>1,2</sup>.

### Workplace

When considering an investment in a major renovation, a client will usually measure the success of a new workplace by cost savings, rather than looking at the business case for design. Even less often do clients implement any ongoing measurement programs to assess and improve the quality of the work environment. In his book “Measuring Workplace Performance”, O’Neill reviews multiple case studies that focus on how the incorporation of flexibility and control into a workplace design improves employee and organizational performance and can provide metrics for future renovations<sup>6</sup>.

Today’s workplace design is influenced by a desire to reduce cost, increase density or adjust for higher churn rates that require workspace to be flexible so that employees or departments can be easily rearranged around the building. Different levels of mobility and technology need to be accommodated and supported in the modern open office. Densification is relatively inexpensive as compared with leasing more space, so it is often a solution that is considered first. In our own offices, we frequently move staff around so that teams

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working on the same project sit together. In the photo below of our New York office you can see that everyone sits in the same size workstation in an open environment with team rooms located at the core. Furniture is designed with mobile tables and storage to allow for flexibility when shifting around teams.



There is a movement gaining popularity in higher education called SCALE UP—Student-Centered Active Learning Environment for Undergraduate Programs. Originally started for the teaching of physics, it has now expanded to all types of learning. Individual universities have been doing their own proprietary studies, show-



Figures 6a-b: New York office of Perkins+Will open office workspaces.

Fewer and more flexible standards mirror flatter and more nimble organizations. Linking workspace with function rather than hierarchy or status compliments modern management theory and allows for this flexibility.

## Education

At the level of the classroom, there has been a significant movement away from traditional lecture style learning<sup>13</sup>. This movement is in parallel with the understanding of the need for collaborative space at many scales mentioned previously. Modern teaching styles require a flexible environment, encompassing a traditional lecture arrangement along with more interactive and collaborative settings. Brown and Lippincott, in their article “Learning Spaces, More than Meets the Eye”, again make the point that technology and the student’s intimate relation to the internet plays a significant role in this transformation<sup>14</sup>.

These new teaching methodologies require flexible and modular physical arrangements. The standard classroom for 30 to 40 students traditionally had rows of seats with tablet arms on which to take notes<sup>15</sup>. Laptops have made even the tablet arm itself obsolete. As most students will take notes electronically, the tablet arm is simply too small. Flexible tables that can be arranged in rows for lecture style teaching, in “u” shapes for seminars or completely separated for learning in groups have replaced the tablet arm chair<sup>13,16</sup>.

ing improved test scores in classrooms where teachers utilize these more interactive and flexible learning environments to augment lectures. Some of the schools that have experimented with this include Clemson University, University of Pittsburgh, Florida State University and MIT. These studies show significant increases in retention. Another surprising result has been that, although female students typically score lower on SATs in science, these environments contribute to leveling-out gender differences<sup>15</sup>.

## 2.3 Sustainability

While some industries lead others in the incorporation of environmental responsibility, many factors have come together to make resource efficiency and public health a leading factor in the design of high performance spaces. This section examines studies showing the implications of sustainable design towards improved general outcomes from each industry’s perspective.

### Healthcare

More than any other industry, healthcare holds responsibility for promoting public health. While slow to adopt sustainable design principles, there is a rising trend towards sustainable healthcare buildings that reduce negative impact and are restorative to their occupants and the Earth<sup>17</sup>.

A growing group of practitioners are compiling research on product composition, life cycle and long-term



Figure 7: Sustainable materials at the Jaffe Center.

environmental impact<sup>18,19</sup>. Materials and maintenance are being investigated by the Health Care Research Collaborative, which is a research collaborative coordinated by faculty of the University of Illinois at Chicago School of Public Health, with support from the Pioneer Portfolio of the Robert Wood Johnson Foundation and initiated by Health Care Without Harm in partnership with Global Health & Safety Initiative and the Healthy Building Network. This collaborative was established to research and advise on toxins in healthcare materials that negatively affect health from construction to operations<sup>18</sup>. The healthcare industry represents 15% of the United States gross national product. With this purchasing power it could demand change from manufacturers, as has been done by Kaiser Permanente following the Green Guide for Healthcare. “In the past 5 years, the organization has chosen ecologically sustainable materials for 2.7 million square meters in new construction, prevented 70 billion pounds of air pollutants each year, eliminated the purchase and disposal of 40 tons of hazardous chemicals, saved more than \$10 million per year through energy conservation strategies and installed more than 50 acres of reflective roofing. It also makes a concerted effort to buy food and products locally.”<sup>20,21</sup>

Ironically, in contrast to its mission for healing, the healthcare industry has lagged in building sustainable environments from construction to operations and in many aspects, related to some interior material challenges. Material costs and installation costs, infection

control concerns and maintenance requirements have yielded many square miles of vinyl-clad, waxed surfaces. Questionable substances comprise the materials and occupants are subjected to off-gassing of maintenance products in 24-hour occupied environments. Healthcare construction projects, typically years in duration, use up precious funding long before allocated resources are preserved to install healthier but typically more expensive finish products. Unfortunately, there is a shortage of cost competitive alternates to inexpensive, vinyl composition tile (vct). The construction industry accounts for more than 60% of world-wide PVC use, according to sources cited in Lent et al. paper “Resilient Flooring & Chemical Hazards: A Comparative Analysis of Vinyl and Other Alternatives for Health Care”. It “has the most pervasive presence of unavoidable persistent bioaccumulative toxicants (PBTs) in its life cycle” when compared to synthetic rubber, linoleum and polyolefin. “PCBs are toxic. They can cause cancer, gene mutations, or impair normal development or reproduction, among other adverse effects.”<sup>18</sup> However, a growing body of research and product information available about the negative health and environmental impacts of vinyl composition tile and its maintenance that can help designers and facilities managers build the case for investment in healthier choices<sup>18</sup>.

Research indicates that high acoustical performance is an important environmental factor. The widely published study by Busch-Vishniac and West demonstrated that noise levels in hospitals have been increasing since the 1960’s and greatly exceed the World Health Organization’s 1995 hospital noise guidelines, and that noise is a top complaint from patients and staff<sup>22</sup>. Noise is tied to physiological responses that compromise health and patient safety<sup>23</sup>. For caregivers, distractions, disruptions in communication and fatigue contribute to error and burn out. For patients, noisy disruptions increase stress and interrupt quality sleep<sup>1</sup>. Hospitals are typically filled with highly reflective materials because these are easier to clean. To reduce sound transmission and ambient noise, designers are considering space configuration to trap sound, enhanced wall construction, acoustically absorptive materials on walls and ceilings with high NRC levels, and spaces that have the ability to close doors and utilize observation windows.

#### Workplace

Reducing an organization’s environmental impact is a goal that many companies have adopted to varying degrees. Five significant factors have been found to endorse the business case for sustainable building design and operation. These include resource efficiency,

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energy efficiency, pollution prevention, harmonization with the environment, and integrated and systemic approaches, including environmental management systems. In an article by Kathy Roper and Jeffery Beard, they discuss how corporate real estate executives can bring these values to their organizations while positively impacting the environment<sup>24</sup>.

In the paper “The Economic Case for High Performance Buildings” Johnson estimates that sustainable workplaces are 6-16% more productive and improves absenteeism by 15-45%. Scott measured these results by analyzing cost and other data of existing facilities as compared to new buildings for the same client. Economic benefits have the potential to add bottom-line value over the long term. Table 1 is his study of what just 1% in productivity improvement can mean to an organization over the life of a building<sup>25</sup>.

Table 1: Analyzing one percent productivity improvement.

A) Average corporate building construction cost	\$80-150/SF
B) Average building size	100,000 SF
C) Number of employees per average building	500
D) Average fully-burdened salary per employee	\$100,000
E) Useful life of building	30+ years
F) Labor costs per square foot over useful life (C*D*E/B)	\$15,000/SF
G) 1% Productivity Improvement over 30 years (1%*C*D*E) =	<b>\$15 million</b>

Sustainable workplaces provide recruitment and retention bonuses for organizations that share their sustainable message with their corporate image. Social responsibility as well as mandated energy conservation measures will make this an integral part of design.

## Education

Over time (anecdotally as designers) we have been seeing an increased interest in sustainable design by educational institutions. While there is not research easily available for review on the topic, we have seen a marked increase in interest in designing facilities that have a metric for measuring sustainability that is easily accessible. For this reason, the majority of our academic work has been mandated LEED compliant, either willingly or by state mandate, usually to a minimum of LEED Silver.

One of the reasons for this interest is that academic institutions at all levels take a long term view for their facilities. Whereas a tenant fit-out space for a corporate client may only have to have a lifespan of the duration of the lease, typically 10 to 15 years, an academic space will have to last the lifetime of the building. Renovation or adaptive reuse of a cosmetic sort may occur, but on a less frequent basis than for corporate interiors, and renovations involving mechanical systems are less frequent still.



Figures 8 and 9 : LEED Gold Cofra offices in New York.

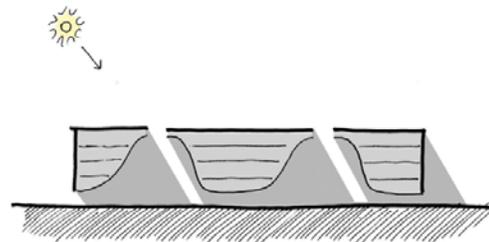


Figure 10: Courtyards self shade from the harsh climate at Kuwait University, College of Arts.

There have been a few studies looking at the cost implications for sustainable buildings, doing high-level life-cycle cost analysis. One in particular, Moussatche and Languel's “Life Cycle Costing of Interior Materials for Florida's Schools,” examines the cost impact of sustainable materials over time<sup>26</sup>. All together, the study

found that sustainable materials did not increase project life cycle costs, and some materials, because of their recycled content, local availability and recyclability, were significantly lower in energy footprint.

In addition, there have been studies of the overall life cycle costs for sustainable buildings, showing that over time sustainable buildings reimburse first costs. The payback period varies significantly, depending on the climate, the cost of energy and the type of sustainable measures taken<sup>24,25</sup>.

Another motivator, outside of cost, is that academic institutions regard their facilities as teaching templates. Buildings are used as teaching tools, and sustainable features can be especially useful in teaching environmental and life sciences, engineering, real-time building operations and economics, and other related disciplines.

Institutions also use their buildings to illustrate their position in the community as a good citizen, thus demonstrating commitment to social responsibility in relation to global warming, energy conservation, etc. A school's "customers" are its students, who are often on the cutting edge of promoting change and vocal about their opinions, which are usually progressive and supportive of environmental stewardship. The sustainable aspects of the building thus can contribute to institutional branding of a positive nature.

### 2.4 Daylighting

Daylighting is one particular aspect of sustainable design that can have a powerful impact on the performance of a facility, both positive and negative. Depending on a variety of factors, especially climate, natural light can be harnessed to enhance and power an environment and result in increased productivity, learning outcomes, and health. It can also render a space uncomfortable, unusable, inefficient, and expensive to operate. A high-performance interior environment uses daylighting in a way that creates a pleasant, effective environment, employs technology to manage it, and accommodates the idiosyncrasies of both the exterior climate and the space's program areas.

#### Healthcare

The lack of adequate natural light, the lack of the full spectrum of light, and the lack of darkness have a negative effect on physical and emotional health as well as behavior and performance. Various studies noted by Ulrich and Zimring, as well as Edelstein show that inadequate lighting levels can result in diminished im-

mune and endocrine function, which may contribute to problems such as Seasonal Affective Disorder (SAD), diabetes, reproductive and growth disturbances, and symptoms associated with premature aging, as well as affecting working memory and cognitive activation<sup>1,27</sup>.

Further study of this research has demonstrated that appropriate lighting conditions are important to human health and well being. There is research that shows shorter length of stays for patients in brightly lit rooms, compared to darker rooms, and that exposure to bright light improves sleep and circadian rhythms<sup>1,27</sup>. In one study noted by Ulrich and Zimring, patients exposed to an increased intensity of sunlight needed 22% less pain

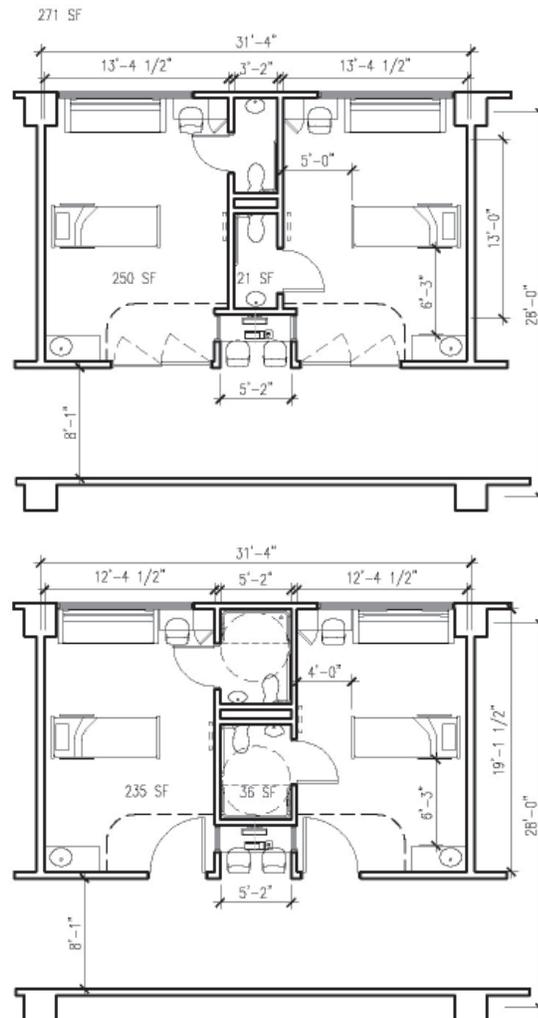


Figure 11: Critical and Intermediate Patient rooms with wall to wall windows at the New Regional Medical Center.

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medication and had 20% less pain medication costs because they perceived less stress and less pain<sup>2</sup>.

Edelstein emphasizes the need for healthcare to have 24-hour design considerations. Day and night shift caregivers need access to daylight and darkness, as well as control of task lighting levels and glare. Patients require individual control of the lighting environment; to be able to darken a room completely for better quality of healing sleep, both day and night, and for adequate access to natural light<sup>27</sup>. The functional drivers for adjacencies and modularity also suggest a large floor plate, and healthcare facilities are challenged to bring natural light into staff work areas and Diagnostic and Treatment areas, as patient rooms typically fill the perimeter to provide daylight to patient rooms. New, sustainable recommendations require a higher percentage of access to daylight for all staff, reintroducing features such as courtyards, light wells to accomplish this.

In addition to the advantages of daylighting itself, patients with views to nature require less pain medication and heal faster<sup>1,2</sup>. There is a trend towards making nature and views to nature accessible to patients, families and care givers. Planning can be organized around opportunities to provide natural views in waiting and respite areas, and especially in patient rooms.

### Workplace

Most people, when asked, would agree that a room with windows is preferable to one that has no natural light. There is a large quantity of consistent data correlating increased daylight to employee satisfaction. Research showing gains in productivity varies, but shows large positives as long as distractions from negative effects, such as thermal heat gain and glare are controlled by sun shading or position of work setting<sup>28</sup>.

Many of the studies examine call centers workers and measure the length of time it takes to service a call. One such study collected data over four weeks in call centers in California. In this study it was observed that there was a 17%–19% reduction in average handling time among workers that had access to daylight. Workers with the highest panels had 11%-18% longer handling times and perhaps the most interesting statistic is that workers who had an unobstructed view directly to the outdoors had a 6%-7% advantage over workers that could not see directly out<sup>28</sup>.

The benefits to office workers are so great that many countries in Europe require that workers be within 27 feet of a window. Stress reduction and focus can also



Figures 12 and 13: Bloomberg Dublin office and briefing room spaces with access to natural light.

be increased by the presence of natural vegetation or plants in the workplace or seen through windows. One study found that employees had lower blood pressure readings and felt more attentive in a room with access to plants. In the post occupancy evaluation of energy edge buildings, the researchers reference that the specific benefits to working in daylit buildings are reduced absenteeism, increases in productivity, financial savings and increases in retention and recruitment of staff<sup>29</sup>.

Views and windows may also add economic value, as a property overlooking a beautiful site may cost more as compared to one without a view. There is anecdotal evidence that the complete absence of windows reduces the rent that can be asked for an office. There is also evidence that the value of office space can also be increased if the space meets environmental accreditation programs such as Leadership in Energy and Environmental Design, daylight admission is an integral part of the programs. Energy studies show that day-lit spaces

lower energy costs significantly and some do not even require lights to be on during the workday<sup>30</sup>.

### Education

While there is copious literature on this subject for workplace in particular, there is much less available regarding academic environments. Much of the literature is in the form of research reviews, such as articles in ASHRAE Journal summarizing the results of research papers. However, in looking at the source material for almost all the literature it traces back to a series of papers by the Hescong-Mahone Group, who have specialized in the study of the relationship between pedagogy and daylight by engaging in a number of large scale studies, involving tens of thousands of students, over time.



Figure 14: Glass walls allow for light to penetrate into circulation and laboratory spaces.

The literature shows varying results, mostly positive, ranging from students doing 15-20% better on standardized tests<sup>31</sup> to negative results where the windows allowed too much noise and glare to enter the space<sup>32</sup>. Most of the research that has been done, when corrected for poorly designed classrooms, trends towards accelerated learning and improved testing<sup>33</sup>.

However, the positive results are reported with wide variations, even in the same papers, between the large scale differences mentioned above down to less than one percent.

This type of research, which takes an epidemiological approach, does not answer the question of underlying causation. Why would students perform better in daylit spaces? A clue to this question might be found in studies showing the relationship between circadian rhythms and daylight. Our biological clocks, or circadian rhythms, which regulate our sleep cycles, etc., require the perception of daylight to be set at their “normal”

relationship to our daily schedules. This relationship is particularly strong in children, who are more susceptible to having their clocks disrupted by environmental factors. Because daylight has more light in the blue spectrum, which seems to be the wavelength that is most effective in setting the clocks, it is four times more effective than fluorescent light and twenty times more than incandescent<sup>34</sup>. This fact may be one explanation for improved performance in daylit spaces.

Finally, there has also been research in journals such as Corporate Environmental Strategy showing cost savings related to reduced energy use in daylit spaces<sup>25</sup>. This is a common sense result, as the majority of energy use in buildings is related to lighting and not the ambient temperature outside. Reducing the necessity for artificial lighting, even partially, has a significant impact on energy savings overall.

## 3.0 CASE STUDIES

The following case studies illustrate incorporating the four elements of a high performance interior design - daylighting, collaborative spaces, sustainability and modularity/flexibility.

### 3.1 Healthcare Case Study – Massachusetts General Hospital Yawkey Center for Outpatient Care

As the first project to follow Massachusetts General Hospital’s comprehensive 20-year master plan, the Yawkey Center for Outpatient Care unites innovative design and planning to significantly improve the efficiency of ambulatory care services and enhance the overall patient experience.

#### Strategic Intent

Massachusetts General Hospital (MGH) is the third oldest general hospital in the United States and the largest in New England. While consistently ranked as one of the top hospitals in the nation (Number 5 in 2009’s US News and World Report’s Honor Roll), in 2000 MGH faced severely escalating demands for services. According to MGH administrators, between 1996 and 2000, inpatient volume increased 32% and ambulatory volume was up 21%, outpatient cancer visits were up 100% and infusions 115%, but in a less-than patient-centered environment. In addition to the increases in patient volume, Massachusetts General Hospital found that, because of the inefficiencies created by its highly autonomous departments, the patient experience had suffered greatly. On average, patients traveled to more than four separate locations to receive care over the course of one

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day. The cardiology department, for example, had services in 14 different locations.

To help remedy this a new building was envisioned with features to provide much needed and convenient parking, to allow the routing of patient and staff pedestrian traffic from the new Massachusetts Bay Transportation Authority (MBTA) station and, most importantly, to accommodate the consolidation and relocation of the rapidly growing ambulatory clinics that had previously been scattered across the MGH campus to the front of the hospital.

Among many campus and operational goals, the following summarize those identified for the building:

- Enhance the quality of the **PATIENT** and **STAFF EXPERIENCE**.
- Maximize **FUNCTIONALITY** and **FLEXIBILITY** of the building.
- Create environments for **COLLABORATIVE** and **MULTIDISCIPLINARY** practices.
- Support new **OPERATIONAL PRINCIPLES**.
- Provide a consistent hospital **IMAGE** with unique program **IDENTITIES**.
- Maintain **BUDGET** and **COST** efficiency of the building.

## Process

MGH retained Perkins+Will, in association with Stefian Bradley Associates, to lead planning and design for the interior architectural fit-out of the new 10-story, 370,000SF center. The core and shell team included planning and design architect Michael Fieldman, archi-

tect, urban design, design and executive architect Cambridge Seven Associates, Inc., and historic consulting architect Ann Beha Architects, Inc.

This new Yawkey Center for Outpatient Care includes design innovations that reinforce the facility's stature as one of the nation's best hospitals as well as provide a dramatic new entrance to the world-renowned institution. It also met a variety of challenges ranging from the shift in hospital culture to site issues such as the disassembly and the reconstruction of a portion of the historic Charles Street jail, construction over and around an existing Proton Therapy building and parking garage, to construction of seven levels of below-grade parking to allow future demolition of the existing garage to open up green space as part of the campus master plan.

## Design

### *Modularity and Flexibility*

A large goal of the project was to centralize and expand ambulatory care services with a new "one-stop" outpatient facility. During a process that fostered communication, Perkins+Will led 25 practice groups through planning and design to consensus and achieved a highly flexible, yet specialized planning model. The flexible 110SF planning module provides various benefits to the organization and the individual.

The flexible module supports the hospital's many operational changes and facilitates increased volume in cancer care, women's and children's care and cardiology and radiology services. Offices and examination rooms can be converted to use for either purpose for a low cost. This helps to provide maximum adaptability



Figures 15, 16 and 17: Planning diagram with 110 SF modules, clinic entrance, waiting area.



Figures 18, 19 and 20: 110 SF exam room, clinic suite corridor, and office.

for future growth and change. Additionally, each floor organizes the various elements and services that make up a clinical program, drastically reducing patient travel.

These 110 SF units are arranged in standard clinic modules that create individual “front door” reception, check in, scheduling and check out areas with interconnected patient treatment areas that can allow collocation of complementary departments for flexing of practice schedules into adjacent clinics if desired. This allowed MGH to build in growth capacity without building additional square footage. The standardized exam room configuration allows expansion and contraction of practices in adjacent spaces with minimal construction.

Components of the build out are also modular. In lieu of custom millwork reception desks, check out and scheduling stations, furniture systems were utilized to easily accommodate future changes.

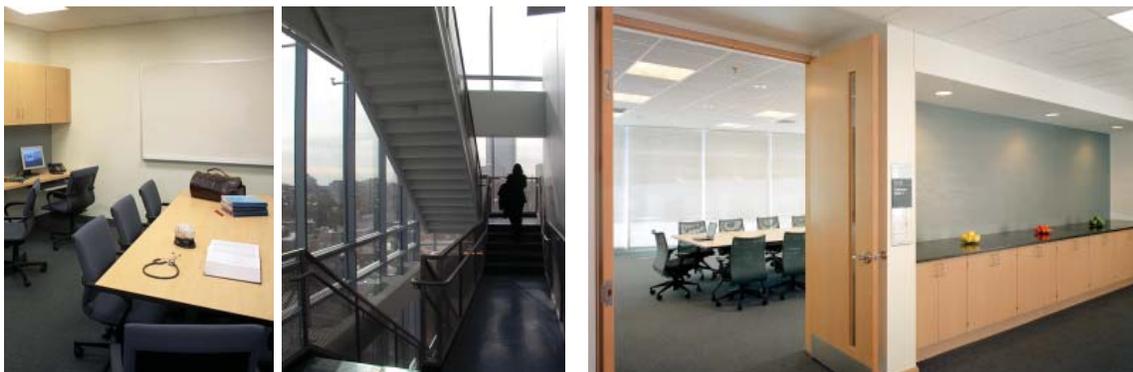
*Collaborative Spaces*

During the program finalization process, all agreed that a consolidated, institutional approach for support spaces would yield the best function while saving valuable space.

Within each exam suite, non-assigned clinician team work rooms are provided for “heads down” work or consultations and mentoring within the clinic areas. Offices are reserved for those physicians with a majority of hours working in the building. Department offices are not in the building.

Consultation rooms in each exam suite are provided for clinician and patient meetings. Conference rooms were agreed to be shared and are consolidated into several suites that are centrally scheduled and no more than one level of light-filled stair walk away from any practice. They are also located along public corridors for public use and to allow access without disruption to clinics.

*Daylighting*  
Quality of light and access to light and views were objectives embraced by all participants in the process. The decision to locate public circulation along the east side of the building with borrowed light and views in all



Figures 21, 22 and 23: Team room, day-lit stair and conference room.

## Transcending Project Type - Principles for High Performance Interior Design



Figures 24 and 25: Oncology infusion bays and borrowed daylight and view in waiting area.



Figures 26 and 27: 8th floor roof garden is adjacent to the Cancer Center infusion bays.

waiting areas via a secondary façade of glass along this corridor was unanimous. Stairwells all have windows to encourage use. Clinic corridors terminate at natural light wherever possible. Staff break and conference rooms are filled with light or have access to dramatic views. Chemotherapy treatment bays are filled with light and have some of the best views in the building over the Charles River and of Cambridge.

### *Sustainability*

Although not a LEED project and not billed as “sustainable”, this building does incorporate some aspects of sustainable design. Most notable are the access to daylight and views, healing roof garden, interior configurations leading to enhanced acoustical performance, reuse of existing buildings, access to public transportation, modularity and flexibility to reduce future construction. Since its completion in 2005, Massachusetts General Hospital as part of Partners Real Estate has embraced sustainable construction and is holding to this standard for its new buildings on the boards and in construction.

### *Outcomes*

In its new central campus location, the award winning Yawkey Center for Outpatient Care offers healthcare in one convenient location, accommodating 600,000 patient visits annually. With a new face to the campus and in a modern, efficient and light-filled environment, it exemplifies the very best in a team partnering success story and illustrates an ambitious concept and highly coordinated design effort for a complex set of circumstances.

## 3.2 Workplace Case Study - L’Oreal USA

Rethinking workplace guidelines to provide a sustainable high performance workspace that is more adaptable to change and less hierarchical.

### **Strategic Intent** – *What is the Mission of L’Oreal?*

L’Oreal’s mission is to “dedicate all the company’s expertise and resources to work for the well-being of men and women and to promote cosmetics as part of the universal quest for beauty.” L’Oreal asked Perkins+Will to help align their work environment with the organiza-

tion’s goal to support working in a more collaborative way. The key objectives for the project were to rethink how group and individual space is allocated, provide a flexible environment that is adaptable to moving departments around the building over time, maximize efficiency, improve opportunities for collaboration and promote the company brand in a sustainable workplace.

- **FLEXIBILITY** in layout and configuration.
- **TIMELESS SOLUTION**, not a trendy design.
- Opportunities to **DENSIFY** space.
- Maximize **EFFICIENCY**; reduce clutter.
- Improve opportunities for **COLLABORATION**.
- Emphasize **FUNCTION** in workspace planning.
- Promote **BRAND** of modern cosmetic company (i.e., beauty and glamour.)
- Emphasize **SUSTAINABILITY** in workplace.

**Process**

Perkins+Will first analyzed the client’s existing workspace in multiple locations, interviewed and held focus groups with employees, benchmarked what other consumer product companies and competitors were doing and provided recommendations for office, meeting room and support spaces. When data was collected on their existing conditions, it was found that individual space was noticeably underutilized. Follow up user meetings showed a need for more informal team space and conferencing space. Workplace guidelines were developed with the client and then applied to the design of the headquarters building in Berkeley Heights, New Jersey.



Figure 28: High performance workplace diagram illustrates that real estate is only one of the critical factors to understand when designing a workplace.

**Design**

*Collaborative Spaces*

As you enter the L’Oreal office as a visitor or employee you are greeted by the welcoming buzz of the activity hub. This multi-function space acts as a lounge for informal meetings or an area for visitors to touch down and check email. There is a kitchen so that staff can prepare lunch or grab a cup of coffee. The activity hub has movable furniture and is able to accommodate departmental or group meetings. Opposite the elevator lobby each floor has a conference space that can seat 24 people around modular tables and can be reconfigured into a training or lecture room for up to 50 people. A combination of semi-private teaming areas and enclosed meetings rooms are adjacent to the open office area give employees a choice about what type of work area supports the task that they are performing.

*Daylighting*

The planning diagram below illustrates workstations (colored in light blue) located at the perimeter of the building floorplate and private offices have glass fronts (colored in bright blue) and are located near the center core to allow natural light to flow into the entire office area. Daylight sensors control the lighting depending on the amount of light coming in to the work area.

*Modularity and Flexibility*

When you enter the work area, ‘neighborhoods’ are created by breaking up clusters of workstations with team and informal meeting areas. In the new environment only senior management sits in an office (approximately a 15% reduction from their previous workplaces). Most of the increased efficiency was reallocated to meeting rooms, team rooms, open pantries and lounge areas that encourage collaboration. The client boasts that these spaces are fully utilized. The layout utilizes one standard size office and one standard size workstation that make it easy to move staff around providing another way to better utilize the inventory of spaces. Clusters of workstations are designed with a module that will allow for a section to be swapped with offices or the reverse as the organization changes.

*Sustainability*

Commissioning ensures the energy related systems are performing to the design standards, which reduces energy use and lowers operating costs. Low-emitting adhesives, sealants, paints and coatings were specified to reduce the indoor contaminants that are odorous or harmful to the comfort and well being of the inhabitants. Lighting is zoned and all offices and team rooms are equipped with occupancy sensors, thus saving on

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Figure 29: Activity hub rendering.



Figure 30: Private meeting areas adjacent to open office.



Figures 31 and 32: Flexible meeting spaces.



Figure 33: Open office area adjacent to team rooms.

energy use. High efficiency fixtures, such as low flow sensed faucets, waterless urinals and dual flush toilets reduce the burden on municipal water supply and waste water systems. Bike storage and showers are provided to employees to reduce load on public transportation system.

Multiple shared support spaces such as copy/print/mail rooms are located along the primary circulation path and provide wall surface for graphic design and messages that remind staff about L'Oreal's commitment to sustainability. The building is LEED Gold and the interior is expected to earn LEED-CI silver.



Figure 34: Typical floor plan.

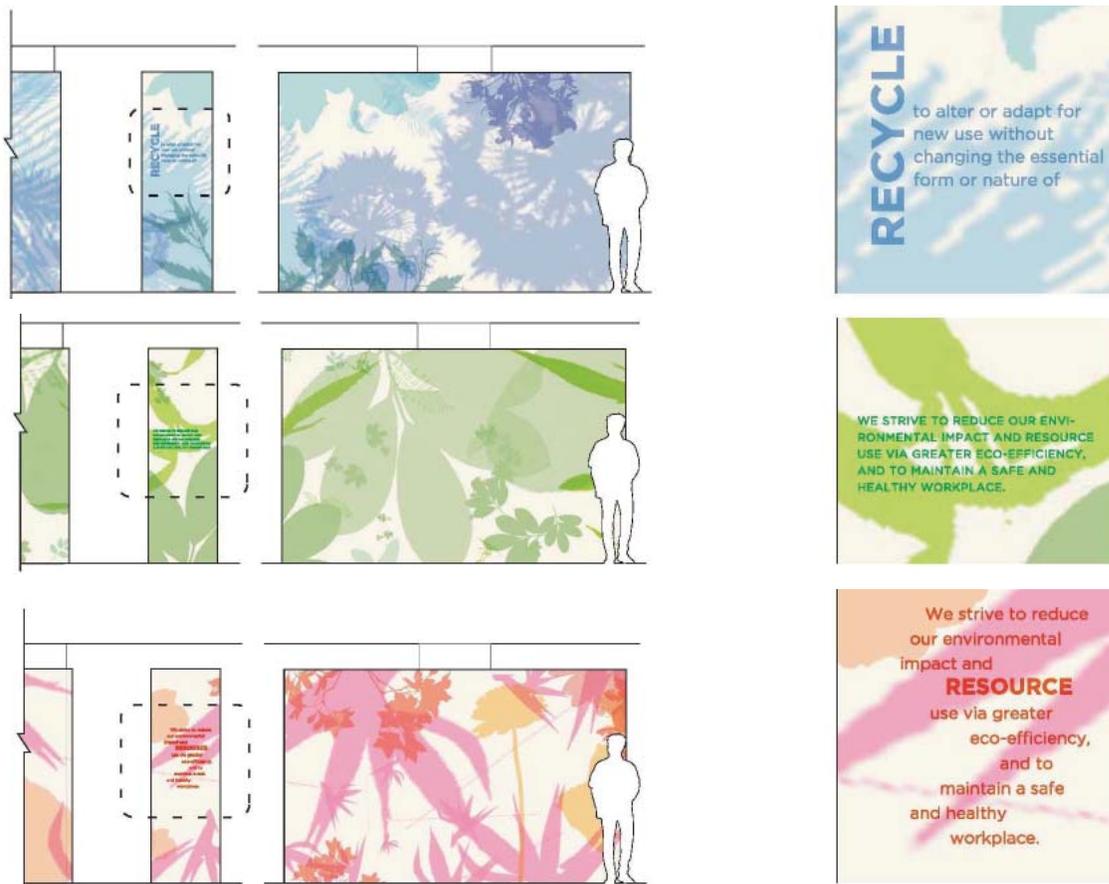


Figure 35: Graphic designs depicting sustainable messages.

# Transcending Project Type - Principles for High Performance Interior Design

## 3.3 Higher Education Case Study – NYU Stern Business School

Renovating an outdated underground facility brings students together in a state-of-the-art educational environment that reflects the world class status of NYU as an institution.



Figure 36: Main entry was formerly tucked back into a dark loggia at left, making the school invisible from the street.



Figure 38: Prefunction space below lobby did not reflect NYU's brand.



Figure 40: Classrooms were not flexible and did not support modern teaching requirements.

### Strategic Intent

NYU's Stern School of Business is located in three disparate buildings on a dense urban site at Washington Square Park on the edge of the Greenwich Village Historic District.



Figure 37: Lobby was dark and cluttered before renovation.



Figure 39: Hallways were treated as locker rooms rather than public areas.

The school retained Perkins+Will to renovate and connect all undergraduate public and instructional space on the ground floor and two basement levels of its three buildings. The classrooms and public spaces had evolved in ad hoc renovations that dated from the 1960's and beyond classrooms were configured in lecture style seating in chairs in rows with tablet arms.

The school did not have a major central space where students could gather and congregate. The classrooms were arranged to accommodate a single and hierarchical teaching style, with minimal audiovisual or technical support. There was no indication from the street that the school existed and the school itself had no connection to the culture and vibrancy of the city.

Goals set for the project were:

- Convey the **high quality of the academic experience** through the physical environment.
- Raise profile of Stern School for students and community with a clear **brand**.
- Link Stern to its **“campus”**: New York City.
- Unify and link existing facilities.
- Improve functionality and integrate **technology**.
- Create state-of-the-art, **flexible** spaces.
- Integrate **clean, modern** design.
- Maximize **transparency** and openness.
- Create a sustainable and minimally **LEED Silver** project within the confines of a renovation that was receiving services from a central plant.

**Process**

NYU Stern School originally staged a design competition to award the project. Perkins+Will chose to reach far beyond the mandates of the design competition, to develop the goals enumerated above and then to come up with an aggressive program of adaptive reuse to achieve them. The project had many stakeholders at NYU: Capital Projects, the Stern School of Business, Development, the students and the community at large

Through observation, interviews with deans, faculty and administration, facilities managers, project managers and presentations to the students, a program was developed. The program was then adapted into a design that was then presented periodically to a steering committee representing most of the major stakeholders. Because the project reached so far beyond the original mandates, it was done incrementally, in a number of phases. This also allowed the school to continue to be fully functional as the project progressed.

**Design**

The final design transforms the existing outdated rabbit warren of vintage 1960’s and 70’s classrooms into a world class business school. The new design incorporates the principals we have discussed above.

*Collaborative Spaces*

The new classrooms are linked to one another by inviting, light-filled corridors, which are in turn punctuated by casual lounge and gathering spaces.

These touch-down/lounge areas (shown in green) are vital in promoting the interaction between students and faculty that make for an academic community. The



Figure 41: Floorplan of Upper Concourse showing renovated classrooms in purple and collaborative spaces in green.

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school is transitioning from a place that students enter for instruction and quickly leave to a destination; a place in which they want to meet and linger.

Within the classroom loops themselves, the two levels have been linked sectionally by cutting an opening that visually connects the levels and that has lounges,

touchdown areas, branding and signage at both ends on both levels. At night, new skylights above this linked corridor glow on the plaza above, indicating the life and vitality of the school below. All three buildings have been linked through new corridors that also include touchdown spaces and branding elements.



Figure 42: Renovated lobby opens three levels to daylight.



Figure 43: Daylight penetrates down to the Lower Concourse, where collaborative spaces link the levels.



Figure 44: The Upper Concourse is connected to the levels above and below.

*Daylighting*

As the project is a renovation of existing underground space, daylighting could not be introduced into the classrooms. However, all the major public spaces have been redesigned to include ample daylight where none existed previously. The lobby entrance at Tisch Hall has become the main entry to the school and a large, three story atrium has been cut through it to reach the two basement levels below.

The entry itself has been pushed out to the building perimeter and the building front has been stripped to create a large glass curtainwall. The major corridor at the rear of the classroom loop has had skylights added and an opening cut into the hallway so that the daylight reaches both basement levels. Because the skylight runs the length of the plaza, it is fabricated of flat, walk-

able panels so that access across the plaza is not interrupted. A new interconnecting stair adjacent to this corridor also has large skylights above so that students see daylight in every direction within the major corridors.

The other major entry lobby, KMC, has had window grilles stripped off and stairways, railings and other obstructions removed so that daylight can penetrate much deeper into the space.

*Sustainability*

As the project was a renovation in a space served by a central plant, LEED certification was not one of the original mandates. However, Perkins+Will suggested that even within these constraints, a sustainable project was achievable, particularly as NYU as a whole has a program to achieve LEED silver on all new construction.

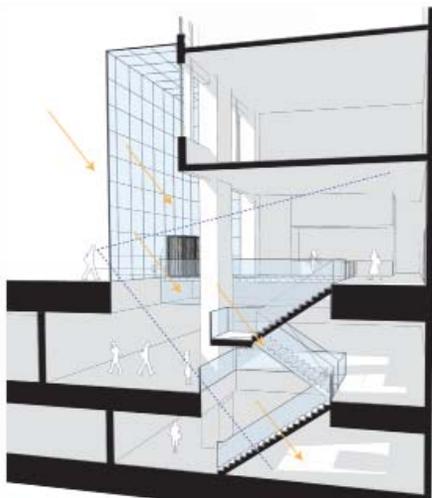


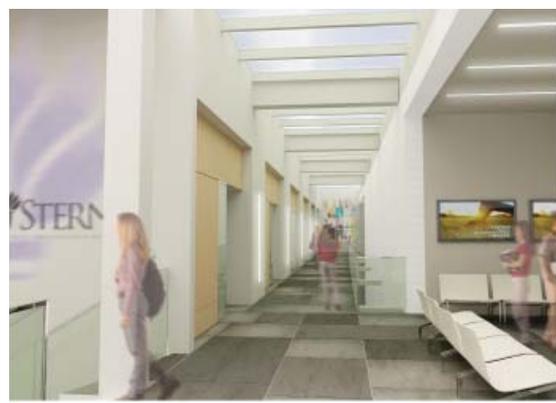
Figure 45: Diagram showing how daylight penetrates to the three levels in the renovated lobby.



Figure 47



Figure 46: A construction photo of the plaza at night showing walkable skylights and a glowing lobby.



Figures 47 and 48: A construction photo and a rendering of the corridor showing the walkable skylights, new interconnecting stair, and collaborative space.

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The project is tracking LEED silver, through the use of recycled and recyclable materials, energy saving lighting, low flow plumbing fixtures, etc.

### *Modularity/Flexibility*

The core motivator in any educational renovation is to provide state-of-the-art facilities for instruction, so the classroom renovations were critical for achieving this goal. Perkins+Will has developed a library of standard classroom configurations, but because this was a renovation within a limited existing envelope, these standard configurations had to be adapted to fit the column grid and corridor locations. A large portion of design time was dedicated to ensuring that these new modular configurations could remain functional in these nonstandard dimensions.

Within those dimensions, all classrooms designed for 40 students or less have movable, flexible furniture, that can be re-arranged for various types of learning environments. Teaching walls have been designed so that in non lecture style configurations, there are still whiteboards and tackboards available for instruction. Power,

AV and data requirements for this kind of classroom have been factored into the design as well. Podiums have been redesigned to be lighter and smaller, with wireless controls, so that they can be moved to accommodate different classroom configurations.

### **Outcomes**

Through the introduction of collaborative and communal spaces, the NYU Stern School of Business now has a central “heart” that symbolizes the community of scholars it houses. It also is strongly connected to the outside world of New York City, both through the introduction of transparency into these communal spaces and through the lantern glow of the skylights and lobbies at night, indicating to passersby that there is a lively and vibrant institution within.

The public areas, formerly dingy basement spaces, now are daylit and bright. Where students formerly had to sit on the floor in between classes, there are now lounges and touchdown spaces for them to meet and work in. Sustainable elements become teaching points, emphasizing NYU’s commitment to being a good neighbor and

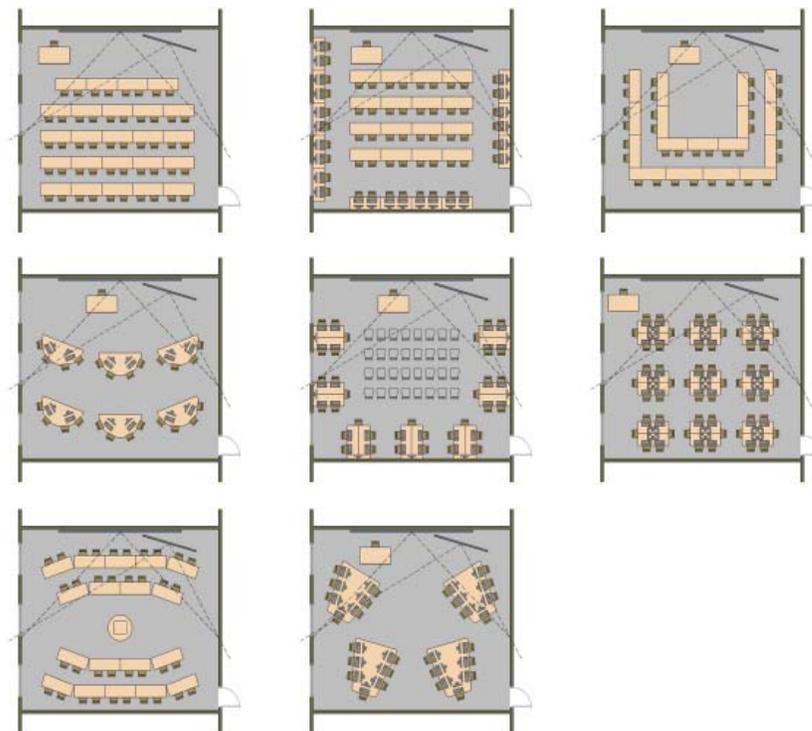


Figure 49: Diagrams showing flexible layouts in a modular classroom.

a good citizen. The business school now has a physical plant that matches the vision and goals of its mission, both for its students, faculty and to the outside world.

#### 4.0 CONCLUSION

In examining the literature available by market sector regarding each of the four parameters we focused on (collaborative spaces, modularity/flexibility, daylighting and sustainability), we have found that there is much anecdotal evidence connecting these parameters to improvements in wellness, productivity and learning, but uneven results in terms of solid metrics. Productivity is difficult to measure, but satisfaction (which is self reported) is far easier to quantify. If worker, patient or student satisfaction becomes a metric for success, then all of these four aspects of current design trends are measurably linked to improvement.

Of all of the four parameters, measuring effects of daylighting has been the easiest component to link to both satisfaction and some aspects of wellness and productivity. Modular design is linked to greater efficiency, which has financial impacts that can be measured and that make a project more successful. This particular trend is not necessarily linked to the more humane parameters that we have been elucidating, however. Sustainability also can be linked to financial gains through energy savings. There are some aspects of sustainability that do translate into increased wellness, through better air quality, emphases on physical design features such as interconnecting stairs that promote fitness. Finally, collaborative spaces have been shown to have positive sociological impacts that can directly affect the health, wellbeing and satisfaction of inhabitants, but again quantifying this has been difficult.

##### Collaborative Spaces

- Informal meeting areas in patient space improve morale and can contribute to rehabilitation, when patients have control and choice between privacy and socialization.
- Dedicated formal and informal collaboration spaces for staff can positively affect patient comfort, safety and outcomes.
- Collaboration areas can facilitate and improve communications between disparate departments to lead to faster and more comprehensive information transfer.
- Worker productivity and morale are linked to providing collaborative areas for teamwork and communication.
- Informal and communal spaces improve student morale and provide recruitment opportunities.

- Large scale studies are now being done in the UK showing links between access to collaborative space and performance.

##### Modularity / Flexibility

- Modular standards for clinical rooms can support staff and contribute to patient safety.
- Modularity can help accommodate future growth and allow flexibility in use.
- Modularity enhances ability to accommodate technology advancements and changing needs with minimized disruption.
- Linking workspace with function rather than hierarchy matches up with modern management theory.
- Fewer and more flexible standards mirrors flatter and more nimble organizations.
- Modern teaching styles require flexible and modular arrangements to physically support them.

##### Sustainability / Wellness

- There is a trend towards sustainable healthcare buildings that reduce negative impact and are restorative to their occupants and the earth.
- Removal of chemicals that negatively affect health from operations to construction.
- Effective acoustical design improves wellness and quiet operations; higher noise levels increase stress and negatively affect caregivers and patients.
- Patients with views to nature require less pain medication and heal faster.
- Sustainable workplaces provide recruitment and retention bonuses with economic benefits over the long term
- Social responsibility as well as mandated energy conservation measures will make this an integral part of future design.
- Employees working in green buildings are more productive.
- Sustainable strategies attract building donors and potential students or patients.
- Institutions have a long term view that supports the financial metrics of sustainability.

##### Daylighting

- Research has demonstrated that lack of natural light and a lack of darkness have a negative effect on health.
- Healthcare facilities are challenged to bring natural light into staff work areas and diagnostic & treatment areas as patient rooms typically fill the perimeter to provide daylight to patient rooms.
- Worker productivity and decreased absenteeism has been correlated with increased access to daylight.

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- Employee satisfaction is strongly linked to access to daylight.
- Cost studies show energy savings in daylit spaces.
- Increased access to daylight has improved and accelerated learning and test scoring.
- Children's hormonal rhythms are negatively affected by lack of daylight.

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