PtD Prevention through Design™

PtD in Motion

Issue 5 July 2009

PtD

- Where good design is important to business success
- Where smart planning minimizes hazards and risks to workers

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Regenstrief Center for Healthcare Engineering

Going Green: Safe and Healthy Jobs

Introduction

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Welcome to a special "Green" edition of PtD in Motion. This edition will demonstrate the links between PtD and the movement toward green and sustainable design. In addition, it will outline some linkages that still need to be established.

There are benefits as well as challenges as we move to a green economy. Defined broadly, green jobs are jobs that help to improve the environment. These jobs also create opportunities to help battle a sagging economy and get people back to work. Yet, with the heightened attention on green jobs and environmental sustainability, it is important to make sure that worker safety and health are not overlooked. NIOSH and its partners are developing a framework to create awareness, provide guidance, and address occupational safety and health issues associated with green jobs and sustainability efforts.

The American Recovery and Reinvestment Act (ARRA), passed in early 2009, makes new investments in our Nation's future. This includes creating jobs to deliver on those investments in industries such as energy, utilities, construction, and manufacturing, as well as job training. The new focus, coupled with the move in America towards energy efficiency and more environmentally-friendly practices, is resulting in changes to traditional jobs and the creation of new kinds of occupations. As we make technological advances in industry, we need to remain vigilant in protecting workers against emerging hazards. As traditional jobs evolve to meet new challenges, workers may be faced with known risks that had not previously affected their occupation. These changes may also present us with the opportunity to eliminate hazards through planning, organization, and engineering—a concept you know at NIOSH as Prevention through Design (PtD). The graphic below illustrates how our knowledge about old and new hazards intersects with challenges created by new technologies and adaptations of work activities to perform green jobs.

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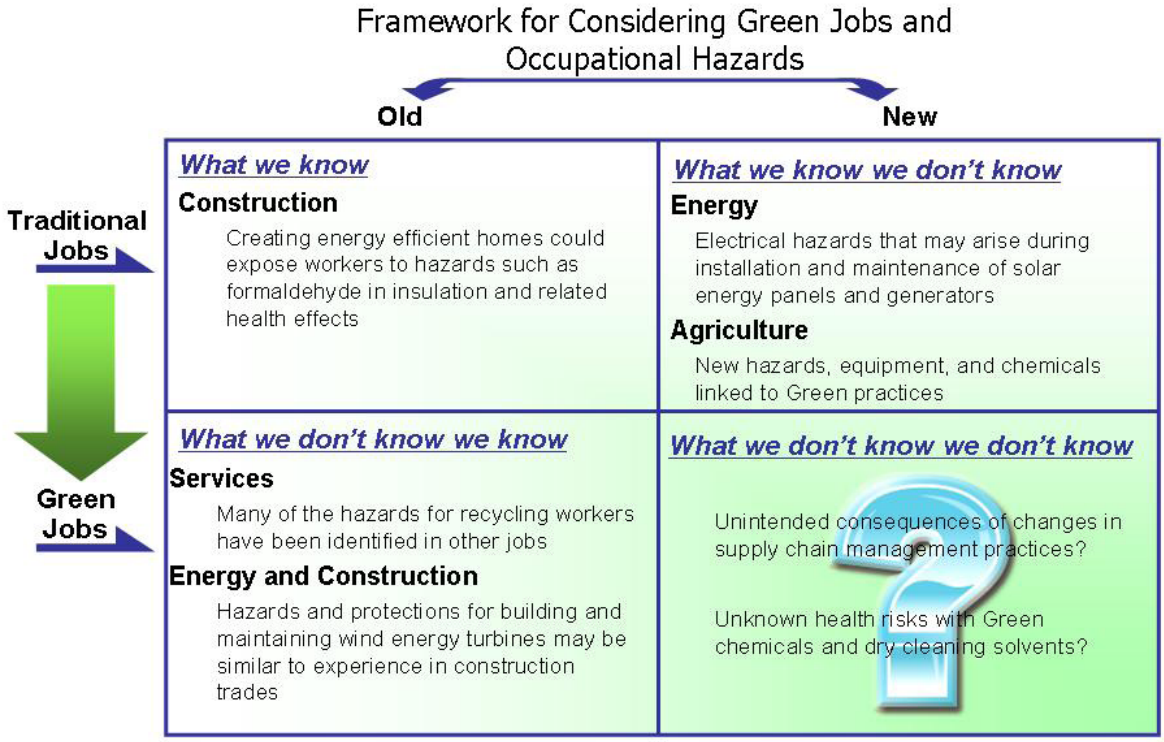


This issue of PtD in Motion highlights examples of applying PtD principles to achieve sustainable design and protect the health and safety of workers.

NIOSH is hosting a workshop on Dec. 14–16, 2009, to help frame issues of incorporating occupational safety and health considerations into green and sustainability efforts. The workshop will include invited participants and limited space will be available to the public. Further information will be made available on registration in the near future.

For more information about the health and safety aspects of green jobs, please visit the NIOSH topic page Going Green: Safe and Healthy Jobs: http://www.cdc.gov/niosh/topics/greenjobs/ and the Prevention through Design program portfolio webpage: http://www.cdc.gov/niosh/programs/PtDesign/default.html.

In the latest post on the NIOSH Science Blog, (http://www.cdc.gov/niosh/blog/nsb070109_greenjobs.html) NIOSH Acting Director, Dr. Christine Branche, discusses the new NIOSH Going Green initiative and the opportunities and challenges faced by workers in the green economy. The blog seeks input from readers on the Going Green initiative—specifically suggestions on defining the term "Green Jobs." Read more and comment on the NIOSH Science Blog. http://www.cdc.gov/niosh/blog/nsb070109_greenjobs.html.

Warm-Mix Asphalt: Preventing Exposure at Its Source

Margaret Blain Cervarich
Vice President for Marketing and Public Affairs
National Asphalt Pavement Association/Asphalt Pavement Alliance

Since the mid-1990s, the asphalt pavement industry has been working in partnership with NIOSH, other government agencies, and unions to improve working conditions at the paving site, including reducing workers' exposure to asphalt fumes. In 1997, the Asphalt Partnership resulted in a

voluntary agreement to put engineering controls on all highway-class pavers manufactured in the U.S. that vent fumes away from workers. Even after this landmark success, the industry continued to pursue the gold standard: minimizing or eliminating fumes at their source.

Asphalt pavement material is a scientifically proportioned mixture of asphalt cement, a petroleum product, and aggregates (stone, sand, and gravel). Numerous studies have shown that the higher the temperature to which the asphalt cement is heated, the more fumes are produced. Lowering the temperature of production and construction seemed a promising avenue for minimizing the fumes to which workers might be exposed.

In 2002, leaders of the National Asphalt Pavement Association (NAPA) learned of three technologies showing promise for lowering temperatures. They immediately sponsored research at the National Center for Asphalt Technology to validate the benefits and explore the opportunities of warm-mix. The first warm-mix demonstration sections in the U.S. were constructed in 2004. Since that time, interest in warm-mix has grown exponentially.

Technology innovators seized the opportunity and introduced a number of new technologies. At last count, there were at least 14 new, warm-mix technologies in the U.S. marketplace. Contractors, occupational health and environmental regulators, state departments of transportation, the Federal Highway Administration, and technology providers across the country have embraced warm-mix. Scores of test sections were constructed and numerous open houses were conducted to provide education about the possibilities. From 2005 to the present, acceptance has grown rapidly, to the point where many producers across the country are producing warm-mix routinely, not hot-mix. The success of the implementation effort was recently honored when NAPA and several of its members received an award from the U.S. DOT/ U.S. EPA's Green Highways Partnership for innovation in sustainable transportation alternatives.

To fully explore the effect of warm-mix technologies on various pavement types, mixes incorporating rubber and polymers have been produced. Also, open-graded pavements—which have interconnected pores that allow rain to sink in and run off to the sides—have been constructed. While each mix has its challenges and requires careful engineering, successful results have been achieved with each type of paving material. To aid in the thoughtful implementation of warm-mix, the industry and researchers have developed guidelines for best practices in production and construction.

Unintended consequences can be good

During the implementation of warm-mix, contractors and researchers discovered some additional benefits of these technologies, some of which were unexpected. For example, it was expected that warm asphalt mixes would improve working conditions, cut overall emissions, and save fuel, which they do. What was not foreseen is that these mixes may extend the paving season in cold climates, improve quality, and lengthen the lifespan of the pavement. Overall it appears that warm-mixes result in more consistent pavement quality. Often the mixes are easy to compact and pavement densities show less variability.

Warm-mix may even help us reuse and recycle more. The asphalt industry is already America's number one recycler; every year, more than 100 million tons of asphalt pavement are reclaimed, and around 95 percent of this material is reused or recycled. Warm-mix allows contractors to reuse a higher percentage of reclaimed material in paving mixes, with no discernible loss in quality.

The worker's point of view

The first difference a paving worker notices is that the paving site is more comfortable. Conventional hot-mix asphalt is produced at 280° to 320° F. Warm-mix technologies allow production temperatures to be reduced to approximately 215° to 275° F, and by the time it is trucked to the paving site, the mix has cooled by another 10° to 20° F. This makes the paving site cooler. Also, the fumes and any odor that may be associated with asphalt paving is virtually gone.

Two trucks pull away from loading silos at an asphalt plant. The truck on the left has hot-mix; the one on the right has warm-mix.

A heavily loaded truck drives over some warm-mix sections at the National Center for Asphalt Technology's pavement test track at Auburn, Alabama.

Working with warm-mix at the paving site is very similar to working with hot-mix. With some mixes, handwork is easier; sometimes, the tendency of a mix to stick to tools and machines is reduced. The rate of cooling of warm-mixes is slower than that of hot-mixes, so warm-mix can be used for paving in cooler weather than hot-mix, and it can be hauled for longer distances.

The transportation agency's point of view

Pavement performance is a priority for highway agencies. So far, all signs indicate that warm-mix pavements will perform as well as, or better than, conventional hot-mix pavements. One reason is that better compaction means better performance of the pavement over the long term, and warm-mix technologies enhance compaction. There is also speculation that lowering the production temperature reduces aging of the asphalt binder, which may reduce the potential for cracking.

Warm-mix technologies are being tested at the National Center for Asphalt Technology's Pavement Test Track. At this track, trucks hauling loads that are much heavier than normal inflict about 10 to 12 years' worth of traffic damage on pavements in just two years. The warm-mix sections are performing very well and showing low rutting. In Europe, where warm-mixes have been used for a few years longer than in the U.S., agencies expect warm-mix to perform as long as, or longer than, hot-mix.

Road paved with warm-mix asphalt

The public's point of view

Asphalt pavement is a basic building block for American life; of the more than 2 million miles of paved roads in this country, 94 percent are surfaced with asphalt. Wherever we go, we see—and use—asphalt.

As the United States goes green, asphalt is keeping pace with the times. Warm-mix is an important step in sustainable development, simultaneously conserving natural resources, reducing emissions and the carbon footprint of the industry, improving the quality of the pavements that Americans rely on, improving conditions for workers.

Warm-mix being paved in Happy Valley, PA

E-waste at a recycling facility

For more information

More information on warm-mix can be found at www.warmmixasphalt.com, the official site of the Federal Highway Administration's Warm-Mix Asphalt Technical Working Group. The site, which is updated frequently, contains articles, presentations, and scholarly publications.

Occupational Safety Hazards and Risks of Recycling

David Biderman, National Solid Wastes Management Association

According to recent data published by the U.S. EPA, the amount of municipal solid waste diverted from landfills or incinerators has increased to about 85 million tons per year—about one-third of all the municipal solid waste generated in the United States. With an increasing emphasis on "being green" in both businesses and homes, and the U.S. population continuing to grow, an increase in recycling can be expected in coming years.

The expected uptick in recycling poses potential workplace health and safety concerns for recycling companies and their employees. Recycling employees face workplace hazards both on their collection routes and at facilities where recyclables are processed. An increased flow of materials and an increasingly heterogeneous mix of recyclables could increase workplace injuries and illnesses for recycling employees. For example, a growing number of states have passed laws prohibiting the disposal of electronics waste (e-waste) in landfills, because e-waste contains small quantities of certain heavy metals. The domestic processing of e-waste potentially exposes workers to exposure to these heavy metals; for this and other reasons, a substantial amount of e-waste generated in the United States is exported overseas. Similarly, the increased use of compact fluorescent light bulbs raises concerns about mercury exposure for waste collection and recycling employees.

Fortunately, most solid waste and recycling companies are aware of these workplace safety hazards and are using engineering controls, administrative controls, and better personal protective equipment to reduce exposure. For example, many companies have automated the recycling process by building and operating "single-

Worker processing solid waste

stream" facilities in which the vast majority of recyclable processing is performed in an automated manner. In addition to reducing the number of employees potentially exposed to hazards, these facilities typically increase recycling rates by up to 25 percent.

Businesses and residents throughout the United States are likely to increase their recycling efforts in the future. It is one of the behaviors that all Americans can easily do to personally contribute to sustainability. State and local governments will need to do a better job educating people about what is (and is not) recyclable. Recycling employers and employees will need to work together to ensure that more recyclables do not cause an increase in workplace injuries or illnesses.

Prevention through Design: Three Examples from Health Care that Integrate Worker Safety with Sustainable Design

Erica Stewart, Kaiser Permanente

For Kaiser Permanente Prevention through Design (PtD) starts with the building itself, by designing the systems and processes that make it easy for staff and physicians to provide high quality care while discouraging unsafe behavior and shortcuts. These processes are tested in the Sydney R Garfield Center for Innovation and piloted in our facilities before being adopted into our Standards program and developed into building templates. Following is a discussion of three examples from our sustainable building program that illustrate how Kaiser Permanente incorporates PtD into its operations.

Rubber Flooring

The first example is the selection of resilient flooring material to replace poly vinyl chloride (PVC) tiles and sheet goods. Kaiser Permanente is working to eliminate PVC from our medical facilities because its manufacture and disposal releases mercury (a neurotoxin) and dioxins (the most potent carcinogens known) into the atmosphere. Vinyl flooring has also been associated with asthma in children who have close contact with it. So eliminating a product that adversely affects the health of our patients is a good thing for them and a good thing for the environment. The alternative Kaiser Permanente chose is a synthetic rubber product and it has other benefits besides avoiding toxic ingredients.

Because it does not require waxing and only needs a neutral cleaner to maintain its surface, fewer toxic chemicals are used during its life cycle and less time is needed for its upkeep. Shiny floors are also disorienting to elderly patients because they make it difficult to judge distances. Rubber floors also provide better traction, which can prevent slips, trips, and falls. They absorb sound and are more comfortable underfoot, reducing leg fatigue and lower back stress.

Reduced noise levels are particularly important in neonatal intensive care units and other patient care areas where unwanted sound is a problem. Patients who cannot sleep or have their sleep interrupted take longer to heal, and staff exposed to noisy environments experience higher levels of stress. Styrene butadiene rubber is also mold and stain resistant, out-performing vinyl that will shrink, crack, and stain overtime.

Resilient flooring material at a Kaiser Permanente facility

Cotton Insulation

Cotton insulation is another example that illustrates how a product that was picked for its environmental attributes led to worker and patient benefits as well. Fiberglass insulation is very irritating to the skin and at high enough levels (as occur during installation) may lead to pulmonary disease and even cancer. Installers must wear impervious coveralls, respirators, gloves, and safety glasses for protection. Cotton bat insulation however does not require such protective measures and is just as easy to install. The cotton bat insulation selected is made from more than eighty-five percent post-industrial recycled blue jeans, is treated with non-toxic borates instead of halogenated fire retardants, and because of that treatment it is also mold, mildew, and pest resistant. So it is better for the environment and better for the workers who install it. It is also better for patients and staff because it has superior insulating and sound absorption properties, giving 3.80 insulation R-value per inch thickness, and a three to five-decibel reduction in noise over typical wall assemblies.

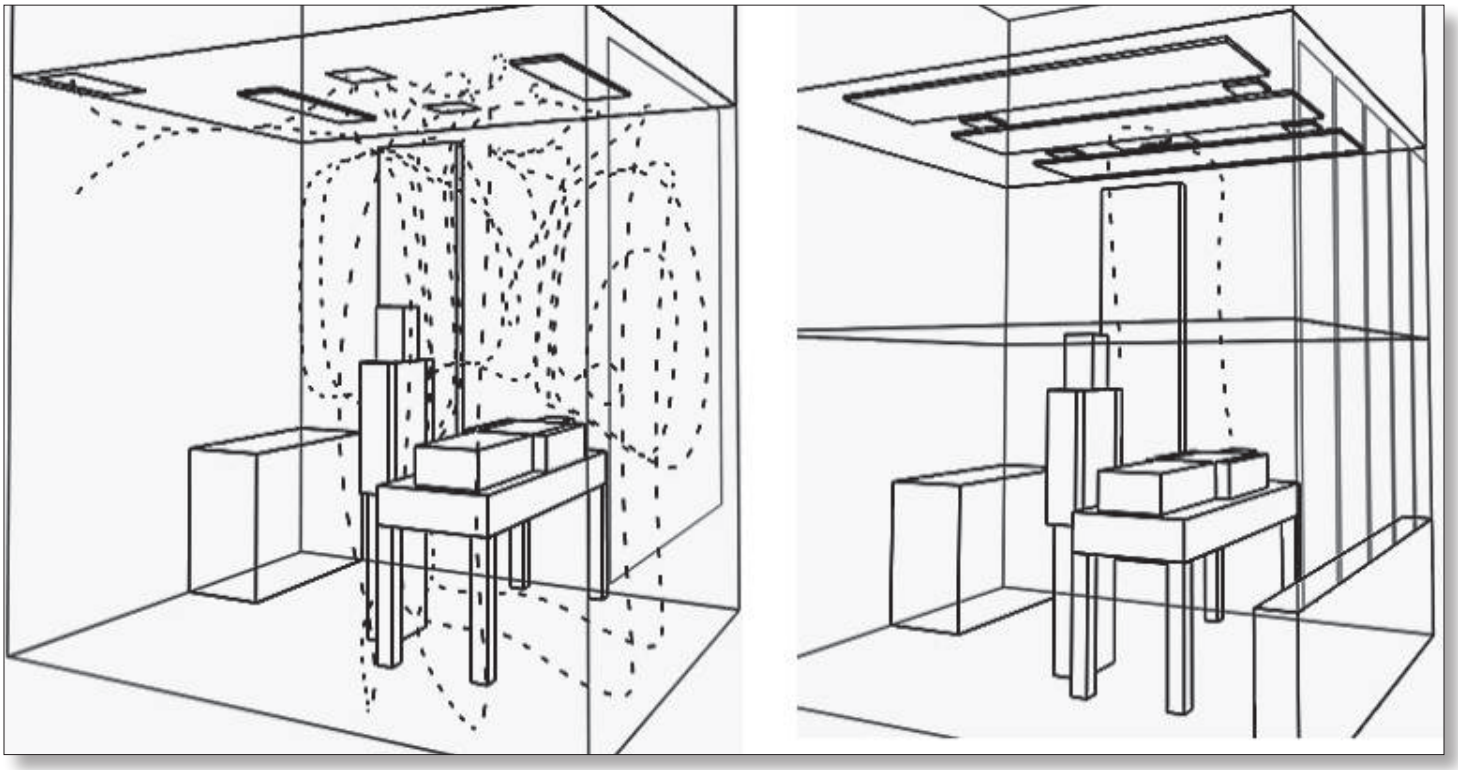
Displacement Ventilation

A final example of PtD in health care is a promising new approach to ventilation. Traditional general dilution ventilation works on the principle of whole room air mixing. Heated or cooled air is released from a ceiling diffuser and allowed to mix with the existing air in the room and exhausted through a return air plenum or ducted exhaust in the ceiling. The completeness of room air mixing is influenced by local air currents and obstructions so that real "air changes per hour" are variable; in some cases air may short circuit directly from the supply to the exhaust without truly mixing with existing room air so dead zones of stale air may be present.

Displacement ventilation on the other hand releases air along the floor at a constant 55° F. As the cool air travels along the floor it rises in thermal bands and exits through a return air plenum or ducted exhaust in the ceiling. The air is not heated as in traditional general dilution ventilation; instead heating is provided by radiant heaters in the floor or in radiators opposite the supply air diffusers. By uncoupling heating from ventilation, more efficiency is gained because the air passes through the room only once. Air at the floor is cooler than in the middle of room and the warmest air is at the top strata of room, where it is exhausted. Instead of spending energy to heat or cool the air of the whole room, heating is concentrated at the occupied zone.

Because air travels in thermal air currents, the "age of air" is less than in general dilution systems and less air overall is needed to achieve occupant comfort. In laboratory testing, field testing, and pilot application, better air quality was achieved (according to ASHRAE Standard 62.1) with less air, meaning that if this strategy is employed, fans can be made smaller thus saving energy. The benefit to patients and staff is that because the air spends less time in the room any particle exhaled or ejected by an infectious patient is

Displacement vs. Mixing Ventilation Systems



Overhead System **Displacement System**

more likely to be taken up by the ventilation system rather than by the care giver.

These are just a few examples of how PtD is being employed in health care. While much has been written about evidence-based design to enhance patient safety, the safety of health care providers in those environments and the construction workers who build them should not be forgotten. The long term impact of operations should also be considered as part of a holistic approach to patient care and the built environment.

Making "Green" Safe

John Gambatese / Oregon State University
Michael Behm / East Carolina University

"Green" is the new buzz word in the construction industry. Whether it involves using such green elements as recycled water for landscaping, reclaimed materials from past projects, or high-efficiency ventilation systems, architects and engineers are more frequently being asked to consider the sustainability of their designs. The drive towards green facilities has led to innovative designs and construction processes and the use of alternative materials. The goal is to use resources efficiently, minimize impacts on the environment, and enhance worker productivity to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission, 1987).

As the use of green designs grows and more innovative designs are developed, consideration should be given to the health and safety of those who build, use, and maintain those designs. While a particular design can be effective in improving the environmental sustainability of a facility, it may also have a negative impact on the safety of those who install or maintain the feature at the facility. One example is the greater use of skylights and atriums in buildings to increase the amount of natural light and heating, thereby reducing electricity usage. However, a significant number of injuries and fatalities result from workers falling through skylights.

To help prevent these incidents, skylights designed or protected to withstand a load of at least 200 pounds applied perpendicular to the skylight at any one area should be specified in the design process. Alternatively, a specification could be included that the skylight be surrounded by a permanent protective guardrail. Another example is the increased material handling and separation work to meet recycling goals. This additional work as part of demolition efforts or jobsite clean-up typically needs to be done by hand rather than machine, thereby exposing workers to a greater risk of musculoskeletal injuries. Recent studies have examined green facilities and found negative impacts on construction worker safety due to green design elements (Gambatese et al. 2007; Silins 2009).

How can the construction industry move forward to ensure that its green designs are also safe to build, maintain, and use? Prevention through design (PtD) strategies and practices promoted by NIOSH and other safety and health organizations provide a means to analyze and design out the hazards. PtD aims to eliminate or reduce the hazards before they exist on the jobsite. When designing green facilities, architects and engineers should create designs that are both sustainable and safe to build, maintain, and use. This important effort could best be facilitated and recognized by incorporating worker safety and health concepts into existing green tools and resources such as the United States Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system (USGBC 2009). Doing so would recognize that people are "resources" that should be sustained just like natural materials, and that their health and safety should be considered throughout the entire lifecycle of a facility. A facility should not be considered sustainable if an injury or fatality occurs during its construction, maintenance, or use and it can be demonstrated that the injury or fatality was influenced by the absence of recognized safe design and construction methods.

References

Gambatese, J.A., Rajendran, S., and Behm, M.G. (2007). Green design & construction: Understanding the effects on construction worker safety and health. Professional Safety, Journal of the American Society of Safety Engineers (ASSE), May 2007, 28–35.

Silins, N. (2009). LEED and the safety profession: Green has come of age. Professional Safety, Journal of the American Society of Safety Engineers (ASSE), March 2009, 46–49.

United States Green Building Council (USGBC). (2009). U.S. Green Building Council, Washington, DC. http://www.usgbc.org.

World Commission on Environment and Development (1987). Our common future. The Brundtland Report. New York: Oxford University Press.

Safe and Green Building Design

Andrew Harte, AIA, LEED AP, bhdp architecture

Over the past ten years, the impact of green design has had an amazing transformative impact on the design and construction industry. There is a fundamental attraction to green buildings' triple bottom line: environmental protection and promotion, social equity, and economic prosperity. Buildings lovingly display their LEED rating plaques in their daylit energy efficient lobbies… green design is sexy.

Meanwhile, the PtD effort is a few years old and seeks to have a transformative impact on not only the construction industry, but also all industry sectors. There is a fundamental aversion to hazards, obviously. Safety-minded facilities prominently display their "days since last lost-time accident," but these remind occupants of the hazards… safe design is not sexy.

It is easy to evaluate the two initiatives separately, but there is a lot of common ground. The LEED rating system addresses design, construction, and operation, broadly covering the various aspects of green building. One such aspect is the health of building occupants. The key question is: can a building be considered sustainable if it fails to minimize risks to its occupants from hazards? In the design of buildings, there is a tremendous opportunity to integrate safe design and sustainable design. Each represents a field of knowledge unto itself, yet there is a powerful synergy between the two. As one explores this synergy, it becomes clear

that safe design must be considered a critical aspect of sustainable design. After all, a building which fails to promote the health and welfare of its occupants cannot be considered sustainable.

This point can be illustrated through examples in the three phases of green building design and delivery.

Design

Indoor allergens have been identified as a serious health issue. LEED addresses this hazard through ventilation system design, filtration of outdoor air, containment, and selection of building materials, for example. By requiring the design to consider eliminating, or significantly reducing, indoor allergens, the hazards are effectively designed out. Many aspects of the LEED rating system address issues of occupant safety and health, especially in the Indoor Environmental Quality (IEQ) section. Building designers are encouraged to use low-emitting materials, design for effective ventilation, control sources of indoor pollution, and design for effective daylighting. Designing for worker health and safety, however, goes beyond indoor allergens. Safe design principles must also be applied to building equipment, machines, noise, and sources of hazardous chemicals.

Construction

The construction industry suffers from a disproportionate number of deaths, a topic of considerable consternation within the safety community. The safety of construction workers is given very little consideration in the LEED rating system. Imagine the tragic irony of a building occupant enjoying the benefits of a wonderful skylight, standing in the same spot where a construction worker was critically injured upon falling through the very same roof opening during construction. Including provisions during building construction to prevent injuries, illnesses, and fatalities among construction workers is an essential component of sustainable design.

Operation

In some building types, the health and safety of occupants are constantly threatened. Take, for example, a LEED-Certified laboratory that meets LEED requirements for low-VOC coatings and sealants. Occupants are spared excessive exposure to volatile organic compounds, but may be exposed to significantly more hazardous chemical reagents if the lab exhaust system is not maintained properly. In this case, the design satisfies "green" requirements, but failure to effectively address safety issues during operation puts occupants at risk.

Next Steps

Occupational safety and health must be considered an essential part of sustainable design. The PtD doctrine preaches tackling the issues as early as possible in the design process. BHDP Architecture recommends hosting a "green design charette" early in the conceptual design phase, where sustainable design goals are established. Metrics to address progress towards achieving these goals are then tracked and measured throughout the project delivery process, along with budget and design goals, in evaluating the success of the project. By doing this, the team effectively "designs-in" the sustainable measures, an integrated approach that has proven successful. This process could very neatly be expanded to consider construction worker and occupant safety and health goals.

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