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Green and Healthy Buildings for the Healthcare Industry

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Introduction

Just as health care professionals diagnose a patient's illness and prescribe appropriate treatment, so too are a growing number of building professionals diagnosing how buildings affect human health and the environment and prescribing strategies to minimize these impacts. This is in response to mounting evidence that buildings through their life cycle are significant causes of human illness and environmental degradation. According to the U.S. Environmental Protection Agency (EPA) and its Science Advisory Board (SAB), indoor air pollution is one of the top five environmental risks to public health.[1] On average, people in the US spend 90% of their time indoors.[2]

Many common construction materials can emit dangerous compounds and harbor infectious molds, fungi and bacteria. Specific materials such as adhesives, carpeting, upholstery, and manufactured wood products emit volatile organic compounds (VOCs), including formaldehyde, a probable human carcinogen. PVC (polyvinyl chloride or vinyl) products such as flooring, carpeting and wall covering can release a variety of hazardous additives, including phthalate plasticizers and heavy metal stabilizers.

For people confined indoors due to illness and particularly for those with depressed immune systems, both prominent populations in healthcare facilities, the consequences of any of these impacts can be significant. As well, facility staff and visitors are susceptible to the range of potential health effects of poor indoor air quality, including asthma and other respiratory health problems, cancer, and reproductive and developmental impairment.

How buildings are designed, and the materials and methods used to construct and operate them, have significant consequences to the natural environment and health outcomes of people outside of the building envelope as well. Building-related activities are responsible for 35% to 45% of carbon dioxide (CO2) releases into the atmosphere,[3] a precursor to global warming, and deplete the stratospheric ozone layer by using refrigerants and products, including some insulation materials, manufactured with ozone depleting compounds. Buildings use over 75% of the PVC produced.[4] The manufacture and disposal of PVC, as well as its combustion in accidental fires, is linked to the emissions of the persistent and bioaccumulative toxins, dioxins and furans. Construction also accounts for about 40% of raw stone, gravel, sand, and steel consumption, and 25% of virgin wood. Buildings use about 40% of energy resources and 16% of water, while building construction and demolition generates about 25% of municipal solid wastes.[5] Each of these impacts has direct or indirect consequences on human health, the extent of which is becoming better understood as the interconnections between buildings, human health and environmental quality are subjected to more rigorous analyses.

Recognizing these issues, professional associations such as the American Institute of Architects (AIA) and the UIA/AIA World Congress of Architects have issued clear directives to incorporate sustainable design and green building strategies as basic and fundamental to standard practice.[6] The American Society of Healthcare Engineering (ASHE) has developed a guidance document specifically to encourage the incorporation of sustainable design elements in healthcare facilities[7]. In addition, local, state and federal public policymakers are adopting green building guidelines, and corporations are establishing environmental building standards. These emerging strategies redefine the way buildings are designed, built, and operated, and extend the conventional notion of building performance to include human health and environmental quality as essential cornerstones of quality and value.

This shift in practice towards green and healthy buildings is fundamentally consistent with the core value of health care professionals – first, do no harm. To this end, healthcare practitioners should assume a public health oriented position relative to the facilities in which they operate, and ensure that these buildings do not degrade the health of individuals or of the general public by implementing sustainable design, operation, and maintenance practices.

Healthcare providers are just beginning to understand the process of creating and maintaining environmentally sustainable healthcare settings. They are changing from first-cost to full cost accounting, which extends the conventional balance sheet to include life cycle costs. They are incorporating preventive maintenance and integrated, anticipatory design concepts into buildings.

Finally, they are partnering with suppliers and design professionals to improve medical outcomes, user satisfaction and productivity through changes in the built environment.[8]

Guiding Principles

More than an optimization of any single component, sustainable design and construction represents the integration of materials and methods that, together, create the physical manifestation of a building. The entire life cycle of building materials and products, as well as the building as a whole relative to its physical, environmental and human contexts on the local, regional and global scales, must be evaluated for environmental and health considerations (see Figure 1 below). We are informed by the U.S. EPA's findings that indoor air pollution is one of the top five environmental risks to public health, and by the U.S. Science Advisory Board's assessment of highest global environmental priorities: global climate change, loss of biodiversity, habitat destruction, and stratospheric ozone depletion. While not as obvious as to their affect on human health as indoor air quality, these indicators of environmental health at risk–rising global temperatures, increased exposure to ultraviolet radiation, and diminished supplies of natural resources–signal trouble for the human species. Establishing life cycle health and environmental considerations as evaluative criteria for design decisions and material and product specifications yield measurable benefits in enhanced patient outcomes, improved worker productivity, and reduced operations and maintenance costs, to name a few. This recognition should trigger immediate review and modification of existing A/E Guidelines, standard procurement policies and specifications.

Upstream environmental and health impacts occur during the materials acquisition (source), transport, manufacture, and distribution of materials and products. These impacts can be equivalent to 10-20 years of a building's operation. In conventional economics, these impacts are called "externalities."

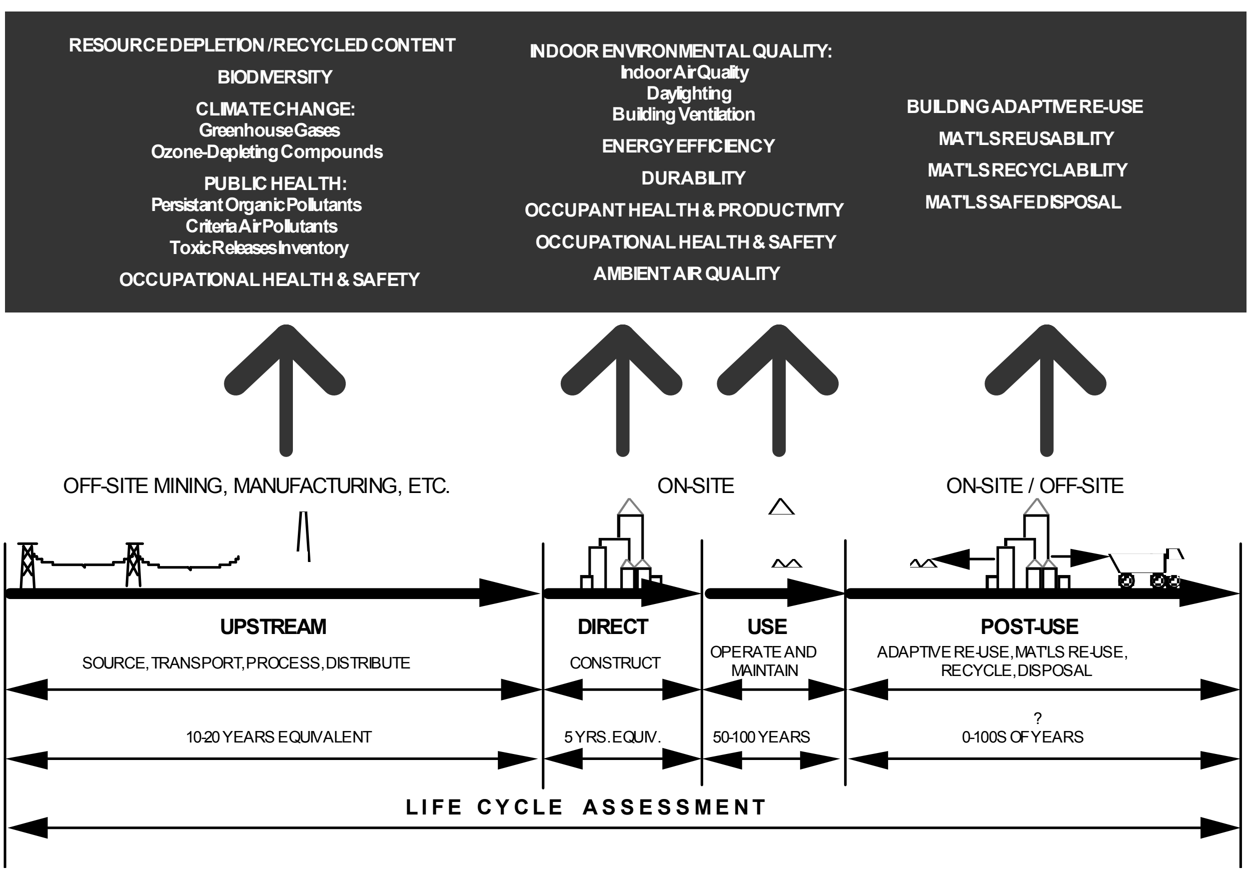

FIGURE 1: LIFE CYCLE ASSESSMENT OF BUILDING MATERIALS AND PRODUCTS
(Figure by CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS)

Construction of the building is the **Direct** life cycle stage. Its impacts are equivalent to about five years of building operation. The **Use** stage includes the operation and maintenance of the building and is typically assumed to be 50 years or more in Life Cycle Costing estimates. Owners are interested in payback periods during the expected life of the building, i.e., in how many years will savings in operational costs become equal to or greater than an initial investment in a particular improvement. Beyond a cost justification, investment in healthy building practices can yield measurable results in medical outcomes for patients.

After the building's useful life, the building can be modified for "adaptive re-use" or the building's materials and products can be reused, recycled, or disposed. This is the **Post-Use** stage of materials and products. Reusing or recycling materials reduces burdens on landfills, conserves resources, and saves the contractor or owner the costs of landfill disposal. This is an example of "cost avoidance".

Case studies confirm that facilities can be greened with nominal, if any, additional costs. Design decisions and material choices that may represent higher first costs are recouped through savings in operations, maintenance and enhanced worker performance over the life of the building. Indeed, recent studies at major commercial/manufacturing facilities, such as Herman Miller's SQA Factory in Zeeland, Michigan and at government facilities such as the U.S. EPA's Research Facility in Research Triangle Park, North Carolina correlate superior indoor environmental quality (IEQ) with enhanced worker productivity.[9] Because worker salaries represent the highest portion of a building's operational costs, a 1% improvement in productivity far outweighs any additional costs associated with green design features or healthy materials and products.[10] Consistent with these findings and more germane to healthcare professionals, other research shows that improving the quality of hospital spaces can lead to decreased length of stays for patients.[11] Establishing the highest achievable standards for IEQ is an important guiding principle for all healthcare facilities.

Problem Statement

Unique Characteristics of Healthcare Facilities

Healthcare facilities, averaging between 70 and 75 million square feet of construction per year,[12] have unique programming criteria that guide design decisions and material, product and equipment specifications. Understanding the complex of human health implications of these decisions is critical. For example, the Academy of Architecture and Health cites research indicating that natural lighting, indoor landscaping, rooftop gardens, solariums, and small atria have a health impact on hospital staff and can improve the feeling of well being and medical outcomes in patients. They recommend maximizing views of nature and landscaping from all patient environments, and increasing the use of skylights, interior transom windows, and natural light.[13]

In addition, these buildings undergo a high rate of change as interior spaces are reconfigured, remodeled and outfitted with new furnishings and equipment, reflecting changes in management and delivery systems.[14] A result is an enormous amount of waste. Recognizing this trend, the International Facility Management Association (IFMA) Healthcare Council has tracked the development of flexible healthcare interiors based on building shell construction with universal distribution networks designed to minimize waste and accelerate schedules. According to an article in IFMA's *Facility Management Journal*, "The advantages of this approach are rapid project completion, clean and quiet installation, great flexibility and costs similar to those of conventional construction, but with significant lifecycle cost and operational savings".[15]

Representing a substantial share of annual design and construction activities in the U.S., the healthcare sector is well-positioned to highlight the potential that buildings have to reverse environmental decline and to create environments for people that enhance health, patient outcomes, and workplace performance. The purchasing power represented by the healthcare industry can lead to industry partnerships to improve the health and environmental profiles of buildings throughout their life cycle. Recognizing this shared responsibility among designers, manufacturers, building owners, facility managers and public policymakers sets an agenda that will yield important outcomes. As the allied building professionals design green and healthy buildings, manufacturers will shift their practices in response to demand for sustainable products and practices.

Similarly, it is appropriate and timely to establish partnerships between the regulating and the regulated communities. Guidelines and regulations overseeing hospital design and construction should be evaluated based on their impacts on environmental quality and human health and revised so that they reflect these as priority considerations.

Indoor Environmental Quality

While poor air quality is commonly associated with outdoor air, air inside buildings is often worse. As buildings were constructed to tighter energy efficiency standards in the 1970's, the materials and compounds used to manufacture common building materials were found to have harmful emissions, with direct affects on people's health. In response, improved ventilation standards were established; however, numerous common building materials and products—standard specifications for commercial and institutional buildings—continue to be sources of indoor air pollution. Both improved ventilation rates and source elimination are necessary to achieve and maintain good indoor air quality.

According to the U.S. EPA, most sources of indoor air pollution come from materials and products used in buildings, such as adhesives, carpeting, upholstery, and manufactured wood products that emit VOCs, including formaldehyde, a probable human carcinogen.[16] Indeed, the construction industry is the primary end-user of formaldehyde-based products, representing 70% of its use.[17] Potential health affects from VOCs and other contributors to poor indoor air quality include asthma, cancer, and reproductive and development effects.[18] Specifications that require use of materials with low or no VOCs and no added formaldehyde certified by strong emissions testing protocols can greatly improve indoor air quality.

PVC building products raise serious indoor health concerns along with the life cycle environmental concerns mentioned above. The release of hydrogen chloride gas fumes and dioxins and furans resulting from accidental or intentional combustion of PVC has prompted domestic and international firefighter organizations to advocate the use of PVC-free products. In addition, exposure to PVC can lead to exposure to the host of hazardous compounds used as additives in PVC products. Particularly notable are the offgassing of phthalate plasticizers used in many flexible PVC products, and the release of heavy metals stabilizers such as lead, cadmium and organotins used in rigid PVC products. PVC has also been found to encourage toxic mold growth as moisture is trapped behind PVC wall coverings.[19]

One of the plasticizer additives used in flexible PVC products, DEHP (di-ethylhexyl phthalate), was evaluated by the federal Center for the Evaluation of Risks to Human Reproduction (CERHR) of the National Toxicology Program. In their report, the CERHR expressed concern that exposure of pregnant women to current estimated adult exposure levels of DEHP might adversely affect the development of their offspring. They also raised serious concern about the possibility of adverse effects on the developing reproductive tract of male infants exposed to very high levels of DEHP from medical devices.[20] As a result, the U.S. Food and Drug Administration recently urged healthcare providers to consider alternatives to PVC medical products that leach DEHP[21] and Health Care Without Harm has recommended that hospitals specify building products made without PVC.[22]

Acknowledging these concerns, some major hospital systems are seeking to eliminate PVC from both medical devices and building products. PVC free products, in both traditional and new material formulations, are available for the entire range of building applications from carpet and flooring products to wall coverings, roof membranes, furniture and pipes.[23]

Obstacles to Green Building

Despite a growing recognition of the benefits of green building, many factors contribute to only a modest transformation of design and building practices to date. These include:

- *Resistance to change*: Innovation in the building industry lags behind virtually every other economic sector, with a few notable exceptions. The consolidation of ownership of natural resources and manufacturing infrastructure retards the competitive vibrancy that has become a distinguishing characteristic of other sectors such as telecommunications. In addition, professional academic training for architects and engineers has been slow to incorporate environmental and human health considerations into the core curriculum, so practitioners leave school without the benefit of this training.

Recommendation: Require the same level of innovation in your buildings as in your healthcare delivery systems; contract with design professionals with established credentials in green and healthy buildings; provide appropriate training to building-related professionals to implement the changed practice.

- *Fear of liability*: Introducing unfamiliar methods and materials raises liability concerns, especially when professional architects and engineers are required to stamp drawings.

  Recommendation: Establish strategic academic and industry partnerships, invest in research, development and demonstration projects, and monitor outcomes to reduce the liability risks. Compare the benefits of enhancing the environmental and health performance of buildings with the present liability of buildings that compromise environmental quality and human health. Consider that these present liabilities could be substantially expanded and increased as a more robust economic valuation of environmental quality and human health is codified and enforced.

- *Perception of higher costs*: Healthcare facilities typically operate for 30, 50, 100 years or more. An accounting system that artificially distinguishes the capital (first cost) budget from the operations and maintenance (O&M) budget hampers the ability to make decisions based on life cycle cost analysis.

  Recommendation: Front-loading the design process and material and product specifications to create a green and healthy building and optimize cost performance over the life of the building is a sound investment. A study by the National Bureau of Standards concludes that in a typical office the labor cost of employees is 13 times the cost of the facility itself over its life cycle, including construction, furnishings, maintenance, and interest, while the cost of design is only about 1/50th the labor cost of people.[24] Investing in design, materials and products that enhance productivity and improve health-related outcomes are quickly recouped and improve the bottom-line over time.

Solution

Redefining buildings through their life cycle as integral parts of a healthy regional ecosystem, and as environments that directly impact human health, are basic principles of green building. Minimizing wastes, pollution, and toxics associated with the construction and operation of buildings and pursuing every opportunity to optimize indoor environmental quality are measurable performance goals. This agenda is consistent with the fundamental mission of healthcare professionals and should be reflected in their building portfolios.

The healthcare industry is positioned to evaluate, recommend and implement policies and procedures that enhance the therapeutic qualities of healthcare facilities and minimize material- and labor-intensive remodeling and renovation practices. Moreover, investments should extend to enhance the environmental performance of their buildings by adopting and implementing green building guidelines and establishing health and environmental performance parameters for all planning, design, specification, operations, maintenance, and post-use decisions.

Implementation

Short-Term Actions (Year 1)

1. Incorporate green and healthy buildings into the strategic plan and establish an in-house "green team" to implement corporate commitment with mandate to:
    - review existing building-related policies and procedures, augmented by consultants as appropriate;
    - develop green specifications;
    - develop green housekeeping guidelines for building superintendent and custodial staff; engage in legislative advocacy; and establish accountability protocols
2. Require architects, engineers and contractors to specify commercially available, cost competitive materials and products as substitutes for products that compromise environmental quality and human health. Example substitutes are:
    - PVC-free products, e.g., flooring, wall covering, carpet backing, ceiling tile, plumbing pipe, roof membrane
    - formaldehyde-free engineered wood products, e.g., oriented strand board, medium density fiberboard, plywood, furnishings
    - no/low VOC products, e.g., paints, adhesives, stains, finishes, floor coverings
    - acoustical ceiling tiles that do not support growth of fungi and bacteria
    - materials and products manufactured without ozone depleting compounds (CFCs, HCFCs and halon), e.g., insulation, refrigerants, fire suppressants
    - treated wood manufactured without chromium or arsenic
    - certified sustainably harvested wood products (as per Forest Stewardship Council)
    - highest available recycled content steel and concrete to fulfill performance requirements
3. Provide and/or require attendance at green and healthy building training seminars for all building related staff and upper management
4. Expand responsibilities of Environment, Health & Safety Department to include monitoring indoor air quality and ongoing commissioning of major operational systems
5. Measure energy and water consumption , greenhouse gas emissions, and waste generation and establish efficiency goals based on baseline
6. Adopt the American Society of Healthcare Engineering (ASHE) Green Healthcare Construction Guidance Statement as a goal for facility project design and use to create a road map of strategies to incorporate in designs.
7. Review and modify, as appropriate, U.S. Green Building Council's LEED rating as a preliminary green building evaluative tool
8. Establish reuse and recycling as prioritized tiers of the facilities' waste management practices

Mid- to Long-Range Actions (Years 3-5)

1. Establish life cycle metrics for environmental, human health and natural resource performance to guide design decisions, material and product specifications and construction and operational protocols
2. Design for the long-term (50-year+ building life expectancy)
3. Merge capital & O&M budgets to optimize life cycle costing
4. Establish procurement policies and building material and product specifications consistent with the green and healthy metrics; provide for annual review/revision
5. Establish partnership with regulators to review/revise regulations to reflect impacts on human health and environmental quality
6. Establish an internal green and healthy building rating system, and/or adopt the U.S. Green Building Council's LEED with amendments to reflect particular priorities of healthcare facilities with focus on environmental health criteria and environmental exposures
7. Establish permanent position to oversee compliance with green and healthy building standards and create a template for green building design, construction, operation and maintenance
8. Provide ongoing green building training opportunities (on-site/off-site) for all building related staff and upper level management
9. Integrate/balance resource flows (energy, water, materials) to enhance life-cycle efficiency
10. Design for flexibility to facilitate operational changes, respond to changing user needs and minimize waste generation and labor requirements

Key Online Resources

- Center for Maximum Potential Building Systems • www.cmpbs.org
- Health Care Without Harm • www.noharm.org
- Healthy Building Network • www.healthybuilding.net
- Hospitals for a Healthy Environment • www.h2e-online.org
- Environmental Building News • www.buildinggreen.com
- National Institute of Building Sciences (NIBS) Whole Building Design Guide • www.wbdg.org/index.asp
- U.S. Green Building Council • www.usgbc.org

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