

665: Building Material Selection and Air Quality in Healthcare Design: A Survey of the Design and Construction Industry

Kelly Cook^{1*}, Pamela Harght¹, Jae Chang¹

School of Architecture and Urban Planning, University of Kansas, Lawrence, USA^{1}
kcooker@gmail.com*

Abstract

The decisions architects make over the selection of materials for interior spaces is crucial in the hospital setting. The depth of understanding the properties of the material influences these decisions. Design parameters include functionality, aesthetics, availability and cost, in addition to economic and social concerns, particularly when designing sustainable buildings.

Common materials selected for interiors emit volatile organic compounds (VOCs), creating an unhealthy, indoor air quality environment for hospital patients and staff. The purpose of this research is to determine when these decisions are made; by whom and which design parameters are the most influential in these decisions.

The research presented here is from a study that was conducted with architectural firms, engineers, and construction firms that specialize in designing healthcare facilities. The information was gathered from an electronic questionnaire as well as in-person interviews. The purpose for the electronic questionnaire was to gather additional information that cannot be conducted by in-person interviews due to the large number of firms available in the United States. The questionnaire targets areas of concern regarding problems in the design phase, material selection in traditional building design as well as sustainable design and determining factors for material selection. The in-person interviews are more in depth responses to similar questions in the electronic survey.

Keywords: indoor air quality, healthcare design, indoor environments

1. Introduction

"The greatest hospital building boom in 50 years is underway in America in anticipation of increasing utilization of healthcare services by Baby Boomers. The boom has generated some \$100 billion since 2003 and could surge another \$100 billion by 2009"[1]. Designing hospitals and healthcare facilities to keep all inhabitants healthy is at the top of the priority list and indoor air quality is very influential in achieving the required environment. Research shows that many patients in hospitals are contracting other diseases or are worsening their health in many hospitals due to air contamination or other unhealthy environmental factors.

Understanding the process the design team undergoes in healthcare facilities is crucial for everyone involved, such as facility managers, employees, doctors, patients, and the general public. Architects and hospital personnel are beginning to understand the importance of protecting patients and doctors from the unhealthy consequences that can result from extended periods of time spent in hospitals.

The goal of this research is to aid all professions involved in creating healthcare facilities to improve the indoor air quality for patients, staff and medical professionals. The focus of this research is on the types of products used in the interior spaces of healthcare facilities and the factors that influence the use of these products.

This investigation is looking at the current field of architecture and design practices to determine if prevention and conscious decisions are practiced daily to create a healthy environment for medical patients and staff.

2. Background Information

2.1 Indoor Air Quality

Controlling the quality, temperature and humidity levels, as well as maintenance, budget and the increasing awareness for the need of infectious disease containment, the hospital environment is a challenge to keep sterile. The spread of disease and risk of a global pandemic breakout is of significant concern among professionals. Hospitals currently require staff, including service and maintenance, as well as construction contractors, to be certified and aware of isolation and infection related issues. Maintenance of mechanical systems and containment of construction debris from ventilation is the main concern, but there are other factors in the indoor environment that contribute to unhealthy environments. One specific factor that, until recently, was overlooked is building materials for interior finishes [2].

Over the past several years, the United States Environmental Protection Agency has issued warnings that indoor air quality (IAQ) is one of the

most important environmental health problems in buildings [3]. Poor indoor air quality is usually caused by two circumstances: poor or inadequate ventilation and exposure to one or more contaminant sources in the building. In 2008, the Center for Disease Control (CDC) and Prevention reported five percent of all acute care hospitalizations resulted in a hospital-acquired infection prior to departing. Airborne or lower-respiratory tract complications accounted for twenty-three percent of the two million cases reported, which led to 90,000 deaths and more than five billion dollars in U.S. healthcare costs. With statistics like these, now, more than ever, it is important for healthcare facilities, architects, contractors, and facility maintenance to understand the importance of preventing indoor air pollution.

Indoor air quality is affected by a number of factors such as mold, bacteria, combustion pollutants, and off gassing that emits VOCs. Carpet, paint, varnishes, flooring, insulation, adhesives, and particleboard are all examples of common products that directly affect the quality of the indoor environment. Currently, there are many alternatives that are safer to use, but knowledge and familiarity with these products is essential for proper utilization.

2.2 Energy Conservation

New innovations in indoor air quality, specifically the control of airborne illnesses in the hospital, are giving those involved in the design process new tools to prevent the spread of hospital-acquired infections. However, another challenge facing hospitals in the United States is the amount of energy consumed [4]. Currently the second largest consumers of energy, inpatient healthcare facilities consume, on average, as much as 250,000 Btu per square feet, compared to the average consumption for all commercial buildings of 89.9 thousand Btu per square feet [4]. New energy efficient HVAC system configurations are being specified to enhance patient comfort and reduce overall utility costs.

2.3 Flexibility and Other Design Concerns

In order to accommodate the aging baby boom population, national level hospitals have increased the amount of spending for construction of new facilities. Both owners and designers are realizing that the interior design needs to be built with flexibility and proper support services because a room may be a patient's room one day and an intensive care unit (ICU) the next [3].

Based on the results to be presented and the background research conducted, the major concerns for healthcare design in the future are infection control, energy efficiency, and the adaptable spaces[3].

3. Research Method

The research designed for this project was divided into two parts. First, an electronic survey consisting of twenty-five questions on material

selection, indoor air quality, indoor environmental concerns and client relationships was distributed electronically to top architecture firms that specialize in healthcare design. A second round of questionnaires was distributed to construction managers as well as common consultants the architects seek out while designing these facilities. The second part of the investigation consisted of personal interviews with several architects that specialize in healthcare design in the U.S.

4. Results

4.1 Electronic Questionnaire

The purpose of this questionnaire was to contact as many practicing architects and professionals in the healthcare field as possible regarding the importance of indoor air quality in their design process, factors that influence the decision for interior material finishes in addition to other considerations in the design process. For the first phase, the questionnaire was sent to approximately one hundred architecture firms throughout the United States who specialize in healthcare design. The questionnaire achieved a twenty percent return rate. Some of the firms that responded to this research include: HKS, Anshen and Allen, Stantec Architecture, Planning for Health, HDR, FKP, Inc., The Neenan Company, RBB Architects, Craddock, Equipment Collaborative, O'Neil, Hill and Associates, Solution Management/FKP Architects, BSA Life Structures, Marhall Erdman and Associates, Herman Miller, Harley Ellis Deveraux, Inc., Eckenhoff Saunders Architects, Burt Hill, NBBS, Karlsberger and Shepley Bulfinch Architects.

The next phase of questionnaires was sent to construction companies and consultants architects seek to work with while designing new facilities, such as nurses, facilities managers, interior design, lighting, acoustics and cost. The response rate from this group of individuals has been unsatisfactory and therefore is still ongoing.

4.2 Design and the Indoor Environment

Since the goal of this research is to address the importance of indoor air quality and the architect's role in the decisions that affect the overall quality, such topics as furnishing materials, paints, finishes, ventilation systems, green materials, etc. were the main focus of the electronic survey.

Chart 1 below displays information regarding which rooms in a hospital are the major concern for the architect and the owner in regards to the quality of the indoor air.

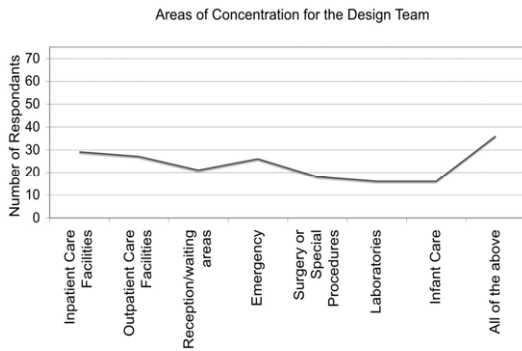


Chart 1: Results display hospital rooms of top priority for attention on indoor air quality.

This question enabled the surveyor to elaborate. The majority who answered stated that all areas were of particular focus but more specifically, patient rooms, surgery and other long-term recovery rooms and special care units as well. Four responses that were the most informative are:

- “The latest developments in HVAC are of interest for lower energy consumption, less infections and better comfort. Also, we are participating in the new Global Health and Safety Initiative.”
- “Attention towards the air intake of the building and selecting materials for low emissions of volatile organic compounds.”
- “Indoor air quality is an important subject and is generally neglected. I would love to see operable windows in patient rooms.”
- “Specifically the State of Michigan, amongst other states, has their own ventilation guidelines that exceed the AIA Healthcare guidelines as to IAQ that we must meet or exceed. NICU areas are of special consideration not only for air quality but for performance (no drafts)”.

Chart 2 displays the results from respondents regarding client concerns and priorities in designing the healthcare facility. The most important concern according to the participants was the flexibility of layout. Materials and finishes was the largest percentage for the next level of priorities, listed as “important”. Although, indoor air quality is not a top priority, 81% of the respondents said their clients are aware of the importance of air quality.

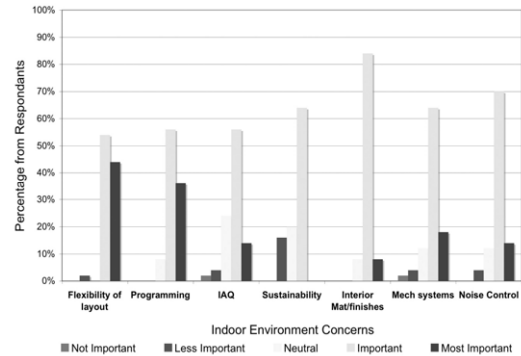


Chart 2: Comparison of Indoor Air Quality to other issues pertaining to the indoor environment.

In addition to comparing indoor air quality to other potential indoor environment issues, the design stage in which air quality becomes a concern is important.

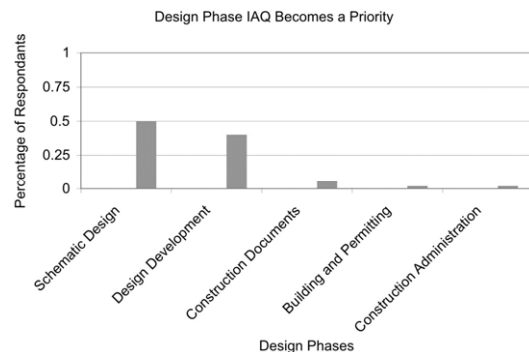


Chart 3: The design phase in which Indoor Air Quality becomes a priority.

The results shown in Chart 3 indicate that 90% of the design team addresses indoor air quality during schematics or design development. As with many other common building issues, the later the problem is addressed, the more difficult it is to address them and make the necessary changes. There is a general consensus that one can achieve the best air quality the earlier it is considered and addressed.

4.3 Green Buildings and Healthcare

In an interview with Earl Wilson of HMN Architects in Overland Park, Kansas, many obstacles that architects face in achieving optimal building performance regarding indoor air quality were discussed. Wilson stated that he strives to design healthcare facilities that create excellent patient and employee environments while also optimizing energy conservation and building efficiency. He and the firm HMN are one of the many architecture firms that follow LEED guidelines, but do not apply for the certification at the completion of the project. He mentioned reasons such as the added cost of documentation and the added time to project deadlines.

LEED certification for hospitals is uncommon in the United States (see the chart below). However, 100% of the respondents stated they implement green products in their design,

regardless of whether or not they are striving for any of the levels of certification. The most common level of certification that is set as the goal for LEED buildings is Silver (33-38 points). Many hospitals communities do not strive for LEED certification (60% stated less than 25% of their work is for certification). However, 67% of the firms stated they issue post occupancy evaluation surveys based upon overall satisfaction with the space.

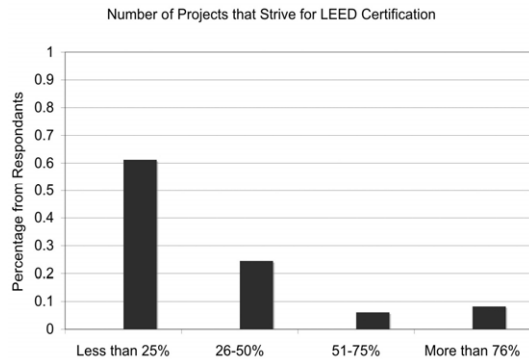


Chart 4: The percentage of healthcare projects that strive for LEED certification in the United States.

Rodney Fage of HMN, is a LEED accredited professional architect. In an interview with Fage, he mentioned the stringent requirements involved in achieving a LEED certification sometimes slows a project down to an unreasonable timeline. Hospitals around the United States are currently building as fast as possible to accommodate the quickly growing number of patients they see. One aspect of LEED certification Fage mentioned was the building purge of running the mechanical systems required before occupancy which was around 14,000 cubic ft. per square foot of tempered air. He believed this was approximately six months of normal air circulation before occupation can occur. The benefit of this procedure is simply hard to convince clients of when the need for healthcare facilities is now.

Fage noted the irony and frustration that the recently completed Bloch building by Stephen Holl, a museum addition in Kansas City Missouri, was flushed for approximately one year before any art entered the building in order to offer the most protection for the art. Yet "hospitals cannot seem to afford even a month of mechanical system flushing."

4.4 Reducing Volatile Organic Compounds (VOCs)

An open-ended question was part of the questionnaire regarding the steps architects take to reduce VOCs. Common responses were complying with LEED recommendations and exceeding them regardless of certification, changing specifications by specifying products that do not have PVC, urea-formaldehyde, safe cleaning products and "green" materials, paints and adhesives. 91% of the respondents stated

they were familiar with the LEED process and companies that make green products like GreenGuard Environmental Institute in the United States. Although many of the architects responded with similar answers, one in particular stood out among the rest:

"The Green Patient Room, an innovative national model patient room design full-size mock-up touring conferences in 2008-2009 designed in collaboration with 30 national manufacturers and all sustainable products demonstrates the convergence of evidence-based design and IAQ: a safer and healthier environment. University of California San Francisco Mission Bay Medical Center designed in partnership with Wm. McDounough and Associates will be the first LEED-cert. MC IAQ neutral or positive (completion 2014)."

In Earl Wilson's interview, he discussed the dependence architects have on vendor information for new products. Wilson stated, "as there are more products and alternatives on the market, there is more research involved by the architect in order to decipher what the best product for a situation is."

Many of the green/sustainable products are relatively new on the market and have not been used and documented performance-wise on the long term. One can see that there is certainly a conflict of interest from a vendor giving performance information for a product that they are trying to sell. Wilson did make the point that "clients do a good job of letting the firm know if a product isn't working." This can make a post occupancy evaluation extremely important when trying to evaluate the performance of new products for future jobs.

Finally, despite the interest of energy savings and reducing the overall energy consumption by hospitals, Wilson states the most important factor remains maintaining an optimal environment for patient health and recovery.

5. Discussion and Conclusion

Responses from the survey and in-person interviews are still being collected and analyzed. This investigation serves as the foundation for potential research investigating and testing new "green" products as well as standard materials. In addition, future outreach to educate the general public, the healthcare community and design professionals on the importance of IAQ. With the current surge in new healthcare facilities, both green and non-green, as well as reducing healthcare costs in airborne illnesses, stopping potential pandemic outbreaks and creating a healthy environment for the staff, indoor air quality is an issue that can no longer be addressed only for those with the budget and time.

In summary, it is clear that indoor air quality is an important issue for both architects and owners. The healthcare environment requires diligent

attention to the subject of IAQ because of the compromised state of the occupants. Considering the statistics from the Center for Disease Control and Prevention that 2 million patients a year acquire infections during hospital stays[8], architects must be constantly aware of the consequences their decisions will have for future occupants. Architects are striving to hit a delicate balance between cost, efficiency, and performance. In regards to building green and striving for LEED certification, further research is needed to learn why more buildings do not strive for certification. A few potential answers are budget restraints, the level of importance for certification versus simply implementing many of the “green” ideas suggested for new buildings. These questions will be addressed in coming interviews with building professionals and healthcare clients.

7. Acknowledgements

We would like to thank the architecture and construction firms who took the time to participate in our survey and personal interviews. As well as the faculty support from Professor Jae Chang, and the School of Architecture at the University of Kansas. Finally, we would also like to thank GEI for their financial support in sponsoring this research.

8. References

1. Reece, Richard L. (2006). “Feeling the impact: Key Operational Trends in Healthcare.” Health Leaders News
<http://kihealthcare.com:80/issues.aspx?ar=71>
2. Checket, H. (2007). “What the Doctor Ordered.” Air Conditioning, Heating and Refrigeration News. Troy: Nov 6, 2006. Vol 229, Iss.10; pg 21,22
3. Center for Disease Control, [Online], Available: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4908a1.htm> [8 June 2008].
[8 June 2008].
4. Fem, C., (2008). “Champion both infection control and energy conservation.” Healthcare Building Ideas: p. 68.
5. United States Environmental Protection Agency, [Online], Available: <http://www.epa.gov/iaq/index.html> [8 June 2008].