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2007 Study of United States LEED Accredited Professionals on the Subject of Smart Glass

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ABSTRACT

A movement is taking place in many parts of the world that has a profound effect on the use of building materials. Reflective of a desire to “go green,” an increasing number of architecture professionals now design buildings that are sustainable and environmentally responsible. At the forefront of this movement is the U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design (LEED) Green Building Rating System™. To facilitate this system, which rates buildings in terms of their performance, the USGBC accredits professionals involved in the design and operation of buildings.

This paper summarizes a nationwide market research study of LEED Accredited Professionals on the subject of smart glass. These professionals name “architect” as their area of practice. Smart glass, also known as chromogenics and switchable glazings, is an emerging category of building materials that visibly change their light-control properties in response to a stimulus. Smart glass can be used in windows, doors, skylights, partitions and other applications. This first-of-its kind study examines a variety of attitudes and usage behaviors as they pertain to smart glass.

INTRODUCTION

Architects and designers have a direct influence on the form and function of commercial and residential buildings. In their service to clients, these professionals are uniquely positioned to recommend innovations that address what have been long-standing challenges. At the forefront of architectural design today is the movement toward sustainability. Contemporary sustainable initiatives have as their genesis the seminal work of The United Nation’s World Commission on Environment and Development, which claimed “Development is sustainable when it meets the needs of the present without compromising the ability of future generations to meet theirs” [1]. There are many compelling reasons to pursue sustainable architectural design. Chief among these is the impact of growing amounts of energy used by architectural buildings. The United States Department of Energy reports that commercial and residential buildings in the U.S. used a total of 39,139 trillion Btu of energy in 2006, an increase of more than twelve percent since 1996, and buildings’ share of total energy consumption in the United States reached 39.3% in 2006, up from a baseline of 32.3% in

1973 [2]. The desire to “go green,” however, involves more than the creation of architectural designs that support higher levels of energy efficiency. Its emerging perspective also encourages greater consideration of eco-friendly materials, the building’s impact on occupants and the environment, and the financial payback of sustainable investments. In contrast to the zero-sum nature of earlier design approaches where a building’s higher performance, for example, may have been at least partially offset by impediments to an occupant’s well being and productivity, the new orientation strives for a more holistic approach where benefits are enjoyed across multiple interests and constituencies. The opinion of the United States Office of the Federal Environmental Executive is consistent with this view when it emphatically states, “Truly sustainable design recognizes the environmental, economic, and social aspects of building” [3].

Smart glass, also known as chromogenics or switchable glazing, is a category of materials that visibly changes its light-control properties in response to a stimulus. There are two broad categories of smart glass. Passive smart glass materials do not involve an electrical interface. Photochromic eyewear, which reacts to the presence of ultraviolet (UV) light, is an example of passive smart glazing. Active smart glass materials change their properties in response to the presence of an electrical stimulus and include liquid crystal (LC), electrochromic (EC) and suspended particle device (SPD) technologies. Going forward, architectural applications of smart glass are most likely to involve active smart glazing because these can be controlled by the user, set to respond automatically to changes in ambient conditions, and integrated with a building intelligence system.

The performance characteristics of active smart glazings vary. For example, Research Frontiers Incorporated, the developer and licensor of SPD technology, recently reported production of a new generation of SPD film by its licensed supply infrastructure. When laminated between panes of glass or polycarbonate, this patented film allows users to control the amount of light, glare and heat passing through products such as windows, doors and skylights. Such SPD products have wide ranges of light transmission, switch quickly, “tune” consistently and precisely to any point between the dark and clear states, and have low haze. Products made with SPD technology also use very low amounts of power

(approximately 0.06 watts per ft²) and block more than 99% of ultraviolet light.

While scientific research about smart glass is bountiful, a limited amount of market research exists. In the aggregate, these market perspectives signal very strong prospects for the smart glass industry. The Freedonia Group reports the dollar value of smart glass demand in the United States is expected to grow more than 250% from 2005 to 2015 [4]. A 2000 study of United States window manufacturers finds high levels of interest to offer commercial and residential smart glass and strong expected market penetration rates [5]. Further, U.S. architects studied in 2004 also report high levels of potential market penetration and particularly value smart glass's ability to control light and heat transmission. Driving forces of smart glass demand include the commercialization and related promotion of smart glass materials, growing interest in quality-of-life enabling technologies, and heightened appreciation for the value of daylighting [6].

It is an exciting time for architectural design. With growing sensitivity to humankind's impact on the environment, architects and designers have a direct influence on how the United States responds to what is increasingly viewed as a mandate for sustainability. This study examines the attitudes of LEED Accredited Professionals on the subject of smart glass. In doing so, it offers insight into awareness, attitudes and usage (both current and prospective) of smart glass. The study's findings can be used to assess markets for smart glazings, assist with the introduction of sustainable smart glass products, and serve as a set of benchmark metrics against which future studies and their results can be compared. Perhaps most importantly, it can support market adoption of a category of materials valued by the design community that can help to meet the country's growing need for sustainable buildings.

SURVEY OF UNITED STATES LEED ACCREDITED PROFESSIONALS

Introduction and Methodology

The study population for this research project is United States LEED Accredited Professionals who have chosen "architect" as their respective area of practice. In February 2007, an email communication was sent to 4,401 of these professionals. The text of the email sought participation in the study and provided a link to the online survey where responses were collected. As an incentive, participants were offered receipt of a copy of the study's results. Over a two-week period, a total of 455 usable surveys were completed, thus yielding a 10.3% response rate.

Respondent Profile and Information Sources

Of the professionals surveyed, 93.6% report having been a LEED Accredited Professional for two years or less. The overwhelming majority of all respondents (84.0%) are employed by an architectural, design or engineering firm, and

53.0% are currently licensed architects. When asked to select their primary sources of information about sustainable design, the leading sources named include published journals and magazines, internet searches, and colleagues.

Activity and Attitudes Regarding Sustainable Design

Nearly three-quarters of respondents have worked on at least one commercial architectural project in the past year. Of these projects, the median percentage that involved sustainable design is 25.0%. Slightly more than one-third of all participants have worked on one or more residential projects in the past year, and of these, the median percentage that involved sustainable design also is 25.0%. Respondents were asked to identify the primary factors driving interest in sustainable architectural design today. By far, the leading driver is the potential for greater energy savings, cited as a top driver by 60.9% of respondents. Other leading drivers include client demand for sustainable building solutions (47.5%), the need for lower lifetime operating costs of buildings (34.5%), and advances in sustainable materials (20.2%). Survey participants have especially robust views toward the future of sustainable design. When asked how they expect the share of total architectural design work that involves sustainable design to change over the next five years, 64.3% said they expect it to increase greatly. Fully 98.4% expect the proportion to increase greatly or increase somewhat.

Architectural Glazing and Shading

Attitudes toward traditional architectural glazing are mixed. Just 11.5% are very satisfied with the current offering of windows, blinds, shades and curtains as it pertains to the ability of these products to address a building's light-control needs. Respondents were asked to rank the importance of various items regarding glazing for commercial and architectural projects. Figure 1 summarizes the percentage of respondents who identified each item as being one of the top two most important items for commercial glazing. For these respondents, energy efficiency, daylighting and aesthetics are the most important. For residential glazing, the distribution of importance is similar but not identical. While the leading items remain energy efficiency, daylighting and aesthetics, others (e.g. view preservation, privacy, protection of furnishings) show notable increases (see Figure 2).

Those surveyed expect architectural glazing to play a major role in sustainable design in the future. Nearly eighty percent expect architectural glazing's importance to increase over the next five years while less than one percent expect its importance to decline. Control of solar energy is an especially important consideration for this group of architectural professionals. Almost forty-seven percent (46.6%) strongly agree with the statement "Demand for solar control architectural glazing is increasing." In addition, there is broad agreement among respondents that overall demand for architectural glazing is increasing, that the price per square

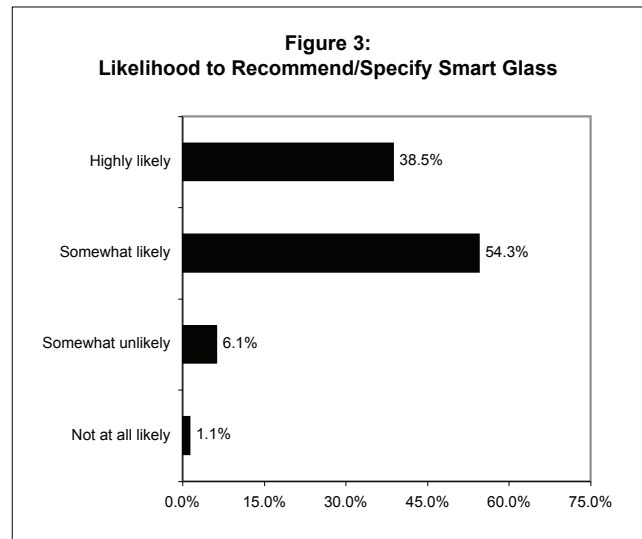
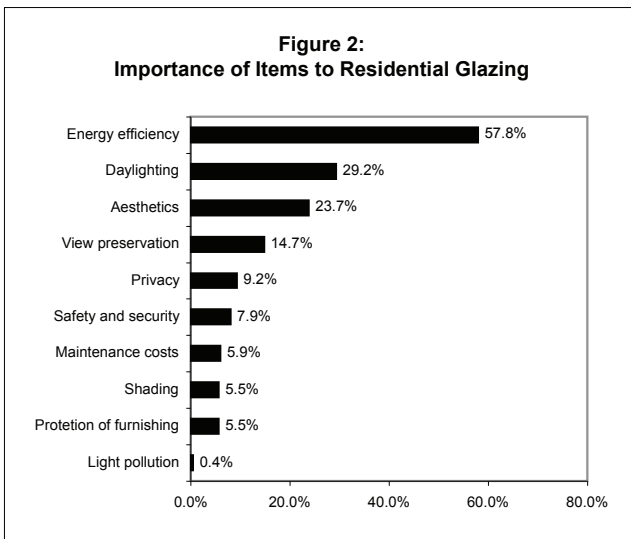
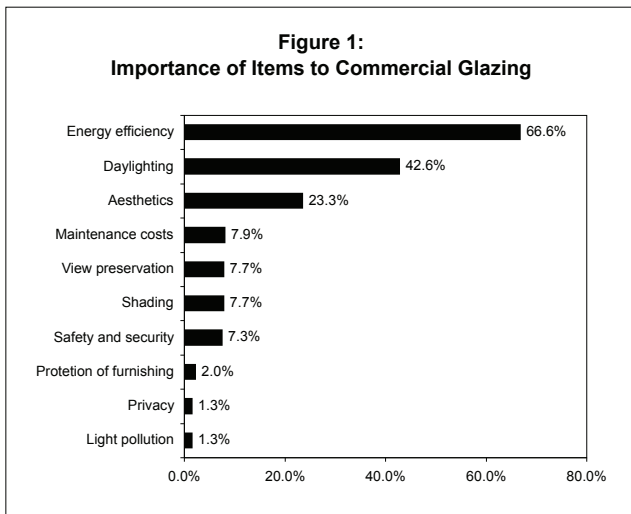
foot of architectural glazing is increasing, and that demand for laminated architectural glazing also is increasing. More than half of those surveyed (53.8%) report having evaluated, recommended or specified commercial architectural glazing for a project in the past year, and 20.4% have done so for residential glazing. Among these study participants, the most common types of glazings evaluated, recommended or specified are exterior windows, interior partitions, and standard skylights (i.e. square, rectangular, domed). When asked how often they refer to energy performance ratings, 57.1% and 30.4% said “always” and “often,” respectively. Finally, the use of glass in architectural design is growing. Among this group, 43.9% claim they are including more glazing in their designs today than in the past, while 53.6% say they are using the same amount. Just 2.4% report they are using less glazing today than in the past.

Smart Glass

As observed in prior studies, attitudes toward smart glass are strongly positive and support the belief that this category of materials will play a major role in sustainable design going forward. While awareness of smart glass among the study population is strong, with 81.5% claiming to have some awareness of smart glass technology prior to the research study, only 6.6% claim they or their firm have ever evaluated, recommended or specified smart glass for a commercial project. Just 2.0% claim to have done so for a residential project.

The professionals surveyed believe that various attributes of architectural smart glass will be desirable for clients interested in this category of building materials. Overall, energy efficient operation and high durability are desired, and operation using alternating current (AC) voltage is preferred versus direct current (DC) voltage. With regard to the performance of smart glass, the most desired characteristics are: 1.) integration with other coatings such as low-e, 2.) glare reduction, 3.) consistent-looking tint changes regardless of window size, 4.) light-control that is controllable to any point between the dark and clear states, 5.) blockage of more than 99% of ultraviolet (UV) light, 6.) fast switching speed, and 7.) solar heat gain control that varies with the tint level of the window.

Despite low usage activity to date, the prospects for smart glass are strong. Assuming the price of smart glass is reasonable and that it meets the desired specifications for a particular project, more than ninety percent of those surveyed claim they would be highly likely or somewhat likely to recommend or specify smart glass. The actual distribution of this finding is summarized in Figure 3.



The professionals surveyed were asked to describe the desired maximum dimensions of the smart glass that they would like to see offered by suppliers. In their opinion, the maximum height of smart glass that will be desired is 10 feet and the maximum width is 6 feet (both are median levels). Respondents also were asked to comment on the maximum price per square foot for smart glass that their clients would be willing to pay. For both commercial and residential projects, the median price per square foot is \$50. Substantial variation exists around these metrics. For example, more than 25% claim their clients would be willing to pay \$75 or more per square foot for smart glass, with a maximum amount of \$200 per square foot. For residential projects, nearly 15% claim their clients would be willing to pay more than \$75 per square foot, with the highest price at \$175 per square foot.

CONCLUSION

The smart glass industry is poised to make a significant step forward in the field of architectural sustainable design. Viewed quite favorably for its potential energy efficiency and solar control benefits, architectural professionals also desire distinctive features of smart glass that include fast and consistent switching regardless of panel size, light-control tunable to any point between the glazing's dark and clear states, and improved aesthetics. While awareness levels of smart glass are reasonably strong, specification activity to date is low. However, the outlook is very promising, with more than ninety percent of these professionals claiming they likely would recommend or specify smart glass if pricing were reasonable and if it meets the desired specifications for a project. This bodes very well for the movement to "go green." Great strides in sustainable design are being made across numerous product categories.

As architectural professionals learn more about the unique blend of functional and design possibilities that smart glass offers, even greater advances will be made toward various sustainable design ideals – low energy consumption of buildings, improved occupant well-being and productivity, support for the community and the environment, and favorable economic outcomes.

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