Green Architecture: Symbolic Sustainability or Deep Green Design?

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The Question

Are high-profile buildings that incorporate technologies and strategies to minimize adverse environmental impacts really "green" or do they merely symbolize concern for the environment?

Background

Construction activities, including renovations and new construction, contribute more than $800 billion to the U.S. economy (Gottfried 1996). Building construction consumes approximately 25% of the virgin wood and 40% of the raw stone, gravel and sand used, 17% of the fresh water withdrawals, 54% of energy used and 50% of fossil fuels consumed on this planet (Roodman and Lenssen 1995; Loken et.al 1994). Construction and demolition debris make up more than 25% of the contents in landfills (Gore 1992, cited in Gottfried 1996). U.S. offices spend up to 30 to 40 cents of every dollar on electric lighting, making it a costly and wasteful expense (Energy Resource Center 1995, cited in Pearce 1999). In recent years, an increasing amount of attentions has been given to minimizing these adverse environmental impacts in building projects, often called "green building" and measuring how well this goal is being achieved.

Green design and construction strategies have been reported to have numerous benefits for the environment, as well as building occupants and organizations. Building professionals can have significant positive impacts on the environment by adopting design and construction practices that minimize environmental degradation, or perhaps serve a restorative function. How does one know if this goal is being accomplished?

Rating Green Buildings

There are several tools recognized internationally for rating the "greenness" of buildings. In the U.S., Leadership in Energy and Environmental Design (LEED™), developed by the U.S. Green Building Council (USGBC), is accepted as the national rating tool for commercial facilities. The USGBC is membership organization with over 500 members representing architects, engineers, manufacturers, government and academia. A consensus-based process was used by the members to develop LEED™. Version 2 was released in April, 2000. There are five categories in which a building can receive credits under the LEED program, including site, water, energy, materials, and indoor environmental quality. By earning specified numbers of points within these credits, a building can become LEED-certified, or receive a silver or gold rating for earning additional points.

No claims are made that LEED is the perfect tool for rating the environmental performance of facilities. In fact, one of the points that can be earned is the "innovation credit". This credit

encourages others to suggest new LEED™ points by providing information for the new requirement, suggested strategies to meet the requirement, and necessary documentation. The elegance of LEED™ is its clarity. The requirements are specific and measurable. However, it is entirely possible for a building to become LEED™ certified by incorporating a wide range of green strategies while ignoring an entire category, such as water conservation. The cost associated with earning points varies widely and this is an important consideration for design teams. There is very little hard data on how to achieve "the most bang for the buck". Some have found that using LEED™ as a framework on a project may stifle the team members' ability to innovate beyond its requirements. It would be interesting, yet difficult, to measure actual environmental benefits from earning specific LEED™ points (e.g., How much CO2 is reduced per square foot when daylighting goals are achieved as compared to typical buildings that are more dependent on artificial lighting).

Other similar systems exist such as BREEAM, used extensively in the UK. The Green Building Challenge is a rating tool currently being developed by multiple countries together.

Case Studies

Whether influenced by regulations, rising oil prices, altruism, or a desire to educate or improve an organization's public image, showcase architectural structures are demonstrating that facilities can reduce adverse environmental impacts associated with buildings.

Two case studies have been selected to evaluate the research question more carefully. Four Times Square in New York was chosen because it is often cited in the green building literature as an example of environmentally considerate design and construction and it has also received some attention in architectural and construction journals, as well as the popular media. The Commerzbank in Frankfurt, designed by Foster and Partners, was also selected because of its high visibility in architectural journals and popular media. It is truly an example of a high-profile architectural structure.

Four Times Square

Location: New York, NY
Designed by: Fox and Fowle Architects
Designed for: The Durst Organization
Construction: Tishman Construction
Completed: 1999
Size: 1.6 million square feet in 48 stories

Project Overview: The building, developed by Durst Developers, was a speculative office tower designed to minimize adverse environmental impacts. Conde Nast occupies the structure. The most prominent exposures are on the west and north, as these are made of glass and metal and incorporate commercial signage into the façade.

On 42nd Street, masonry provides a look that conforms to the style of other buildings there in Midtown Manhattan and Bryant Park (www.edcmag.com/archives/9-97-05.htm).

Green Strategies

Energy Efficiency: High-rise office towers with a large, central core present significant lighting and mechanical system demands. Some of the strategies to reduced energy consumption are described below.

- Fuel Cells: Two 200 kw fuel cells generate nighttime energy requirements (substantial due to signage) on site. Fuel cells generate power quietly and cleanly by converting a hydrogen-containing gas (natural gas in this case) using a chemical reaction without combustion. Each of the fuel cells used in Four Times Square required 700 square feet of floor space (Kaplan 1997) and they are located on the fourth floor.

- Photovoltaics: Thin film photovoltaic panels were incorporated into the spandrels in the top 19 stories, providing an additional 48,000 kWh of energy annually (www.edcmag.com/archives/9-97-05.htm). The panels were placed in a 60' wide area on the south and east sides.

- Glazing: Glazing is low-e glass to provide daylight while improving energy efficiency. Higher reflective glass is used on the upper floors to reduce solar gain (Stehpens 2000).

- Lighting: Exit signs contain LED bulbs. Interior lighting is energy efficient, controlled centrally and by using occupancy sensors (Stephens 2000).

- Energy Modeling: Using DOE-II, energy consumption modeling shows a 30% reduction over the New York state code requirements (AW September 13 2000).

- HVAC: Heating and cooling is provided by natural gas absorption chillers/heaters. The high efficiency of the HVAC system is expected to result in a payback period of 3 years.

Materials and Resources:

- Special attention was given to the amount of energy and material required to make and transport the construction products used in Four Times Square. In order to reduce these impacts from the structural steel, a hat truss structure was used to bind the center core and outside columns (Cook 1999).

Indoor Environmental Quality:

- Outside air is provided at .20 cfm per square foot to all floors after it has been filtered. The occupants can have an additional 0.05 cfm provided when desired. Monitoring of the air quality will also occur on a regular basis. Dedicated exhaust is provided in smoking

and copying rooms. The exterior is designed for relative humidity of 30% in the winter to reduce risks from condensation (Kaplan 1997) and related moisture problems.

Great Architecture?

Four Times Square has been described as a building that does nothing to "radically redefine the skyscraper as an urban building type", not unlike some of the most notable towers that create the city's skyline, such as the Empire State building or Rockefeller Center (Stephans 2000). The building has a lot going on, with its hybrid design. Towards Bryant Park, the building is designed to blend in with the neighborhood. The entrance is made of granite and structural glass and is somewhat subdued. On Broadway one sees the glitzy storefront of the ESPN Zone designed by Disney. On 43rd Street, LED signs ensure that passersby know they are in Times Square. For this building, 20,000 square feet of signage was required by zoning. Four additional signs, 4,300 square feet each, were added (Ibid.).

The architectural firm, Fox and Fowle, is recognized in New York for its ability to design discreet and stylish Manhattan skyscrapers.(Stephens 2000) The firm has received compliments on its proportions of building mass and setbacks (Ibid.). Four Times Square has been called a "million and a half square foot building that everyone likes" (Kaplan 1997).

Green Architecture?

Who had the idea to go green? *The Americus Journal* (1998) wrote that the National Resources Defense Council encouraged the owners, The Durst Organization, to include renewable energy and energy efficient technologies into the new skyscraper.

Douglas Durst, president of Durst Organization, writes that he has always understood the relationship between nature and humans. He became most aware of it during a time of living in pristine Newfoundland, Canada. Regarding Four Times Square, Durst writes (Earth Day NY 1997),

> *There was never any question that the building would be ecologically responsible, we had for a number of years been retrofitting our existing buildings in this manner. But this decision, really took us to a different level, we had to apply our knowledge to new construction and push the learning curve considerably further"*

The biggest challenge, according to Durst, was determining what 'environmentally responsible' really meant for their building" (Ibid.). They relied on the help of the National Resources Defense Council and independent consultants to determine the answer to that question. In fact, according to Jonathan Durst, Executive Vice President, an entire network of people helped them identify appropriate products, equipment and vendors to utilize. The Architectural firm, Fox and Fowle, had been selected by the Department of General Services for New York city as a company that was green based on their previous work (Ibid.).

One lesson cited over and over again is the importance of early planning and research. Technologies such as fuel cells were learned about late in the process and could have been incorporated more economically if done sooner.

The greatest constraints were the fact that is had to be a skyscraper and economic factors, especially those resulting from the developer-tenant relations (Kaplan The one lesson cited over and over again by the developer is that early planning is essential. There were technologies that they learned about late in the process, such as fuel 1997).

It is interesting to note the differing perceptions of the greenness of Four Times Square. Efforts to save energy are described by Stephens as "more symbolic than actual". It was described as "the nation's premier green building" that will help "transform the Big Apple into the Green Apple" *(The Americus Journal* 1998). Kathryn Brown (1999) writes in *Discover* "Four Times Square is its own freestanding environmentally friendly electric utility". The proactive use of fuel cells places Four Times Square in a leadership role, however, the 2 fuel cells that were purchased and installed will supply only about 8% of the building's electricity. The nearly 3,000 square feet of photovoltaic panel spandrels provide about ½of 1% of the energy required (Stephens 2000). Stephens also writes, "Nevertheless, that the developers and architects took the symbolic lead is significant". Perhaps the most accurate description comes from Cook in *Building Design & Construction* (1999) who writes, "Everything from material consumption to the HVAC design has received an environmentally sound tint". The tint may well be light to medium green.

What do the designers think about their contribution? Daniel Kaplan, principal with Fox and Fowle, is quoted as saying "We really didn't do anything groundbreaking, except bring under one roof a number of god ideas from a variety of sources" (Cook 1999).

Commerzbank Headquarters, Frankfurt

Location: Frankfurt Germany
Designed by: Sir Norman Foster & Partners
Designed for: Commerzbank
Structural Engineers: Ove Arup and Partners with Krebs and Keifer
Completed: 1997
Size: 70,000 square meters [CONVERT SF}in 60 stories

Project Overview

The Commerzbank Headquarters is the tallest building in Europe, standing at 258 meters (725 feet) with a 40-meter mast on top. The Commerzbank previously occupied approximately 30 buildings, and changes in the banking business made it desirable to bring the employees together under one roof to improve communication and promote creative teamwork (Davies and Lambot 1997). The skyscraper is

triangular with curved sides to improve the efficiency of the space. All necessities such as elevators, stairs and other services are housed in the 3 corners. The layout is composed of "village like clusters and gardens" (Buchanan 1998). The gardens, four stories tall and placed around the building to serve a few floors each, help distinguish the Commerzbank. Even workers in the interior spaces have views of natural light from the gardens. Employees' favorite offices are not those on the perimeter, but those that overlook these gardens (Davies and Lambot 1997) that link to a central atrium serving as the "chimney" for natural ventilation. All offices have daylight and operable windows (GA Document 1997). As mandated, shops, housing, an auditorium and parking spaces for 300 cars and 200 bicycles are also provided (Pepchinski 1998).

Green Strategies

Energy Efficiency:

- Natural ventilation: This is perhaps the most significant energy-saving strategy, for it had not previously been accomplished in a building of such a scale (Buchanan 1998). It is supplemented with air conditioning. The occupants have operable windows, but when the outdoor temperature is extreme, the windows automatically close and the AC is turned on.
- Triple layer cladding: It provides the ability to use natural ventilation while shading the building from unwanted heat gain during warmer months (Buchanan 1998). Interestingly, the outer layer also absorbs radar for German flight security purposes.
- HVAC: Cooling is provided to the center core of the building at "elevated chilled water under dewpoint controls" which is intended to prevent condensation risks (Buchanan 1998). The chilled water is located in a grid above the perforated metal ceiling (Pepchinski 1998). All nighttime cooling in the summer is through natural ventilation, reducing energy demands. Perimeter heating is provided in the winter, and central steam form the city's mains will supply space heating.
- Lighting: Energy efficient lighting with dimming control in response to daylight are used throughout the building (Evans 1997a).
- Building Management System: This system monitors indoor and outdoor conditions and overrides manual controls of blinds, windows, etc. (Davey 1997b).

Water Efficiency:

- Greywater from cooling towers is used for toilet flushing (Pepchinski 1998).

Indoor Environmental Quality:

- Raised floors: This type of floor system, composed of removable squares covered with carpet tiles, is raised by adjustable feet, allowing easy access to all wiring (Davies and Lambot 1997).

- Acoustics: The floor panels are made of a composite that provides good sound insulation. This floor, combined with partitions and the ceiling provide a sound reduction between rooms of 42 decibels (Davies and Lambot 1997).

Great Architecture?

Architectural literature is filled with praise for the Commerzbank. Peter Buchanan writes (1998) "What Foster and Partners have achieved is nothing less than the reinvention of the skyscraper". The building has been called Frankfurt's "only true skyscraper", the "eco-tower", an "energy churner with celestial gardens" and "a column of advertising" (Pepchinski 1998). It has been described by Peter Davey (1997b) as the only tower in Europe that can compare to the "picturesque drama" of those in South-east Asia, none of which can compare to the environmental considerations and internal design of the Commertzbank.

Of course there is also criticism of the building. While some workers used communal spaces as they were intended, others filled the space with file cabinets. Food smells from the garden cafeterias fill nearby corridors and offices during lunchtime and the atrium is noisy. The main entrance is seldom used because of its location on a less busy street, and the furnishings are "clearly not consistent with the architectural aesthetics" (Pepchinski 1998). The building has received praise from the German media, but critics of skyscrapers say the building is too massive and dominating and some feel that the building, with its gardens, is "an arrogant fortress for an elite class" (Ibid.). The building has also been criticized for receiving so much attention on its "gardens in the sky" and "talk of (aerial) villages" rather than its energy-saving strategies (Evans 1997b).

The building is not considered, at least by some, as one of Foster and Partners "more exciting and elegant designs", due in part to the bland, fully-glazed exterior. The public level does not work well, partly because of budget constraints. However, the Commerzbank may prove to be one of the most influential buildings designed by the firm. Foster and Partners is said to have talked about the importance of social and environmental responsibility, but have never delivered that message more clearly than with this design (Buchanan 1998).

Green Architecture?

The Commerzbank is different from Foster's earlier and well-known Hong Kong bank, a deep plan that was completely dependent on air conditioning. Ian Lambot (Davies and Lambot 1997) writes of the Commerzbank, "With its natural ventilation and shared gardens, its openness to

daylight and views, it marks a new beginning, an important step on the road to an ecologically-aware architecture".

Who had the idea to go green? The local government. In the early1980's, new high-rise development was outlawed, but by 1989 public opposition to these tall structures lessened. The Commerzbank realized that development on a site next to its largest building at the time could be developed for their new facility. Politicians demanded that the design competition would include international architects. Other requirements were for the design to provide public space for the community and ensure that ecological issues were addressed, otherwise planning permission would be denied (Davies and Lambot 1997). The architects invited to compete on the design were challenged to design a naturally ventilated and naturally lit skyscraper in order to conserve energy. A variety of other energy saving strategies were encouraged during the brief to the architects, such as passive solar heat gain, innovative mechanical systems and a minimum external envelope. The Commerzbank was delighted with the requirements, realizing that they would save money on energy in the long-term and better yet, they would be portrayed as a company concerned about social responsibility (Ibid.).

Typical high rise structures with their deep plans and reliance on mechanical systems and lighting may be efficient in terms of the capital costs and the amount of leased space floor to area ratios. However, when considering the operating costs over the life of the building and the health and satisfaction of workers with high salaries, these buildings are "extremely inefficient" (Buchanan 1998). The Commerzbank is estimated by modeling to require 25-30% less energy than Germany's strict requirements (Pepchinski 1998), but real numbers were not identified in the literature.

The final cladding on the Commerzbank resulted in reduced costs from the original design, but also compromised performance (Evans 1997a). However, the building is still expected to operate on natural ventilation for 60% of the year.

Conclusions

The green strategies incorporated in high-profile architecture may serve more of a symbolic role than actually improving the natural environment. Perhaps that is enough right now. The construction industry is very slow to change and it is encouraging that designers and owners are interested in green architecture, regardless of their motivation. Since a radical transformation in this industry is unlikely, demonstrating green strategies, proving their strengths, and identifying their weaknesses serves an important role. It appears as though less energy is being consumed in the two case studies evaluated than in more traditional skyscrapers. Design teams and owners are giving special attention to environmental concerns as well as occupant satisfaction by incorporating more natural daylight and communal areas. Unfortunately, hard numbers regarding actual energy consumption and efficiency were not identified.

For green building to work, it seems as though the process of design and construction, at least as it usually occurs in the U.S. must be transformed so that all key players are brought into the

planning and design from the very beginning, as occurred in the Four Times Square and Commerzbank projects.

The search of the literature indicates that the U.S. is trailing Europe in designing green architecture. While the emphasis on case studies presented in the U.S. are most often examples from the U.S., it would seem as though more attention would be given to learning from the Europeans. From reading only the green building literature from the U.S., one could believe that William McDonough and Partners and Steven Winter and Associates were leading the few firms capable of designing and constructing green buildings. It is encouraging that internationally recognized architectural firms such as Norman Foster and Partners are capable of incorporating energy efficient and water-conserving design strategies while considering the impacts of materials and indoor environmental quality.

All decision makers, be they politicians, building owners, tenants, architectural firms or construction companies must become aware of the importance of designing, constructing and operating buildings to minimize adverse environmental impacts. Peter Davey (1997a, p.5) eloquently writes:

> *If we continue to oppose natural forces to the extent we are doing now, the planet will simply change to make human life vastly unpleasant, or perhaps even impossible. Everyone has some responsibility for trying to avert this quite likely and imminent future – none more so than those who design the man-made environment, who if they use imagination responsibly, will begin to evolve new architectures and forms of planning which will draw on ancient wisdom and modern technology alike to help humanity live in harmony with nature.*

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