THE GREENING OF THE ROOFTOP: WHAT THE GREEN MOVEMENT MEANS FOR ROOFING AND THE BUILDING ENVELOPE

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INTRODUCTION

Beginning with the inception of the US Green Building Council ten years ago, the green building movement has gained significant public recognition. And while almost everyone associated with the building envelope industry has become aware of this emerging trend, few industry stakeholders have had the opportunity to learn about the foundations and dynamics of the movement. What does green mean? Why is green important? Who is promoting green? Where will the green building movement go on the future? And most importantly, what does green mean to roofing and building envelope practitioners?

The goal of this paper is to provide a background of the green building movement, with a special focus on the unique social and technological dynamics that are shaping "green thinking" among building professionals. The presentation will also review the basic principles of green or sustainable building design and how these principles are being implemented within the roofing and building envelope industries. Finally, the presentation will discuss how emerging private initiatives and government policies may influence the future of green for the building industry.

GREEN LINKS TO THE ENVIRONMENTAL PAST

In its broadest usage, "green" may be viewed as the latest manifestation of a growing concern for the environment dating back over a century. But today's green agenda has moved beyond past environmental initiatives. From the founding of the Sierra Club in 1892 to the celebration of the first Earth Day in 1970, the primary goal of the environmental movement has been conserve scarce natural resources and reduce human impact on the environment. In many ways, environmentalism prior to the green movement could be viewed as a zero-sum game in which we could only slow down the inevitable destruction of the earth and its resources. Although the green movement continues to acknowledges that many natural resources are scarce and irreplaceable and that environmental impacts are serious and complex, the green mindset has successfully moved beyond a framework of scarcity by adding the assumption that human ingenuity and technological advance offer many ways to expand resources well beyond currently perceived limitations.

FROM SCARCITY TO SUSTAINABILITY

By asserting that natural scarcity may be countered by human ingenuity, green has dramatically redefined the historical goal of the environmental movement. Instead of losing a slow and

painful battle as limited resources are drained from the earth, society now stands a chance to win - providing new and innovative resources can be added faster than existing resources are depleted. In other words, with the emergence of the green movement, environmentalism moved from *scarcity* to *sustainability.*

Defining green to be sustainable was first advocated by the Brundtland Commission, chartered by the United Nations in 1987 to address the potentially conflicting goals of global environmental protection and economic development. In an effort to move beyond a mindset of scarcity but still recognize the critical importance of environmental stewardship, the commission established sustainability as a new benchmark. And the commission succinctly defined sustainability to be the kind of global development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[1] With this definition, the goal of sustainability continued to recognize the need to preserve resources, but it also established a criterion by which the merits of development could be measured: Will we preserve and generate sufficient resources for our children and their children to live productive and satisfying lives?

GREEN = SUSTAINABLE

Beginning with the Brundtland report, "green" became synonymous with "sustainable." Using this new definition, the US Green Building Council could also be called the US *Sustainable* Building Council. Likewise, the Sustainable Buildings Industry Council should also be considered to be the *Green* Buildings Industry Council. This broader usage of green /sustainable may generate some confusion within the building industry because "green" is frequently used to describe the application of vegetation to building components, such as "green roofs," frequently used to describe roofs covered with plants. Hopefully, the use of "green" as a broader term will prevail, and other names for vegetated roofs will be coined. (As a suggestion, "living roofs" may be a good choice since it is also used to describe wall systems that support vegetation: "living walls.")

In addition to becoming synonymous, "green" and "sustainable" also have become broad, all-encompassing terms for many other environmental concepts. Examples of terms used to describe portions of the larger green/sustainable movement include "environmentally responsible", "energy-efficient", "resource renewable", "recyclable", "carbon neutral", etc. This conceptualization suggests, for example, that an energy-efficient roof is also a green roof, just as a recyclable roof is also a green roof. But it also implies that a green roof in its fullest sense is an environmentally responsible/energy-efficient/ renewable/recyclable/carbon-neutral roof!

WHY IS GREEN IMPORTANT?

The emergence of "green" as a new development paradigm could not have arrived at a more opportune time, as a confluence of factors is triggering a virtual tsunami of environmental alarms across the globe. And just as the green mindset is broader than previous environmental thinking, the environmental issued we are confronted with today may be larger than any challenge humanity has previously experienced.

Energy Concerns. For those of us who can remember the OPEC oil embargo of 1970, it is easy to identify both similarities and differences in today's predicament of rapidly increasing oil prices. In some ways, the current crisis appears to be milder – after all, there are no lines forming at gas stations, which was a common sight in 1970. At the same time, the current crisis may be viewed as much more severe for several reasons. First, the double-digit run-up in oil and gasoline prices hasn't been driven by acute supply constrictions or willful embargos: the world is simply demanding more petroleum-based fuels than currently available. As illustrated in Figure 1, global demand for oil as projected by the International Energy Agency is skyrocketing – and expected to grow even faster – as the developing nations seek to join the developed world with modern consumer-driven economies. In fact, IEA projections suggest that the developing world (which consumed less than 15% of all oil during the 1970 oil crisis) will consume more oil than all the developed nations combined by 2030.

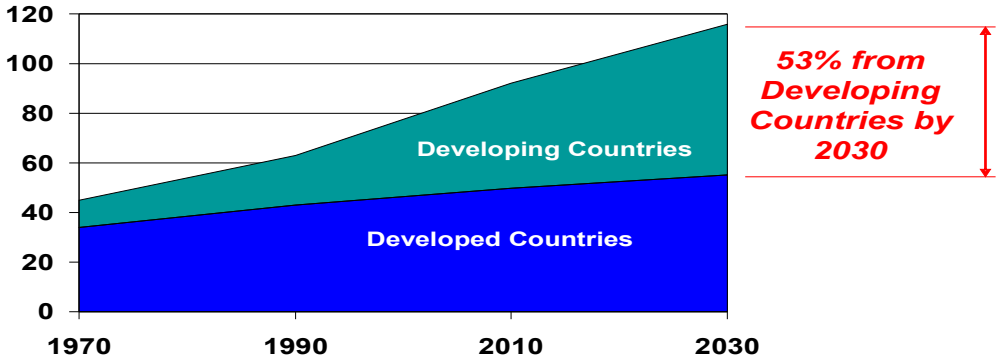

Figure 1:
Projected World Oil Demand: 1970 – 2030
Millions of Barrels Per Day
Source: International Energy Agency "World Energy Outlook, 2006" (Reference Scenario)

In addition to rapidly growing demand for oil in the developing world, US dependence on imported oil is growing at an even faster rate. During the OPEC oil embargo of 1970, the United States was dependent on imports for only 20% of its total oil. Today, that percentage is over 50%, and, as illustrated in Figure 2, it is projected to grow to 86% by 2030.

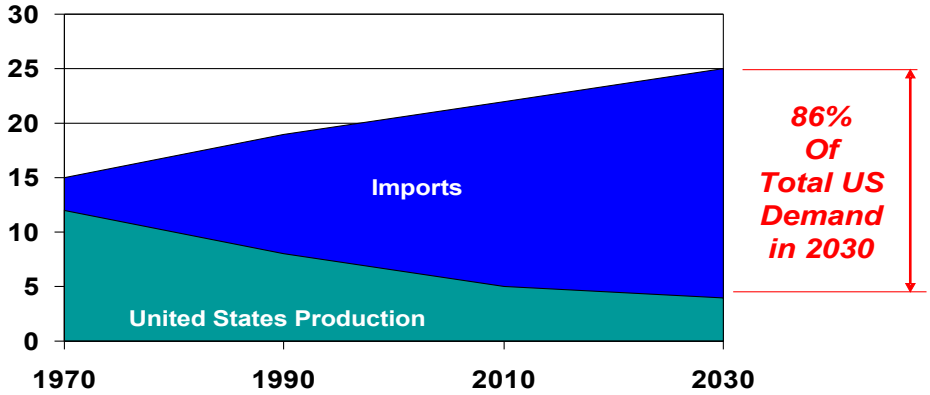

Figure 2:
Projected U.S. Oil Supply: 1970 – 2030
Millions of Barrels Per Day
Source: International Energy Agency "World Energy Outlook, 2006" (Reference Scenario)

Regardless of the costs of oil, and regardless of the environmental impacts of continued fossil fuel usage, these two charts clearly indicate the fundamental problem with the current oil-based US economy: it simply isn't *sustainable* if dependence on imported oil continues to grow as projected.

Environmental Concerns. Increasing energy demands and continued reliance on fossil fuels have heightened concerns about the role of combustion gasses in the apparent warming of the earth's temperature. Although a detailed discussion of global warming is well beyond the scope of this brief paper, it would be important to note two relatively indisputable facts. First, the planet is warming compared to the recent past. As shown in Figure 3, average annual global surface temperatures since 1980 have increased between ½ and 1 ½ degrees Fahrenheit as compared to the three decades prior to 1980. In addition, the average for the 1950 – 1980 period is ½ to 1 degree warmer than previous averages since 1880.

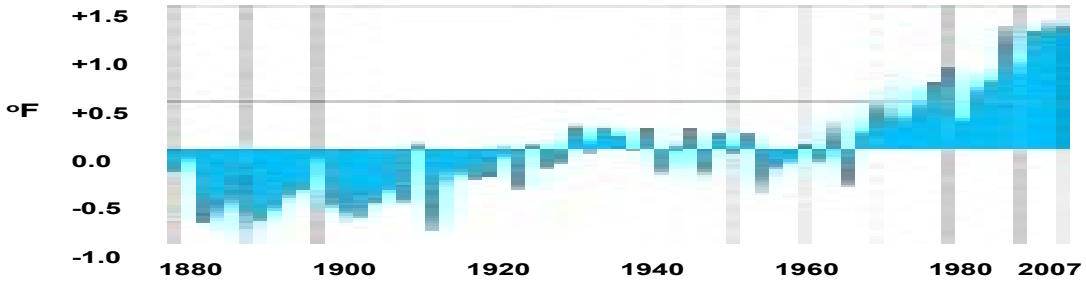

Figure 3:
Deviation of Global Surface Air Temperature
From 1951-1980 Average
Source: Source: NASA Goddard Institute for Space Studies

Although there may still be reasonable debate regarding global warming and fossil fuel consumption, it is important to recognize that fossil fuel-generated CO^2 will continue to climb at a dramatic rate as the developing world escalates its projected usage of oil, gas and coal. Figure 4 illustrates how over 80% projected global energy supply will continue to come from fossil fuels by 2030, causing greenhouse gas emissions to rise over 57% during the same time period.

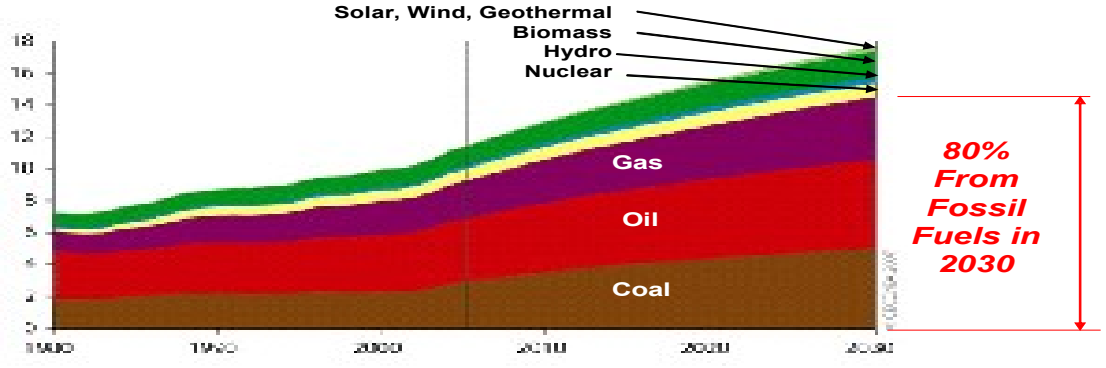

Figure 4:
Projected Global Energy Supply: 1980 – 2030
Billions of Tons of Oil Equivalents
Source: International Energy Agency "World Energy Outlook, 2006" (Reference Scenario)

Given the sizeable projected increase in greenhouse gas emissions over the next two decades, perhaps the best possible outcome for the planet might come about if the global warming doubters are right. But, if global warming is real and inextricably linked to CO^2 production, then we may be dangerously increasing the risks of irreparable change to the planet's ecosystems.

Other environmental concerns exist as well beyond the issue of global warming and CO^2. Many urban areas in the United States, as far north as Chicago, are subjected to increasing summer air temperatures due to the "urban heat island" effect of dark paving and roofs. These same urban areas also tend to suffer from unusually high levels of ozone, produced through the confluence of heat and emissions from vehicles and volatile organic chemicals. Finally, many urban areas of the U.S. continue to endure unacceptably high instances of pollution spills into lakes and streams due to the continued use of combination sewer systems. These environmental problems can be attributed to many different causes, but a sizeable portion of their effects can be linked to buildings – the materials used to construct them, the characteristics of their surfaces, and their relationship with the cities in which they are constructed.

Beyond the litany of environmental risks lies one more very important reason why the way we design and construct our buildings is so important. Simply put, we can do so much better. Comparing the experience of California, a state recognized for environmental leadership, with the rest of the United States, the opportunity for improvement becomes painfully obvious. As shown in Figure 5, while per capita electrical consumption (used mostly in buildings) has remained relatively constant, per capita electrical usage for the entire U.S. has escalated nearly 100%. Clearly, this indicates a significant opportunity for improvement in energy efficiency.

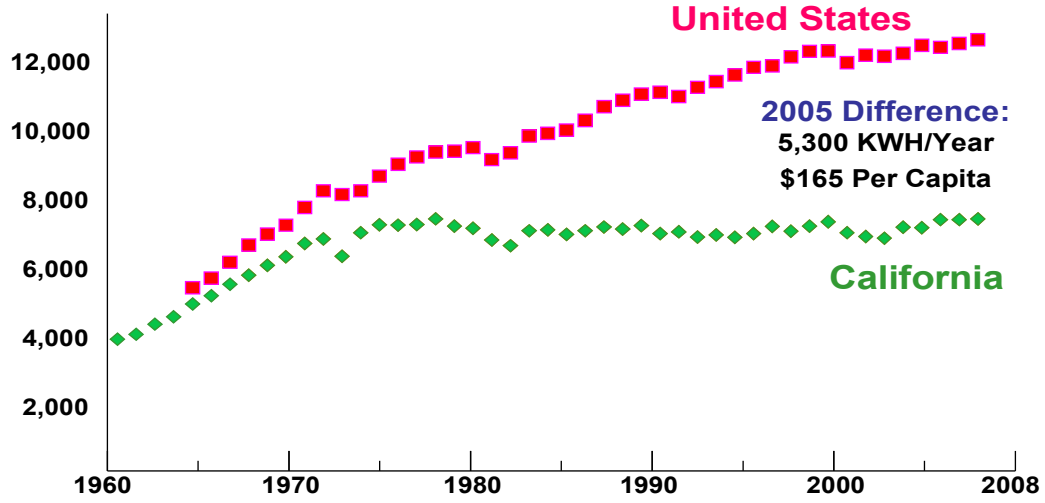

Figure 5:
Per Capita Electricity Consumption:
United States v. California
KWH / Year
Source: California Energy Commission

WHO IS LEADING THE GREEN BUILDING MOVEMENT?

Non-Governmental Organizations. As mentioned previously, the green movement is uniquely different from past environmental initiatives, and this difference is reflected in its leadership. Most important are the many *non-governmental organizations,* or NGOs, that have formed under the green banner. A few years ago, the acronym "NGO" was rarely used, but today over 1 in 15 Americans work directly for NGOs, and their combined annual budgets exceed $500 billion[2]. The following is just a sampling of the many new NGOs involved in the green building movement:

- The U.S. Green Building Council / LEED
- Global Building Initiative / Green Globes
- Sustainable Buildings Industry Council
- Alliance to Save Energy
- Energy Efficient Building Association
- Green Roofs for Healthy Cities
- Environmental Energy & Study Institute
- Smart Growth Network
- Center for Resourceful Building Technology
- Indoor Air Quality Association
- New Building Institute
- American Council for an Energy Efficient Economy
- American Solar Energy Society
- The Daylighting Cooperative
- The Center for Environmental Innovation in Roofing

With the exception of several energy-efficiency organizations (whose roots go back to the first U.S. energy crisis of the 1970s), almost all the green organizations on this list have been formed within the past decade.

Global Corporations. In the past history of the environmental movement, corporations frequently were cast as antagonists, but in today's green movement many of the world's largest private corporations are playing a leading role. Obviously, some of the interest of large companies involves a desire to project a positive public image, but corporate involvement in the green movement extends far beyond mere image concerns. Global corporations are also concerned about the prospects for economic growth so vital to their shareholders as well as the need for common standards to conduct business across the world.

Because of this multi-faceted interest, global corporations are playing a key role in the funding of green research and the development of sustainable standards. In Europe, the BASF Corporation is a recognized leader in the scientific analysis of environmental impacts through its Eco-Efficiency Analysis program. In the United States, corporate support provided to organizations such as the U.S. Green Building Council by corporations in the building sector has truly been impressive.

State and Local Governments. Finally, governments also are involved; but much of this involvement has emerged at the state and local level and not from Washington. From the state of California's Title 24 to the city of Chicago's cool roofing standards, green innovation is being spearheaded at local and regional levels of government. As stated in a review of the green movement in a recent edition of *The Economist*:

"The federal government's recalcitrance remains the biggest obstacle to an effective global scheme to tackle the problem. But where in Europe or Asia new ideas often flow from the center to the regions, in America the states are the incubators of big shifts in policy. *This means that change is coming—fast!"* [3] (Italics added)

HOW IS GREEN DIFFERENT?

Process-Based. The focus on sustainability as the watchword of the green building movement has lead to nuanced differences from historical environmentalism that are very important to building industry professionals. First, green tends to emphasize *process* over *product*. While the first response of some in the building industry to the emerging green movement is to quickly specify and use green products, the concept of sustainability extends how these products are designed, produced, used, maintained, and eventually disposed of. Perhaps the best explanation of this process-based perspective was given by Steve McGuire, environmental market manager for Philips Lighting, at a recent green building conference when he asked rhetorically, "How can a 'green' product be produced in a 'brown' factory? How can a 'green' product be used in a 'brown' facility?"[4]

In many ways, the process-based approach of the green movement is related to a similar process-based perspective that was a hallmark of the quality revolution that started in Japan in the early 1950s and swept across the globe in the 1980s and 1990s. In fact, just as quality management revolves around the well-known ISO 9000 standards, the green movement also involves similar series of standards: the ISO 14000 series of environmental management standards. And just like the ISO 9000 standards with their emphasis on documentation, accountability, and continuous improvement, the ISO 14000 standards provide a roadmap to fully integrate our factories, our building sites, and our living environments into a harmonious, sustainable whole.

Science-Based. The green movement's emphasis on process naturally extends to other rational methods, most importantly a *science-based approach* to resolving problems. At one point in the historical environmental movement, the word "natural" was used widely to promote environmentally preferable products. Today, however, synthetic products may be just as environmentally suitable, providing they are more sustainable than the "natural" alternative. As an example in the building materials industry, studies[5] have demonstrated that some materials made from plastic – most notably plastic foam insulation materials – may be more sustainable and produce lower environmental impacts that naturally occurring materials, such as cork or mineral fiber. In an of it self, an ounce of raw plastic probably has a greater environmental impact than an ounce of raw cork, but that ounce of plastic may produce a larger quantity of finished product (foam plastic insulation may be significantly lighter than similar cork or mineral wool insulation), and the extraction and processing of the plastic may require less energy than the extraction and production of cork or mineral wool.

It is important, however, to emphasize that these differences between the "new green" and previous environmental initiatives are more subtle than substantive. Certainly, environmentalism has always emphasized process-based and science-based solutions, but the green movement's emphasis on sustainability makes this much more apparent and salient.

WHERE IS GREEN BUILDING GOING?

From Life Cycle Cost to Life Cycle Assessment. Life Cycle Assessment (LCA) is a scientific approach to evaluating the environmental impact of a product throughout its life cycle. LCA is frequently referred to as a "cradle-to-grave" approach, although with the addition of comprehensive recycling programs, it may also be called a "cradle-to-cradle" approach that tracks the impact of a product from the initial extraction raw materials to the final recycling of these materials into new products. Recently, the Board of Directors of the U.S. Green Building Council voted to incorporate LCA as a key component in its well-known LEED® Green Building Rating System™, and with this endorsement, it is reasonable to assume that the LEED system will be progressively modified to integrate LCA principles and procedures into the traditional point structure.

Because LCA measures the indirect environmental costs of a product, LCA differs from traditional Life Cycle Cost analysis (LCC), which focuses almost exclusively on direct economic impact. As a consequence, LCC may be more directly related to a product's durability as reflected in its service life. However, if environmental impact is considered a superior measure of economic cost in the long run, then LCA may be viewed as a more accurate form of traditional LCC. And if the long-run environmental impact of a product is indeed the best reflection of its true economic cost, then LCA should be equally as sensitive to the comparative durability of materials as traditional LCC. For example, if an apparently "environmentally friendly" roofing system with a useful service life of under 20 years is compared to a more traditional roofing system with a service life of over 30 years, the total environmental impact of the traditional roof will be lessened due to its superior service life. As a result, the lowered environmental impact of a longer service life may make the traditional roof a superior choice over the supposed environmentally friendly roof.

From Code Compliant to High Performance. While all buildings are (or should be) constructed to mandated minimum codes, the concept of the *high performance building* refers to "above the code" buildings with significantly enhanced energy efficiency and longevity. In its High Performance Buildings Program, the U.S. Department of Energy defines a high performance building as a building that "delivers energy savings, environmental performance, and economic benefit substantially better than standard practice." [6] High performance buildings assure a safe environment protected from the elements, reduce energy costs & resource requirements through operating efficiencies, and deliver a lower life cycle cost by extending service life.

This concept of an "above average" building as opposed to a code-mandated minimum standard is starting to take hold in the marketplace. As a most recent example, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is preparing a draft of a building energy standard that is *not* initially designed to be part of standard building codes.

ASHRAE 189.P "Standard for High Performance Green Buildings" is intended to provide a new "above the code" level of performance for use by building designers and owners concerned about long-term sustainability. Some of the provisions of this new standard may not be as cost-effective as current building code standards, but given the rapid increases in energy costs, they may accurately anticipate where energy design needs to go in order to provide the best economic payoff in the long run. Table 1 provides an example of the amount of roof-related energy savings possible using the new ASHRAE 189.P standard for a 100,000 square foot heated and cooled warehouse in Chicago. As compared to the current standard in Chicago (currently based on the 1999 version of ASHRAE 90.1), and even the most recent 2007 version of the ASHRAE minimum standard, the new "Standard for High Performance Green Buildings" may provide a significant annual energy savings, especially if the standard is incorporated either at initial construction or during periodic roof system replacement.

Table 1:
Roof-Related Heating & Cooling Costs
100,000 Sq. Ft. Heated & Cooled Warehouse
Chicago, IL

Standard	Roof R-Value	Annual Heating & Cooling Costs	Savings
ASHRAE 90.1-1999	15	$15,295	n/a
ASHRAE 90.1-2007	20	$13,172	$2,123
ASHRAE 189.P	25	$10,855	$4,440

Source: NRCA EnergyWise Roof Calculator (Roof System Only, Gas Heating / Electric Cooling)

From Energy-Efficient to Carbon Neutral. Because high-performance measures like the example above may be incorporated with minimal up-front expense and yield sizable cost savings over a building's lifetime, some forward-looking building organizations have established even more ambitious goals to reduce the environmental impacts of energy usage. Most notably, the American Institute of Architects (AIA) has called for a 50 percent reduction by 2010 of fossil fuels used to construct and operate buildings, with an additional reductions every five years to achieve "carbon neutral" buildings by 2030. Moving beyond energy-efficiency measures like increased insulation, tomorrow's buildings will actually have to start generating energy in order to achieve zero net carbon emissions. Examples of these "clean" energy sources include photo-voltaic, thermal solar, wind, geo-thermal, and daylighting.

WHAT DOES GREEN MEAN FOR THE BUILDING ENVELOPE PROFESSIONAL?

For the building envelope designer and consultant, the green building movement offers both opportunities and risks. As awareness of the importance of sustainable buildings increases, so too will the importance and prestige of informed building professionals who can help building owners chart a green course for their facilities. And because the building envelope will play such a large role in the development of the next generation of green buildings, building envelop designers will have the opportunity to become leaders in the green building movement. But this

enlarged role comes with a pre-requisite for increased education and professionalism. In the process-based, science-based world of green design, there will be less and less room for building professionals who lack fundamental organizational and technical tools.

For the building envelope designer and consultant seeking ongoing professional development to prepare for a broad and meaningful role in sustainable construction, the following areas of professional development may be very important:

ISO 9000 and 14000. To better understand the process orientation of the green movement, building designers should consider investing time to learn about the ISO family of management standards, both for quality management (ISO 9000) and environmental management (ISO 14000). ISO has become the quality and environmental "language" of major corporations, and building designers would be well-served to understand this language. One of the easiest and most economical ways to learn more about ISO is to review the extensive ISO information collected on Wikipedia for ISO 9000 (http://en.wikipedia.org/wiki/ISO_9000), as well as ISO 14000 (http://en.wikipedia.org/wiki/ISO_14000)

Sustainable Building Design. An excellent resource for integrating sound management principles into green building design is the Whole Building Design Guide(http://www.wbdg.org) , published online by the National Institute of Building Sciences. The WBDG contains important chapters on key sustainability concepts, including sustainable design principles, building commissioning, and ongoing building systems management.

Life Cycle Assessment. LCA is becoming the primary analytical tool of the green movement, and building professionals need to understand the key principles of LCA in order to make credible design recommendations. Some excellent objective resources for LCA include the U.S. Environmental Protection Agency (http://www.epa.gov/ORD/NRMRL/lcaccess/) and the Athena Institute (http://www.athenasmi.ca/about/).

NOTES:

[1] UN World Commission on Environment and Development, "Our Common Future," April 1987.
[2]Encyclopedia of Public Health (http://www.answers.com/topic/non-governmental-organization)
[3] *The Economist*, "The Greening of America," January 25, 3007.
[4] Personal notes, High Stakes Asset Intelligence Forum, University of Toronto, May 15, 2008.
[5] BASF Corporation, "Label Eco-Efficiency Analysis Pitched Roof Insulation above Rafter (Northern Italy)," June 15, 2005.
[6]U.S. Department of Energy Office of Renewable Energy and Energy Efficiency, http://www.eere.energy.gov/buildings/highperformance/