Everything Old is New Again: What Works, What Does Not Work

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Introduction

Unfortunately, much of the "Green" movement to reduce energy use in buildings is simply a rediscovery of techniques that are over 20 years old. And in many cases, the lessons learned long ago have been forgotten or ignored. Much to the dismay of architects, Green techniques that garner the most attention are not appropriate for collections-holding institutions with a goal of environmental control for preservation.

Green Buildings and Energy Conscious Design: Everything Old is New Again

The primary operative elements of the Green movement in buildings are not news. The energy saving approaches were first discovered in the post-oil-embargo 1970s, and have been recycled ever since.

Basic principles for Green buildings that save energy can be found in Energy Conscious Design (ECD). ECD principles usually concern load reduction, meeting loads efficiently, and avoiding the use of "new" energy for reheating (usually required for dehumidification).

Load Reduction

From ECD, we have learned the best way to conserve resources is simply to need less. For most building types, including preservation environments, this is best done through restraint in architectural design. Presuming prudent architectural design has provided minimal envelope loads; for HVAC energy management in commercial buildings, the big loads are outside air and lighting.

Specious Architectural License

All too often, architects use "Green" and energy savings to drive project costs up and actually waste energy, if not also putting collections at risk.

Whenever a "Green" element is to be added to a project, three questions should be asked:

- Does it reduce the amount of outside air needed?
- Does it reduce the amount of lighting energy use?
- Does it have a building envelope that actually causes a net increase in energy use, or place collections at risk?

Daylighting
The most common problem in energy conscious design is daylighting (and associated additional loads) with no effective reduction in actual electric lighting used.

In the early 1980s, the GSA built a new office building in Queens, New York. Part of the project goals was to set an energy-efficient precedent, and daylighting was seen as a key element. The project mechanical/electrical design firm, Syska & Hennessey, undertook a study to determine where to place glazing to be most efficient in providing illumination that could reduce the use of electric lighting. The study showed that a strip of glazing just below the ceiling plane, extending down one to two feet, provided daylighting that could allow the electric light use to be reduced. However, because of the thermal loads from the glazing, the energy savings relied on the office occupancy to end at 5 pm. This allowed some of the heat gain from the glazing to be "rejected" by simply curtailing cooling and letting the empty offices heat up. Without this, the energy used for cooling would offset the energy savings from the daylighting.

The GSA study also showed that lower glazing, including at eye level, was not effective in providing net energy savings. It did not have sufficient efficacy in lighting, and had all the solar load penalties. Ultimately, a "T" design was adopted for the building, with the upper part for daylighting, and the descending part for views necessary for the occupants.

Daylighting to Save Energy
In order for daylighting to save energy, the project has to have two critical elements.

First, the inevitable heat gain from an efficacious daylighting aperture must be avoided, usually by abandoning the expectation of "comfort conditions" after 5 pm. Only by rejecting the late-afternoon load can there be any hope of energy savings, and this is why daylighting can work in some office applications.

This load rejection simply does not apply to collections-holding institutions where high and fluctuating temperatures and humidities must be avoided. These problematic conditions are often created by the daylighting aperture anyway, even if overheating is not part of a planned scheme.

Second, the electric lighting must be reduced by the daylighting for any savings to accrue. This compensation can work in an office where the daylight illumination can be detected and the general electric lighting, such as in an office or warehouse, can be reduced. Even in an office, daylighting rarely works for task lighting. In fact, daylighting can often be counter-productive by creating veiling reflections on the tasks areas.

However, any savings from electric lighting in collections-holding institutions is extremely rare. On the contrary, daylighting usually increases the use of electric lighting to counter-balance the flat look of the diffuse daylighting. Display areas for most collections look best with point-source illumination, which gives better color saturation, surface texture, and simple highlighting of the objects in a figure-ground relationship. Daylighting almost always highlights architectural surfaces and not the items on display.

Productivity Factor
For a moment, consider that hypothetical office building, a good daylighting subject. If the daylighting were to diminish productivity by as little as 1%, this loss would wash out all energy savings. Let's suppose that the office were to use $1 per gross square foot (GSF) for lighting – which is a very high number. Let's also suppose the daylighting were to save 30% – another very high number – to save $0.30/GSF per year in operating costs. Most office buildings have about 200 gross square feet, or less, per employee. Suppose each employee were to cost $50,000 per year to employ, or more, including benefits. The cost of having the employees do their work is $50,000/200 GSF, or $250/GSF. Therefore, a loss in productivity of 1% would cost $2.50/GSF, which hardly justifies the $0.30/GSF savings from daylighting.

Daylighting in the Getty Energy Study
In the 1980s, the Getty Conservation Institute funded and published "*Energy Conservation and Climate Control in Museums*," a study by Ayres, Haiad and Lau of the energy use of a prototype museum building in several locations in the United States, also published as an ASHRAE Transaction.[1] The study not only considered five locations, but also a parametric for the museum to have no skylight, a small skylight, a medium skylight, and a large skylight. For that parametric, the study concluded that the "small" skylight actually reduced energy use. This conclusion was quite surprising, given the associated loads and the previous points made, even presuming that there was some sort of workable system to reduce the use of electric lights. Surely, the associated envelope loads would wash out the savings.

The study used the DOE 2 energy simulation program, and the story is told in the input files. When examined, one can see that the numbers were stacked in favor of the small skylight. The only reason the smallest skylight showed a net energy savings is that it was assumed, unlike the larger skylights, to cause no increase in fan sizing and fan energy use. Increased for the other skylight sizes, fan energy was left the same in the small skylight as for no skylight. If these systems are re-sized proportionally between the medium skylight and no skylight, the net savings from the small skylight disappear, and it is a net loss.

The conclusion that the small skylight saves energy is simply wrong.

What has Our Experience Been with Daylighting Museums?
Clearly daylight has been used in most museums. How well has it proved to work over time?

Walter Netsch and a Tale of Two Museums
Among may other things, Walter Netsch, the noted "Field Theory" architect, has designed two museums: the Miami University Art Museum in the mid-1970s, and the Fort Wayne Art Museum in the mid-1980s.

The Miami University Art Museum theme is an aggressive series of clerestory skylights. These provided generous daylighting to every gallery and the storage areas. This light exposure resulted in damage to collections. The interesting thing is that Netsch was an alumnus of Miami University and a major donor to the Museum, mostly works of art on paper. These works tended

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[1] Ayres, J.M., H. Lau, and J.C. Haiad. 1990. Energy Impact of Various Inside Air Temperatures and Humidities in a Museum when Located in Five U.S. Cities. ASHRAE Transactions 96(2):100-11.

to suffer from all the daylighting and the additional electric lighting needed to create meaningful displays.

Ten years later, and wiser, Netsch designed the Fort Wayne Art Museum. Although not a collections donor there, he had learned what museums needed. Fort Wayne is marked by restrained daylighting and no appreciable damage to collections from it. Typically, only 3 footcandles of daylighting ever hits displays from the modest north-facing skylight monitors. The electric lighting easily establishes the character of illumination at the displays.

Did the aggressive daylighting at Miami University save in energy costs? The large expanses of glass cause additional heat gain and heat loss, requiring more heating and more cooling. What about lighting energy use? Miami University uses more energy for lighting since it must offset the inconsistent and usually excessive daylight.

The Albany Institute of History and Art

The old building at the Albany Institute of History and Art originally had daylights in most of the top floor galleries, backlit by clerestory skylights. Over time, these proved problematic to maintain, mostly from leaks, and they were removed. In the mid-1980s, one skylight was "reopened." However, the architect did not follow the historic precedent: a modest clerestory with about one foot of vertical glazing. Instead, he covered the entire roof opening with a modern "greenhouse" style skylight. This lead to very excessive light levels, even after it was whitewashed to reduce light transmission.

The past precedent was ignored, with the erroneous thinking more daylight is better.

The Harvard Depository

Perhaps the best example of ideal preservation storage is the Harvard Depository, located over an hour away from Harvard's main campus in Cambridge. There are simply no windows. Masonry walls provide thermal mass to moderate envelope thermal loads. Special HVAC systems, now in their fourth generation of refinement, provide a constant 50 degF/30% RH. These conditions are excellent for preservation of paper and similar materials.

Value of a Preservation Environment

Like in the "good old days" of ECD, where the energy issue was a rounding error compared to office productivity, so energy costs for preservation environments are a rounding error compared to the implications on the rates of chemical deterioration for many organic collections, particularly paper and photographic media.

Relative Costs – Energy vs. Preservation: 1 Square Foot of Stack Storage

One square foot of stacks can typically hold 20 volume-equivalents, at a typical cost to reformat of $130 per volume. This means that one square foot of stacks typically holds information that would cost $2,600 to preserve by reformatting instead of environmental preservation.

Suppose the collections are to be stored at a state-of-the art 50 degF/30% RH, and the expected collection life at these conditions is 500 years, or a rate of loss of 0.2% per year, or $5 per year per square foot of reformatting to recover from loss.

Suppose a "Greening" of the system to save energy suggests that criteria are relaxed to a more "comfortable" 72degF/50% RH. Sebera's Isoperms[2] predict that, at those conditions, the 500 year life will be reduced to 110 years, or a rate of loss of 0.9% per year, or $23 per year per square foot, or $18 a year in additional collection loss each year that would require recovery with reformatting.

It is rare for the 50 degF/30% RH preservation conditions to have a significant increase in energy use over maintaining 72degF/50% RH comfort conditions. In fact, they often use less energy. Suppose a ham-handed design did have an energy cost premium of $2 per square foot per year. *Those $2 of energy savings would be at the cost of $18 in collection loss per year per square foot.* This makes the relaxed criteria hardly an appropriate preservation decision.

Understand the Levels of "Environmental Control" and Mechanisms of Damage
Four levels of environmental control can be considered to protect collections, listed in general priority:

1. Protection from Major Risks (fire, flood, mayhem);
2. Protection from Biological Attack (vermin, mold);
3. Protection from Use (handling, light);
4. Protection from Mechanical, Chemical and Photochemical Vectors.

Many people may say they have "environmental control" because they have been successful in achieving (1) and (2). While these goals are critical to protecting collections from wholesale loss, they are hardly the real challenges for effective preservation and extending the life of collections. Surely there are some institutions that have collections where these are the only goals, but these are largely just protection. They are also largely disjointed from the challenge of providing an environment to extend the life of collections, and the significant use of energy.

While (3) may also command some capital cost and change in behavior, only (4) has irreducible energy implications. (4) is where there can be major improvements in preservation environments for most modern institutions holding environmentally sensitive collections. Yet (4) is where the application of Green techniques may or may not rightly factor into a design.

Beware of "low energy footprint" precedents, particularly those cited in the third world, when their "breakthrough" may be to have added (2) or (3) to their institution, with no progress on (4).

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[2] Sebera, Donald K., 1994. Isoperms: An Environmental Management Tool, Commission on Preservation and Access. (Based on "A Graphical Representation of the Relationship of Environmental Conditions to the Permanence of Hygroscopic Materials and Composites," Proceedings of Conservation in Archives, International Symposium (Ottawa, May 10-12, 1988), Paris: International Council on Archives (1989), p. 51-75). (The Commission on Preservation and Access has merged into the Council on Library and Information Resources, 1755 Massachusetts Avenue, NW, Suite 500, Washington, DC 20036, 202-939-4750. They are now the source for the old Commission publications, including Sebera's Isoperms. Available for no charge on-line at http://www.clir.org/pubs/reports/isoperm/isoperm.html.)

Different Cultural Institutions Have Different Needs
Each institution has to assess its needs and priorities, but this should be done based on a study of the institution’s goals, as well as past precedents. Rhetoric needs to be replaced with facts, so decisions can be made that will best meet the institution’s needs.

High Energy Use in the United States
Much is made of how much energy the United States uses compared to the average use in the rest of the world, and the tighter comfort conditions typical in the US are often cited as unnecessary. Consider that the US is also distinguished by one of the highest rates of productivity. Certainly gratuitous energy use is a waste, and should be avoided. However, energy use and cost has to be kept in perspective. Where energy is used to create something, the use is necessary.

Consider again the daylighting and productivity argument. Instead of daylighting, if less comfortable conditions were maintained in that same office building, leading to a decrease in productivity of only 2%, would that be wise? Again, each employee costing a minimum of $50,000 per year to employ, and each employee taking a generous 200 GSF, yields a cost of $250/GSF. That 2% loss in productivity would cost $5/GSF – over twice the cost of *all* the energy used in a well-designed, modern office building.

Architecture for Purpose Rather than Justification
The recent modifications to the Harry Ransom Center at the University of Texas at Austin are a good example of architecture for purpose. Although no energy use numbers were presented, it is likely that the energy impact was largely neutral. It was not, in that sense, a “Green” project – it did not reduce the overall energy use of the Center. However, it made the building “better” and arguably more productive. While there was justification of modifications to better suit the building program, that is not what is enjoyable about the renovations. Those needs could have been met without the net increase in the quality of the space. The renovations went further, and made the building friendlier to users and staff. Consider the value of their increased productivity, and moreover, the increase in the use and meaning of the collection to society.

Architecture should not hide behind energy justifications, which rarely prove valid. Instead, architecture should add value to the building project, where it is applicable. Books paged out of the Harvard Depository and the vans that run them to campus do not mind the austere setting. The primary purpose of the Depository is to hold books, and any meaning and value to the architecture of the building will add little if any real value to the collection or the institution. The Depository does its job – to preserve collections for posterity. While the Ransom Center renovations also serve its purpose, in 100 years, the Depository will have had the most value to culture. While that may not be considered “Green,” it is nonetheless very good for civilization.

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Mr. Lull is a graduate of the Building Technology program at MIT, a principal and senior conservation environment consultant at Garrison/Lull Inc.*, and Adjunct Associate Professor of Building Technology at New York University. He has formerly worked as a designer and project manager for architects, engineers and government agencies.

Mr. Lull has been an invited lecturer for many university, professional and state-sponsored training programs. He has made presentations at AIC, IES, ASHRAE and AIA, and has consulted to the National Bureau of Standards, and to the Department of Energy. He is active in ASHRAE and AIC, and has written several articles and papers on conservation environment issues in building construction. With the assistance of Paul Banks, he wrote Conservation Environment Guidelines For Libraries And Archives for the New York State Library, updated and republished by the Canadian Council of Archives. Chapters in the 1999 ASHRAE Handbook, and the ASHRAE Humidity Control Design Guide contain material he provided. He is listed in Who's Who In America, Who's Who In Science And Engineering, Who's Who In Finance And Business, and Who's Who In The World.

In the last 20 years, he has consulted on new or renovated preservation environments on over 200 museums, libraries and archives, including: the Museum of Modern Art, the Nelson-Atkins Museum, Monticello, the new Mount Vernon Museum, the Harvard Depository, Widener Library; the new or renovated state archives in Alabama, Arizona, Delaware, Georgia, Mississippi, New York, Oregon, South Carolina, Utah; and the Bermuda Archives.

Before his conservation environment consulting, Mr. Lull's particular responsibilities for energy management included work as the manager of the Energy Management Division, Dubin-Bloome Associates, and while there was Project Manager for the 1981 Conceptual Design of the Solar Energy Research Institute (SERI), now the National Renewable Energy Laboratory (NREL). He was also project designer in the Solar and Energy Conservation Group, Architectural Design Branch (ADB), Division of Engineering Design (EnDes), at the Tennessee Valley Authority (TVA); and Assistant Chief of Design at Syska & Hennessy Engineers. In recent years, he as consulted several times to the Department of Energy to evaluate grants on energy conservation in buildings.

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