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Shades of Green: Improving the Energy Efficiency and Environmental Impact of Historic Building

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A thesis in Historic Preservation Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements of the Degree of Master of Science in Historic Preservation 2008.
Advisor: Michael C. Henry

Shades of Green: Improving the Energy Efficiency and Environmental Impact of Historic Building

Abstract

The recent dramatic increase in oil prices as well as a growing worldwide concern with climate change has brought renewed attention and interest in energy efficiency and consideration for the environment among all areas of industry, in particular the built environment. According to the U.S. Department of Energy, operational energy consumption in residential and commercial buildings accounted for 40% of total energy consumed in the United States in 2007, and produced nearly 48% of the country's greenhouse gas emissions. While architects have been making their contribution to the environmental cause, designing more efficient buildings with tools such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system, historic preservationists are edging their way into the "green" movement within a complex set of constraints and guidelines, such as the Secretary of the Interior's Standards for the Treatment of Historic Properties, but equally motivated to reduce the historic building stock's adverse effect on the environment and energy consumption.

Comments

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SHADES OF GREEN: IMPROVING THE ENERGY EFFICIENCY AND ENVIRONMENTAL IMPACT OF HISTORIC BUILDING

Anita M. Franchetti

A Thesis

In

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Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements of the Degree of

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2008

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DEDICATION

to my parents, for their enduring love and support.

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CHAPTER 1

HISTORICAL BACKGROUND ON ENERGY POLICY AND THE BUILT ENVIRONMENT

The recent dramatic increase in oil prices as well as a growing worldwide concern with climate change has brought renewed attention and interest in energy efficiency and consideration for the environment among all areas of industry, in particular the built environment. According to the U.S. Department of Energy, operational energy consumption in residential and commercial buildings accounted for 40% of total energy consumed in the United States in 2007, and produced nearly 48% of the country's greenhouse gas emissions.[1] While architects have been making their contribution to the environmental cause, designing more efficient buildings with tools such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system, historic preservationists are edging their way into the "green" movement within a complex set of constraints and guidelines, such as the Secretary of the Interior's Standards for the Treatment of Historic Properties, but equally motivated to reduce the historic building stock's adverse effect on the environment and energy consumption.

This thesis considers both the limitations and opportunities in upgrading historic buildings for greater energy efficiency and reducing their impact on the environment, in

[1] United States Department of Energy, Energy Efficiency and Renewable Energy. "2007 Building Energy Data Book. " Available from http://buildingsdatabook.eere.energy.gov/?id=view_book; Accessed on January 14, 2008.

the hope of providing guidance to design professionals. Project teams have so many elements to consider in the rehabilitation of historic buildings, such as cultural and historical significance from an entire site, building, or shell, to the original historic fabric and individual components throughout the structure. How then are preservationists resolving the issue of disrupting any or all of these elements in the name of upgrading the building for improved energy efficiency and environmental impact? With the field of preservation consistently placing emphasis on not disrupting the appearance of the exterior, the primary collision points between preservation and improved energy efficiency have long remained at the wall plane (insulation and windows) and with the introduction of contemporary mechanical systems, where improvements of any of these components must make every effort not to encroach on character-defining building fabric. What amount of compromise and flexibility can be reached to attain energy and environmental goals while abiding by the rules of preservation, and how is the profession informing practitioners on the subject?

The challenges and solutions in upgrading systems and improving the performance of historic buildings requires looking beyond the common presumption that historic buildings are inherently energy inefficient, and requires investigating how the preservation community will adapt to the world's growing concern with energy prices and a damaged environment. Preservationists would argue that historic buildings are already a step ahead of the rest in their consideration for the environment since they embody energy that has already been spent as part of their construction. Embodied energy is described by Mike Jackson, Chief Architect at the Illinois Historic

Preservation Agency, as "the sum of all the energy required to extract, process, deliver, and install the materials needed to construct a building."[2] And while embodied energy does not contribute to an existing building's present-day performance and cost of operation, by reusing an existing building we are not generating or wasting more energy to build anew. According to a statistic quoted from a Brookings Institution report,

> by the year 2030 half of all buildings will have been built after the year 2000…then it follows that the other half will be existing buildings built before 2000, more than 30 years old to be maintained and upgraded.[3]

According to the January/February 2008 issue of *Preservation,* nearly 1,770,000 buildings are constructed annually in the United States and 290,000 buildings are demolished, generating nearly 136 million tons of construction waste per year.[4] When considering the negative ramifications of what those statistics mean for our environment, it is difficult not to see the important connection between preservation and embodied energy and the environmental benefits of retaining original fabric, cutting waste production, and limiting greenhouse gas emissions.

Before investigating ways of upgrading historic structures for energy efficiency and environmental impact, it is crucial to understand the history of the constraints on energy

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[2] Jackson, Mike. "Embodied Energy and Historic Preservation: A Needed Reassessment," APT Bulletin 36, no. 4 (2005): 47.
[3] Del Rance, Kim. "Preservation and Sustainability: The Greenest Building is the One Already Built" AIA COTEnotes, Spring 2007. Available from http://www.aia.org/nwsltr_cote.cfm?pagename=cote_a_0701_preservation; Accessed on October 10, 2007.
[4] Curtis, Wayne. "Amid our green-building boom, why neglecting the old in favor of the new just might cost us dearly," Preservation. (January/February 2008): 20.

resources in the United States, namely oil, and its connection to resulting energy conservation measures in the built environment. The background on energy constraints and policy informs us of how the cost of constructing and operating buildings has escalated over time with the price and availability of oil. It also helps us to understand improved public awareness on topics such as climate change, why the U.S. federal government established policies on environmental protection, and how these policies effected how buildings are constructed and operated. In simple terms, there is a chain reaction in the built environment when oil prices escalate. If the price of oil is high, it may cost more to manufacture environmentally friendly materials in an environmentally friendly factory, and also cost more to transport those materials greater distances from that distinctive, eco-friendly factory instead of the former one that might be closer to the job site. The vehicles transporting the materials are paying higher gas prices to a construction site that is running heavy machinery on the same expensive gas and emitting carbon dioxide fumes into the air. Oil prices are tied to the overall cost of everything we purchase, including the production and transport of building materials.

The oil crisis of 1973, with growing consumption of petroleum-based energy products and a tightening of supplies by oil producing nations, is hauntingly familiar to concerns being expressed today regarding oil. Understanding the effects of the 1973 event on buildings helps us to understand how design professionals and building owners responded to increased energy costs, and why owners of historic buildings might want to improve their buildings to make them run more efficiently and reduce their impact on the environment. The 1970's became a time when the field of historic preservation moved away from simply being a movement to save old buildings, and into the realm of social and economic responsibility with concern for urban renewal, farmland preservation, and economic revitalization. When the rest of the country became concerned with energy conservation, so did historic preservationists.[5]

THE 1970'S OIL CRISIS AND ITS EFFECT ON THE BUILT ENVIRONMENT

> Today, one-sixth of the entire global economy is dedicated to the staggering effort of harvesting oil from its uneven accumulations within the earth's crust. From birth to death our mobility, health, and sustenance all depend, in various ways, upon crude oil and its progeny.[6]

Since 1970 production of crude oil in the United States has been on a steady decline, increasing domestic reliance on foreign imports.[7] In 1972, Americans were consuming roughly 19,000 barrels of oil per day.[8] In 2008, the United States was the top oil consumer in the world at a staggering 20,517 barrels per day.[9] Though domestic oil production has been declining for almost 40 years, our daily dependence on it has not decreased, as evidenced by the data. This would indicate that the United States did not learn from the energy crisis of 1973-74, triggered by OPEC (Organization of the Petroleum Exporting Countries) cutting off shipments to western countries in support of

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[5] Ainslie, Michael L "Forward" in New Energy from Old Buildings, National Trust for Historic Preservation (Washington, D.C.: Preservation Press, 1981): 15-16.
[6] Shah, Sonia. Crude: The Story of Oil, (New York: Seven Stories Press, 2004): vii.
[7] Daniels, Tom and Katherine Daniels. The Environmental Planning Handbook, (Chicago: American Planning Association, 2003): 361.
[8] WTRG Economics "Oil Price History and Analysis." Available from http://www.wtrg.com/prices.htm; Accessed on April 30, 2008.
[9] Shah, Sonia. Crude: The Story of Oil, (New York: Seven Stories Press, 2004): 183.

Israel. The crisis established several enduring legacies for the United States relating to the economy and market behavior, and made an indelible mark on the role of government in regulating energy use, conservation efforts, and stimulating research on alternative energy sources, but clearly it has not altered domestic oil consumption.[10]

Some would argue that the energy crisis of the 1970's had been building for decades, since World War II. In a 1973 roundtable discussion on the energy crisis, Morris K. Udall (Representative, Democrat, Arizona), commented on public reaction to the crisis and oil consumption saying "The American people have been on a binge, a joy ride, and it is all over now."[11] Consumers were about to be shocked by U.S. federal government policies that were about to drastically alter oil prices. An executive from Standard Oil Company commented in the same roundtable discussion in 1973 that oil companies may have underestimated the acceleration in demand and usage.[12] Simultaneously in the 1960's and 1970's, the U.S. federal government was beginning to implement a number of policies and regulations on energy and the environment. Federal air quality legislation began in 1955 with the Air Pollution Control Act and became the Clean Air Act of 1963, giving states funding to control pollution, and amended in 1970 establishing National Ambient Air Quality Standards and emissions standards for sources of pollution such as buildings. Legislation was also passed on Mine Safety and Health, making coal an expensive and unattractive resource and placing a higher

[10] Feldman, David Lewis. The Energy Crisis: Unresolved Issues and Enduring Legacies, (Baltimore: The Johns Hopkins University Press, 1996).
[11] McCracken, Paul. The Energy Crisis .(Washington, D.C.: American Enterprise for Public Policy Research, 1973): 4.
[12] Ibid.

demand on oil and gas. Domestic wellhead taxes encouraged foreign oil imports, and the selling price of natural gas was held below market value leaving producers with little incentive to open new gas fields. The 1970's also brought environmental and safety regulations imposed on utilities which triggered a dramatic increase in the cost of nuclear energy. These regulations were partly intended to improve public confidence in nuclear technology, where even before the Three Mile Island nuclear power plant disaster in 1979, people were fearful of the potential risk of operator or mechanical error or failure at nuclear plants.[13]

Some say the environmentalists brought on higher oil prices themselves with the policies they demanded for protecting the environment, but in the long term, legislation resulting in higher oil prices forced consumers to conserve energy and make better choices when it came to energy consumption. Additionally

> Americans expected their government to take decisive action to resolve a shortage of petroleum that caused considerable economic inconvenience and hardship. Follow-up governmental responses, designed to encourage the development of alternative sources of energy and to prevent such a crisis from recurring, may not have been economically rational, but they may have been politically prudent.[14]

As oil prices continued to rise, President Nixon (1969-1974) instructed Americans to curb energy consumption by shortening working hours, turning down the thermostats,

[13] Feldman, David Lewis. The Energy Crisis: Unresolved Issues and Enduring Legacies, (Baltimore: The Johns Hopkins University Press, 1996): 4.
[14] Ibid., 6.

and limiting vehicular gas consumption. In 1978, President Carter (1977-1981) pressured companies to return to coal and instituted a tax on inefficient cars.

Many of the policies presented in the 1970's failed to fulfill their promises of independence from foreign imports and creating new, cheap, renewable technologies. The Department of Energy was created in 1977 in response to the oil crisis to study how energy was used and affecting the economy. The Department of Energy was given the task of establishing a long-term plan. Though never mentioning energy conservation specifically, some of their objectives were:

- Reducing America's dependence on imported oil;
- Promoting energy efficiency in homes and buildings;
- Developing technologies that increase the production of domestic oil and natural gas;
- Developing alternative energy sources.[15]

Unfortunately, the energy consumption habits of Americans did not change, and a second oil crisis came in 1979 in the wake of the Iranian Revolution. This slowed oil exports and raised prices again, but by the 1980's the United States was experiencing economic relief and enjoying the benefits of their own prosperous oil pipeline which opened in Alaska in 1977.

> By the time Ronald Reagan took the White House [1981-1989], the country was instructed to go back to doing what it did best: driving cars around and shopping. Reagan brushed off the cautious energy conservation of the 1970's like unsightly dandruff. He ostentatiously removed the solar panels on the White House roof, and let the energy

[15] Daniels, Tom and Katherine Daniels. The Environmental Planning Handbook, (Chicago: American Planning Association, 2003).

> efficiency requirements pioneered in the 1970's expire. The country didn't need an energy policy, Reagan thought, just strategic reserves and strategic forces.[16]

By the end of the 1980's another conflict was brewing with the Middle East; this time based on Iraq's territorial claims with respect to oil-rich Kuwait, a conflict that threatened both oil supply and its price. The United States was determined to protect its source of oil by launching a war with Iraq. By 2001 the oil industry was valued at between $2 and $5 trillion and worldwide consumption was over 29 billion barrels of oil a year, with the United Sates accounting for a staggering 20 of those 29 billion barrels.[17] Domestically, the wealth and prosperity experienced in the 1990's and early 2000's only led to greater consumption, and U.S. federal government policies were not affecting the bonanza. By 2001, domestic crude oil production was at only 5.8 million barrels a day as compared to 9.1 million barrels per day of imported oil. As of 2002, the United States had only 11 years of oil in their reserves to serve their domestic needs. Americans, previously looking for advancements in energy conserving technology, reacted unfortunately.

> The more efficiently energy could be harnessed, the more savvy marketers would encourage people to consume…More efficient refrigeration technology led manufacturers to market bigger refrigerators, and more fuel-efficient cars led Americans to step up their leisure driving…As long as more efficient technology drives prices down, the technology stimulated more energy consumption, not less.[18]

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[16] Shah, Sonia. Crude: The Story of Oil, (New York: Seven Stories Press, 2004): 37.
[17] Energy Information Administration, Official Energy Statistics from the U.S. Government: "Petroleum." Available from http://www.eia.doe.gov/oil_gas/petroleum/info_glance/petroleum.html; Accessed on April 30, 2008.
[18] Shah, Sonia. Crude: The Story of Oil, (New York: Seven Stories Press, 2004): 40.

In 1983 the Brundtland Commission convened by the United Nations to address "concern [for] the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development."[19] The Commission's findings were reported in 1987 in *Our Common Future*, which defines sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[20] The Commission addressed concerns with dependence on non-renewable energy sources and the unknown damage being done by high energy use on the environment. Some key elements mentioned in the report are:

- The need for energy efficiency and conservation measures, such that waste of primary resources is minimized;
- Protection of the biosphere and prevention of more localized forms of pollution;
- The serious probability of climate change generated by the "greenhouse effect" of gases emitted to the atmosphere, the most important of which is carbon dioxide produced from the combustion of fossil fuels;
- The need for fundamental political and institutional shifts to restructure investment potential in order to move along these lower, more energy efficient paths.[21]

The convening of the Brundtland Commission and the resulting report in 1987 brought worldwide attention to the dangerous effects of climate change and initiated an international effort to reduce greenhouse gas emissions and establish policies for

[19] Brundtland, Gro Harlem and World Commission on Environment and Development. Report of the World Commission on Environment and Development: "Our Common Future." (New York: United Nations, 1987).
[20] Ibid.
[21] Ibid.

sustainable development. The report is still credited today with forever changing the world's attitude towards preserving the environment for future generations.

U.S. GOVERNMENT POLICY AND THE BUILT ENVIRONMENT

In June of 1999, President Clinton (1993-2001) signed Executive Order 13123 *Greening the Government through Energy Efficient Management.* The order

> calls for federal agencies to improve the energy efficiency of their buildings, promote the use of renewable energy, and reduce greenhouse gas emissions associated with energy use in their buildings, among other energy-related requirements.[22]

In 2005, President Bush (2001-present) signed the Energy Policy Act offering federal tax credits for businesses and consumers purchasing fuel and energy-efficient items. The tax credit extended into home energy-efficiency improvements for consumers who install products, such as energy-efficient windows and insulation. The Energy Policy Act of 2005 (also known as EPACT) also provides a credit for the purchase of photovoltaic systems. Commercial buildings receive similar credits.

The General Services Administration, who some term "the governments master builder and landlord," are working to guide federally-owned sites in reducing their operational costs and the environmental impact of federal buildings through energy efficiency, as well as encouraging the incorporation of renewable energy systems whenever possible.

[22] Executive Order 13123 "Greening the Government through Energy Efficient Management". Available from http://catalog.gpo.gov/F?func=find-b&find_code=WRD&request=executive+order+13123; Accessed on March 25, 2008.

This mandate by the GSA includes the management responsibilities and retrofitting of historic buildings. The U.S. Department of Energy's Federal Energy Management Program, under the Energy Policy Act and Executive Order 13123 mandates a reduction in energy use in federal buildings by 35% by the year 2010 in comparison to 1985 levels.[23] In addition, existing federal buildings have been mandated to reduce their energy use by 2% per year by 2015, by which time they must be obtaining a minimum of 7.5% of their electricity from renewable sources.[24] Federal buildings are also required to attempt LEED accreditation.

The General Services Administration makes a strong contribution to the restoration of historic buildings. From roughly the mid-nineteenth to mid-twentieth centuries, some of history's greatest architects were designing federal buildings in the United States under the guidance of the Supervisory Architect of the Treasury. The GSA was created in 1949 by President Truman (1945-1953) to oversee the federal government's building stock, and has continued to function according to a philosophy of maintaining these architectural representations of our country's history. The historic preservation program under the GSA "provides technical and strategic expertise to promote the viability, reuse, and integrity of historic buildings GSA owns, leases, and has the

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[23] US Department of Energy Federal Energy Management Program "Overview." Available from http://www1.eere.energy.gov/femp/about/index.html; Accessed on March 25, 2008.
[24] US Department of Energy Federal Energy Management Program "Proceedings of the Workshop on Historic Preservation and Energy Efficiency in Federal Buildings." Available from http://www1.eere.energy.gov/femp/pdfs/ee_historicbldgs_report.pdf; Accessed on March 25, 2008.

opportunity to acquire."[25] Additionally, the GSA is committed to solutions to renovations and restorations that make its buildings more efficient, minimize or reduce any negative effects the building may have on the environment, and keep them functional and useful.

THE PRESERVATION COMMUNITY'S GUIDANCE AND OPINIONS ON THE TOPIC OF ENERGY

In response to the national concern over depleting energy resources and the need for increased energy efficiency and reduced air pollution in the 1970's, the National Park Service's Technical Preservation Services began publishing technical documents, with the third one being issued in 1978 on the subject of retrofitting historic buildings for improved energy efficiency. *Preservation Brief #3* "Conserving Energy in Historic Buildings"

> [was] developed to assist those persons attempting energy conservation measures and weatherization improvements such as adding insulation and storm windows or caulking of exterior building joints. In historic buildings, many measures can result in the inappropriate alteration of important architectural features, or, perhaps even worse, cause serious damage to the historic building materials through unwanted chemical reactions or moisture caused deterioration.[26]

The Brief describes the inherent energy-saving features of 19th and 20th century buildings and characterizes their performance capabilities. Acknowledging the

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[25] General Services Administration "Historic Preservation Overview." Available from http://www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8195&channelId=-12906; Accessed on January 17, 2008.

[26] Smith, Baird M. "Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978).

likelihood of future considerations as materials and techniques evolve and technology advances, the Brief warns that retrofitting measures should not be permanent or overzealous. Recognizing that each project is unique and should be handled on a case-by-case basis, the Brief itemizes several acceptable intervention techniques for energy savings, and encourages building owners to refer to the *Secretary of the Interior's Standards for Historic Preservation Projects* before making any alterations. *Preservation Brief #3* is a technical guide, and has not been updated since the original version was released.

The Advisory Council on Historic Preservation began to quantify the environmental value of rehabilitating older buildings as compared to building new ones in 1979. Proving the embodied energy (the sum of energy required to construct a building) of a particular structure could be a helpful tool in justifying the retention of the historically valuable fabric of a structure. "When energy savings became a national priority, the council wanted to be able to make enlightened judgments not only on historical significance and social and economic factors, but also on the energy trade-offs in these cases."[27] When the Advisory Council commissioned the consulting firm of Booz, Allen & Hamilton to conduct the study *Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples* in spring 1979, it signaled an awareness among preservationists that there may be some hurdles in making National Register and Landmark buildings more energy efficient while protecting historic fabric, as well as

[27] Carter, Calvin W. "Assessing Energy Conservation Benefits: A Study" in New Energy from Old Buildings, National Trust for Historic Preservation (Washington, D.C.: Preservation Press, 1981): 103.

showing the world the energy and economic benefits of preservation. Booz, Allen & Hamilton was asked to establish formulas to measure the following:

- Energy already existing in a structure to be rehabilitated;
- Energy needed for construction and rehabilitation;
- Energy needed for demolition and preparation of a construction site;
- Energy needed to operate a rehabilitated or newly constructed building.[28]

The report presented case studies on three buildings, including: Lockfield Garden Apartments in Indianapolis, IN; Grand Central Arcade in the Seattle Pioneer Square Historic District; and the Austin House on Capitol Hill in Washington, DC. By calculating the BTU's (British Thermal Units) embodied in each building and comparing that figure to the amount of BTU's required to tear down and rebuild, the study concluded that even with extensive renovation or rehabilitation, preservation is more energy efficient than demolition and reconstruction. The study did not present conclusions on operating costs and did not detail a connection between embodied energy and financial savings.[29]

The aforementioned study issued by the Advisory Council on Historic Preservation was published in the book <u>New Energy from Old Buildings</u>, by the National Trust for Historic Preservation in 1981. The book is a compilation of papers by various authors on energy and historic preservation, and still exists as the only book of its kind.

[28] Ibid., 103-104.
[29] Ibid., 103-111.

In 1994 the National Park Service published *Guiding Principles for Sustainable Design* and later launched the Sustainable Development Initiative, all of which developed as a result of the National Park Service Vail Symposium in 1991. Like the Brundtland Commission, NPS was addressing sustainability and the relationship between humans and the environment and the interactive effects relating to several topics, including: interpretation, natural resources, cultural resources, site design, building design, energy management, water supply, waste prevention, and facility maintenance and operations.

> Future technologies must function primarily within bioregional patterns and scale. They must maintain biological diversity and environmental integrity, contribute to the health of air, water, and soils, incorporate design and construction that reflect bioregional conditions, and reduce the impacts of human use.[30]

The *Guiding Principles* address the role of historic buildings by stating that "cultural resource preservation intrinsically is a form of sustainable conservation. The built environment represents the embodied energy of past civilizations. Where resources can have a viable continued use, preservation is conservation in every sense of the word."[31]

In 1998 Sharon Park published "Sustainable Design and Historic Preservation" on behalf of the National Park Service in *Cultural Resource Management*, and cited the *Guiding Principles* and our duty to contribute to protecting the environment. Park notes that the study of sustainability is still in its infancy and that historic preservation is gaining attention as a part of the environmental cause. Park

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[30] National Park Service. "Guiding Principles of Sustainable Design." Available from http://www.nps.gov/dsc/dsgncnstr/gpsd/; Accessed January 22, 2008.
[31] Ibid.

> Encourages environmental stewardship through a less consumptive lifestyle; the reduction of polluting forms of manufacture and chemical byproducts that may be damaging the ozone; and the practical reuse of existing and renewable materials. The retention and careful reuse of existing buildings, particularly historic buildings which have a strong connection to our past, is an emerging focus of sustainability nationwide.[32]

Additionally, Park discusses the rehabilitation of Letterman Hospital located within the National Historic Landmark site of the Presidio of San Francisco, California, where architects followed the NPS *Guiding Principles for Sustainable Design* and met the Secretary of the Interior's Standards for the Treatment of Historic Properties. According to Park, the success of this project could be duplicated and should stand as a model.[33]

In early 2006 the GSA released their Environmental Policy Statement[34], and in December of that same year the Federal Energy Management Program, Office of Energy Efficiency and Renewable Energy, sponsored a workshop at Decatur House Museum in Washington, DC titled "Historic Preservation and Energy Efficiency in Federal Buildings", to address the role of energy efficiency and environmental concerns relating to historic buildings. The ruling on a reduction in energy use in federal buildings in the Energy Policy Act of 2005 does not exempt historic buildings. Executive Order 13287 *Preserve America*, encourages public/private partnerships to

[32] Park, Sharon C. "Sustainable Design and Historic Preservation," CRM: [Bulletin] 21, no. 2 (1998): 13.
[33] Ibid.
[34] General Services Administration "Environmental Policy Statement". Available from http://www.gsa.gov/gsa/cm_attachments/GSA_BASIC/EnvPolicy_R20JGE_0Z5RDZ-i34K-pR.pdf; Accessed on March 25, 2008.

meet the goals in historic preservation and energy efficiency. As of 2006, roughly 25% of the GSA's 1,600 buildings are on the National Register of Historic Places, and 50% are more than 50 years old, making them eligible for Register status. According to the U.S. Department of Energy, "30% of the Department of Defense's 350,000 buildings are historic with a full 69% eligible for designation within 20 years."[35] The meeting in 2006 was the latest attempt at identifying obstacles and recommending solutions for energy and environmental improvement measures faced by stewards of historic buildings. At this point, the issue of retrofitting historic buildings in this manner was not treated as an "if" or "why", but "how". Social pressures and expectations have raised the bar on how a building should and can perform, and preservationists are taking note that they need to move forward with clearer guidelines on how historic buildings can improve energy efficiency and lessen their impact on the environment. This is all considered while still keeping in mind what separates the premise of this thesis from retrofitting an ordinary existing building: that careful consideration for the retention of original historic fabric must be a priority. The Workshop on Historic Preservation and Energy Efficiency in Federal Buildings included five sessions on topics that looked at measures for retrofitting historic buildings and the issue of disruption of historic fabric relating to each. The five topics were:

[35] US Department of Energy Federal Energy Management Program "Historic Preservation and Energy Efficiency in Federal Buildings" (December 7, 2006) . Available from http://www1.eere.energy.gov/femp/news/news_detail.html?news_id=10482; Accessed on March 25, 2008.

- Measuring the energy performance of historic buildings;
- Thermal control in historic assemblies;
- Ventilation and moisture control;
- Air infiltration and windows;
- HVAC and codes.

Key points made were:

- A holistic approach should be taken when evaluating energy consumption. Several evaluation factors should be considered, including building condition, history of energy consumption, use, and length of time involved;
- Building management should be addressed, including physical controls to regulate use, maintenance, selecting equipment for large and small buildings, etc.;
- Air conditioning is a major energy consideration. Energy savings have much to do with adjusting indoor air conditioning, including thermostat regulation and control of window use. Lighting and appliance loads may outweigh space conditioning energy costs;
- Insulation is most effective in the attic, followed by walls and floors, if at all;
- Infiltration and exfiltration are considered major areas of heat loss and moisture;
- Windows are an important character defining feature of historic buildings and replacement is generally not cost effective. Calking, weather-stripping and interior or exterior storm windows are recommended instead of replacement.[36]

SUMMARY

With concerns and priorities addressed, it is clear that preservationists are ready to begin solving the dilemma of retrofitting historic buildings for energy efficiency and reducing their impact on the environment, taking the initiative in problem solving with challenges such as insulation, windows, and mechanical systems. The reuse and rehabilitation of existing buildings will result in the preservation of architectural,

[36]Further details on the Workshop on Historic Preservation and Energy Efficiency in Federal Buildings can be found here: http://www1.eere.energy.gov/femp/pdfs/ee_historicbldgs_report.pdf.

cultural, and historical legacies while fulfilling social responsibilities with respect to energy efficiency and the environment.

CHAPTER 2

IN DEFENSE OF REHABILITATING HISTORIC BUILDINGS: EMBODIED ENERGY

The argument for rehabilitating historic buildings can be as strongly tied to economic and environmental considerations as historic and cultural value with the concept of embodied energy. With a national concern for the built environment's effect on energy use and the environment established, it is necessary to examine the premise that the values of historic preservation and the practice of rehabilitating existing buildings can be part of the solution to the problem of reducing energy consumption. When considering embodied energy, it can be argued that the reuse and upgrading of an existing building will account for less total energy consumed in rehabilitation efforts then tearing down the old and constructing a new building. Embodied energy is defined as "the sum of energy required to extract or harvest a raw material, manufacture and fabricate that material into a useful form, and transport it to its place of use."[37] By calculating embodied energy into the equation of the total energy cost of a building, the average annual energy cost is reduced the longer the building is in operation. For this reason, it is not necessary for historic buildings to mimic the high performance of a new building because the existing structure's embodied energy reduces its total energy consumption over time. Improving an historic building's energy efficiency in any way will therefore reduce its overall impact on energy resources.

[37] Meryman, Helena. "Structural Materials in Historic Preservation: Environmental Issues and Greener Strategies," APT Bulletin 36: no. 4 (2005): 31.

With the reuse of existing buildings, embodied energy becomes a significant factor in energy and resources that have already been expended and do not need to be expended again. In rehabilitating a building for continued or new use, the embodied energy of the retained materials and construction becomes an asset, and results in a lower energy cost of construction and diminished adverse effect on the environment.

In 1978 Baird M. Smith, AIA, described the inherent energy-saving characteristics in historic buildings in *Preservation Brief #3* "Conserving Energy in Historic Buildings" (described in further detail in Chapter 4). "Many historic buildings have energy-saving physical features and devices that contribute to good thermal performance. Studies by the Energy Research and Development Administration show that the buildings with the poorest energy efficiency are actually those built between 1940 and 1975. Older buildings were found to use less energy for heating and cooling and hence probably require fewer weatherization improvements. They use less energy because they were built with a well-developed sense of physical comfort and because they maximized the natural sources of heating, lighting and ventilation."[38] Therefore, if the natural, intended performance of an historic building already uses less energy, these buildings will require less energy over time to operate, contributing less to the energy cost distributed over time with respect to embodied energy.

[38] Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978): 33.

In 1979 Booz, Allen & Hamilton, Inc. published a study on embodied energy for the Advisory Council on Historic Preservation based on research by architect Richard G. Stein, FAIA, and Bruce Hannon, at the Center for Advanced Computation, University of Illinois. The study was titled "Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples." According to Bruce Hannon, who reflected in a 2005 *APT Bulletin* article on the 1970's research conducted that led to the study, the agenda was to make energy calculations for new buildings and for remodeling, and to be able to point to the energy cost of remodeling buildings as compared to building replacements. Stein and Hannon calculated how many BTU's are required in the production of building materials which provided a metric for calculating the amount of energy embodied in a particular building.[39] Looking at the assessment provided by Booz, Allen & Hamilton, William I. Whiddon wrote "The Concept of Embodied Energy" in the 1981 New Energy from Old Buildings, and in analyzing the concept concluded that "preservation and energy conservation can indeed be considered synonymous. Preservation today has the potential to become an instrument in national energy policy."[40]

Mike Jackson, FAIA, Chief Architect for Preservation Services at the Illinois Historic Preservation Agency wrote on the topic of embodied energy and historic preservation in a 2005 article for *APT Bulletin* titled "Embodied Energy and Historic Preservation: A Needed Reassessment." Jackson touts embodied energy as the topic necessary to

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[39] Jackson, Mike. "Embodied Energy and Historic Preservation: A Needed Reassessment," APT Bulletin 36: no. 4 (2005): 52.
[40] Whiddon, William I. "The Concept of Embodied Energy" in New Energy from Old Buildings, National Trust for Historic Preservation (Washington, D.C.: Preservation Press, 1981): 119.

discuss when considering the environmental impact of a building in addition to its economic, cultural, and design values of historic preservation.[41] With many shared values between historic preservation and environmental conservation, the most dominant one is a less-is-more attitude, minimal intervention or disruption for both a cultural and environmental gain. Though not typical of American culture where over consuming is commonplace, this less-is-more attitude could prove to bring historic preservation into the spotlight, where in 2008 the United States is grappling with a tumultuous economy and a troubled mortgage market.

In 2008 Mike Jackson discussed the topic of embodied energy with Wayne Curtis in *Preservation,* as embodied energy becomes an engaging topic again due to rising energy prices, notably oil and natural gas. Curtis writes

> The data behind embodied energy are compelling. According to Jackson, if embodied energy is worked into the equation, even a new, energy-efficient building doesn't actually start saving energy for about 40 years. And if it replaces an older building that was knocked down and hauled away, the break-even period stretches to some 65 years, since demolition and disposal consume significant amounts of energy.[42]

The statistics that Jackson presents make a strong case for the rehabilitation of historic buildings, where the destruction of an existing building only adds to the energy expended by a new building replacing it. This also ties the value of embodied energy to the environment. Reusing an existing building not only uses less energy, but prevents

[41] Jackson, Mike. "Embodied Energy and Historic Preservation: A Needed Reassessment," APT Bulletin 36: no. 4 (2005): 47.
[42] Curtis, Wayne. "Amid our green-building boom, why neglecting the old in favor of the new just might cost us dearly." Preservation: January/February 2008: 23.

unnecessary demolition and construction waste from being sent to landfills. Embodied energy then provides a very practical justification for the rehabilitation of historic buildings with both financial and environmental support of the argument.

SUMMARY

Ultimately, it can be argued that the energy efficiency of existing buildings begins with its reuse, before any energy is expended in rehabilitation. Demonstrating the value of the embodied energy of a building, where reuse means not having to generate waste and materials, is contributing to a reduction in its operating cost and initial energy investment. The argument for retaining original historic fabric then reduces energy cost. Choices in keeping certain features of an historic building, even if they do not perform optimally, is still more efficient then replacing or retrofitting that feature. Value then can be found at multiple levels of historic preservation rehabilitation projects, where small to large scale interventions and alterations might improve on energy consumption. Sometimes the choice to leave things unchanged can be the most effective measure.

CHAPTER 3

ILLUSTRATIVE EXAMPLES OF HISTORIC BUILDINGS RETROFITTED FOR ENERGY EFFICIENCY AND ENVIRONMENTAL DESIGN

Without a concise, updated, comprehensive guide to inform practitioners on how they can retrofit historic buildings with systems to improve energy efficiency and reduce their impact on the environment, the design profession is left to learn from decades old documents and the example of their peers and the work they are doing. An inherent characteristic of historic preservation rehabilitation projects, no matter what type of work they include, is the fact that each building is and should be treated on a case-by-case basis, with each building being recognized for its unique qualities, some more significant than others, with a variety of details and features having degrees of importance and relevance. Having an example of successes or failures to guide decision making can be an asset in evaluating and choosing the appropriate course of action.

Included in this chapter in chronological order are four examples of projects spanning several years of work and incorporating a variety of systems and techniques to improve the performance of historic buildings with a priority on energy efficiency and consideration for the environment. Each example follows a slightly different approach according to the goals of the project team and client, with varying degrees of historical significance of the building, retention and disruption of original historic fabric, and small to large scale systems upgrades. By representing projects with a range of historical value and intervention, the examples are able to illustrate the complexities and solutions where architects and preservationists are handling multiple levels of historic preservation mandates and constraints according to the significance of the structure.

The first example presented is Audubon House in New York City. The objective of the project team was to preserve valuable original 19^{th} century fabric from a building not recognized on a local or national register, while making numerous but sensitive alterations on the interior to upgrade the building with systems for improved energy efficiency and reducing the building's impact on the environment. Audubon House serves as a good example for showcasing the opportunities in technological upgrades in a building with historical value, but without the constraint of regulation.

The second and third projects discussed, Schlesinger Library and 46 Blackstone at Harvard University in Cambridge, Massachusetts, are examples of rehabilitation and adaptive reuse projects of buildings unrecognized by local or national registers for historic buildings. They possess a degree of value in original fabric and context that warrants consideration before alteration, but without the constraint of regulations. These projects serve as unique examples of valuable buildings, though not historically significant, and rehabilitated with the primary goal being reuse with energy-efficient systems and a reduced impact on the environment. The two projects also well illustrate contemporary rehabilitation methods, techniques, and technology being used and practiced to achieve these goals.

The last example, Thurgood Marshall U.S. Courthouse, has not yet begun construction but details the high level of complexity in proposing the rehabilitation of a building of great local and national significance, and having both cultural relevance and valuable original historic fabric. This project illustrates the regulations and restrictions the project team were faced with in designing an appropriate rehabilitation of a historically significant building, while also proposing the incorporation of necessary systems upgrades and measures to improve performance and occupant comfort to satisfy energy-efficiency mandates.

AUDUBON HOUSE
NATIONAL AUDUBON SOCIETY HEADQUARTERS
NEW YORK, NY (1994)

In 1993, years before the U.S. Green Building Council's Leadership in Energy and Environmental Design rating system, and over a decade before *An Inconvenient Truth* brought sensational attention to the effects of climate change, the National Audubon Society set a new standard by commissioning the rehabilitation of an existing building with objectives focused on energy efficiency and reducing the building's impact on the environment. Their new headquarters was originally built in 1891 by George B. Post and located at 700 Broadway in the heart of New York City. In 1994, with project architect Croxton Collaborative, they jointly published *Audubon House: Building the Environmentally Responsible, Energy-Efficient Office*, providing a sort of "guide to environmental design" by telling the story of how the project was executed. Then

National Audubon Society CEO Peter A.A. Berle said "doing business the environmental way is no longer the wave of the future: It has arrived."[43] If only this were true. Fourteen years later preservationists are still learning from Audubon House, and still proclaiming "today" to be the time when environmental design has finally arrived. Though it is here, it appears to eternally be a work-in-progress, with clients and architects still adapting to new technologies and placing a priority on energy efficiency and environmental impact, but still learning how to make this a reality, especially in historic preservation. Architects strive to make all buildings energy-efficient, but preservationists have the added challenge of not only considering the energy performance of an historic building, but how improving the performance might affect the value, materials, and experience of the building.

Audubon House is an especially compelling example not only because of what they accomplished with the design, but in setting the standard for bringing together a team of professionals who worked towards a goal, from conception to completion, described as "seeing the act of building in a new way- thinking about its ramifications on the environment, looking for alternatives to traditional methodologies, and reconciling those objectives with the practical, business-oriented goal of economy."[44] That the building was to house a non-profit organization whose mission is to protect and study wildlife and the environment should not be overlooked; it reminds us of the importance of a client's influence during the design process, and how their goals can affect the

[43] National Audubon Society and Croxton Collaborative Architects. Audubon House: Building the Environmentally Responsible, Energy-Efficient Office. (New York: John Wiley & Sons, Inc., 1994): xii.
[44] Ibid., xix.

product. However, Audubon House was an exercise in looking beyond the mission of a client committed to the environment, and as architect Randolph R. Croxton said "was focused on value…at the core of every strong environmental concept, there is an economy."[45] Alterations to the building had to meet the team's financial and environmental expectations and goals in order for the changes to be worthwhile.

Though in 1994 Croxton did not consider Audubon House to be an example of perfection, he did call it a case study for a "framework within which deeper levels of quality, performance, and value can be pursued."[46] Bringing together the various components of their "vision" is not too distant from where we are today in retrofitting existing buildings with a sustainable, environmentally-friendly design. What is surprising is that for all of the praise Audubon House received after its completion in the early 1990's, it did not significantly impact decision making in the field. It became an example of what is possible, but one which was not followed too quickly or by too many. Unfortunately, in 2006 the National Audubon Society decided to decentralize their operations and move out of the 700 Broadway building in response to economic challenges for the non-profit organization, and because of their commitment "to devote as much as possible from every available dollar toward our conservation mission"[47] said then Audubon President John Flicker.

[45] Ibid., xv.
[46] Ibid., xvii.
[47] National Audubon Society. "Lincoln Property Company Acquires 700 Broadway from National Audubon Society in $53 Million Sale." Available from http://www.audubon.org/news/press_releases/1206-december2006.html. Accessed on April 30, 2008.

The National Audubon Society purchased the eight-story George B. Post structure formerly known as the Schermerhorn Building at 700 Broadway, and located in the dense metropolis that is New York City. The building is an example of the Romanesque Revival style, complete with a cast-iron frame clad with glazed brick masonry, brownstone, and terra-cotta. Except for retail shops on the ground floor, the building had remained empty for ten years prior to Audubon's purchase. The exterior was in very good condition, though the interior was in need of extensive renovations. The Audubon project team identified four categories to guide their design and set environmental priorities supported by extensive studies on each subject. They were:

1) Energy Conservation and Efficiency
2) Direct and Indirect Environmental Impacts
3) Indoor Air Quality
4) Resource Conservation and Recycling

When the project began in early 1990, few precedents existed for the renovation of an historic building with systems for improved energy efficiency and reduced environmental impact. The environmental goals for Audubon House were balanced against financial ones, as the project team developed a parallel set of financial and environmental criteria. In Audubon House: Building the Environmentally Responsible, Energy-Efficient Office, the Audubon Team said "[it] is critically important at present, when the public is demanding justifications for environmental programs…to show that environmental design can indeed be achieved at a reasonable cost."[48] The cost of construction for the Audubon House project came in at market rate, costing roughly the

[48] National Audubon Society and Croxton Collaborative Architects. Audubon House: Building the Environmentally Responsible, Energy-Efficient Office. (New York: John Wiley & Sons, Inc., 1994): 48.

same per square foot as a rehabilitation project of similar size and location. The team said this was due to their careful financial considerations all along. Systems and products chosen had to be justified both economically and environmentally, as well as durability and service life of a system or product and anticipated payback. The Audubon team decided on a five-year maximum payback for energy related systems to allow for the selection of environmentally-friendly systems which was a sacrifice by not having a quicker payback period. Payback was based on "the amount of time it takes a system or systems to offset additional cost with accrued savings."[49] Randy Croxton and the National Audubon Society wanted Audubon House to serve as a model to others looking to rehabilitate a building with similar energy and environmental objectives. Choosing a short payback period would have meant sacrificing meaningful environmental performance, but choosing a longer period would hinder the project team's ability to make Audubon House a model because environmental performance would seem financially unachievable. It is worth noting that the Audubon Team evaluated solar photovoltaic (PV) arrays for roof installation but found that it would have taken more than 10 years to receive the financial payback, and instead decided that the energy savings without the PV system was enough to satisfy their energy saving goals. [50] Operation of Audubon House consumes 62% less overall energy then a similar building meeting minimum legal code requirements.

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[49] Ibid., 50.
[50] Ibid., 45-51.

Not surprisingly, the renovation of Audubon House required upgrading the insulation and windows. As with most 19th century buildings of masonry construction, the outer shell was an issue for energy efficiency because there was no insulation. In search of the most eco-friendly insulating material, the Audubon Team discovered air-blown cementitious foam manufactured by Air-Krete ™, which contains no chlorofluorocarbons and was blown in as a wet foam into the newly created wall cavities, the space between the original exterior masonry wall and a new interior wall. The windows installed at Audubon House used heat-mirror technology, a coated film suspended between two panes of glass which deflects much of the sun's heat outward, and also deflects convector radiant heat inward which helps conserve energy in the winter months.[51]

For heating and cooling, the Audubon team installed a gas-fired chiller-heater on the top floor; this equipment does not emit sulfur oxides or chlorofluorocarbons. The chiller-heater saved the National Audubon Society significantly in electricity costs associated with heating and cooling. In 1994 the project team estimated that they were saving roughly $18,000 per year by using the gas-fired chiller-heater instead of relying on an electrical system operating off of the electricity grid. For further information on the HVAC system at Audubon House, see Chapter 5 in Audubon House: Building the Environmentally Responsible, Energy-Efficient Office.[52]

[51] Ibid., 84-87.
[52] Ibid., 91-93.

The case of Audubon House stands as a groundbreaking example of a project team determining environmental goals in conjunction with financial feasibility in conjunction with the reuse of an existing building, and maintaining these goals as the priority for the project. Audubon House did and does not have any specific historical significance, it is not on a national or local register of historic places, but was designed by an architect of note and well over a hundred years prior to the rehabilitation. The reuse of an existing building was part of the endeavor as decided by the project team and their client, who saw the environmental value in reuse.

> Audubon consciously took no new, previously undeveloped land to build a new building, thus making no direct contribution to loss of habitat. By choosing to renovate an existing structure, moreover, rather than tearing it down and building a new one, Audubon not only saved resources but also preserved an important part of New York's urban fabric—a building of great distinction and historic significance.[53]

Audubon House exemplifies the possibilities in upgrading an existing building for improved energy efficiency and considering the building's impact on the environment, but was not under any historic preservation mandates or constraints. The project also serves as a tremendous example of success when a project team is organized around well defined goals and objectives.

[53] National Audubon Society and Croxton Collaborative Architects. Audubon House: Building the Environmentally Responsible, Energy-Efficient Office (New York: John Wiley & Sons, Inc., 1994): 18

HARVARD GREEN CAMPUS INITIATIVE

Established in 1636, Harvard University presents an interesting case study in campus sustainability initiatives as a university with a tremendous collection of historic buildings designed by some of the most prominent names in architectural history and a multitude of styles. In October of 2006, an initiative called the American College & University Presidents Climate Commitment was established to address global warming and encourage universities to become carbon neutral by, for example, constructing and retrofitting campus buildings with energy-conserving systems, and generating and buying renewable power. Harvard was ahead of the curve, establishing their Green Campus Initiative several years earlier in 2000, with the mission of making the University "a living laboratory and learning organization for the pursuit of campus sustainability."[54] As of March 2008 Harvard has over 20 LEED designated projects, many of which are historically significant buildings.

ARTHUR AND ELIZABETH SCHLESINGER LIBRARY
RADCLIFFE INSTITUTE FOR ADVANCED STUDY
HARVARD UNIVERSITY
CAMBRIDGE, MA (2004)

Founded in 1903 by the Radcliffe College Alumnae Association and a donation from Andrew Carnegie, the Arthur and Elizabeth Schlesinger Library was built in 1907 by the Boston architectural firm Winslow & Bigelow to house the Radcliffe College

[54] Harvard Green Campus Initiative. Available from http://www.greencampus.harvard.edu/about/; Accessed on February 12, 2008.

Library. The library underwent extensive alterations and renovations over the years in attempts to keep the growing collection under one roof, but was eventually moved to another facility. In 1967 the Winslow & Bigelow structure became a research library named the Arthur and Elizabeth Schlesinger Library on the History of Women in America, and in 2001 was described as "perhaps the greatest repository of its kind in the world, is not, however, of any note architecturally."[55] Though not every "old" building is an icon, this example speaks to Harvard University's interest in retaining and upgrading their original campus buildings; architecture is part of their identity.

The Philadelphia-based architectural firm Venturi, Scott Brown and Associates was hired by Radcliffe Institute for Advanced Study and completed work on the library in 2004, earning a LEED Certified designation by the U.S. Green Building Council. At the forefront of the agenda for the client and architect was to retain the building's shell and restore and recover interior elements lost over almost a century of alterations, as well as updating mechanical systems for greater energy efficiency and improving conditions for an environment housing sensitive materials, such as new climate control systems to maintain proper temperature and humidity for the preservation of rare books and manuscripts.

Situated on Radcliffe Yard, part of the Old Cambridge National Register District and within the Old Cambridge Local Historic District, the building's location required that

[55] Shand-Tucci, Douglass. The Campus Guide: Harvard University .(New York: Princeton Architectural Press, 2001): 258.

Venturi, Scott Brown pay careful attention not to disrupt or encroach on The Yard with the renovations. The Cambridge Historical Commission and the Massachusetts Historical Commission were both consulted on the project. Venturi, Scott Brown preserved the open space, with 32% of the site's area shaded by trees, thus reducing the heat island effect. The entire building shell including original window casements was preserved, except for the addition of an accessibility ramp at the main entrance and the installation of interior storm windows. On the interior, a stained glass window and marble stair were conserved, and the second floor reading room was restored to its original double-height.

Energy use in the library was reduced by 25%, the result of a carefully designed energy model developed by the mechanical engineer on the project, Cosentini, Inc. The improvement and savings is 25% better then code requirements, as well as the standard set by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHARE). In addition, Facility Dynamics Engineering who handled building commissioning ensured optimal performance of the systems installed. Renewable energy certificates, commodities that represent proof that electricity was generated from a renewable energy resource, were purchased to offset approximately 50% of electricity use.[56] Other measures to decrease the building's impact on the environment are low-VOC (Volatile Organic Compounds) emitting paints and carpets, and reduction of water consumption by installing low-flow lavatories. An impressive 91% of construction

[56] Harvard Green Campus Initiative. "Schlesinger Library Case Study." Available from http://www.greencampus.harvard.edu/theresource/case-studies/documents/Schlesinger_Case_Study.pdf; Accessed on March 28, 2008.

waste from the project was diverted through reuse and recycling instead of going to a landfill.

As mentioned earlier, the case of Schlesinger Library underscores the relevance of a building in its context and the importance of retaining it. As a building on Radcliffe Yard, an area of great Cambridge and University history, Harvard wanted to keep the building but upgrade it for improved performance and occupant comfort. This example illustrates the technological opportunities while keeping the building in its original use and with minimal changes to the envelope, a result of careful energy modeling.

46 BLACKSTONE
HARVARD UNIVERSITY OPERATIONS SERVICES (UOS)
CAMBRIDGE, MA (2006)

Cambridge Electric Light Company built the coal-fired electricity power station “Blackstone” along the Charles River in Cambridge, Massachusetts in 1888, with several closely integrated outbuildings added on over the years (eight in total) dating from the late 19^{th} and early 20^{th} centuries. In 2003, Harvard University Operations Services purchased three of the historic masonry outbuildings from the eight that made up the Blackstone power station, including a parking lot, the “Diary” Building dating from 1889, Building 7 dating from 1926, and Building 10a dating from 1929. Harvard’s Green Campus Initiative served as Sustainability Consultants on the project, where the client, University Operations Services, drafted sustainability goals before beginning the search for an architect, ensuring “that sustainability was a primary focus at every stage of the design and construction process."[57] Jeffrey Smith, Harvard's Director of Facilities, Maintenance, and Operations said that from the beginning, the goal for the Blackstone site was to create a facility to serve "as a model for sustainable design, renovation and occupancy for the rest of [the Harvard] campus."[58]

The 40,000 square foot renovation was an adaptive reuse project, maintaining the outer shell of each of the three outbuildings with essentially complete renovation of the interior spaces. Though not listed on the national or local register of historic places, Harvard University consulted with the Cambridge Historical Commission on the project, as per an agreement the two entities have had since 1986 in which Harvard reviews alterations to university owned buildings on the National Register with Cambridge Historical Commission staff to ensure appropriate actions. According to Charles M. Sullivan, Executive Director of Cambridge Historical Commission who handled the negotiations with Harvard on this project, Harvard agreed to treat the property as an historic site when they acquired it in 2003. Sullivan reviewed the exterior alterations Harvard was proposing with no major disagreements.[59]

46 Blackstone was to become headquarters to several separate University Operations Services departments, bringing them together on one site. The project team included

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[57] Harvard Green Campus Initiative. "46 Blackstone Renovation Case Study." Available from http://www.greencampus.harvard.edu/theresource/case-studies/Blackstone.php; Accessed on February 26, 2008.

[58] Matt, Chris "Sustainability Standard: Blackstone renovation serves as Harvard's template for green building projects" Maintenance Solutions. January 2008. Available from http://www.facilitiesnet.com/ms/article.asp?id=8083; Accessed on April 5, 2008.

[59] Charles M. Sullivan, email correspondence with the author. March 19, 2008.

the architect, Bruner/Cott & Associates, a landscape architect, contractor, mechanical, geotechnical and civil engineers, a sustainability consultant, and a cost estimator. Project team strategies included addressing the sites energy needs, water use, materials and waste, and environmental quality, all goals set by University Operations Services Vice President Tom Vautin at the outset of the project. In keeping with the sustainability goals, the project team found that adaptively reusing the existing building shell was "the most sustainable measure possible."[60]

Upgrading the 46 Blackstone complex included:

- Insulating the walls of the original masonry shell;
- Geothermal/Ground source heat pumps;
- Ventilation systems for improved energy efficiency and occupant comfort;
- Installing new high performance windows

Improving the building envelope involved repairing cracks and joints in the masonry walls with a vapor permeable insulating foam to prevent moisture from being captured in the wall. A gypsum board was placed inside the wall to seal off air infiltration. A "perm-a-barrier", an air and watertight foil, was installed around windows and doors. Unfortunately, all of the original windows at 46 Blackstone were removed. They were all replaced with operable units, with double pane, argon-filled low-e glass.[61]

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[60] Bruner/Cott Architects and Planners. "Sustainable Measures in the Harvard Blackstone UOS Renovation." Available from http://isites.harvard.edu/fs/docs/icb.topic212493.files/blackstone_sustain_brochure_from_Bruner_Cott.pdf; Accessed on March 24, 2008.
[61] Ibid.

Geothermal standing column wells 1500 feet deep and 6" in diameter were drilled into the bedrock at Blackstone, with PVC tubes transporting water from a submerged pump to the heat pump on the surface.

> Because the amount of returning water is small in comparison to the amount of ground (and ground water flowing through the well), the ground and ground water represent a constant heat source in the winter and heat sink in the summer.[62]

Another of Bruner/Cott's approaches to efficiency involved the ventilation system incorporated into Blackstone, by using a "decoupling" method from heating and cooling, as well as controlling ventilation and a heat recovery system. According to Bruner/Cott, decoupling of the ventilation system is more efficient and comfortable when the water is coupled with a geothermal well and heat pump.[63] Ventilation is also controlled for air quality, monitoring CO_2 levels and optimizing fresh air. In the heat recovery system devised at Blackstone "warm inside air flows out through very thin metal fins. On the other side of these fins cool outdoor air flows in. The warm air gradually heats the fresh outside air."[64] Heat recovery systems achieve a 75% energy recovery.[65]

The case of 46 Blackstone is an example of an adaptive reuse project where flexibility in renovations and rehabilitations can be made when the structure is of less significance historically. The goals set by the project team were not too dissimilar from the

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[62] Ibid.
[63] Ibid.
[64] Ibid.
[65] Ibid.

Audubon House team in their effort to make the building as energy efficient and considerate of the environment as possible. However, in consulting with the Cambridge Historical Commission, Harvard University did their due diligence in respecting artifacts of Cambridge industrial history.

THURGOOD MARSHALL U.S. COURTHOUSE
NEW YORK, NY (IN PROGRESS)

As architect Cass Gilbert's last design begun in 1933 and completed in 1936, two years after his death, the Thurgood Marshall U.S. Courthouse has long stood as an iconic New York City building, serving as home to the U.S. District Court and hosting some of the city's most controversial trials in over 20 courtrooms throughout the building. Listed on the National Register of Historic Places in 1986 and designated a New York City Landmark in 1975, the 33-story tower had suffered inappropriate renovations over the years, and had not received any major systems upgrades in several decades. The Thurgood Marshall U.S. Courthouse has remained in its intended use since it opened and will continue to indefinitely.

As a federal building undergoing a renovation, the project was subjected to a variety of reviews and required a cooperative project team consisting of a diverse group of professionals. The United States General Services Administration, "landlords" of the courthouse, selected New York architecture firm Beyer Blinder Belle to design the rehabilitation, and under the guidance of the GSA, their plans were put before a peer review in 2005. As a government-owned building, the Landmarks Preservation Commission had no authority on this project, but Beyer Blinder Belle's design was put through a Section 106 review with the New York State Historic Preservation Office, as well as review by historic preservation specialists at the GSA. Additionally, the GSA went into the project planning to achieve a LEED Certified rating. It is worth noting that the GSA has set the standard of encouraging a LEED Silver rating or better with all of their projects including new construction, rehabilitation, and renovation. An exception was made for the Thurgood Marshall U.S. Courthouse project to meet a LEED Certified rating because of the historical significance of the building.

At present (early 2008), Beyer Blinder Belle has completed their proposed plan and design for rehabilitation of the courthouse and work has begun on conserving exterior elements and demolishing some interior spaces that have been determined not to be architecturally significant. As mentioned earlier, the courthouse suffered many years of inappropriate additions, which were mostly in the form of temporary walls or infill construction erected to expand office spaces, many of which cut off daylight from entering the hallways. Some of these spaces will remain but most are being removed.

The design team was confronted with a multitude of challenges in making systems upgrades in a federal building without disrupting original fabric. Based on feedback from the 2005 peer review of the project, Beyer Blinder Belle engaged the services of a consultant to evaluate thermal performance of the exterior walls and thermal performance of the windows. According to Larry Gutterman, AIA, associate partner with Beyer Blinder Belle, the consultants conducted

> a thermal performance analysis of the building to ascertain whether any retrofit of insulation absent a window replacement or retrofit would benefit the building's overall thermal performance. The report advised that no such benefit occurred, and therefore it made no sense to put insulation at the interior face of the exterior walls if the windows were to remain as is.[66]

This study resulted in the retention of an enormously significant historical element being the original bronze casement windows which exist throughout the building.

The courthouse building was never fitted with ducted central air-conditioning, although some rooms had window units. For this reason and others, a significant task was to incorporate a modern heating, ventilating, and air-conditioning system. The design team evaluated the impact systems would have on the building and considered two options: a fan-coil system and a ducted system. Looking at Cass Gilbert's design, they considered

> channeling in walls and floors for pipe versus running ducts in ceilings, and relying on soffits to keep any drops in the ceiling away from the windows and outside of the perimeter offices. A life cycle cost analysis conducted at the pre-design phase gave the ducted scheme a modest advantage cost-wise over the piped scheme.[67]

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[66] Larry Gutterman, email correspondence with the author. April 14, 2008.
[67] Ibid.

The new heating system will make use of the existing historic radiators by installing new two-pipe hot water radiators in the existing steam radiators. Additionally, one of the upper-most floors will be transformed into a mechanical room.

As a federal building undergoing a renovation, a significant amount of wiring and communications upgrades are necessary to bring the building up to current security requirements set by the government. Beyer Blinder Belle is able to take advantage of the existing in-floor electrical raceway for power and telecommunications wiring upgrades.

Lastly, Beyer Blinder Belle will incorporate a siphonic system to the roof for drainage, which de-pressurizes the flow of water and can be connected to a single vertical discharge pipe reducing the number of discharge points. A siphonic roof drainage system is

> ideal for building retrofits, especially where architectural preservation is desired. Not only can it accommodate tight ceiling spaces and limited chase and wall space, it reduces construction costs. It also makes it possible to install all the new piping overhead (in ceilings) thereby eliminating the need to saw cut existing floor slabs to excavate and replace buried piping.[68]

Additionally, having one discharge point means easy capture and storage of stormwater runoff or "graywater" for reuse.

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[68] Siphonic Roof Drainage for Building Retrofits. Available from http://www.jrsmith.com/products/roof/Siphonic/tech/td_installation.htm#Retrofit; Accessed on April 7, 2008).

The project team for Thurgood Marshall U.S. Courthouse is also considering a green roof over a small roof section of the 7-story base, using low-VOC materials, and upgrading lighting throughout the building with compact fluorescent bulbs as additional energy efficiency and environmental enhancements.

Since this project is currently in progress it is not yet possible to qualify or quantify the outcome. However, the process by the GSA and the project team was no small feat, and their diligence in making the best decisions for the sake of the building are apparent already. The team spent several years conducting studies on the building's performance and use and the ramifications of disrupting original historic fabric of such a significant and iconic New York City building. And though the course of action does not place primacy on energy efficiency, it is an excellent example of the challenges in making energy-efficient upgrades in a nationally recognized historic building, and the thoughtful analysis taken in the process to balance energy efficiency, comfort and historic preservation.

SUMMARY

The examples presented in this chapter illustrate the numerous levels of historical significance preservationists are working with when rehabilitating historic buildings, and how varying degrees of value associated with a building's cultural and material fabric results in different interventions. The cases of Audubon House and 46

Blackstone demonstrate the design opportunities and more invasive upgrades possible with the rehabilitation of a building envelope that is not restricted by historic preservation constraints. Schlesinger Library, though also not under the restrictions of historic preservation constraints, demonstrates upgrading opportunities while not disrupting or altering the original building envelope. For this reason, the approach at Schlesinger Library is more like the last example, Thurgood Marshall U.S. Courthouse, which serves as a model for historic preservation projects where rehabilitation, improved performance, and systems upgrades are desired. The plan, goals, and actions of the project team reflect consideration for historic preservation and governmental mandates and constraints, and how those restrictions were dealt with and conquered to achieve a thoughtful and appropriate solution. Though not yet carried out, the rehabilitation plan for the Thurgood Marshall U.S. Courthouse should result in the successful preservation of an iconic New York City building with dramatically improved performance through energy efficiency and occupant comfort.

CHAPTER 4

ANALYSIS OF RECOMMENDED TECHNIQUES TO UPGRADE HISTORIC BUILDINGS FOR IMPROVED ENERGY EFFICIENCY AND ENVIRONMENTAL IMPACT

In conducting research for this thesis, it became apparent that the field of historic preservation is lacking up-to-date technical guidance for practitioners on techniques to improve an historic building's energy efficiency and reduce its impact on the environment. Questions arose as to how architects and preservationists working with energy and environmental goals are achieving energy savings and reducing the environmental impact of buildings without guidance from the field. What technical and values-based information is helping architects and engineers to re-create the face of historic preservation, giving building's a new life that is more efficient and environmentally friendly while retaining its essential character-defining features and historic fabric? The energy crisis of the 1970's brought an influx of professional papers, briefs, and guides on how one might update an existing building, most notably an historic one, for greater energy efficiency. And though many practitioners have written on the topic with opinion pieces since then, actual instruction or guidance is obtained by looking at examples of completed projects without any compilation or analysis of successes and failures. While technical approaches have advanced over time, the values associated with energy and the environmental have also evolved, and outdated documents do not reflect this.

The examples detailed in Chapter 3 exhibit the current design goals and challenges faced in historic rehabilitation projects. Deliberate decisions led to carefully selected materials and systems chosen for energy efficiency and reduced environmental impact, with careful consideration of the value of the buildings and their materials. In the absence of guidance from the field, it becomes apparent how valuable the knowledge gained from these processes could be to other practitioners. What compromises are being discussed and made throughout the design process between architects and, for example, State Historic Preservation Officers or a local historical commission? Are the rules of preservation bending or being broken with the incorporation of modern systems and rehabilitation techniques?

At present, there is a growing worldwide concern for depletion of natural resources and for the protection, preservation, and conservation of the environment as a whole. Now and in the future, history preservation will have to be accomplished while simultaneously reducing an historic building's negative impact on the environment and energy consumption. As shown in Chapter 2, finding a new use for an existing building could be considered energy efficient, if one can demonstrate the value of the embodied energy of the building, where reuse means not having to generate more waste and manufacture new materials. And while the goals in historic preservation rehabilitation projects, especially those examples cited in this thesis, place energy-efficiency measures as the priority, the projects demonstrate that architects are concurrently addressing environmentally sensitive systems and materials as part of their design with simple improvements such as using low-VOC carpet and paint, maintaining green space and pervious surfaces, limiting impervious surfaces, and recycling. In short, the historic preservation field is advancing with technical expertise and values with regard to energy and the environment, but resources explaining how are still absent.

The work of the architect practicing in historic preservation has always been challenged by multiple objectives – retention of historic fabric, manageable rehabilitation costs, and finding functionality and utility in an existing, fixed configuration of spaces. In today's world, two objectives have been added, increased energy efficiency and environmental sensitivity with respect to materials and processes. These conflicts and collision points are being handled appropriately and inappropriately, with decisions being influenced by a number of parties including architects, preservationists, engineers, and consultants. Documentation of these decisions in a clear and concise way is lacking. This becomes further evident when looking at the Preservation Briefs published by the National Park Service Technical Preservation Services, which when published were up-to-date and helpful to practitioners. With advancements in energy-efficiency measures over the past 30 years, solutions to energy saving rehabilitations have become numerous and vary on a case-by-case basis. This may contribute to the difficulty in compiling a distinct list of appropriate and inappropriate measures for retrofitting historic building for energy efficiency and environmental design, where any number of possibilities may be appropriate or inappropriate depending on the project and circumstances.

To fully understand where decision making in the rehabilitation of historic buildings begins, it is important to have a grasp of the Secretary of the Interior's Standards for the Treatment of Historic Properties. It is also helpful to understand the role the Standards play in guiding preservation goals and objectives in rehabilitating historic buildings with respect to energy and the environment.

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR THE REHABILITATION OF HISTORIC PROPERTIES

The Standards for the Rehabilitation of Historic Properties are the most commonly applied of all of the Standards, which includes Preservation, Restoration, and Reconstruction. According to Sharon C. Park, FAIA, who served as Chief of Technical Preservation Services for the National Park Service for 10 of her 27 years there, and is now Associate Director for Architectural History and Historic Preservation at the Smithsonian Institution, the Standards are often misunderstood and considered to be very rigid, but are actually inherently flexible. Park also thinks the task is for the architects to solve the challenge of creating appropriate modifications of historic buildings.[69]

The National Park Service published the four distinct Standards (Preservation, Rehabilitation, Renovation, Restoration) in 1978 with revisions in 1983 and 1992, which are enforced by the Secretary of the Interior and the National Park Service under

[69] Roberts, Tristan "Historic Preservation and Green Building: A Lasting Relationship", Environmental Building News (2007).

the National Historic Preservation Act of 1966. The National Park Service defines the Standards as

> neither technical nor prescriptive, but are intended to promote responsible preservation practices that help protect our Nation's irreplaceable cultural resources. For example, they cannot, in and of themselves, be used to make essential decisions about which features of the historic building should be saved and which can be changed. But once a treatment is selected, the Standards provide philosophical consistency to the work.[70]

The Standards for Rehabilitation are defined by the National Park Service as

> the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.[71]

Each set of Standards comes with Guidelines to assist in applying the Standards. The Secretary of the Interior describes the issue of energy conservation in the Guidelines as

> work that must be done to meet accessibility requirements, health and safety requirements or retrofitting to improve energy efficiency is usually not part of the overall process of protecting historic buildings; rather, this work is assessed for its potential impact on the historic building. Some features of a historic building or site such as cupolas, shutters, transoms, skylights, sun rooms, porches, and plantings can play an energy-conserving role. Therefore, prior to retrofitting historic buildings to make them more energy efficient, the first step should always be to identify and evaluate existing historic features to assess their inherent energy-conserving potential. If it is determined that retrofitting measures are appropriate, then such work needs to be carried out with particular care to ensure that the building's historic character is retained.[72]

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[70] National Park Service. "Introduction to Standards and Guidelines." Available from http://www.nps.gov/history/hps/tps/standguide/overview/choose_treat.htm. Accessed on March 28, 2008.
[71] National Park Service. "Standards for Rehabilitation." Available from http://www.nps.gov/history/hps/tps/standguide/rehab/rehab_index.htm. Accessed on March 28, 2008.
[72] Ibid.

With the Standards and Guidelines outlining preservation theory to consider in rehabilitation projects, the National Park Service took another step towards more practical guidance and began publishing technical Briefs in the 1970's, offering more specific information on appropriate and inappropriate intervention measures with respect to historic structures. As of 2008, 47 Briefs have been compiled and published over the past 40 years, ranging in topic from "Dangers of Abrasive Cleaning to Historic Buildings" to "Removing Graffiti from Historic Masonry". In 1978 the first Brief was published on the subject of the energy consumption of historic buildings and improvements that might make them more energy efficient. Other Briefs have been published over the years addressing energy-related issues with respect to historic buildings, such as:

- *Preservation Brief #8*: "Aluminum and Vinyl Siding on Historic Buildings: The Appropriateness of Substitute Materials for Resurfacing Historic Wood Frame Buildings;"
- *Preservation Brief #9*: "The Repair of Historic Wooden Windows;"
- *Preservation Brief #13*: "The Repair and Thermal Upgrading of Historic Steel Windows;"
- *Preservation Brief #19*: "The Repair and Replacement of Historic Wood Shingle Roofs;"
- *Preservation Brief #24*: "Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches;"
- *Preservation Brief #33*: "The Preservation and Repair of Historic Stained and Leaded Glass;"
- *Preservation Brief #39*: "Holding the Line: Controlling Unwanted Moisture in Historic Buildings;"
- *Preservation Brief #44*: "The Use of Awnings on Historic Buildings: Repair, Replacement and New Design."

Some of these Briefs are discussed in part throughout this chapter, but the main focus is on *Preservation Brief #3* "Conserving Energy in Historic Buildings", because it was the foremost document published by the National Park Service with the sole objective of addressing the energy performance of historic buildings, with very specific measures presented that were deemed acceptable and unacceptable. An update to this Brief would likely include aspects of other Briefs which are noted when suitable.

PRESERVATION BRIEF #3
"CONSERVING ENERGY IN HISTORIC BUILDINGS"
BY BAIRD M. SMITH, AIA (1978)

In 1978, Baird M. Smith, AIA published *Preservation Brief #3* "Conserving Energy in Historic Buildings", with an interest in educating architects and preservationists on how to improve the energy performance of historic buildings in response to the U.S. oil crisis. Smith's Brief outlines appropriate alterations to improve an historic buildings performance, and creates guidelines and approved measures for updating historic buildings to make them more efficient both in function and expense. At the time, the issues of greatest concern were air infiltration and insulation with extraordinary importance and attention placed on limiting and avoiding disruption or destruction of original fabric, issues architects continue to grapple with today. He acknowledges that "In the future, it is likely that the standards and the technologies will change and a whole new retrofitting plan may be necessary"[73] though as of 2008, as building

[73]Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978).

technology has evolved and the performance and physical size of systems have altered, *Preservation Brief #3* remains the same, unrevised, updated, or edited. Materials and techniques have become more refined and appropriate for historic preservation projects with so many years of practice, though the Brief does not reflect the evolution over time.

AN UPDATE TO PASSIVE MEASURES

The way a building is used, in conjunction with the inherent qualities of its materials and construction play a large part in the energy efficiency of the building, which should be considered when making deliberate decisions to improve conditions. Passive measures can be described as energy-saving techniques in a building that do not require alterations or new systems. In 1978, *Preservation Brief #3* offered a list of simple, passive, energy-saving techniques. They are:

- Lowering the thermostat in the winter, raising it in the summer;
- Controlling the temperature in those rooms actually used;
- Reducing the level of illumination and number of lights (maximize natural light);
- Using operable windows, shutters, awnings and vents as originally intended to control interior environment (maximize fresh air);
- Having mechanical equipment serviced regularly to ensure maximum efficiency;
- Cleaning radiators and forced air registers to ensure proper operation.[74]

Passive measures have improved moderately since 1978. Modern climate control systems allow for improved management of room temperatures which is helpful in

[74] Ibid.

conserving energy by not heating or cooling unnecessarily. Fortunately, with the success and popularity of green building design, architects are encouraging and incorporating spaces that maximize natural light and operable windows. Technology in the energy efficiency of interior lighting has also evolved. As with climate control systems, sensors can be installed in a room to turn on and shut off when the room is entered or unoccupied for a period of time. Additional contemporary passive measures for energy conservation are:

- Offset the use of electricity with the purchase of renewable energy such as wind energy which is collected off-site and purchased through most local energy providers. In Pennsylvania, for example, the energy provider PECO has the PECO WIND program, where energy users pay an additional fee as low as $3.00 per month to help fund wind farms thus increasing the amount of wind energy delivered to the electrical grid, and reducing the need for energy from other sources;[75]
- Recycling programs for the collection of paper, plastic, and aluminum;
- Recycling of construction and demolition waste. This can result in energy saved as well as less waste to the landfills. In the Wyss Hall project at Harvard Business School, discussed in Chapter 3, 249 tons of construction and demolition waste was generated during the rehabilitation of the building, and only 10 of the 249 tons went to a landfill. The remaining 239 tons were salvaged or recycled. The company handling the recycling for the project, The Institution Recycling Network of Concord, New Hampshire, calculated that recycling the waste resulted in saving roughly 87 barrels of oil;[76]
- Selecting materials with low off-gassing of volatile organic compounds (VOC's) such as adhesives, sealants, paints, carpets, composite wood;
- Selecting materials made locally reduces the amount of gas used and pollution created when materials have to travel shorter distances to get to the site;
- Metering and monitoring energy use.

[75] PECO WIND. Available from http://www.exeloncorp.com/ourcompanies/peco/pecores/peco_wind/; Accessed on April 2, 2008.
[76] Harvard Green Campus Initiative. "Wyss Hall Renovation Case Study." Available from http://www.greencampus.harvard.edu/theresource/case-studies/documents/Wyss_Project_Profile.pdf; Accessed on March 28, 2008.

In 1978, *Preservation Brief #3* sited a number of common retrofitting measures for improved energy efficiency in historic buildings. Some of these measures are appropriate and others can be detrimental to the building and fabric. Smith identified the most common retrofit measures for energy efficiency as:

- Air Infiltration;
- Attic Insulation;
- Storm Windows;
- Basement and Crawl Space Insulation;
- Duct and Pipe Insulation;
- Awnings and Shading Devices;
- Doors and Storm Doors;
- Vestibules;
- Replacement Windows;
- Wall Insulation - Wood Frame;
- Wall Insulation – Masonry Cavity Walls;
- Wall Insulation – Installed on the Inside;
- Wall Insulation – Installed on the Outside;
- Waterproof Coatings for Masonry.[77]

The U.S. Department of Energy held a workshop on Historic Preservation and Energy Efficiency in Federal Buildings on December 6-7, 2006 where a group of professionals, such as architects, engineers, State Historic Preservation Officer's, and representatives from the National Trust and the Department of Energy, discussed revisions of *Preservation Brief #3*. The group did discuss treatments and updating technical instruction based on developments in the fields of engineering and design, and they

[77] Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978).

agreed that improving historic buildings for energy efficiency is a complex endeavor requiring consideration of multiple components. Ultimately, it became evident that revisions of the Brief should get away from the model of instructing with specific intervention "do's" and "don'ts", and guide decision making on the whole.

A new approach in guidance might direct preservationists to consider overarching themes such as evaluating the importance and significance of the building, its existing conditions and historic fabric, as well as the goals of the retrofit project and cultural and regional considerations. In the name of energy efficiency, inhabitants of the buildings might be required to make allowances when it comes to their personal comfort. This holistic approach would be more general and sensitive to the unique aspects of each project, with ways to improve energy efficiency instead of explicit recommendations on how to do so. Updated guidance should also show attention to maintenance, operations, and physical process.[78]

THE COLLISION POINTS: GUIDANCE ON UPGRADING INSULATION, WINDOWS, AND MECHANICAL SYSTEMS

Keeping in mind the recommended future approach to historic preservation rehabilitation projects just discussed, the analysis presented next focuses on the three most prevalent collision points encountered in historic preservation rehabilitation

[78] U.S. Department of Energy, Federal Energy Management Program "Proceedings of the Workshop on Historic Preservation and Energy Efficiency in Federal Buildings." Available from http://www1.eere.energy.gov/femp/pdfs/ee_historicbldgs_report.pdf; Accessed on March 14, 2008; Antonio Aguilar, phone interview with the author. April 18, 2008.

projects where energy efficiency and reduced environmental impact are a priority: insulation; windows; and mechanical systems. For each topic, the following analysis reviews the past and current approaches with brief summaries of the Secretary of the Interior's Guidelines on each topic.

GUIDELINES FOR REHABILITATION WITH SPECIAL REQUIREMENTS FOR ENERGY EFFICIENCY: INSULATION

Recommended: Installing thermal insulation in attics and unheated cellars and crawlspaces to increase the efficiency of the existing mechanical systems; Installing insulating material on the inside of masonry walls to increase energy efficiency where there is no character-defining interior molding around the windows or other interior architectural detailing.

Not Recommended: Applying thermal insulation with a high moisture content in wall cavities which may damage historic fabric; Installing wall insulation without considering its effect on interior molding or other architectural details.

PRESERVATION BRIEF #3 ON INSULATION

Of importance in understanding the challenges with insulating older buildings for new uses is understanding the inherent qualities of the materials commonly used in historic buildings, and the passive design strategies applied for heating and cooling. From the late 19th and early 20th century, typical building construction involved heavy masonry systems. Smith writes

> It has been determined that walls of large mass and weight (thick brick or stone) have the advantage of high thermal inertia…This inertia

> modifies the thermal resistance of the wall by lengthening the time scale of heat transmission…High thermal inertia is the reason many older public and commercial buildings, without modern air conditioning, still feel cool on the inside throughout the summer. The heat from the midday sun does not penetrate the buildings until late afternoon and evening, when it is unoccupied.[79]

Citing insulating measures as having the greatest potential for energy-savings by fixing issues with air infiltration and heat loss, the Brief details how insulation retrofitting measures can wreak havoc on original historic fabric and create or perpetuate moisture related deterioration. Baird M. Smith writes in the Brief about air infiltration and heat loss through windows, attics, and basements, as well as duct and pipe insulation, with the majority of the recommended interventions relying on vapor barriers to control and regulate moisture intrusion.

PRESERVATION BRIEF #8 ON INSULATION

Preservation Brief #8 "Aluminum and Vinyl Siding on Historic Buildings: The Appropriateness of Substitute Materials for Resurfacing Historic Wood Frame Buildings" by John H. Meyers (1979), revised by Gary L. Hume (1984), discusses the ineffectiveness of substitute siding materials in improving an historic buildings energy-efficiency.

> Aluminum and vinyl material themselves are not good insulators, and the thickness of any insulating backing would, of necessity, be too small to add to the energy efficiency of a historic building. What energy savings

[79] Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978)

> did accrue as a result of a siding application would probably be as much the result of the creation of an air space between the old and new siding as the addition of insulating material. If the historic wood siding were removed in the course of installing the aluminum or vinyl siding (even with an insulating backing), the net result would likely be a loss in overall thermal efficiency for the exterior sheathing.[80]

Meyers and Hume go on to support Baird M. Smith's case in *Preservation Brief #3* that the primary challenges with respect to insulation and energy loss in small buildings is windows and roofs. They argue that for energy efficiency and financial feasibility, improving windows with weatherstripping or storm windows and adding attic insulation is more effective than treating the walls with insulation improvements. They cite a study of a small two-story house in Rhode Island where the payback period for 23 storm windows, two storm doors, and six inches of attic insulation was four years, while the payback for aluminum siding was 30 years.[81] It is important to note that Meyers and Hume's Brief was aimed at informing practitioners on the preservation of historic wood frame buildings, but their discussion on energy as related to retrofitting measures further supports the point that oftentimes the less invasive procedure is more effective both for energy efficiency and affordability. The result is the retention of original historic fabric and preventing an alteration that would dramatically alter the exterior appearance of the building.

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[80] Myers, John H. and Gary L. Hume. "Aluminum and Vinyl Siding on Historic Buildings: The Appropriatness of Substitute Materials for Resurfacing Historic Wood Frame Buildings" in Preservation Brief #8, National Park Service Technical Preservation Services (Washington, D.C., 1979, 1984).
[81] Ibid.

As opposed to the challenge of retrofitting an historic building with windows and mechanical systems which can be highly visible, insulation is typically not visible. Insulation may disrupt or alter original historic fabric and have a negative impact on the performance of the structure if done incorrectly. The problems that Baird M. Smith described in 1978 with regard to moisture related deterioration are still a problem today, with buildings being inappropriately sealed and insulated. Likewise, inappropriate climate control systems can also adversely affect the intended system of insulating the building. *Preservation Brief #36* published in 1996 and written by Sharon C. Park, AIA, addresses issues and concerns with unwanted moisture in buildings. Park says

> buildings were traditionally designed to deal with the movement with air. For example, cupolas and roof lanterns allowed hot air to rise and provided a natural draft to pull air through buildings. Cavity walls in both frame and masonry buildings were constructed to allow moisture to dissipate in the air space between external and internal walls. Radiators were placed in front of windows to keep cold surfaces warm, thereby reducing condensation on these surfaces. Many of these features, however, have been altered over time in an effort to modernize appearances, improve energy efficiency, or accommodate changes in use. The change in use will also affect moisture movement, particularly in commercial and industrial buildings with modern mechanical systems. Therefore, the way a building handles air and moisture today may be different from that intended by the original builder or architect, and poorly conceived changes may be partially responsible for chronic moisture conditions.[82]

[82] Park, Sharon C. "Holding the Line: Controlling Unwanted Moisture in Historic Buildings" in Preservation Brief #39, National Park Service Technical Preservation Services (Washington, D.C., 1996).

When discussing problems facing historic buildings in retrofitting for energy conservation, Antonio Aguilar, historical architect for the National Park Service, says that a concern is pressurizing for the prevention of moisture movement.[83] In Brief #39, Park says that

> treatments discussed…will look at managing moisture by draining bulk moisture and ventilating vapor moisture before setting up new barriers with impermeable coatings or over-pressurized new climate control systems that threaten aging building materials and archaic construction systems.[84]

In the 46 Blackstone project discussed in Chapter 3, engineers had to improve the thermal performance of a monolithic load-bearing brick structure.

> Adding insulation to a wall tends to reduce its drying potential by reducing movement of air and heat through and around the wall. These walls do not have the protection of the drainage plane common on today's brick veneer walls, and with increased exposure to freeze-thaw cycles with insulation added to the interior of the walls, they can degrade.[85]

Marc Rosenbaum, engineer for the 46 Blackstone project recounts that the team chose to insulate from the inside with a sprayed open-cell urethane foam, and added details such as flashing to divert bulk moisture from the wall surface. "Recognizing the reduced drying potential of this arrangement…involved keeping the brick dry from the outside with careful detailing of flashing, windows, and parapets so that there is no

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[83] Antonio Aguilar, phone interview with the author. April 18, 2008.
[84] Ibid.
[85] Roberts, Tristan. "Historic Preservation and Green Building: A Lasting Relationship", Environmental Building News (January 2007). Available from http://www.preservationnation.org/issues/sustainability/additional-resources/HPandGreenBuildingArticle.pdf ; Accessed on March 17, 2008.

concentrated wetting of the wall."[86] Rosenbaum went on to say "You'd love to insulate [the walls] on the outside, which would allow the introduction of a drainage plane and insulation from freeze-thaw cycles, but if it's a historic building, this is in direct conflict with the preservation intent."[87] The direct conflict that Rosenbaum is referring to is the alteration of the original exterior building shell, one of the few remaining original elements of the building. Taking measures that would alter the exterior appearance would have negated the project team's goals in this way as well as preservationists because of the high visibility of insulating a building from the exterior, even though they are already changing so many exterior elements. Criterion two of the Secretary of the Interior's Standards for Rehabilitation recommends retaining and preserving the historic character of a property and avoiding the removal of distinctive materials or alteration of features that characterize the property. Altering the exterior wall would have been in direct conflict with the Secretary of the Interior's goals.

By contrast, as discussed in Chapter 3 through the help of a consultant, the Thurgood Marshall U.S. Courthouse team ascertained that without window replacements, improving the insulation of the interior side of the exterior walls would not benefit the overall thermal performance of the building. Since the bronze windows were a character-defining feature, retention of the original bronze casement windows was a preservation priority. In this case, careful analysis of both envelope improvement

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[86] Ibid.
[87] Ibid.

strategies, windows and walls, whether undertaken individually or together, led to the retention of the building's original interior fabric and windows without insulation.

An intermediate solution between the 46 Blackstone and Thurgood Marshall U.S. Courthouse insulation interventions is evidenced by the insulation treatments Venturi, Scott Brown and Associates chose for Schlesinger Library at Harvard University. The building had been subjected to many interior wall alterations over the years, so there was still an interest among the project team and client to retain as much original fabric as possible while also improving the building's performance, including special considerations for relative humidity management in a library housing sensitive collections. Insulation was carefully upgraded in the interior side of the exterior walls as well as the attic, providing improved thermal performance and retention of original historic fabric as much as possible. Exact details of the improvements, materials, and technique for vapor control and insulation were not available at the time of completion of this thesis.

GUIDELINES FOR REHABILITATION WITH SPECIAL REQUIREMENTS FOR ENERGY EFFICIENCY: WINDOWS

Recommended: Utilizing the inherent energy conserving features of a building by maintaining windows and louvered blinds in good operable condition for natural ventilation; Improving thermal efficiency with weatherstripping, storm windows, caulking, interior shades, and if historically inappropriate, blinds and awnings; Installing interior storm windows which do not damage or obscure the windows and frames.

Not Recommended: Removing historic shading devices rather than keeping them in an operable condition; Installing interior storm windows that allow moisture to accumulate and damage the window; Installing new exterior storm windows which are inappropriate in size and color; Replacing windows or transoms with fixed thermal glazing or permitting windows and transoms to remain inoperable rather than utilizing them for their energy conserving potential

PRESERVATION BRIEF #3 ON WINDOWS

"Windows are a primary source of heat loss because they are both a poor thermal barrier and often a source of air infiltration"[88] Baird M. Smith offers extensive details on the advantages and disadvantages of adding storm windows both internally and externally, with instruction for paying careful attention to 1) not damage original historic fabric, and 2) the potential for the collection of condensation if improperly installed. Also discussed by Smith is the issue of replacement windows. He argues in favor of storm windows over replacing historic units in accordance with Criterion five of the Standards for Rehabilitation which states: "Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved."[89] Smith does say, however, that if windows are so deteriorated that replacement is the only option, that the replacement windows should

[88] Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978).
[89] National Park Service. "Standards for Rehabilitation." Available from http://www.nps.gov/history/hps/tps/standguide/rehab/rehab_index.htm; Accessed on March 28, 2008.

match their historic predecessors, an important component of which is the reflective qualities of the glass.[90]

PRESERVATION BRIEF #9 ON WINDOWS

In 1981 John H. Meyers wrote *Preservation Brief #9* "The Repair of Historic Wooden Windows". The Brief informs practitioners on evaluating the architectural and historical significance of existing windows in an historic building and offers extensive technical instruction on how to repair them. Meyers breaks down the maintenance process into three classes to make an existing window "like new". The first class is routine maintenance on an operationally sound window which can include paint removal, sash repair or removal, frame repair, and weatherization. The second class, stabilization, addresses a higher degree of deterioration then the first class and offers techniques on how to repair decaying wood. The third class instructs on the replacement of parts, where some components of the window are beyond repair but some original fabric is salvageable. *Preservation Brief # 9* also details measures for weatherization of existing windows to benefit energy efficiency such as weatherstripping and storm windows.[91]

Lastly, the Brief addresses the fact that sometimes existing and historic windows are beyond repair and proposes a plan for selecting appropriate replacement windows.

[90] Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978).
[91] Meyers, John H. "The Repair of Historic Wooden Windows" in Preservation Brief #9, National Park Service Technical Preservation Services (Washington, D.C., 1981).

Meyers makes an important point with regard to energy efficiency when choosing replacements:

> Consider energy efficiency as one of the factors for replacements, but do not let it dominate the issue. Energy conservation is no excuse for the wholesale destruction of historic windows which can be made thermally efficient by historically and aesthetically acceptable means. In fact, a historic wooden window with a high quality storm window added should thermally outperform a new double-glazed metal window which does not have thermal breaks. This occurs because the wood has far better insulating value than the metal, and in addition, many historic windows have high ratios of wood to glass, thus reducing the area of highest heat transfer.[92]

PRESERVATION BRIEF #13 ON WINDOWS

Similar to John H. Meyers' approach to evaluating historic windows for rehabilitation and preservation is Sharon C. Park's *Preservation Brief # 13* "The Repair and Thermal Upgrading of Historic Steel Windows," published by the National Park Service Technical Preservation Services in 1984. Like Meyers, Park presents ways to ascertain the historic and architectural significance of the windows as well as their physical state. She says that the intent is not to retain every historic window "but rather to insure that preservation is always the first consideration in a rehabilitation project."[93] With the Brief, Park aims to educate the reader on the misconception that historic steel windows cannot be made energy-efficient, and demonstrates ways to do so that can prove to be more economical than replacement.[94] *Preservation Brief #13* explains that the energy-

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[92] Ibid.
[93] Park, Sharon C. "The Repair and Thermal Upgrading of Historic Steel Windows" in Preservation Brief #13, National Park Service Technical Preservation Services (Washington, D.C., 1984).
[94] Ibid.

efficiency of historic metal windows, though not generally good, can be improved with simple enhancements such as weatherstripping, caulking, glazing, storm windows, and replacement glass. Like Meyers in Brief #9 and Smith in Brief #3, Park advises on appropriate replacements for metal windows in the event that the existing windows are beyond repair. She discusses the preference for replications over choosing replacements made of materials such as aluminum, wood, or vinyl trying to mimic the appearance of the rolled steel window profile. A compatible replacement window is preferable with duplication of the original material, "configuration, color, operability, number and size of panes, profile and proportion of metal sections, and reflective quality of the original glass."[95]

THE CURRENT PERSPECTIVE ON WINDOWS

In 2005, *APT Bulletin* published a paper by preservation architects Walter Sedovic and Jill H. Gotthelf titled "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows," in which the authors form a likely relationship between sustainability and the authenticity of historic windows. Citing the very premise of this thesis by placing great concern on the environmental impact of intervention as well as energy efficiency, they discuss windows saying

> windows are a critical element of sustainability, but sustainability is not just about energy. It is about making environmentally responsible

[95] Ibid.

> choices regarding historic windows that take into account the spectrum of associated costs and effects.[96]

In addition to their discussion of the "holistic benefits of preserving historic windows," Sedovic and Gotthelf present some interesting statistics as well, including an effort to warn practitioners of the misinformation disseminated by the manufacturers of new replacement windows, whose warranties are roughly 2 to 10 years as compared to the service life of historic windows, which can be as much as 60 to 100 years. Sedovic and Gotthelf cite the primary issue affecting energy in a building as the infiltration of outside air and "can account for as much as 50 percent of the total heat loss of a building."[97] Approximately 25 percent of this can be attributed to windows and doors. They also say that 12.5 percent of that is due to windows, which, as Sedovic and Gotthelf write, is a small percentage for the potentially costly investment of replacement windows as compared to retrofit measures such as weatherstripping or weathersealing. According to the authors "the energy efficiency of restored windows incorporating retrofit components can meet and even exceed the efficiency of replacement units."[98] Lastly, and in response to Criteria two and five of the Standards for Rehabilitation regarding the retention and preservation of historic character and distinctive materials, Sedovic and Gotthelf discuss aesthetics and authenticity saying

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[96] Sedovic, Walter and Gotthelf, Jill H. "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows," APT Bulletin 36: no. 4 (2005): 29.
[97] Fisette, Paul. "Understanding Energy-Efficient Windows," Fine Homebuilding 114 (1998): 68-73 as found in Sedovic, Walter and Gotthelf, Jill H. "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows," APT Bulletin 36: no. 4 (2005): 29.
[98] Sedovic, Walter and Gotthelf, Jill H. "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows," APT Bulletin 36: no. 4 (2005): 27.

> nuances in molding profiles, shadow, line, and color of windows, along with quality and appearance of the glass contribute greatly to the overall building aesthetic and generally emulate the stylistic details of the building as a whole…Outfitting historic buildings with modern replacement windows can and often does result in a mechanical, contrived, or uniformly sterile appearance. Worse, when historic windows are replaced, authenticity is lost forever.[99]

In agreement with Walter Sedovic and Jill H. Gotthelf is Jean Carroon, AIA, who addresses the issue with windows in the January/February 2008 issue of *Preservation.* In "The Greening of the Yard" by Allen Freeman, Carroon says that there is commonly a collision between green architecture advocates and preservation. Freeman writes that

> A recent United Nations report on the environment estimated that nearly 20 percent of the energy that a building uses in its first 100 years is expended during its construction. By extension, then, making an old building perform better would seem to conserve more energy than replacing its parts.[100]

Carroon agrees with Sedovic and Gotthelf on the misleading information put out by window manufacturers and says that the United Nations data is strong support "against tearing out windows and replacing them."[101]

The complex issue of windows is not just the removal of historic units, but the introduction of rehabilitation measures that may prevent the operability of existing windows that are retained. The operability of the historic windows is critical to the building performing as it was intended. With the introduction of new systems,

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[99] Ibid., 29.

[100] Freeman, Allen. "The Greening of the Yard" <u>Preservation: The Magazine of the National Trust for Historic Preservation</u> (January/February 2008):40.

[101] Ibid., 40.

however, a case can be made by engineers to minimize window operability in order to better regulated indoor climate control and reap the benefits of the new, more energy-efficient systems conditioning outside air for interior comfort. It becomes important then for project teams to consider the passive systems of a building before introducing new systems, and defining their expectations for indoor air and climate. Maintaining operable windows is not just for exterior aesthetics or retention of original historic fabric, but also occupant comfort with accessibility to fresh air.

As demonstrated in the case of the Thurgood Marshall U.S. Courthouse, the project team chose to keep the original, single-pane operable windows. It was proven by analysis that their removal would not improve the thermal performance of the building enough to warrant the loss of such a significant piece of original historic fabric that had maintained its integrity. In addition, removal of windows as well as the production and installation of new, unnecessary windows replacement would have expended even more embodied energy. Storm windows were considered but will not be introduced at the Courthouse and the primary windows will remain operable even with the installation of new climate and air filtration systems.

The 46 Blackstone project at Harvard University replaced the windows because the existing windows were unusable. The existing windows were from a replacement campaign in the early 1990's, so there was no concern with loss of historic fabric. According to Charles M. Sullivan, Executive Director for the Cambridge Historical Commission, the project team consulted with the Commission on selecting appropriate replacement windows and consulted historical photographs to determine their pattern.[102] At Schlesinger Library, Venturi, Scott Brown and Associates retained the operable windows based on their intent to retain as much original historic fabric as possible, keeping the exterior appearance of the mostly unchanged.

GUIDELINES FOR REHABILITATION WITH SPECIAL REQUIREMENTS FOR ENERGY EFFICIENCY: MECHANICAL EQUIPMENT

Recommended: Improving energy efficiency of existing mechanical systems by installing insulation in attics and basements.

Not Recommended: Replacing existing mechanical systems that could be repaired for continued use.

On the subject of mechanical systems, the Standards for Rehabilitation offers Guidelines for interior concerns with regard to mechanical systems, and specifies five areas with recommendations and measures not recommended for each. They are:

Recommended: Identifying, retaining, and preserving visible features of early mechanical systems that are important in defining the overall historic character of the building, such as radiators, vents, fans, grills, plumbing fixtures, switchplates, and lights.

Not Recommended: Removing or radically changing features of mechanical systems that are important in defining the overall historic character of the building so that, as a result, the character is diminished.

Recommended: Protecting and maintaining mechanical, plumbing, and electrical systems and their features through cyclical cleaning and other appropriate measures; Improving the energy efficiency of

[102] Charles M. Sullivan, email correspondence with the author. March 25, 2008.

existing mechanical systems to help reduce the need for elaborate new equipment. Considering should be given to installing storm windows, insulating attic crawl space, or adding awnings, if appropriate.

Not Recommended: Failing to protect mechanical systems from deterioration, installing unnecessary HVAC which may add excessive moisture to the building.

Recommended: Repairing mechanical systems by augmenting or upgrading system parts, such as installing new pipes and ducts; rewiring; or adding new compressors or boilers.

Not Recommended: Replacing a mechanical system or its functional parts when it could be upgraded and retained.

Recommended: Installing a completely new mechanical system if required for the new use so that it causes the least alteration possible to the building's floor plan, the exterior elevations, and the least damage to the historic building material; Providing adequate structural support for new mechanical equipment; HVAC systems should only be added if historic features will not be compromised or damaged.

Not Recommended: Installing a new mechanical system so that character-defining features are radically changed, damaged, or destroyed; Concealing mechanical equipment in walls or ceilings in a manner that requires the removal of historic building material; Failing to consider the weight and design of new mechanical equipment.

PRESERVATION BRIEF #3 ON MECHANICAL SYSTEMS

The 1978 discussion of mechanical systems is the one which seems to be the most outdated. The recommendations appear to have the greatest conflict with new technology that might improve energy efficiency and reduce the building's impact on the environment. Smith says "the best advice concerning mechanical equipment in historic buildings is to assure that the existing equipment works as efficiently as possible."[103] He warns against disrupting historic fabric in the name of fitting a system into the building which may become outdated and need replacement or maintenance too quickly, and places this as a greater priority then keeping a less efficient system.

PRESERVATION BRIEF #24 ON MECHANICAL SYSTEMS

The National Park Service went beyond *Preservation Brief #3* with their discussion of mechanical systems and provided further guidance for practitioners in 1991 by publishing the comprehensive and thoughtful *Preservation Brief #24* "Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches" by Sharon C. Park, AIA. As one of the most common and often necessary upgrades when retrofitting historic buildings, Park emphasizes the importance in careful planning when selecting systems and designing where and how they will be installed. She lists the following as the repercussions of hasty planning or inappropriate retrofit measures:

- Large sections of historic materials are removed to install or house new systems;
- Historic structural systems are weakened by carrying the weight of, and sustaining vibrations from, large equipment;
- Moisture introduced into the building as part of a new system migrates into historic materials and causes damage, including biodegradation, freeze/thaw action, and surface staining;
- Exterior cladding or interior finishes are stripped to install new vapor barriers and insulation;
- Historic finishes, features, and spaces are altered by dropped ceilings and boxed chases or by poorly located grilled, registers, and equipment;
- Systems that are too large or too small are installed before there is a clearly planned use or a new tenant.[104]

[103] Smith, Baird M. Conserving Energy in Historic Buildings" in Preservation Brief #3, National Park Service Technical Preservation Services (Washington, D.C., 1978)

At the core of the issue on retrofitting historic buildings with upgraded mechanical systems is human comfort and health. There is an expectation among building occupants that they will be comfortable with the air temperature and quality, and in 2008, do not expect to suffer under unpleasant conditions when they know the technology exists to keep them comfortable. Furthermore, mechanical codes establish minimum requirements for fresh air, comfort conditions and energy efficiency. In historic buildings, one aspect of rehabilitation projects for energy efficiency and improved performance (as well as comfort) is understanding how the building was intended to function with operable windows and passive ventilation systems. Additionally, it is imperative to understand how interventions with inappropriate mechanical system to historic buildings previously without climate control systems can adversely affect the integrity of the structure and perform incorrectly. In Spring 2007, Michael C. Henry, PE, AIA, wrote "From the Outside In: Preventive Conservation, Sustainability, and Environmental Management" for the Getty Conservation Institute, explaining some of the crucial characteristics to understand the performance of new and old buildings.

> It is important to recall that many older buildings predating the development of four-season climate management systems typically have

[104] Park, Sharon C. "Heating, Ventilation, and Cooling Historic Buildings: Problems and Recommended Approaches" in Preservation Brief #24, National Park Service Technical Preservation Services (Washington, D.C., 1991).

> some inherent capability to moderate external influences on interior conditions. In these older structures, the building itself was the system for ventilation and human comfort. The design and construction of these buildings relied on certain materials, an overall form, and horizontal and vertical communication between interior spaces. A key component of the interior conditioning of older buildings was occupant operation of building features—such as windows, doors, and shutters or shading devices—which moderated the influence of the exterior on the interior while capitalizing on favorable external aspects, such as breezes, for ventilation and comfort.[105]
>
> By contrast, the majority of buildings from the late twentieth century rely on centralized mechanical systems to moderate the effects of the exterior climate on the interior conditions. In these buildings, should the mechanical systems fail to operate or receive the necessary electrical power, the combination of building materials, building form, and spatial arrangement may actually exacerbate the adverse effects of the outside environment on interior conditions.[106]

Some thoughts on this also came out of the National Summit on The Greening of Historic Properties at the 2006 National Trust Annual Meeting. On the difficulty of retaining fabric while incorporating new building climate control systems:

> Many historical buildings were built to accommodate mechanical systems that are considered primitive by today's functional, safety and comfort standards. Gravity heating systems, non-existent or inefficient cooling systems and substandard electrical, fire protection and plumbing systems are more often than not the norm in older, non-updated structures, and are well-known for their inefficiency and ineffectiveness. Integrating new HVAC systems and retrofitting old wiring and plumbing often requires the gutting of an interior of a structure to reach or create mechanical spaces. Unfortunately, this creates a direct conflict with historic standards…and the invisibility of any new systems or equipment.[107]

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[105] Henry, Michael C. "From the Outside In: Preventive Conservation, Sustainability, and Environmental Management", GCI Newsletter 22.1 (2007). Available from http://www.getty.edu/conservation/publications/newsletters/22_1/feature.html; Accessed on August 29, 2008.

[106] Ibid.

[107] National Trust Annual Meeting, "The Greening of Historic Properties National Summit" (2006) Available from

Confronting the issue of disrupting original historic fabric in the name of incorporating new systems is one which seems to require the most consideration in the unique aspects of each project. Depending on the significance of the building and the retrofit plan, a number of options should be presented or considered. For example, the first LEED Platinum building on the National Register of Historic Places, the Gerding Theater at the Armory in Portland, Oregon, was an adaptive reuse project. Originally the home of the Oregon National Guard built in 1891, the fortress-like masonry structure was transformed into the home of the Portland Center Stage theater company. Ultimately, the historic shell was maintained and other elements such as the historic roof and narrow gun-sight windows were not altered. With a modest amount of historic fabric to take into account, architects were free to plan extensively for a LEED Platinum building, with energy efficiency and optimal performance a priority. A report published by the American Institute of Architects in 2007 named the Gerding Theater a Top Ten Green Project. The project was honored because of its reuse of an existing building. Planning for energy efficiency meant focusing on mechanical systems because the building's massing, envelope, orientation, and footprint were pre-determined.[108]

Superficially, the Gerding Theater at the Armory might appear to fall short of conformance with the Secretary of the Interior's Standards, specifically Criterion one, with the property taking on a new use and Criterion two, avoiding the removal or

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http://www.ncshpo.org/PDFs/2007AM/LEED/GreeningNationalSummitWhitePaper2006.pdf; Accessed on March 15, 2008.

[108] American Institute of Architects: Top Ten Green Projects, Gerding Theater at the Armory . Available from http://www.aiatopten.org/hpb/overview.cfm?ProjectID=833; Accessed on March 17, 2008.

alteration of distinctive features, spaces, and spatial relationships that characterize the property. The Gerding Theater project is an example of the flexibility of the National Park Service and their ability to evaluate project conformance to the Secretary of the Interior's Standards on an individual basis. The NPS approved change in use and resultant interior alterations and additions, and in doing so, assured the survival of the iconic historic shell and its substantial embodied energy. The NPS approval made the project eligible for the 20% historic rehabilitation tax credit. Though the project team did completely overhaul the interior, the new spaces are distinctly different and will not be confused for the original armory building. Ultimately, the project team met a number of their goals, including achieving LEED Platinum certification and a predicted energy savings of more than 30% above ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) standards, as well as the historic preservation tax credit.[109] Some of their energy savings came from the incorporation of sensors monitoring natural light to dim electric lights when not needed, and a displacement ventilation system brings fresh air to indoor spaces and distributes it through an underground system improving indoor air quality as well as saving energy.[110]

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[109] Roberts, Tristan. "Historic Preservation and Green Building: A Lasting Relationship", Environmental Building News (January 2007). Available from http://www.preservationnation.org/issues/sustainability/additional-resources/HPandGreenBuildingArticle.pdf. Accessed on March 17, 2008.

[110] Green Building Services "Portland Armory Earns LEED Platinum Award", October 1, 2006. Available from http://www.greenbuildingservices.com/news/releases/2006_27__25_PR_Armory_LEED_Platinum_100106.pdf; Accessed on May 3, 2008.

Another example of a recent historic preservation rehabilitation project is the case of Trinity Church in Boston, Massachusetts. Unlike the Gerding Theater which involved the transformation of an historic shell, Trinity Church involved more substantial historic interior fabric. This project is a model for how the project architect, Goody Clancy, engineers Cosentini Associates, and LeMessurier Consultants, succeeded in incorporating new systems for energy efficiency in a National Historic Landmark. Jean Carroon, AIA, Principal for preservation at Goody Clancy said that the team approached H.H. Richardson's 1877 masterpiece as an artifact "Our first mandate was to do no harm."[111]

Trinity Church needed mechanical systems upgrades and the addition of a new meeting space to be constructed beneath the church's sanctuary. Adding mechanical systems which would be visible on the exterior, such as roof-mounted condensers, was not an option due to the high visibility of all exterior elevations of the building. Being a National Historic Landmark, the building adhered to the Secretary of the Interior's Standards for Rehabilitation. The design team chose a geothermal system for heating and cooling, installed below grade, which eliminated the need for visibly intrusive air cooled exterior equipment. Additionally, the geothermal system addressed a desire by the client for greater energy efficiency. Other environmental goals were met with

[111] Roberts, Tristan. "Historic Preservation and Green Building: A Lasting Relationship", Environmental Building News (January 2007). Available from http://www.preservationnation.org/issues/sustainability/additional-resources/HPandGreenBuildingArticle.pdf. Accessed on March 17, 2008.

sustainability measures such as recycled glass in the bathrooms, low-VOC paints and adhesives, and water conserving measures through on-site water collection.[112]

SUMMARY

Historic preservation is a field where rehabilitation techniques are perpetually developing, with practitioners constantly discovering new ways to resolve the conflict between new systems and historic fabric. With new methods of practice constantly changing, it is challenging to keep technical guides and educational documents up-to-date, to inform on appropriate and inappropriate interventions to improve a building's energy efficiency or environmental impact. However, the foundation of preservation values remains constant with the Secretary of the Interior's Standards for the Treatment of Historic Properties, guiding preservationists on the appropriate treatment of historic buildings for many decades. The Standards should continue to serve as the starting point for all rehabilitation projects.

As evidenced by the development of thought within the profession on the treatment of insulation, windows, and mechanical systems discussed in this chapter, it is recommended that guiding principles are established for the treatment of historic buildings seeking improved energy efficiency and reducing its impact on the environment. A reassessment is needed on the documents published in the 1970's and

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[112] Bowen, Ted Smalley and Deborah Snoonian, P.E. "H.H. Richardson's Romanesque Revival Masterpiece Prompts Inspired Green Preservation", Architectural Record vol. 193: no. 12.

1980's in particular, with technical information being mostly still valid but outdated. Additionally, updated or new technical documents should reflect the current line of thinking among preservationists and architects that the rehabilitation of historic buildings with energy and environmental goals should be handled on a case-by-case basis, where historic value should be retained whenever possible.

CONCLUSION

As emphasized throughout this thesis, the professional practice of historic preservation is in great need of updated technical and philosophical guidance on the subject of upgrading historic buildings for improved energy efficiency and reducing a building's impact on the environment. The treatment of rehabilitation projects involving historic properties requires careful planning and sensitive intervention, but this should not mean that historic buildings are incapable of improved performance with consideration of energy and the environment. By educating professionals on the opportunities and limitations in making such improvements, appropriate interventions may offer a building new and continued life while retaining local, cultural, or historical significance.

Historical facts on the evolution of energy policy in Chapter 1 details an awareness among Americans for depleting natural resources and increased energy prices. The story reads as a waxing and waning of national concern for natural resources and the environment, and describes how historic buildings have long been a part of the solution with the reuse of existing buildings. In support, preservationists had a strong response with guidance for practitioners beginning in the 1970's with the National Park Service's Technical Briefs on acceptable intervention measures for energy efficiency in historic buildings, as well as the book <u>New Energy from Old Buildings</u> shortly after. Historic preservation appeared as an opportunity when it was established that the built environment is significantly responsible for annual energy consumption and a damaged environment. The opportunity comes in the form of reusing existing buildings and capitalizing on their embodied energy, as described in Chapter 2, as well as determining appropriate interventions to improve the energy efficiency of those buildings. Another opportunity is the extended service life of many of the materials found in historic buildings, which contributes greatly to the financial value of the building, where less money is required for rehabilitation than replacement.

Chapter 3 presents a variety of examples of buildings rehabilitated for improved energy efficiency and reducing their impact on the environment. In the absence of updated technical guides for practitioners, historic preservationists are still finding ways to meet the needs and expectations of owners and occupants by making the buildings more energy efficient, as well as implementing passive and active measures for reducing their impact on the environment. The cases of Audubon House, Schlesinger Library, 46 Blackstone, and the Thurgood Marshall U.S. Courthouse are each very different in historical significance and value. Their differences were further pronounced in their rehabilitations, with each building taking measures for energy efficiency and reducing their impact on the environment, though in very different ways and in varying degrees from small to large interventions. What is significant is that each intervention was appropriate for that particular building when considering its historical significance and value of original historic fabric, supporting the argument that upgrading buildings with these goals in mind should be handled on a case-by-case basis.

Just as understanding the history of energy resources makes it possible to understand why we would want to utilize historic buildings and improve on their inherent value further by making them more energy efficient, it is possible to understand the need for updated technical documents after looking at examples of successes (and failures) in the field. The examples presented in Chapter 3 illustrate the opportunities and limitations in upgrading historic buildings with new systems and energy-saving measures. Those projects, among several others discussed throughout this thesis, help support the point that technical documents and briefs intended to educate practitioners need to be updated. The examples don't just showcase new technology and techniques, but also represent a progressive way of thinking about the relationship between energy, the environment, and historic preservation.

Technical documents such as the Preservation Brief's discussed throughout this thesis previously itemized explicit "do's" and "don'ts" for interventions and the treatment of historic fabric. Updated or new documents might take a fresh approach by moving beyond the "do's" and "don'ts" and present guiding principles, deciding what goals are to guide decision making and what tools are employed to inform those decisions on a project-by-project basis. They may also place a greater emphasis on the embodied energy of a building and the service life of its parts to capitalize on economic as well as historic savings. An argument can also be made for encouraging project teams to take their time, consult the experts, and conduct studies. In the case of the Thurgood Marshall U.S. Courthouse, the team went through a peer review process and consulted with preservation specialists representing the General Services Administration and the

State Historic Preservation Office. They conducted a study on the performance of the original bronze casement windows which led the project team to understand that replacing the windows would not impact the quality of energy efficiency enough to warrant removing the original windows, and so an important character-defining element of a National Register building was retained. With careful study, the normal reflexive solution of window replacement was avoided. In the case of 46 Blackstone, a structure of local significance but without national recognition or any designations, the building shell was adapted for a new use. With clear sustainability objectives from the outset, the team consulted with the Cambridge Historical Commission and was able to rehabilitate the original brick outer shell and incorporate new, appropriate windows. Having so little original fabric and value to consider, while still making an effort to retain what of value remained, the project team was free to incorporate multiple systems for energy efficiency as well as reducing the building's impact on the environment. These projects exemplify the result of a carefully planned project with a team of experts collaborating for optimal, appropriate results.

Preservationists have long been grappling with determining appropriate and inappropriate measures for the rehabilitation of historic buildings. When considering improvement for energy efficiency and reduced environmental impact, rehabilitation projects should be treated individually based on what is appropriate for that unique project. What can strengthen the field of historic preservation is sharing successes and failures among professionals and experts in the field on new techniques and solutions, and updating technical documents so architects and preservationists can learn from others as they evaluate their goals and options going into the next project.

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