

## CLASS OF 1959 MEMORIAL CHAPEL



**44%** reduction in the Chapel's Energy Use Index (EUI) since May of 2008.

**74%** reduction in electric consumption from lighting system upgrade

**15%** of total project costs compensated by rebate money.

**51%** projected reduction in energy consumption as a result of building control upgrades

**51%** reduction in water consumption for irrigation purposes in comparison to a conventional system

**49%** reduction in water consumption over UPC 2006 compliant fixtures

### PROJECT HIGHLIGHTS

- Installation of a Direct Digital Control Building Automation System
- Sanctuary has lighting controlled by occupancy sensors
- Hallways equipped with new LED lights operated with occupancy sensors
- Green Cleaning services offered by UNICCO
- Enhanced ventilation controls for the sanctuary and garden areas to reduce steam and chilled water consumption
- Environmentally preferable Landscape Management Services
- Anticipated LEED EBOM Gold Rating



## PROJECT SUMMARY

The Class of 1959 Memorial Chapel is an approximately 5,900 square feet Chapel located on the campus of the Harvard Business School in Boston, Massachusetts. The building is a two-story concrete and copper structure originally constructed in 1992 and contains an indoor garden, Koi pond, and sanctuary. Its simple construction has required few modifications and little upkeep. It is representative of the Business School's approach to sustainability well before the creation of the LEED rating system.

Beginning in June 2008, the LEED for Existing Buildings project was fostered by an upgrade of an existing functional space to an energy efficient gathering place for the greater Harvard Business School community. The building control system was updated from a pneumatic system that ran on compressed air to a direct digital control system that was better suited to modulate the operation of the building's mechanical equipment based on the fluctuating occupancy of the Chapel. Along with the control system, the Operations staff opted to update the lighting, lighting controls, and ventilation controls.

The Harvard University Office for Sustainability and the LEED-EB rating system helped the project team develop sustainability goals, which guided selection of the mechanical, electrical and plumbing (MEP) systems installed. The project team was committed to sustainability throughout the realization of the project, which is currently pursuing LEED-EB:O+M Gold certification.

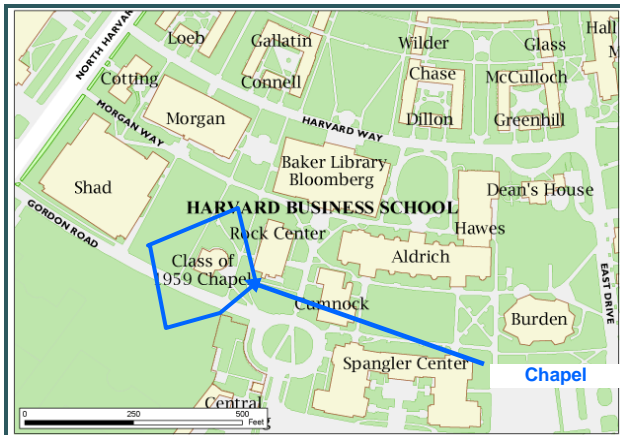


## PROJECT TEAM

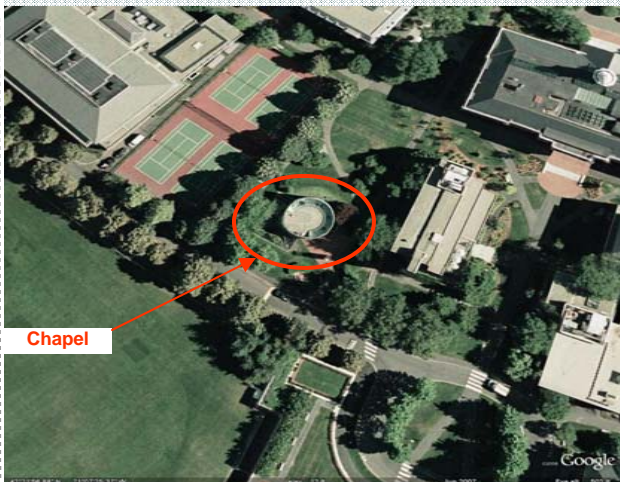
<b>Owner</b>	Harvard Business School
<b>Project Manager</b>	Meghan Duggan
<b>Contractor</b>	Gallagher Mechanical Contractors
<b>HVAC Engineer</b>	BLW Engineers
<b>Controls Contractor</b>	Invensys ENE
<b>Sustainability Consultant</b>	Harvard University Office for Sustainability



## LOCATION



The Chapel is located on the Harvard Business School campus and is managed by the Business School's Operations staff.



Chapel

## SUSTAINABLE SITES

- Environmentally Preferable Landscape Practices including:
  - **100%** of Landscape waste is composted or burned as a source of biofuel.
  - Fertilizers are only applied to the grounds when needed. Slow-release fertilizers are used to mitigate weeds and prevent premature grass growth.
  - Limited pesticide use. The only chemicals applied on the HBS grounds are to protect mature elm trees from infection. These applications are not sprayed but injected at each tree.



## WATER EFFICIENCY

The project included the renovation of two bathrooms located in the lower level of the Chapel. Only water efficient fixtures were installed in the bathrooms during the renovation. Some examples of water efficient fixtures are dual-flush toilets, ultra low-flow urinals, and sinks with low-flow aerators.

Fixture Type	Chapel Flush & Flow Rates	Standard Flush & Flow Rates
Water Closet [GPF]	Dual-Flush 1.6 & 1.1	1.6
Urinal [GPF]	0.125	1.0
Bathroom Sink [GPM]	0.5	2.5

GPF - Gallons Per Flush

GPM - Gallons Per Minute

The fixtures installed during the renovation **reduces domestic water consumption by 49.16% over standard fixtures.**

UPC (Uniform Plumbing Code 2006) compliant fixtures prohibit toilets from using more than 1.6 gallons per flush, restroom sinks from using more than 0.5 gallons per minute, and urinals from using more than 1 gallon per flush.



## Energy Savings

### Optimize Energy Efficiency Performance: HVAC, Lighting Power and Controllability

- > A Direct Digital Control (DDC) Building Automation System was installed to closely monitor the building's mechanical equipment.
- > Because the occupancy of the Chapel varies throughout each week, enhanced ventilation controls are used to modulate the amount of fresh air entering the space.
- > In total, the DDC and control sequences like the demand control ventilation are estimated to reduce steam, chilled water, and electric consumption at the Chapel by **51%**.
- > To reduce energy consumption, fluorescent and LED fixtures controlled by occupancy sensors are provided throughout the Chapel space.
- > T8 and LED lamps are used in the lighting system to reduce power consumption. In comparison to the old lighting system, the newly installed fixtures are estimated to reduce lighting electric consumption by **74%**.



### Existing Building Commissioning and Implementation

- > A private engineering firm was contracted to perform a ASHRAE Level II Energy Audit of the Chapel to identify low or no cost opportunities to save energy and lower operating costs.
- > Collectively, the recommendations are estimated to reduce the building's energy consumption by **51%**.
- > With the newly installed equipment, the Operations staff also instituted an ongoing Commissioning plan for the building's mechanical systems. This process will ensure that the systems are operating to their design intent.



## Materials and Resources

- > As a result of upgrading their lighting system, the Chapel was able to integrate new LED lights into their hallway's lighting system. This not only helps them to save energy, as the LED bulbs use 3 watts while their predecessors use 100 watts each, but also helps them to earn a couple LEED points for purchasing bulbs with a low mercury content. In this instance, LED bulbs use less energy and contain no mercury, unlike their compact fluorescent counterparts.
- > The Chapel and HBS campus have an impressive Solid Waste Management Policy. In fiscal year 2008, the campus reported a 54% recycling rate for all waste generated on campus. After incorporating a single stream recycling plan, the campus is looking to improve their marks in 2009.



## Indoor Air Quality

Occupancy varies in the Chapel from day to day and week to week. However, since 1992, the building has been ventilated constantly to ensure that its occupants receive enough fresh air. As part of the controls upgrade, the Operations staff elected to install additional ventilation control sensors.

These sensors measure the concentration of carbon dioxide in the building. The outside air dampers inside the ventilation duct are now programmed to modulate based on the concentrations of carbon dioxide. This allows the building to ramp down its Air-Handling Units when unoccupied, and temper less outside air.

Conditioning air in the summer and winter costs facilities thousands of dollars each year; however, if the building is safely ventilating less, then substantial energy and cost savings can be realized.



## Occupant Education

- > **HBS Green Team**
- > Green Teams are small groups of staff and faculty members in a department, building, or office who work on projects to make their office more sustainable. Green Teams work at their own pace and have been very effective as they know which projects should be implemented in their respective areas.
- > **Green Teams at HBS include:**
- > The Green Team sponsors an annual energy competition in which campus residents compete to reduce energy use in their buildings for one month. In 2007, participants saved almost \$20,000 and offset carbon emissions by 220,000 lbs or 100 MTCDE.

## Sustainability

### ABOUT US

### Meet the Green Team



Reduce • Reuse • Recycle

The mission of the HBS Green Team is to establish a sense of environmental awareness throughout the HBS community. Our goal is to influence behavioral change through communication and education so that HBS realizes a reduction in waste, water, and energy consumption.

Everything we do, every action we take, impacts the environment, and consequently life as we know it. It is not enough for a few concerned people to recycle bottles. Comprehensive environmental stewardship must become a way of life for all of us.

The Green Team has been charged with the task of changing the attitudes and behaviors of HBS faculty, students, and staff. This is not as easy as you might think. First, we have to understand the complicated dynamics of the green movement. The amount of information out there is staggering. Second, we have to simplify all that information and find practical, doable solutions for the HBS community. Last, we must inform and educate.

Since its inception, under the leadership of Meghan Duggan, Assistant Director of Sustainability and MEP Projects, the Green Team has grown to 32 members. Our team is made up of representatives from each department within HBS. Members are selected by management to represent their department and act as the liaison between operations and their peers.

## Sustainability Mission

- > **The goal of the program** is to reduce the environmental impacts of the Harvard Business School operations and to foster environmentally conscious students, faculty and staff. The program has several major components:
- > **Occupational Education Program:** Behavioral campaigns target specific occupant behaviors. The goal is not only to raise environmental awareness but also to use social marketing techniques in order to engage occupants in more sustainable behaviors. Every other month, the Green Team runs a different educational campaign.
- > **Sustainable Renovation/LEED Practices:** The operations department has partnered with OFS to analyze historical energy use in buildings, and identify and implement energy conservation measures (ECMs). All ECMs are evaluated on their return on investment, their eligibility for NSTAR rebates, Green Campus Loan funding, and trimming within the school's capital planning. All potential projects are brought to the Operations staff and discussed in detail to ensure that they are in line with the mission. Their implementation is coupled with educational campaigns so that building occupants are aware of the upcoming changes and know how to make the most of the new infrastructure to reduce energy use in their building.
- > **Campaigns:** The Green Team is dedicated to helping the Business School become a leader in the campus sustainability movement through a number of initiatives and programs:
  - > **Recycling:** Developing an efficient recycling infrastructure and raising the level of awareness and participation amongst the staff, students and faculty.
  - > **Resource Conservation:** Running monthly campaigns focused on a wide range of resource conservation topics: taking the stairs, closing the blinds at night, switching to energy efficient light bulbs, greening office supplies, composting at events, etc.
  - > **Greenhouse Gas Reduction:** Working on reducing greenhouse gas emissions and tracking progress in order to reach the University's Greenhouse Gas reduction target