Daylighting a New England Elementary School
A Disclaimer:

1. A New England elementary school is not a prime building use to show how to save energy using daylighting.

2. I selected this project for BEST2 because I was on the building committee and on the integrated design team that guided the high performance design and know the design process intimately and considered it to be a good example of a creative architect using objective methods to use daylighting for the first time.

3. Office building; European model (2x the height of windows).

4. The school’s electric and gas bills for the first few months of occupancy lower than those for two other elementary schools in the town that are the same size.
Daylighting a New England Elementary School

13. Integrated Design: The designer will bring the team together as early as possible in the design process to maximize the benefits of integrated design. The team must not only physically meet together, but must understand the constraints and objectives of the other members. The team members should include the Owner, facilities manager, architect, consulting engineers, energy and daylight modelers, and commissioning agent. This does not imply an increase to schedule or budget, but an emphasis on a front-loaded process.

14. High Performance:
   - Provide leadership and guidance in achieving a LEED Silver building that is a model for sustainable public schools in the Commonwealth and is designed to use 30% less energy than the current Massachusetts Energy Code allows.
   - Comply with the Massachusetts High Performance Schools Green Schools Criteria to the maximum extent feasible within the budget, including but not limited to:
     1. Energy modeling
     2. Life cycle cost analysis
     3. High performance enclosure
     4. Maximum benefits of orientation and daylight
     5. High efficiency systems and heat recovery techniques
     6. High standards for indoor air quality (including mechanical air conditioning)
     7. Water conservation
     8. Buildings shall provide generous amounts of outdoor air for ventilation with a minimal energy cost
     9. Use recycled and durable materials to lessen environmental impact

15. Coordination of all legal documents with the Owner’s Counsel. Incorporation of all applicable local and state laws and regulations into all construction documents.

16. The design will incorporate measures to make the school safe and secure with respect to ingress/egress of students and staff for all hazard situations as well as control of unauthorized access to the school.

17. Where required, preparation of construction phasing plans and recommendations for contract packages to meet phasing plans.

Request for Proposals from Architects

Key document.

IMPORTANT: Occurs very early, before the architect is even hired.

An even earlier, step is to be sure that the budget for design is adequate.

Makes the architect the driver of the high-performance design process.

When the committee asks for high performance elements to be included, the architect doesn’t then say that he needs more fee (because the committee already owns high performance design), thereby avoiding turning the discussion into talk of the amount of the fee rather than the merits of the possible high performance element.
Multiple options were considered for the orientation and layout of the school; note that all options were oriented toward the south to allow sunshading and daylighting.
Plan options for north facing rooms
Orthogonal scheme uses less energy
Goals and Values for the Design of the School

1. Design to meet the students’ educational needs in all respects
2. Use the school (building and site) as an educational tool
3. Create a “high performance” school
4. Organize the school so that it functions optimally and there is an enhanced sense of community

This presentation discusses the first three of these goals and values.
1. Design to meet the students’ educational needs in all respects.

All classrooms and almost all other spaces receive natural light. Yellow spaces receive daylight. Studies by Heshong-Mahone and others show increased performance by students in daylit classrooms.
2. Use the school building (and site) as an educational tool

Section of analemma roof monitor  Sketch of sundial on south elevation
3. Create a high-performance school

Site plan and isometric view of Options A1 and B

Energy model comparison chart of Options A1 and B

“Base school model” and one prioritizing daylighting.

Computer energy model (AGi32) was used to compare the energy consumption of the two options and the potential cost savings.
Daylighting:
  Enhanced lighting controls (occupancy sensors)
  Overhangs and light shelves

Other energy-saving features:
  Demand controlled ventilation
  Building envelope enhancements (insulation and window performance)
  High efficiency condensing boilers with optimized water loop temperature
  Energy recovery units
  Very significantly reduced lighting power density
Daylighting computer model of 2nd floor classroom; note light monitor

The first floor classrooms were too difficult geometrically to model on the computer; see later field data confirming good performance
Daylighting Study for Alternate 1 - Reduce Monitor to 12’
September 21, 2007 @ 12:00 p.m.

SEPT 26, 2009 @ 1:30 PM

UPPER LEVEL CLASSROOM
- Alternate 1.a32

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CONCORD

Daylighting Study for Lower Level, Opt. 2 - 24' Transom Glass, 24' Vision Glass
September 21, 2007 @ 12:00 p.m.

**SEPT 28, 2009 @ 1:30 PM**

**Lower Level Classroom Opt. 2.a32**

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![Diagram of Lower Level Classroom Opt. 2.a32]

- X142 FC
- X138 FC
- X30 FC
- X38 FC
- X25 FC
- X21 FC
Daylighting studies with scale models to confirm computer models intuitively

A device similar to a heliodon was used to maintain the proper orientation of the sun

Window size and light shelf design were tweaked
Sunshades at south façade of classroom wing looking east

Interior light shelf at typical classroom
Note that the base cabinets also serve as a light shelf, reflecting more light up to the ceiling and into the room
Monitors (clerestory lighting)

Section through south-facing classroom wing showing roof monitor and light well

Light well showing monitor above and borrowed light to classroom below

The monitors were carefully studied:
Slope of the top
Balance between light for upper and lower classrooms
Bottom of the light well; daylight coming into lower classroom

Upper level classroom corridor showing slot in ceiling for shared clerestory daylight; important further down the hallway, away from the window
DAYLIGHT DESIGN ELEMENTS AT CORE/ASSEMBLY SPACES

Auditorium

Media Center

Gym
Media center
Clerestory lighting at the core

Media center entrance from lobby

Bridge from media center to classrooms
Analemma skylight above the bridge
Once the extensive use of windows for view, psychological benefit, and increased classroom performance) was assumed, energy modeling and daylighting studies were used to assist in the design of the façade to effectively harvest daylight, enabling the electric lighting to be turned off in the classrooms, thereby saving energy.