COMBINING
ENERGY EFFICIENCY
AND QUALITY DESIGN

A *know**how***™
CASE STUDY

demonstrating lighting

HARVARD ELEMENTARY

Students at Harvard Elementary School in Harvard, MA, are enjoying the fresh look and higher light levels of a pilot lighting system in one of their classrooms. Suspended direct-indirect lighting fixtures bounce light throughout the space, creating a more open feeling in the room, while also directing light down onto the children's desktops. The overall result is a more cheerful atmosphere and better "'seeability" for students and the teacher—an environment more conducive to learning.

Effective classroom lighting optimizes energy use while creating a productive, comfortable, and adaptable learning environment. A quality lighting system provides good color, uniformity, and balanced brightness relationships. To support concentration, shadows, glare, lamp flicker and chaotic patterns should be avoided.

Massachusetts Electric, Harvard's local utility, chose which high-quality lighting design to demonstrate in this 768 square-foot classroom. The previous existing lighting, which is still used throughout the rest of the school, consists of old T12 very-high-output (VHO) fluorescent lamps in indirect-only valences running along three sides of the classroom; the fourth wall is the window wall. No overhead lighting existed in the center of the room. While the concealed lighting caused no glare, the amount of light that ended up on the desktops was only 25 footcandles—woefully insufficient.

"The new lights shine up onto the ceiling, and the light on the desks is much brighter. The kids like them, and I'm sure they're seeing better."

Janet Woodward, teacher

Today, well shielded direct-indirect linear pendants with energy-efficient T8 lamps and electronic ballasts have doubled the amount of light in the center of the room. The valences at the front and back of the room were refitted with good-color rendering T8s to shine light directly onto the bulletin board and chalkboard.

PROBLEMS OVERCOME

Particularly on cloudy winter afternoons, the old lighting system created a gloomy atmosphere for these second graders. The valence system produced higher light levels at the perimeter of the room and very little at the center. The amount of light falling onto the students' desks was far below recommended practice, and (though scientific tests were not conducted) likely failed to facilitate their reading, writing, and creating artwork tasks. High brightness on the walls immediately above the valence and glare from the windows, which was often cut by pull-down blinds, probably exacerbated the situation and produced eyestrain.

In addition to the extremely low light level, the color qualities of the T12VHOs lacked punch. To catch and keep students' attention, elementary education is largely based on the arts: painting, photography, dioramas, classifying by color, etc. Though greens and blues may "pop" under cool-white fluorescents, all the warm colors—reds, oranges, yellows—tend to appear muddy. The lighting failed to enhance the students' creative efforts and carefully developed instructional tools, dampening their appeal to children. The contributions of daylight helped, because daylight renders all colors, but did not extend all the way into the room. Plus, due to glare, the shades were often drawn.

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Janet Woodward, teacher

Elementary education is largely based on the arts: painting, photography, dioramas, classifying by color, etc.

Finally, the older fluorescents and magnetic ballasts did not use energy efficiently, and were in dire need of modernization.

Lighting Quality

The DesignLights™ Consortium developed the *Classroom Lighting knowhow™ Series* guides to provide general criteria for energy-effective classroom lighting. The layouts suggested in the various *knowhow™ Series* all easily meet the requirements of national and local energy codes. Most important, the prescribed systems include lighting on the walls and ceiling and reduce glare. The system in the Harvard Elementary demonstration classroom corresponds to the "better-yet" layout for multipurpose classrooms described in the guide. Direct-indirect fluorescent pendants are supplemented with wall lighting. This solution represents a balance between lowest lifecycle cost (because it saves energy) and maximum benefits.

Quality Indicators

	Rating		
	Acceptable	Good	Excellent
Control of Direct and Reflected Glare		✓	
Light on Walls and Ceilings		✓	
Fixture Locations Related to People			✓
Light Patterns and Uniformity			✓
Daylighting Integration	✓		
Color Rendering and Color Temperature		✓	
Lighting Controls and Flexibility			✓
Quantity of Light on Horizontal Surfaces (fc)			✓

Most important, the quality lighting solution is conducive to learning. More light is available on the desktops; a better balance of surface-brightness reduces glare; and drastically improved color rendering augments the appearance of artwork and educational materials.

Quality Lighting Solution

Two rows of 24 foot long pendants stretch along the length of the room. The pendants cast 59 percent of their light up and direct 41 percent downward onto the children's desks. Thus, they still bounce a good deal of illumination off the ceiling and walls to create a spacious appearance. And light levels on the desktops now exceed recommended levels.

Parabolic blades on the pendants shield the lamps from direct view unless students look up into the fixtures. Spaced 8 feet on-center, the luminaires utilize two F03278835 fluorescent lamps with a color rendering index of 80 (out of 100 possible) and a correlated color temperature of 3500K. The color properties of the lamps render the artwork well and reveal the rainbow of vivid hues seen throughout the classroom. The combination of T8 lamps and electronic ballasts provides maximum efficiency and flicker-free light. The overall effect is a warm cheerful ambiance.

Four new T8 strips are hidden behind the existing valence at the front of the room, and four at the rear, providing good vertical illumination. They promote visibility of the chalkboard and instructional materials displayed on these walls.

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Impressions

Harvard Elementary's facility manager, Phil Orifice, judged the previous lighting systems as terrible: "The indirect atmosphere was nice, but it was pretty dark in the middle of the room. It did nothing for the students at all." He oversaw the installation of the T8 pendants in the demonstration space, Ms. Woodward's classroom. "The fixtures are very handsome and they hang from aircraft cable, which is unique. It's still indirect lighting, but there are more lumens thrown downward," Orifice said.

Teacher Janet Woodward said that she hadn't realized how dim the old system was: "We'd lived with it as long as the school has been there. But once they came in and put the brighter lights in, then it was very obvious that the other rooms were quite dim. You never know what you're missing… People would walk by my room and say, 'Wow! Have they painted in there? What have they done?'

She added that light levels on the desks in the center of the room are greatly increased while maintaining bright walls and the shadow-free feeling of light bouncing throughout the room. "It's a challenge in this day and age to light classrooms because in the old days you just put all the desks in the middle. But now the kids use little corners and spaces behind partitions - all those areas have to be lit."

Woodward also appreciates the change in lamp color qualities. "There's a rosy glow to them, and they brighten the colors in the room. The artwork glows a little bit more," she said. "The rooms that don't have this lighting have a colder blue-white light that dulls the colors."

And Now the Numbers

Average light levels in the classroom doubled to 55 to 60 fc, while energy consumption was almost halved. This illumination level is a bit higher than recommended, but the tasks are largely fine artwork, reading, or paper-and-pencil-based (minimal computer usage); the eyes are young but the work is intensive. Connected load fell from 2.13 to 1.25 watts per square foot, 20 percent below ASHRAE 90.1 power limits for general classrooms. Massachusetts Electric predicts small energy savings from just this small demonstration site, but a school-wide relighting would multiply all the benefits.

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Phil Orifice, Harvard Elementary's facility manager

Costs	
Total fixtures and lamps	$3,432
Total installation labor	$1,110
Installed system cost	$4,542
Materials per square foot	$4.47
Installation labor per square foot	$1.45
Total cost per square foot	$5.92
Savings	
Demand reduction	0.7 KW
Watts saved per square foot	0.86 W/SF
Annual utility cost savings[1]	$250

[1]Based on 4,160 hours per year usage and local utility rate of $0.09 per kilowatt-hour.

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Project Summary

Utility:	Massachusetts Electric Company
Utility Representative:	Dave Watson
Customer:	Harvard Elementary School
Facility:	Harvard Elementary School Classroom
Location:	Harvard, Massachusetts
Space:	School Classroom
Area:	768 square feet
Ceiling Height:	9 feet 4 inches
Fixtures Used:	LiteConrtrol LC-91-P-ID-91-4-8-T8-PARSS with low-mercury content 2950 lumen T8 lamps
Mounting:	Suspended 18 inches from ceiling on 12-foot centers
Light Levels Achieved:	55 to 60 footcandles average (horizontal)
Lighting Power Density:	1.27 Watts per square foot
Lighting Specifier:	WV Engineering Associates
Installing Contractor:	Wayne J. Griffen Electric Inc.

The Lighting *knowhow*™ Series

The DesignLights™ Consortium publishes the *knowhow*™ *Series* for office, small retail and classroom lighting. This *demonstrating lighting knowhow*™ *Case Study* highlights a specific installation of lighting that showcases quality, comfort and efficient use of energy. With members located throughout the Northeast, the DesignLights™ Consortium is "a regional collaboration seeking to influence naturally occurring lighting events towards quality, comfort and efficiency." The DLC includes among its members many New England electric utilities as active participants, as well as several other interested stakeholders. The DLC created these case studies with the intention of helping contractors and lighting specialists sell and deliver the benefits of high quality, energy efficient lighting to their customers in the commercial building market.

National Grid

- Massachusetts Electric
- Narragansett Electric
- Granite State Electric
- Nantucket Electric

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Northeast Utilities

- The Connecticut Light and Power Company
- Western Massachusetts Electric Company

NStar

- Boston Edison Company
- Commonwealth Electric Company
- Cambridge Electric Light Company

United Illuminating

Unitil

- Fitchburg Gas and Electric Light Company

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