Human Factors Evaluation: Overview

SEPTEMBER 2004

Published by the Energy Center of Wisconsin for the United States Department of Energy and National Association of State Energy Officials (NASEO)
PROJECT OVERVIEW

The Association of State Energy Research and Technology Transfer Institutions, Inc. (ASERTTI) and the National Association of State Energy Officials (NASEO) with the Department of Energy (DOE) and the EnergySmart Schools Program conducted a joint project that encompassed applied research, field testing and technology integration.

The following organizations worked collectively to conduct this research:

- Energy Center of Wisconsin
- Iowa Energy Center
- Lighting Research Center
- Lawrence Berkeley National Laboratory
- Dalhoff & Associates
- Fort Collins Utilities

As part of the overall project there were eight distinct tasks outlined, each with its own set of goals, activities and deliverables. This document was created as part of Task 4: Advanced Daylighting Research.
Final Report Overview

Cool Daylighting – Human Factors Evaluation

Report submitted to:

Energy Center of Wisconsin
Project J30447
Energy Smart Schools

Report submitted by:

Lighting Research Center
Rensselaer Polytechnic Institute
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See also:

• Congress Elementary School, Milwaukee, WI: Daylight Human Factors Evaluation

• Zach Elementary School, Fort Collins, CO: Daylight Human Factors Evaluation

• Georgina Blach Intermediate School, Los Altos, CA: Daylight Human Factors Evaluation

• Solon High School, Solon, IA: Daylight Human Factors Evaluation
Introduction

The Lighting Research Center (LRC) was invited to evaluate human factors at four classrooms demonstrating Cool Daylighting™ principles in fulfillment of NASEO contract J30447. In Fall of 2003 and Spring of 2004, LRC visited four schools selected by the Energy Center of Wisconsin. The four sites are located in Wisconsin (Congress Elementary), Colorado (Zach Elementary), California (Blach Intermediate School), and Iowa (Solon High School). Energy use at these sites has been monitored or coordinated by other researchers, at Lawrence Berkeley National Laboratories.

Typical features of the Cool Daylighting curriculum include tinted windows, sloped and high ceilings, perforated roller blinds, and automatically-controlled fluorescent lighting systems that are mounted parallel to windows. As shown in the table on page 3, local architects have adapted the Cool Daylighting curriculum to fit their projects’ needs.

At all the schools, LRC interviewed teachers and other staff members to evaluate acceptance of the key characteristics of the Cool Daylighting curriculum. LRC also developed a survey to be used with students grades 4 and older.

Horizontal illuminance was measured at multiple times of day in several classrooms to verify daylighting operation. It was difficult to perform measurements in active classrooms at regular intervals (Congress, Solon). As a result, later school visits (Blach, Zach) included a visit on the weekend when the school was not in session. Typical use patterns for window blinds were noted as well.

The results of these human factors evaluations are summarized herein, and in the four reports attached. Although outside the scope of this project, it should be noted that in the near future, LRC will submit a paper for publication that shows the results of a lab study about acceptance of tinted glazing.
Zach Elementary School
Fort Collins, Colorado

Georgina Blach Intermediate School
Los Altos, California

Solon High School
Solon, Iowa
# Classroom Summary Table

<table>
<thead>
<tr>
<th>Location</th>
<th>Congress Elementary School</th>
<th>Zach Elementary School</th>
<th>Georgina Blach Intermediate School</th>
<th>Solon High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grades</td>
<td>K - 6</td>
<td>K - 6</td>
<td>7 - 8</td>
<td>9 - 12</td>
</tr>
<tr>
<td>School type</td>
<td>Urban</td>
<td>Suburban</td>
<td>Suburban</td>
<td>Rural</td>
</tr>
<tr>
<td>Demo size</td>
<td>2 classrooms (grades 1-2)</td>
<td>Whole school (24+ classrooms)</td>
<td>Whole school (25 classrooms)</td>
<td>Whole school (20 classrooms)</td>
</tr>
<tr>
<td>Construction scope</td>
<td>Small Retrofit</td>
<td>New construction</td>
<td>New/Substantial retrofit</td>
<td>New construction</td>
</tr>
<tr>
<td>Fenestration</td>
<td>Window wall, East-facing</td>
<td>Punched window openings, mostly North-facing, some South</td>
<td>Clerestory and roof monitors, North-facing</td>
<td>Punched window openings, North- and South-facing</td>
</tr>
<tr>
<td>Blinds (Upper)</td>
<td>Venetian blinds</td>
<td>North, none; South, venetian blinds</td>
<td>Perforated roller shades</td>
<td>Venetian blinds</td>
</tr>
<tr>
<td>Blinds (Lower)</td>
<td>Black perforated roller shades</td>
<td>North, venetian blinds; South, black perf. shades</td>
<td>Curtains (on sliding doors)</td>
<td>Venetian blinds</td>
</tr>
<tr>
<td>Lighting</td>
<td>Direct-indirect pendants</td>
<td>Direct-indirect pendants</td>
<td>Direct-indirect pendants</td>
<td>Pendants, indirect</td>
</tr>
<tr>
<td>Photosensor location</td>
<td>On fixture</td>
<td>Outside</td>
<td>On fixture</td>
<td>Outside</td>
</tr>
<tr>
<td>Controls type</td>
<td>Dimming</td>
<td>Switching</td>
<td>Dimming</td>
<td>Switching</td>
</tr>
<tr>
<td>Survey Scope</td>
<td>2 teacher interviews (children too young for survey)</td>
<td>140+ students, grades 4-6</td>
<td>240+ students, grades 7-8</td>
<td>80+ students grades 9-12</td>
</tr>
<tr>
<td>Pros</td>
<td>Automatic dimming not noticeable</td>
<td>Windows, blinds, lighting generally well-accepted</td>
<td>Windows, lighting, well-accepted Dimming works well, not noticeable</td>
<td>Window tinting not noticeable</td>
</tr>
<tr>
<td></td>
<td>Dimming override appreciated by teacher</td>
<td>Window tinting not noticeable</td>
<td>No major concerns about restricted view</td>
<td>No major concerns about restricted view</td>
</tr>
<tr>
<td></td>
<td>Window tinting not noticeable</td>
<td>Few complaints of switching being noticeable</td>
<td>No major concerns about restricted view</td>
<td>Use of blinds does not impact electric lighting energy savings</td>
</tr>
<tr>
<td>Cons</td>
<td>Eastern exposure, too much sun in mornings</td>
<td>Insufficient shading on South side, making blinds essential.</td>
<td>Some find the space dark</td>
<td>No major concerns about restricted view</td>
</tr>
<tr>
<td></td>
<td>Numerous blinds must constantly be adjusted, inaccessible.</td>
<td>Overlighted in some spaces (kindergarteners).</td>
<td>Some blinds inaccessible</td>
<td>Use of blinds does not impact electric lighting energy savings</td>
</tr>
<tr>
<td></td>
<td>Diminished space for posting teaching aids</td>
<td>Some find the space insufficiently dark for A/V</td>
<td>Some find the space insufficiently dark for A/V</td>
<td></td>
</tr>
<tr>
<td>Other Staff Comments:</td>
<td>The school is awaiting outcome of energy monitoring before applying Cool Daylighting widely</td>
<td>Would like after-hours lighting override</td>
<td>Occupancy sensors false-off when working afterhours; lamp seasoning not being done when spot relamping</td>
<td></td>
</tr>
</tbody>
</table>

Classroom Evaluation Overview
Submitted to NASEO / ECoW
- 4 -
Lighting Research Center
Rensselaer Polytechnic Institute
Human Factors Summary

The tinted glass is considered visually comfortable in all classrooms; contrary to expectations of other daylighting experts, there were almost no complaints that the tinted windows appeared dark. However, the window tinting alone is insufficient to promote visual comfort when direct sun is streaming in (Congress, Solon, Zach). For this reason, shading devices are necessary, both for everyday teaching, as well as audio-visual projector use. Teachers object to spaces where blinds require frequent adjustment, particularly when the blinds are difficult to access. If blinds are functionally inaccessible, they will be left in one position (as shown at Solon and to a lesser extent, Blach). Teachers objected to being asked to restrict their use of blinds (Solon), and posting of materials on glass (Congress).

Use of a limited number of view windows is acceptable to the teachers and students. Occupants do not complain of claustrophobic feelings, and teachers appreciate increased wall space for posting of visual learning aids.

In terms of the lighting systems, continuous dimming is less noticeable than step-switching, but switching is acceptable once the occupants become accustomed to the system. There were few complaints of lights switching at inappropriate times and due to weather.

In any age group, teachers make regular use of overhead projectors and television monitors, both of which require reduced light levels. As such, blinds are used extensively, even when exterior shading is provided. Some teachers are willing to work without electric lights even when not using audio visual projectors. In any case, it is important to provide teachers with local lighting control.

There were no major maintenance complaints about any of the systems, neither with windows, shading devices, nor lighting systems. It should be noted that schools often face budget cuts that undermine the ability to do any kind of maintenance. At one school with a dimming system (Blach), maintenance staff do not follow industry recommendations to “season” lamps before dimming. This may be difficult or impossible to achieve with an automatic dimming system, and thus such schools may in the future experience lamp flicker or premature lamp failures.

In summary, all four of the schools have successfully adapted the principles of Cool Daylighting to create comfortable, bright and cheerful environments. All four schools find their classrooms visually comfortable, and think their lighting is comparable or superior to other schools.