Daylight Dividends

CAPTURING THE DAYLIGHT DIVIDEND

DaySwitch Demonstration Project

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Lighting Research Center

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SUMMARY

This report analyzes data from the two test sites at the Lighting Research Center (LRC). Additionally, two sites were analyzed at the University of Oregon and its results reported in a separate report. The analysis at the University of Oregon was conducted by the Energy Studies in Buildings Laboratory.

The conceptual development of the DaySwitch was achieved with funding through the Daylight Dividends program. A second grant from the California Energy Commission's Public Interest Energy Research, Energy Innovation Small Grants program allowed for the development of a prototype device. Daylight Dividends then funded a small demonstration project of the DaySwitch. This report describes the results of that small demonstration at the LRC.

The LRC test sites included an east facing office area located in an open office and a west facing private office. Data was collected and recorded for sky conditions, work surface illuminance and whether the lights were on or off via a recording ammeter. Survey instruments were used to record occupant satisfaction with the lighting before and after the installation of the DaySwitch.

The two LRC DaySwitches were easy to install and calibrate once an installation issue at one of the test sites was resolved. It was discovered the DaySwitch does not work where a manual electronic dimmer is present in the electrical circuit. Once this dimmer was replaced with an on/off switch, installation proceeded without any problems. The use of electronic dimmers in electrical circuits where the DaySwitch will normally be used is rare. A review of the data reveals the DaySwitches operated according to the algorithm programmed in the device. The lights were turned off at approximately 2.7 times the lighting only illuminance level after this level was maintained or exceeded for ten minutes at test site Howard and 2.2 times and 5 minutes at test site John. However, it appears there may be an issue with how the algorithm calculates the amount of lighting only illuminance in open office settings. The algorithm determines the electric lighting level only by subtracting the daylighting level from the daylighting and electric lighting level. This works fine if all the lights in an area are controlled by the DaySwitch, but may not be correct where electric lights are present that are not turned on and off by the same DaySwitch controller. These other lights are contributing to the light level of the space being controlled. The DaySwitch may mistakenly take this light contribution to be part of the daylight illuminance contribution. This will occur in all open office areas and produces low illuminance levels before the lights are turned back on by the DaySwitch.

The data at these LRC sites were analyzed. The data revealed that the DaySwitch normally only switched the lights off and on only once during the day. In the private office, the switching sometimes occurred twice a day. This minimal switching should allow for high acceptance by building occupants. Energy savings measured was 67% for the open office and 11.3% for the private office compared to the lights being on 100% of the time. The conceptual study (Leslie et al, 2005) conducted for Daylight Dividends and reported in *Lighting Research and Technology* indicated a 24% annual savings for

Albany, NY climate conditions. While the measured results and the conceptual study utilize different parameters, the conceptual study does provide an indication of potential energy savings. The dramatic difference in savings between the open office and private office, in part, is due to test site John requiring the shades to be closed more frequently to reduce glare on his computer screen. The west sky is much brighter during the total working hours than the east sky during winter months. Sky conditions did not seem to greatly affect the energy savings. Savings were similar on sunny, partly cloudy and cloudy days.

Occupant satisfaction with the DaySwitch at test site Howard was found to be less than adequate. The number of switching operations was acceptable and did not create occupant dissatisfaction. However, the illuminance levels at the work surface were deemed too dark in the afternoons with the lights remaining off until illuminance levels fell below 14 foot candles. Occupant satisfaction at test site John was acceptable for both switching and light levels.

Additional development of the DaySwitch must be achieved and a larger demonstration of the device must occur prior to the full commercialization of the DaySwitch. The development will allow for an examination of the issue surrounding lighting levels measured by the DaySwitch and inserted into its algorithm. A larger demonstration will produce more accurate energy saving estimates and allow for a greater measure of occupant acceptance of the DaySwitch operation. Both of these needs will be fulfilled through a grant received from the New York State Energy Research and Development Authority.

TEST CONDITIONS

Two locations were chosen for installations of the DaySwitch. This report captures the two locations at the Lighting Research Center (LRC). They are designated by the person who occupies the space.

Test Site Howard

This site is an open office setting with five foot high partitions separating individuals. The size of this cubicle is six feet wide along the outer east wall and eight feet deep extending from the outer wall. Ceiling height is twelve feet and light fixtures are mounted ten feet above the light colored wood floor. All walls are painted a light cream color.

There is a large window within this space facing east. The window is 48 inches wide and 80 inches high. It utilizes single pane glass with no tinting or exterior shading. The visible transmittance is approximately 0.85. A horizontal shade provides glare control. There are south facing windows approximately 15 feet from this cubicle.

The light fixture is of the pendent variety with direct/indirect lighting provided by two four feet T8 lamps linearly placed. Total wattage is 60 watts. The total length of the

fixture is eight feet. The DaySwitch was installed between the power leads entering the fixture and the ballast. The photosensor is located horizontally at the end of the fixture facing downward, approximately five feet from the window.

This DaySwitch is programmed to turn the lights off at 2.7 times the illuminance level of the electric lights only as long as this illuminance level or higher is maintained for ten minutes. The DaySwitch calculates the lighting only illuminance level as part of its calibration process by subtracting the illuminance level it measures with the lights off (daylight only) from the illuminance level with the lights on (daylight and electric lights). The lights will be turned back on at the electric lighting illuminance level. The DaySwitch was installed on November 10, 2005.

The individual occupying the space is male, between 35 and 44 years old, wears glasses and considers himself to be sensitive to light. He works in this space approximately two to fours hours per day, Monday through Friday usually doing work on the computer. He has a fluorescent 20 watt task light that he uses approximately one hour per day.

See photos below of Test Site Howard.

Photosensor

Test Site John

This site is a private office. The size of this office is eight feet wide along the outer west wall and ten feet deep extending from the outer wall. Ceiling height is twelve feet. However, HVAC duct work is suspended for the ceiling essentially reducing ceiling height to ten feet. Two direct/indirect light fixtures are mounted along the north and south walls and a third light fixture is mounted in front of the HVAC duct work parallel to the window. All walls and duct work are painted a light cream color.

There is a large window within this space facing west. The window is 48 inches wide and 80 inches high. It utilizes single pane glass with no tinting or exterior shading. The visible transmittance is approximately 0.85. A horizontal shade provides glare control.

The two wall mounted light fixtures are direct/indirect with one four foot T8 lamp per fixture. The light fixture parallel to the window is located about eight feet from the window and is pendent mounted. It too is a direct/indirect fixture with two four foot T8 lamps. All light fixtures were controlled from an electronic manual dimmer with an on/off function. This dimmer control was replaced with a simple on/off switch because of operation interference between the dimmer and the DaySwitch. (See the Installation Issues section for more details regarding this issue.) The DaySwitch was installed between the incoming power lead and the power leads to each individual light fixture. The photosensor was initially placed horizontally approximately three feet from the window. Due to installation problems discussed in the next section, the sensor was changed to a vertical position approximately six feet from the window.

This DaySwitch is programmed to turn the lights off at 2.2 times the illuminance level of the electric lights only as long as this illuminance level or higher is maintained for five minutes. The lights will be turned back on at the electric lighting illuminance level. The DaySwitch was initially installed on November 9, 2005. Installation issues were overcome on December 14, 2005 and the DaySwitch has operated properly since.

See photos below of Test Site John.

DATA COLLECTION

Data collection was achieved using Hobo recording instruments. Information regarding window shade positioning was collected via periodic visual observations. A recording ammeter was placed on the power lead from the DaySwitch to the light fixture's ballast at both sites. This apparatus measured whether the light fixtures were on or off and the time they switched states. Data was collected and recorded in five minute intervals. The ammeter readings were not used to determine power consumption because of their inaccuracy at the low power end of their capacity. The error rate was too high.

A recording illuminance meter was place on work surfaces at each site. For site Howard, the meter was approximately six feet from the window and two feet away from being directly under the light fixture. For site John, the meter was approximately two feet from the window and directly under one of the wall mounted fixtures. These meters collected and recorded data every one minute.

A weather station with recording capabilities was placed on the roof of the LRC to determine solar intensity. It measured solar radiation and outdoor temperature. Data was collected and recorded every one minute. Some troubles were encountered with this device working in cold weather. Battery life is dramatically shortened. Because of this issue some solar data was not gathered.

Surveys were conducted with space occupants to determine their acceptance of lighting conditions before and after the installation of the DaySwitch. The survey instruments are included in Appendix A of this report.

INSTALLATION ISSUES

Prior to commencing installation each DaySwitch was tested in the daylighting control simulator to ensure proper operation. The simulator allows for varying daylight levels, turning the electric lights on and off using the DaySwitch and measuring the work surface illuminance levels at different test points.

The electric lights alone in the simulator produced 44 foot candles on the work surface. The DaySwitch used for test site Howard was programmed to turn the lights off at 2.7 times the electric lights illuminance value or 118 foot candles as long as this level is maintained or higher for 10 continuous minutes. A test was conducted with 101 foot candles on the work surface. The lights did not turn off. A second test was conducted with 116 foot candles on the work surface. The lights did turn off after ten minutes. The lights turned back on when the illuminance level on the work surface reached 41 foot candles. The DaySwitch unit was deemed to operating properly.

The unit was installed at test site Howard on November 10, 2005. It was calibrated and has operated properly since that date.

The DaySwitch used at test site John was also tested in the simulator prior to installation. For this test set, the electric lights alone produced 38 foot candles of illuminance on the work surface. This DaySwitch was programmed to turn of the lights at 2.2 times the electric lighting level or 84 foot candles as long as that level is maintained or higher for at least five minutes. The unit was tested at several work surface illuminance values. At 102, 94 and 89 foot candles, the unit turned the lights off after five minutes. At 84 and 80 foot candles the unit did not turn off the lights. Each time the work surface illuminance levels were reduced after the DaySwitch turned off the lights, the lights were switched back on by the DaySwitch at 37 foot candles.

The unit was installed at test site John on November 9, 2005. On subsequent days it was noticed that regardless on the amount of daylight present, the DaySwitch never turned off the lights. The DaySwitch was recalibrated on November 29, 2005. With 130 foot candles measured on the work surface, the DaySwitch still did not turn off the lights. On December 6, 2005 this DaySwitch was removed and placed back in the control simulator. During testing on the simulator, this DaySwitch worked flawlessly. It was reinstalled on December 7, 2005 and recalibrated. Readings were taken at the sensor and the work surface under daylight and no daylight conditions. The readings were placed in the control algorithm and hand calculated to ensure the algorithm was correct. It was found to be accurate. However, the DaySwitch still was not turning off the electric lights regardless of how high the work surface illuminance levels reached. A second DaySwitch replaced the original DaySwitch at test site John. This second DaySwitch did not work either.

A close examination of the electrical wiring was undertaken. The lights at test site John are controlled through an electronic manual dimming switch with an on/off switch also included in this device. When the device is in the off position (lights off), the researchers measured 35 volts on the load side of the switch. It is believed this "leakage" voltage, which may be common on electronic manual dimming devices, may have been the cause for the inoperability of the DaySwitch. The electronic dimming switch was replaced with a simple on/off toggle switch. The DaySwitch was re-commissioned on December 14, 2005 and has worked properly since.

It appears a limitation of the DaySwitch is it will not work in conjunction with a manual electronic dimming switch.

DATA ANALYSIS

Data for test sites Howard and John are included in this interim report. The two sites at the University of Oregon will be analyzed in the final report to be completed in March.

Test Site Howard Analysis

The following table illustrates when the lights were turned on and off and at what work surface illuminance levels.

Date	Sky Condition	Lights on at/ Illuminance level	DaySwitch turned Lights off at/ Illuminance level	DaySwitch turned Lights on at	Illuminance Level just Before lights on	Illuminance Level just after lights on
Nov. 30	Partly Cloudy	7:39 AM 24.5 fc	10:09 AM 33.3 fc	4:04 PM	14.3 fc	24.5 fc
Dec. 1	Sunny	7:30 AM 24.5 fc	9:29 AM 35.5 fc	3:45 PM	14.3 fc	24.5 fc
Dec. 2	Cloudy	8:34 AM 24.5 fc	8:44 AM 33.3 fc	4:06 PM	12.1 fc	24.5 fc
Dec. 6	Partly Cloudy	8:04 AM 26.7 fc	8:29 AM 30.4 fc	4:04 PM	12.1 fc	24.5 fc
Dec. 7	Partly Cloudy	7:44 AM 27.5 fc	8:04 AM 30.4 fc	4:14 PM	12.1 fc	24.5 fc

Problems with the outdoor weather station and the recording ammeter and illuminance meters stopping recording because their memories were filled, only allowed for a short period of time to be analyzed with all data present. A check of the recording ammeter on other days where no weather data is available indicates the DaySwitch only switched the lights off and then on once per day with the exception of November 15. During that day, the lights were turned off and on three times.

This minimal switching should not cause any occupant complaints regarding frequent switching. However, the low light levels (approximately 12 - 14 foot candles) reached

before the lights were turned back on is of concern. Design light levels are approximately 24 foot candles as measure just after the lights are turned on in the morning or afternoon. Why this low light level switching occurred is being explored. There may be a deficiency in the calibrating algorithm programmed into the DaySwitch. The algorithm determines the electric lighting level only by subtracting the daylighting level from the daylighting plus electric lighting level. This works fine if all the lights in an area are controlled by the DaySwitch, but may not be correct where electric lights are present that are not turned on and off by the same DaySwitch controller. These other lights are contributing to the light level of the space being controlled. The DaySwitch may mistakenly take this light contribution to be part of the daylight illuminance contribution. This will occur in all open office areas. More analysis will occur outside the Daylight Dividends program.

The DaySwitch at test site Howard is programmed to turn the lights off at 2.7 times the electric lighting illuminance level. Since the electric illuminance level alone, as calculated by the DaySwitch, is between 12 and 14 foot candles, the lights should turn off at approximately 33 to 37 foot candles. The data collected indicates the lights were turning off when the work surface illuminance level was around 33 foot candles. This indicates the correct operation of the DaySwitch. Lights were turned back on at approximately the 12 to 14 foot candles range.

Energy savings based on the conceptual design work conducted for this program indicated an expectation of about 24% annual savings for climate conditions in the Albany, NY area. Actual savings measured at test site Howard were considerably higher at 67%. However, different parameters exist between the conceptual design work and the test site that would cause the large energy savings difference. The conceptual design savings is an annual amount compared to a few days for the demonstration. The conceptual design controlled two rows of light fixtures, one near the windows and the second row from the windows. The test site only controlled a light fixture near the windows. Some of this increase in energy savings may also be attributable to the lower electric illuminance level (12-14 foot candles) calibrated into the DaySwitch. The following table indicates energy savings under the different sky conditions.

Date	Sky Condition	Hours on Normal Day	Hours off due To DaySwitch	Energy Savings	Percent Savings
Nov. 30	Partly Cloudy	10.5 hours	5.917 hours	0.36 kWh	57.1%
Dec. 1	Sunny	10.5 hours	6.267 hours	0.38 kWh	60.3%
Dec. 2	Cloudy	10.5 hours	7.417 hours	0.45 kWh	71.4%
Dec. 6	Partly Cloudy	10.5 hours	7.583 hours	0.455 kWh	72.2%
Dec. 7	Partly Cloudy	10.5 hours	8.167 hours	0.49 kWh	77.8%

It was assumed the lights would be on during the normal work day from 7:30 AM to 6:00 PM or 10.5 hours. The lights are either on or off when controlled by the DaySwitch. The total wattage controlled is 60 watts. To determine the energy savings, the hours the lights are off are multiplied by the controlled wattage. Sky conditions did not dramatically change the amount of the energy savings.

Test Site John Analysis

The following table illustrates when the lights were turned on and off and at what work surface illuminance levels. The work surface illuminance, as measured by the Hobo, was closer to the window (only two feet from window) than the actual work surface by approximately two feet. This accounts for the higher illuminance readings than the actual work surface illuminance.

Date	Sky Condition	Lights on at/ Illuminance level	DaySwitch turned Lights off at/ Illuminance level	DaySwitch turned Lights on at	Illuminance Level just Before lights on	Illuminance Level just after lights on
Jan. 12	Sunny	9:35 AM 51.6 fc	11:55 AM 20.1 fc	1:20 PM	28.2 fc	63.4 fc
Jan. 13	Partly Cluody	9:20 AM 54.6 fc	11:55 AM 31.9 fc	12:55 PM	28.2 fc	62.6 fc
Jan. 20	Partly Cloudy	9:00 AM 60:4 fc	Never turned off			
Jan. 31	Cloudy	9:10 AM 50.2 fc	Never turned off			
Feb. 1	Partly Cloudy	9:25 AM 56.8 fc	12:30 PM 23.8 fc	1:10 PM	33.4 fc	75.1 fc
Feb. 2	Sunny	9:15 AM 59.7 fc	11:50 AM 31.9 fc	12:55 PM	35.5 fc	80.2 fc
Feb. 6	Party Cloudy	9:05 AM 56.8 fc	11:50 AM 22.3 fc	1:05 PM	25.3 fc	67.0 fc
Feb. 9	Sunny	9:10 AM 61.2 fc	11:50 AM 28.2 fc	1:10 PM	31.1 fc	66.3 fc

The minimal switching should not cause and occupant complaints regarding frequent switching. Illuminance levels remained reasonable throughout the experiment both with the lights on and when switched off by the DaySwitch. The DaySwitch appears to be operating properly, turning off the lights when illuminance reaches 2.2 times the electric lights only level. The lights are being turned back on when illuminance levels approach that of just the electric lighting.

Energy savings at test site John are much lower than those experienced at test site Howard, 11.3% versus 67%. Much of this difference is attributed to the necessity to close the shades in the early afternoon to reduce glare at test site John which has a west facing window and a highly reflective paint on the building across the street from this window. A west facing window, under winter sky conditions, will receive more direct daylight than an east facing window. Because of the location of the computer screen at test site John, the shades must be drawn to reduce glare. Also, the issue regarding the low electric light level calibrated by the DaySwitch at test site Howard contributes to the large energy saving difference.

The following table indicates energy savings under different sky conditions.

Date	Sky Condition	Hours on Normal Day	Hours off due To DaySwitch	Energy Savings	Percent Savings
Jan. 12	Sunny	9.0 hours	2.83 hours	0.36 kWh	31.5%
Jan. 13	Partly Cloudy	9.0 hours	1.00 hours	0.12 kWh	11.1%
Jan. 20	Partly Cloudy	9.0 hours	0.0 hours	0.0 kWh	0%
Jan. 31	Cloudy	9.0 hours	0.0 hours	0.0 kWh	0%
Feb. 1	Partly Cloudy	9.0 hours	0.67 hours	0.08 kWh	7.4%
Feb. 2	Sunny	9.0 hours	1.08 hours	0.13 kWh	12.0%
Feb. 6	Partly Cloudy	9.0 hours	1.25 hours	0.15 kWh	13.9%
Feb. 9	Sunny	9.0 hours	1.33 hours	0.16 kWh	14.8%

Before and after surveys were conducted of the occupants to determine their satisfaction with the lighting system before the DaySwitchs were installed and after their installation. The before surveys reveal the occupants are very satisfied with lighting levels, finds the lighting to be comfortable and believes they can see well to do their work. They believe the lighting in their areas are better than other places where they have worked.

The survey conducted after the DaySwitchs was installed indicates the occupant of test site Howard was not satisfied with the lighting levels during late afternoon hours when the DaySwitch had the lights in the off position until illuminance levels reached approximately 13 foot candles on the work surface. This is quite a low illuminance level and the occupants concern is justified. The occupant indicated the switching operation of the DaySwitch was tolerable and did not affect job performance.

CONCLUSIONS

- The interim report results are based on limited data and must be reviewed in that light.
- Data collecting problems further limited the available data.
- The DaySwitch does not work when a manual electronic dimmer is employed in the lighting control system. This dimmer switch must be removed prior to the DaySwitch being installed. It is believed this situation will not be found in many places where the DaySwitch would be employed.
- Installation and calibration were easy and required little time for both test site Howard and John once the electronic dimmer was removed.
- The proper operation of the DaySwitch was observed at both test sites. The lights were turned off and back on at the illuminance level programmed into the DaySwitches. This assumes the DaySwitch believed the electric lighting only illuminance was 12 to 14 foot candles at test site Howard and 28 to 30 foot candles at test site John.
- Minimal switching during the day leads the researchers to believe that the switching would be acceptable to building occupants.
- Sky conditions did not seem to greatly impact energy savings. This may be true because the occupant of test site Howard manually adjusts his blinds to minimize glare throughout the day. The occupant of test site John closes his blinds during most afternoon hours to reduce glare.

- Energy savings are very dependant on the operation of the shades within the test areas. On average, the energy savings measured at test site Howard was 67% and test site John 11.3% compared to calculated annual energy savings for the Albany, NY area of 24%. Occupant satisfaction as measured through the surveys indicate ????

RECOMMENDATIONS

- Further development of the DaySwitch is needed to examine the lighting only calculation embedded in the algorithm when the DaySwitch is used in open office areas where not all lights are controlled by a single DaySwitch.
- A larger demonstration is required before any definite conclusions can be drawn regarding energy savings and occupant acceptance of the DaySwitch.
- Better data collection control is needed to ensure accurate and timely data collection. Researchers must pay closer attention to the operability of the instruments and their ability to record data. The batteries in the weather station, when used in cold weather, must be checked and changed more frequently.

References

Leslie, R., Howlet, O., Raghavan, R., Eaton, C., 2005, The Potential of Simplified Concepts for Daylight Harvesting, *Lighting Research and Technology* 37 (1) 21-40

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Thanks also goes to the Daylight Dividends program sponsors for their funding of this demonstration project.

Appendix A: Occupant Survey

General Lighting and Window Blind Survey

August 22, 2005

The University of Oregon's Energy Studies in Buildings Laboratory and Rensselaer Polytechnic Institute's Lighting Research Center are conducting an experiment that examines automatic lighting and window shade controls. So we may obtain a baseline on the current lighting and window shade systems, we need you to complete the following survey questions.

Please consider the lighting and window shades of your office and your work area and answer the following questions by circling the appropriate answer or filling in the blank. Then, please return this questionnaire to Ms. Terry Blomqiust at the University of Oregon or Peter Morante at the LRC. Your responses will be kept in the strictest confidence.

Background:

1. How old are you?
   18-24 25-34 35-44 45-54 over 54

2. Do you wear glasses or contact lenses? Yes No

3. How long have you worked at your current work location? _____ years

4. How many months during the year do you work at this location? _____ months

5. What days of the week do you work at this work location? _____

6. How sensitive to light would you say you are? Very sensitive sensitive average not sensitive

7. How far is your work space from the closest window? (_____ feet)

8. Which way does the window face?
   North South East West

9. In a day, how many hours do you usually spend at your work area?
   less than 2, 2-4, 4-6, 6-8, or more than 8

10. While you are at your work area, how do you spend most of your time?
    paper work, computer work, telephone, other ( )

11. Please describe your job briefly, e.g., engineer, clerical, accounting, management, etc.
( )

12. Do you have task lights in your work area? Task lights are "extra" lights (desk lamp, under shelf lighting, etc.) beyond the lighting provided by the ceiling lights.
    yes, no

    If yes,
    - How many task lights do you have? ( )
    - How many lamps do you use for each task light? ( )
    - What types of lamps are they? Fluorescent lamps, incandescent lamps, halogen lamps, or other ( )
    - What are the wattages of the lamps? ( )
    - How many hours do you usually use the task lights per day? ( )

General Questions On Lighting:

1. Can you turn the overhead lights in your work area on and off with a switch?
   Yes No

   If yes:
   - When do you normally turn the lights on? _____
   - When do you normally turn the lights off? _____
   - Do you normally turn the lights off and on manually during the day if there is plenty of natural light from the window? Yes No Once in awhile

   If there is no light switch in your area to turn the lights on/off, how are they turned on and off?

   Master switch controls all lights in the area.

   A time clock turns the lights on in the morning and off at night.

   I've never seen the lights off.

   I don't know

   Other (explain) _____

2. How do you like the lighting in this office?
   dislike very much, dislike, neutral, like, like very much
3. How comfortable is the lighting in this office?
   very uncomfortable, uncomfortable, neutral, comfortable, very comfortable
4. How well can you see to do your work at your work area?
   very poorly, poorly, neutral, well, very well
5. How bright does the office look?
   very gloomy, gloomy, neutral, bright, very bright
6. Do the light fixtures in the ceiling appear:
   too dark, dark, neutral, bright, too bright
7. How bright is the lighting at your work area for the tasks you perform?
   too dim, dim, about right, bright, too bright
8. How does the lighting in your office compare with other offices?
   much worse, worse, about the same, better, much better

General Question on Window Shades:

1. What types of window blinds do you currently have at your work area?
   Vertical Blinds Horizontal Blinds No Blinds

2. Do you close and open the blinds during the day to meet your needs?
   Yes No
3. If you close and open the blinds during the day:

   Why do you close the blinds? _____

   What time of the day do you normally close the blinds? _____

   When do you normally reopen the blinds?
   After the sun has passed by When I remember to do so The next day

   I forget to reopen them and the blinds remain closed for extended periods of time

   Other (explain) _____

4. How easy are the blinds to close/open?
   Very difficult Difficult Neutral Easy Very Easy

5. How well do the current blinds reduce glare from the windows at your work area?
   Very poorly Poorly Neutral Well Very well

6. What are you more inclined to do to provide good lighting through the window?
   Raise or lower the shade tilt the shade's louvers do both

Lighting and Window Shade Survey Under Experiment Conditions

The University of Oregon's Energy Studies in Buildings Laboratory and Rensselaer Polytechnic Institute's Lighting Research Center are conducting an experiment that examines automatic lighting and window shade controls that respond to natural light coming through the window. The purpose of the survey is to examine your reactions to these systems.

Please consider the lighting and window shades of your office and your work area and answer the following questions by circling the appropriate answer or filling in the blank. Then, please return this questionnaire to Ms. Terry Blomqiust at the University of Oregon or Peter Morante at the LRC. Your responses will be kept in the strictest confidence.

Date survey completed: _____

1. Were the instructions you were given for the operation of the lights and the window shades sufficient to allow you to properly operate these devices? Yes No

   What additional instructions would you have liked? _____
   _____

2. Did you notice the lights in your work area turning off or on in response to the amount of light coming through the window? Yes No

3. If yes:
   In your opinion, did the lights turn on or off excessively during the course of a day?
   Yes No

   Was the amount of light at your work area sufficient for you to conduct your work when the electric lights were turned off?
   Too Dark Dark Neutral Bright Very Bright

   How acceptable to you was turning the lights on/off automatically at your work area?
   Very unacceptable Unacceptable Neutral Acceptable Very acceptable

4. Did you notice the window blinds being opened automatically? Yes No

5. If yes, was the way the blinds reopened acceptable to you?
   Very unacceptable Unacceptable Neutral Acceptable Very acceptable

6. Were there any times the window blinds opened automatically and you had to shut them again? Yes No

   Why did you have to shut them again? _____

7. How well were you able to manually operate the blinds?
   Very poorly Poorly Neutral Well Very well

8. After you manually shut the blinds, did you have to manually open the blinds before they were opened automatically? Yes No

   If yes, why did you have to open the blinds manually?

   _____

   _____

9. Did you find the fixed angle of the blind's slats either in their closed or open position to be troublesome to you?
   Very troublesome somewhat troublesome neutral
   No trouble at all