Daylight Dividends

Field Test Shade Control and DaySwitch: Final Report on DaySwitch Demonstration Project

Purchase Order No. P0052476

April 2006

Daylight Dividends

Field Test Shade Control and DaySwitch: Final Report on DaySwitch Demonstration Project

Purchase Order No. P0052476

Prepared for:
Lighting Research Center
Rensselaer Polytechnic Institute
21 Union Street
Troy, NY 12180
518-687-7100
518-687-7120 (fax)

Prepared by:
Energy Studies in Buildings Laboratory
Department of Architecture
University of Oregon
Eugene, OR 97403

14005/06-1:tm

RESEARCH TEAM

G.Z. Brown
Jeff Kline
Tom Nelson
Dale Northcutt
Crawford Smith

EXECUTIVE SUMMARY

The Energy Studies in Buildings Laboratory (ESBL) tested a lighting control system called the DaySwitch, which was designed by the Lighting Research Center at Rensselaer Polytechnic Institute. The DaySwitch is a device that turns off the electric lights during times when enough daylight is present in the space.

Two DaySwitches were sent to the ESBL for testing. The University of Oregon test sites were in buildings on campus. One room is an office for two people in Prince Lucien Campbell Hall (PLC), which has east facing windows. The other is in the Knight Law Center, an open office with several occupants, which has west facing windows. Data was collected and recorded for whether the light being controlled was on or off (via a HOBO data logger located very close to the light) and for the light level on the work surface. Daily sky conditions were obtained from weatherunderground.com. Surveys were used to record occupant satisfaction with the lighting both before and after the installation of the DaySwitch.

The installation and commissioning process appeared to be straightforward, but problems were encountered at both test sites. At 736 Prince Lucien Campbell Hall, the light would not turn off, and at 139 Knight Law Center, the light would not turn back on once it turned off. It is unclear why this was the case.

The lights switched on and off a maximum of two times per day at each test site during the test phase, which does not seem to be excessive.

We recommend that the DaySwitch be tested in a situation where either it operates more than one light or multiple DaySwitches are installed in the same room. This study did not evaluate DaySwitch performance in situations where there are several adjacent and individually DaySwitch controlled fixtures that contribute illumination to each other's field of view.

Room occupants were told not to operate their blinds, which could have an effect on energy savings if they chose to operate them and close them when there was enough daylight present to turn off the light. However, the shades may have been closed and left closed even when the outdoor conditions did not warrant their closure.

In 736 PLC, the room users reported that in the past they turn on the lights only when there is not enough daylight, so in this test the DaySwitch installation actually resulted in more energy being used, assuming that the users would normally have the lights on for two hours per day. It is possible that, because the DaySwitch was supposed to turn the light off at a fairly high illuminance level (approximately 122 fc as recorded), the light was on when the room users would have otherwise had the lights off. If the lights had been on whenever the room was occupied, as is the case with many offices, the resulting savings due to the DaySwitch would have been 59.0%. At the Knight Law Center test site, the energy savings was 27.1%.

Differences to keep in mind between the two sites are that the DaySwitch sensor was further from the window in the Knight Law Center than in the PLC office, so less of the total light

falling on it was daylight and more was electric light from the other fixtures in the space. The fact that each room had a different orientation (the PLC office had east facing windows and the Knight Law Center office had west facing windows) may have had an effect as well. Also, the DaySwitch in the Knight Law Center had a ten minute delay rather than a five minute delay, which could have led to the light turning off later. However, it should be noted that the DaySwitch in PLC had a higher setpoint, so higher light levels were required before it turned the light off. Another difference is that the shades were probably lowered at times in the Knight Law Center space. Additionally, the room occupants had the lights on more of the time in the Knight Law Center than in PLC.

Sky conditions did not seem to have a significant effect on energy savings, as similar savings were achieved on cloudy and clear days (although almost all of the days were cloudy and rainy).

INTRODUCTION

The DaySwitch is a device that turns a single fixture off when sufficient daylight is present in a room. It can be installed inexpensively and in existing lighting systems. It is designed to turn the lights off when the work surface illumination reaches the target level for a sustained period of time (five or ten minutes depending on the DaySwitch model being tested). The target level for switching off is determined by the illumination at the work surface when only electric light is present, times a multiplier (2.2 or 2.7 depending on the DaySwitch model being tested). It is designed to turn the lights on when the work surface illumination drops below the electric lighting level.

Method

Sites were selected based on space use and occupancy patterns, as well as window configuration and orientation. Once the sites were selected, we administered pre-installation surveys to room users in order to gauge their satisfaction with the lighting. The DaySwitches were then installed in each space by electricians with the University of Oregon. DaySwitch performance was monitored for approximately one month. We collected work surface illumination and electric light switching data for twenty-three days with HOBO data loggers. Shade position was observed before the devices were installed to get a general sense of how the users operated the shades. However, users were asked to keep their shades open while the testing was in progress in both spaces. After the test phase was completed, another survey was administered to gauge user satisfaction with the DaySwitch.

The data was analyzed by comparing the on/off state of the light fixture being controlled with the illumination levels on the work surface (desk) below the light fixture. We looked for times when the DaySwitch performance did not appear to be within the design specifications.

TEST CONDITIONS

Two test sites were chosen at the University of Oregon. One DaySwitch was installed in Room 736 in Prince Lucien Campbell Hall, and another was installed in Room 139 of the Knight Law School.

Room 736 Prince Lucien Campbell Hall

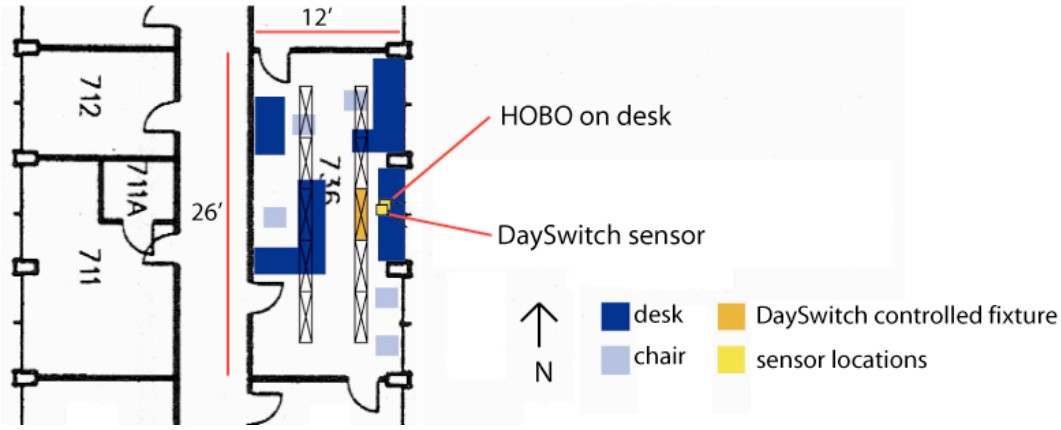

Figure 1, Floor plan of 736 Prince Lucien Campbell Hall

This site is an office space that is occupied by two people most of the time. The room is long and narrow, meaning that daylight can penetrate to the full depth of the room. The room dimensions are 26' long by 12' wide, with an 8'6" ceiling. One person has a desk up against the window at the north end of the room, while the other person has a desk that is roughly in the middle of the space. The room has white walls and a white ceiling. There are six windows facing east in this space, each 45" wide by 62" tall. All of the glazing is single pane with no exterior shading**.** Each window has a set of 1" vertical aluminum Venetian blinds.

The room is lit by 2 rows of 5 fluorescent fixtures which are mounted on the ceiling at a height of 8'-6". Each fixture has two 4' T8 lamps, which are 32 W per lamp. The fixtures are operated by two switches. It was noted that several of the lamps had been removed because they were unnecessary to light the space, according to the office occupants. Neither room user has task lighting.

The DaySwitch was installed in the light fixture closest to the center window, as shown in Figures 1, 2, and 3. The fixtures were rewired so that the fixture controlled by the DaySwitch had constant power and was always on, and all of the other fixtures were controlled by one switch.

The DaySwitch with the serial number DS12051.7 was installed in this space. According to the literature sent with the DaySwitch, this means that there is a five minute delay, and the lights turn off when the light levels are "2.7 times the light level of the electric lights only". This level must be maintained continuously for 5 minutes before the lights turn off, and "if the light level drops below the set point, even for just one second during this delay period, the internal clock will start the delay period again." "Once the light level at the work surface drops below the design lighting level, the electric lights will be instantaneously turned back on."

A HOBO data logger was placed in the fixture cover facing up towards the light to record when the light was on or off based on the light level measured. It took one reading every five minutes. Another HOBO was placed on a cleared desktop approximately 2' in from the center of the

central window. This HOBO measured illumination on the work surface in five minute intervals as well. See photos of 739 Prince Lucien Campbell Hall in Figures 2 and 3.

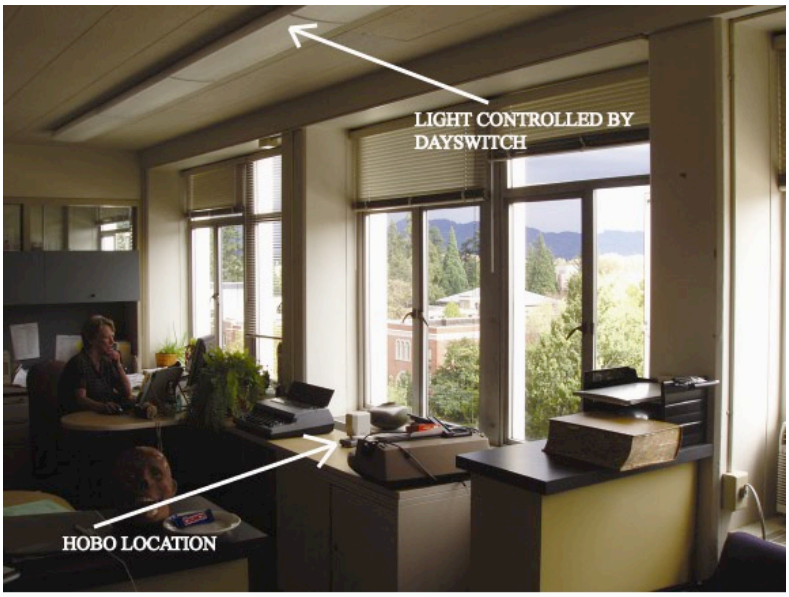

Figure 2, Looking NE in 736 PLC

Figure 3, Sensor locations

The two primary room occupants have the following characteristics: one is over 54 years old, wears glasses, and considers herself to be sensitive to light. She works in the space 6 - 8 hours per day, Monday through Friday, all year long. Work is done primarily on the computer, with some paperwork and time spent on the telephone. The other user is between 25 and 34 years old, does not wear glasses, and considers himself to be sensitive to light. He also works in the space 6 - 8 hours per day, Monday through Friday, all year long. Work is done on the computer, along with paperwork and filing, copying, etc.

Room 139 Knight Law Center

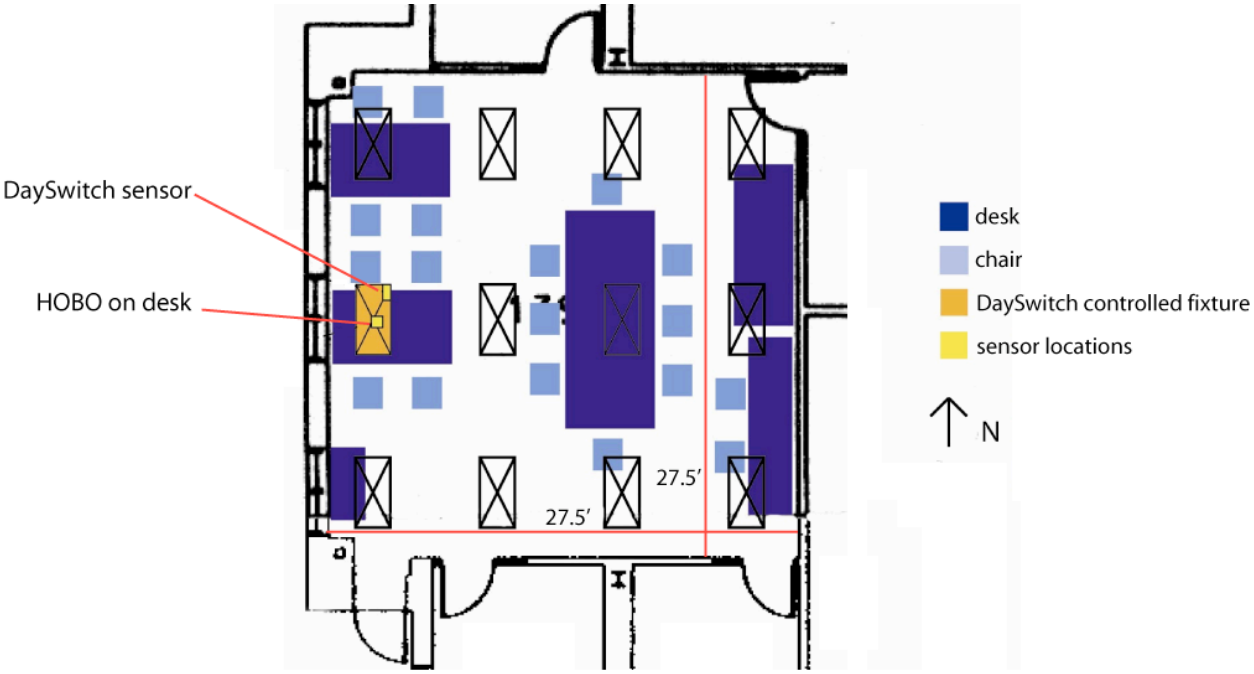

Figure 4, 139 Law School Plan

This site is an open office space that has many users throughout the day for varying lengths of time. There are two clusters of four desks located near the windows and a large conference table in the center of the room. The room dimensions are 27.5' long by 27.5' wide, with a 10.5' ceiling. The room has cream colored walls and a white ceiling. The lights are inset in the ceiling at a height of 10.5'.

There are three windows that face west. Each window is 54" wide by 64" tall. The glazing is double paned with no exterior shading. Each window has a semi-transparent roll down shade on the interior.

The room is lit by 4 rows of 3 fluorescent fixtures. Each fixture has two 4' T8 lamps, which are 32 W per lamp. There is no task lighting in the space.

The DaySwitch was installed in the recessed fluorescent light closest to the center window, as shown in Figures 4, 5, and 6. This light is an emergency light, which means that it is on 24 hours a day.

The DaySwitch with the serial number DS277101.2 was installed in this space. According to the literature sent with the DaySwitch, this means that there is a ten minute delay, and the lights turn off when the light levels are "2.2 times the light level of the electric lights only". This level must be maintained continuously for 10 minutes before the lights turn off, and "if the light level drops below the set point, even for just one second during this delay period, the internal clock will start the delay period again." "Once the light level at the work surface drops below the design lighting level, the electric lights will be instantaneously turned back on."

A HOBO data logger was placed with Velcro on the inside of the light frame facing towards the light to record when the fixture was on or off based on the light level measured. It took one reading every five minutes. Another HOBO was placed in the corner of the desk in front of the same window approximately 4' from the center of the central window. This HOBO measured illumination on the work surface in five minute intervals as well.

This space is used by law students who work for a law journal. Surveys were administered during finals week before winter break, which meant that there was rarely anyone in the space. Only one survey was collected. That particular room user was between the ages of 25 and 34. He wears contacts and considers himself to be sensitive to light. He works in the space all year except for the summer months, between 4 and 6 hours a day. Most work is done on the computer.

Figure 5, Sensor locations in 139 Law School

Figure 6, Sensor locations in 139 Law School

RESULTS

The DaySwitch is designed to switch the fixture off when the illumination level it records stays above the electric lighting only illumination level times a multiplier for a set period of time. The DaySwitch is programmed to switch the fixture back on if the illumination it reads drops below the electric lighting only level.

The work surface HOBO was used to estimate these switching levels so that the DaySwitch performance could be evaluated. We took the average nighttime reading when the DaySwitch controlled fixture supplied the only light in the space from the HOBO as an indicator of the DaySwitch's electric lighting only switch-on threshold. This value was multiplied by the appropriate multiplier for each site (PLC = 2.7, Law Center = 2.2) to obtain the switch-off threshold.

As previously described, the HOBO data loggers collected data every five minutes. Both HOBOs at each test site were synchronized. We assume that the work surface illumination reading recorded just prior to the fixture switching off was above the DaySwitch's switch-off threshold.

It does not tell us what that threshold was. Work surface illumination readings prior to the switch-off that are lower than the expected threshold may indicate that the DaySwitch was not performing as designed. Likewise, we also assume that the work surface illumination just prior to the fixture being switched on is above the switch-on threshold. Because the HOBO data is not continuous and the daylight illumination can be highly variable, we cannot draw any conclusions from the readings just after switching events.

It should be noted that there are limitations to the method. Because the work surface HOBO and the DaySwitch are "seeing" different illuminated fields, and some of the illumination is directional and does not vary the same for the HOBO as for the DaySwitch, there will be times when the HOBO does not accurately predict the behavior of the DaySwitch. This is especially true of sunny days. It is possible to correct for this somewhat by comparing switch-on and switch-off values for times when the sky conditions are similar.

There is also a potential problem that could be caused by local obstructions and other changes to the DaySwitch and HOBO's field of view. There is a larger issue of how DaySwitch performance changes when occupants change the overall reflectivity of the DaySwitch's field of view, perhaps by covering their dark desktop with papers. For the study method, if an object, such as a box, were placed so that it changed the HOBO's field of view (especially if the HOBO's view of the window was obstructed), the values recorded by the HOBO could change significantly.

The installation and commissioning process appeared to be straightforward, but problems were encountered at both test sites. At 736 Prince Lucien Campbell Hall, the light would not turn off, and at 139 Law School, the light would not turn back on once it turned off. It is unclear why this was the case. The problems were corrected in both cases, as detailed below.

The lights switched on and off a maximum of two times per day at each test site during the test phase, which does not seem to be excessive.

Sky conditions did not appear to have a significant effect on energy savings.

Room occupants were told not to operate their blinds, which could have an effect on energy savings if they chose to operate them and close them when there was enough daylight present to turn off the light. However, the shades may have been closed and left closed even when the outdoor conditions did not warrant their closure. This situation probably occurred in Room 139 of the Knight Law Center. This would also affect the energy savings recorded.

We recommend that the DaySwitch be tested in a situation where either it operates more than one light or multiple DaySwitches are installed in the same room. This study did not evaluate DaySwitch performance in situations where there are several adjacent and individually DaySwitch controlled fixtures that contribute illumination to each other's field of view.

The HOBO data logger specifications state that they have an accuracy of ± 20% of reading. This should be taken into account when examining the data.

The graphs must be read with care. Since the data is a five minute sample and not continuous, it is not possible to know the illumination during the switch-off delay period. For instance, on January 11, 2006 at 10:20 AM (Figure 9), it is seen that the lights switched on without apparently falling below the switch-on threshold. However, the illumination may have briefly fallen below the threshold between HOBO readings. However, the possibility does exist that the DaySwitch did not perform as designed. The limitations of the data collection method as mentioned above also need to be kept in mind. Thus, these graphs point to potential problems that need further study.

A question that we have is whether it matters when it is calibrated. Will it function the same whether it is calibrated at night or during the day?

736 Prince Lucien Campbell Hall

When the DaySwitch was initially installed and commissioned in 736 PLC, it did not switch the light off. The electrician commissioned it without someone from the ESBL present. After this problem was noted, we shined a flashlight at the DaySwitch sensor for five minutes. The light did turn off when we did this, which demonstrated that the device was functioning. We recommissioned the DaySwitch and moved the sensor so that it was not in the halo of light around the periphery of the fixture, as it was when it was originally commissioned. The sensor was then remounted so that it was directly over the HOBO located on the desk surface in front of the window. In the new location, the DaySwitch switched the fixture off during a portion of each day.

The HOBO data collected for PLC during the entire test period is shown in Figure 7. Sky conditions during these days are shown in Figure 8. At night when only the fixture that the DaySwitch was connected to was on, the work surface illumination stayed between 38 fc and 47 fc for a great majority of the time, so we consider the average of those two values to be the approximate baseline, or 43 fc. If this is the case, then the fixture should turn off when the light level is maintained at 116 fc or higher for a period of five minutes. The light should turn back on when the light level drops below 43 fc, if only for a moment. These thresholds are shown with dashed lines in Figures 7 and 9 through 17.

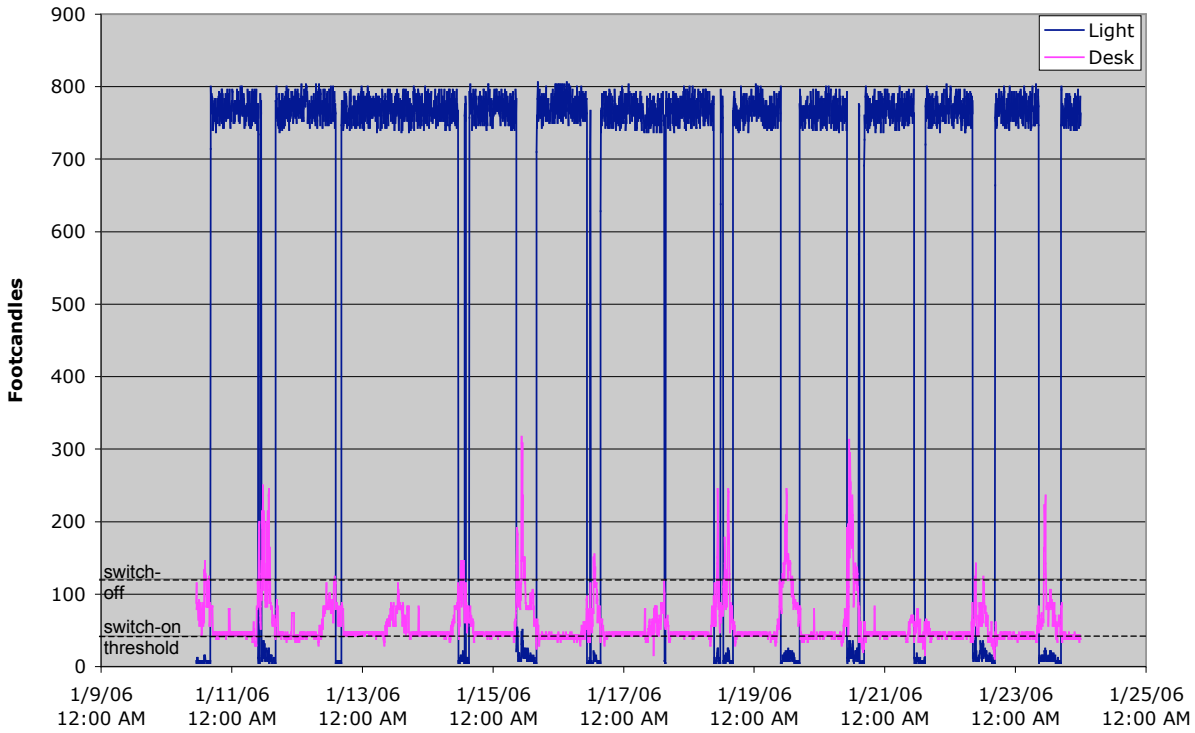

Figure 7, Overall illumination levels in 736 PLC

Date	Sky Condition	Date	Sky Condition
1/11/2006	Mostly cloudy/rain	1/27/2006	Mostly cloudy/rain
1/12/2006	Mostly cloudy/rain	1/28/2006	Mostly cloudy/rain
1/14/2006	Mostly cloudy/rain	1/29/2006	Mostly cloudy/rain
1/15/2006	Mostly cloudy	1/30/2006	Mostly cloudy/rain
1/16/2006	Mostly cloudy/rain	1/31/2006	Mostly cloudy/rain
1/18/2006	Mostly cloudy/rain	2/1/2006	Mostly cloudy
1/19/2006	Mostly cloudy	2/2/2006	Mostly cloudy/rain
1/20/2006	Mostly cloudy/rain	2/3/2006	Mostly cloudy
1/21/2006	Mostly cloudy/rain	2/4/2006	Mostly cloudy/rain
1/22/2006	Clear	2/5/2006	Mostly cloudy
1/23/2006	Mostly cloudy	2/6/2006	Partly cloudy
1/25/2006	Mostly cloudy/rain	2/7/2006	Clear
1/26/2006	Mostly cloudy/rain		

Figure 8, Weather Conditions

In general, and given the limitations noted above, we conclude that the DaySwitch performed as designed. However, there are several times when the data suggests there may be problems. Figures 9 through 17 show in detail the switching events for these days.

There was one issue that arose that may have affected the data collection during the test phase. When data was downloaded from the HOBOs on January 24, 2006, it was noted that a computer monitor had been placed on the desk on which the HOBO was located. This must to have happened between January 19 and January 24. This could have blocked some of the incoming light and changed the reading of the HOBO on the desk. On the other hand, the DaySwitch sensor was pointed at the same spot on the desk, so the light level read by the HOBO might not have been lowered by any more than the light level read by the DaySwitch sensor. In examining the data for these days, it appears likely that the monitor was moved during the middle of the day on January 20, 2006.

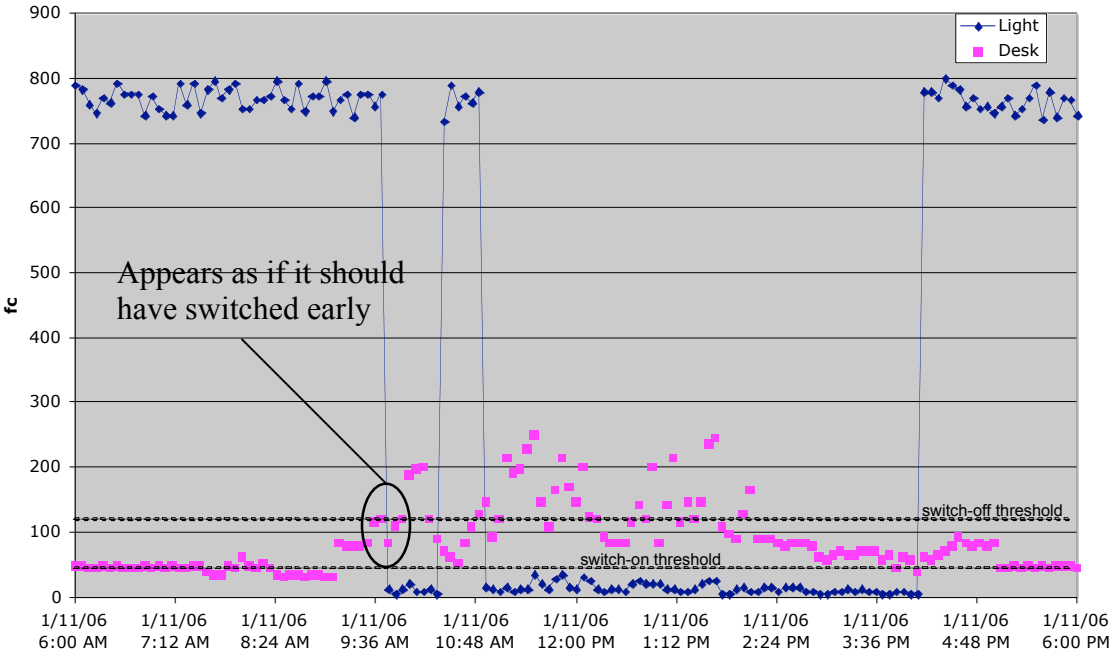

Figure 9, Illuminance in 736 PLC on January 11, 2006

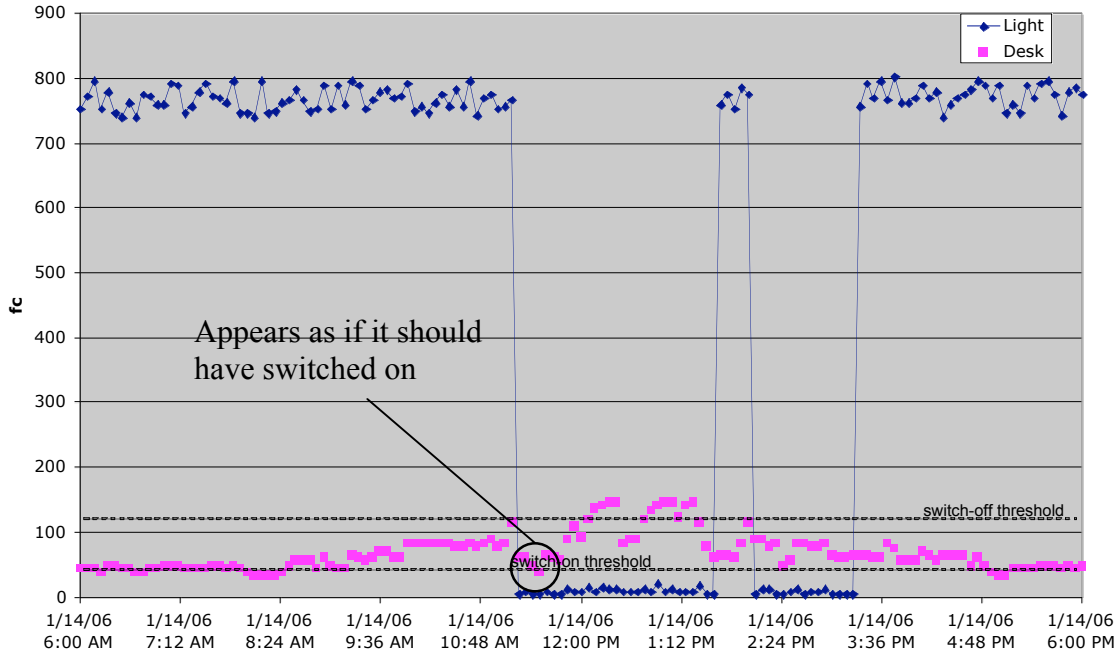

Figure 10, Illuminance in 736 PLC on January 14, 2006

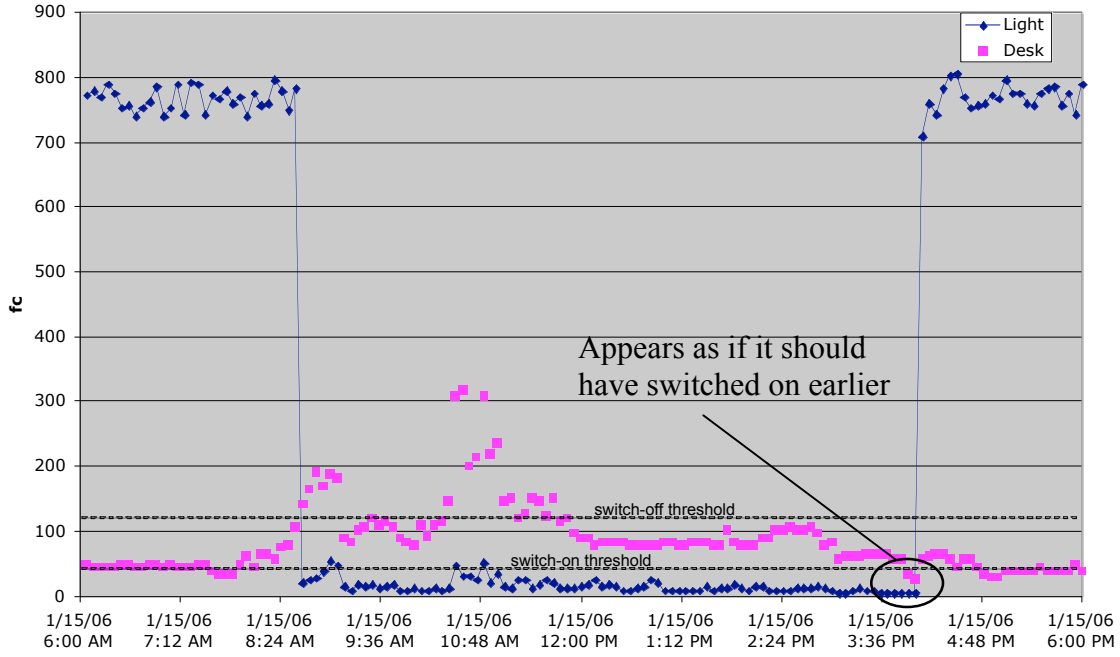

Figure 11, Illuminance in 736 PLC on January 15, 2006

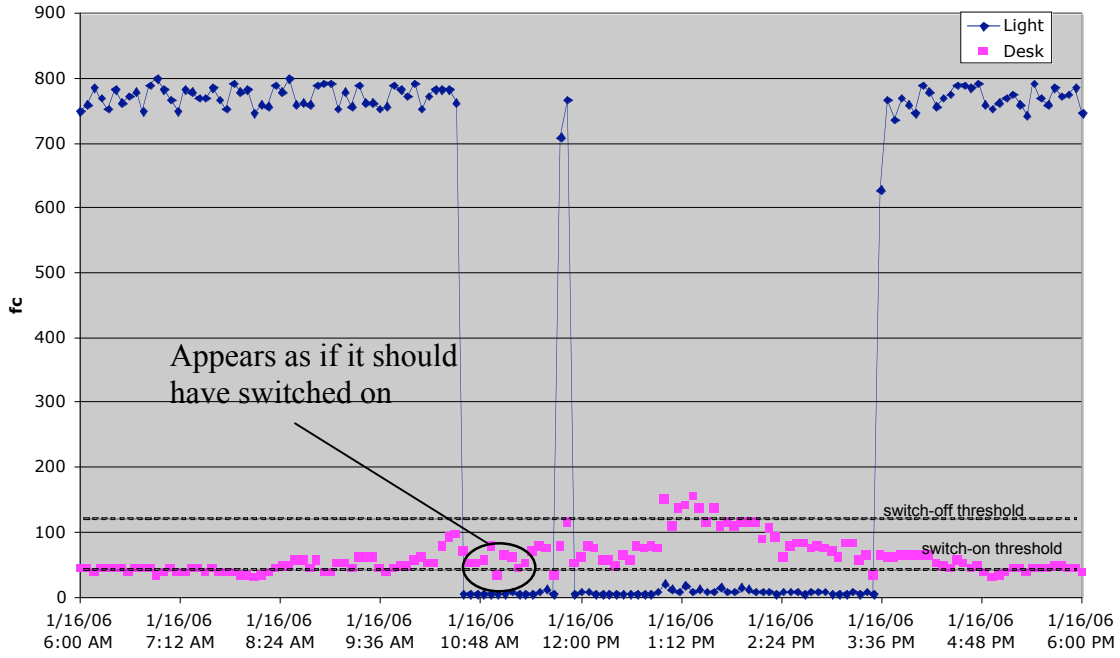

Figure 12, Illuminance in 736 PLC on January 16, 2006

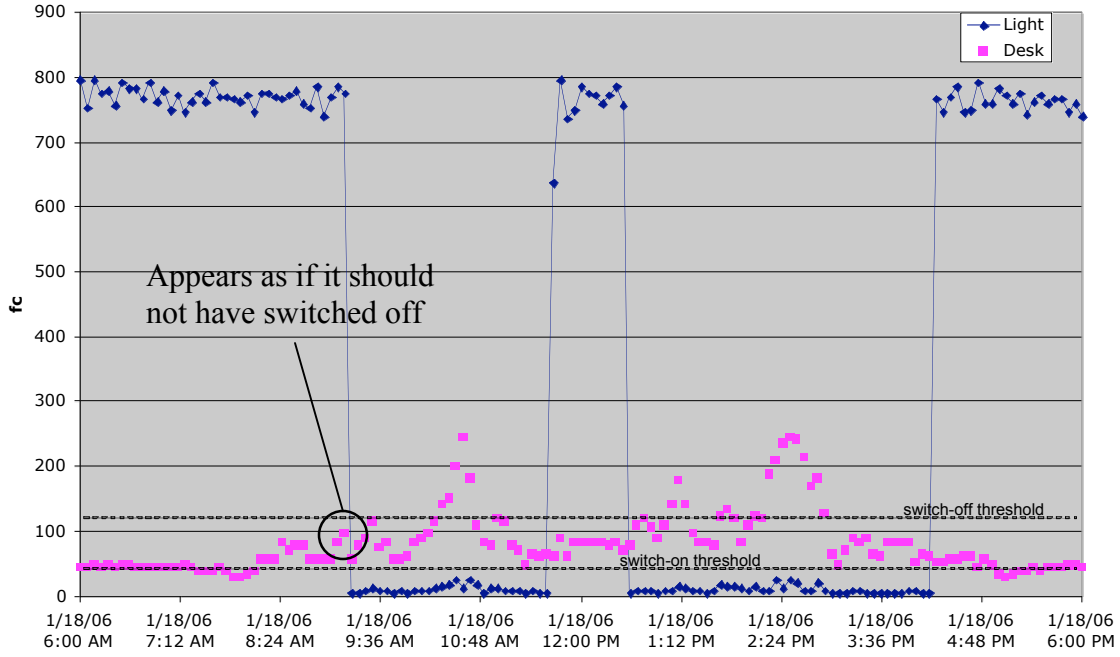

Figure 13, Illuminance in 736 PLC on January 18, 2006

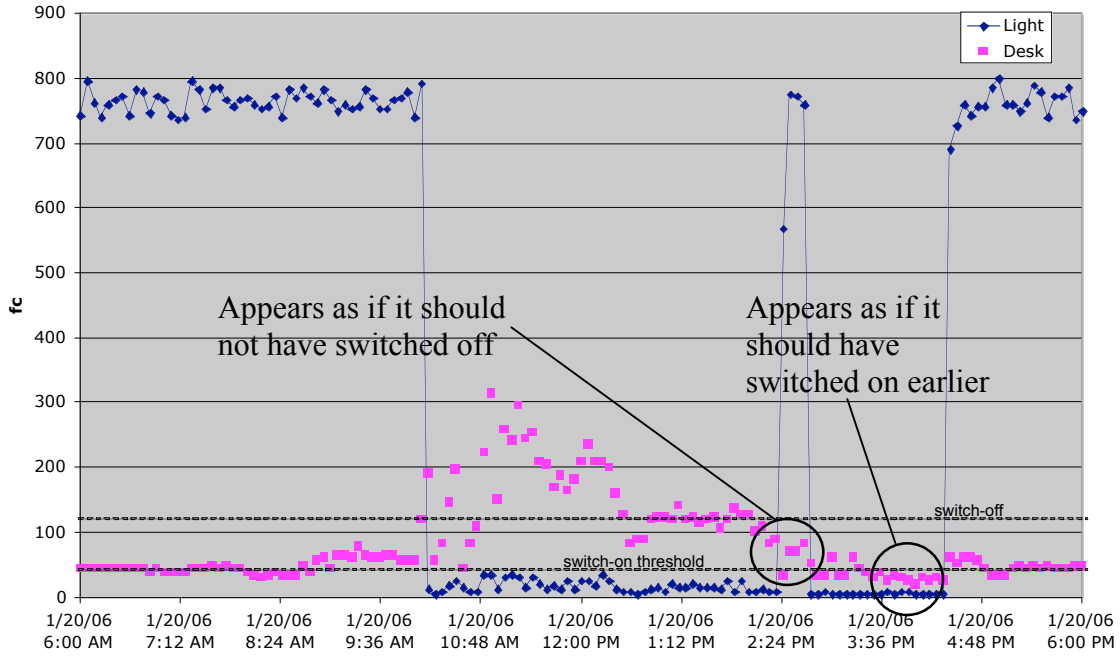

Figure 14, Illuminance in 736 PLC on January 20, 2006

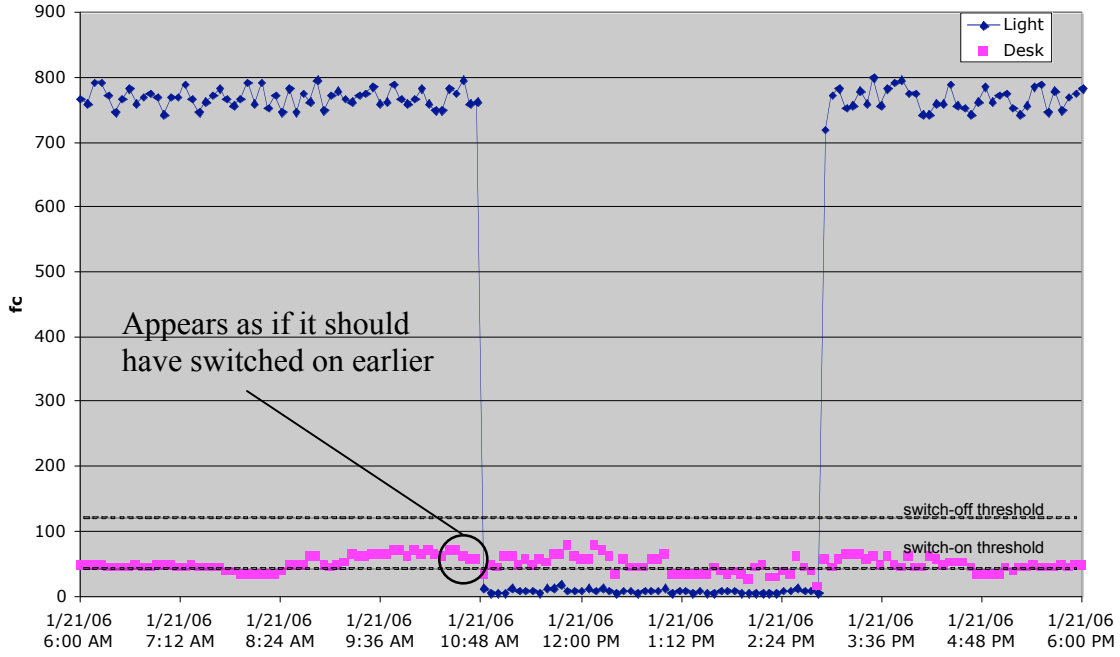

Figure 15, Illuminance in 736 PLC on January 21, 2006

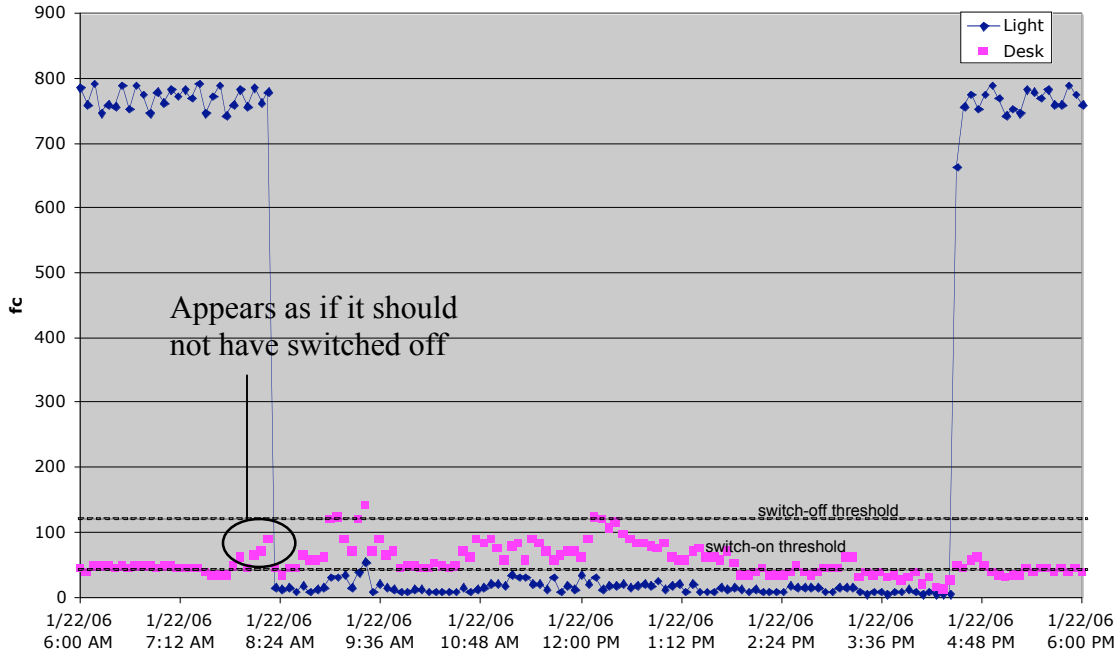

Figure 16, Illuminance in 736 PLC on January 22, 2006

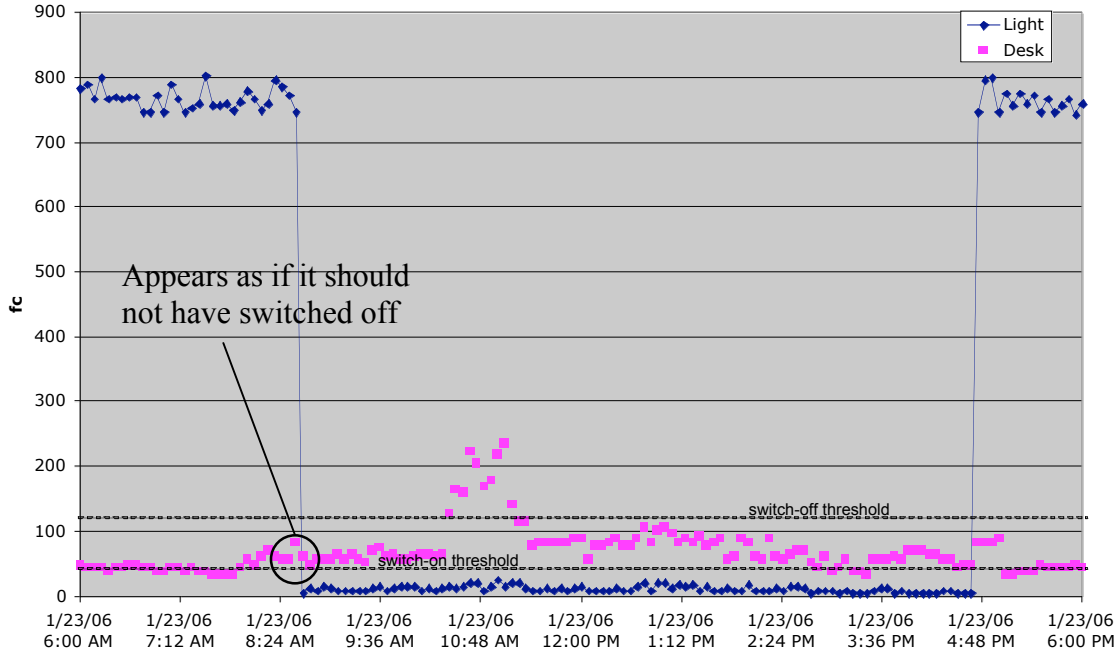

Figure 17, Illuminance in 736 PLC on January 23, 2006

ENERGY SAVINGS

736 PLC	64 W					
Date	Sky conditions	Hours on normal day	Hours on due to DaySwitch	Energy Savings (kwH)	% Savings	Times lights off/on per day
1/11/2006	Mostly cloudy/rain	2	3.08	-0.07	-54.0%	2
1/12/2006	Mostly cloudy/rain	2	6.92	-0.31	-246.0%	1
1/14/2006	Mostly cloudy/rain	2	5.33	-0.21	-166.5%	2
1/15/2006	Mostly cloudy	2	1.58	0.03	21.0%	1
1/16/2006	Mostly cloudy/rain	2	4.17	-0.14	-108.5%	2
1/17/2006	Mostly cloudy/rain	2	8.50	-0.42	-325.0%	1
1/18/2006	Mostly cloudy/rain	2	2.92	-0.06	-46.0%	2
1/19/2006	Mostly cloudy	2	2.08	-0.01	-4.0%	1
1/20/2006	Mostly cloudy/rain	2	3.08	-0.07	-54.0%	2
1/21/2006	Mostly cloudy/rain	2	4.92	-0.19	-146.0%	1
1/22/2006	Clear	2	0.83	0.07	58.5%	1
1/23/2006	Mostly cloudy	2	0.92	0.07	54.0%	1

Figure 18, Energy Savings in 736 PLC

Figure 18 details energy savings for 736 PLC. The normal working hours are 8 a.m. to 5 p.m. The occupants said that the lights are off up to 90% of the time, unless it is very dark out, such as the late afternoon hours during the winter. Based on the survey responses and talking to the room users, we estimate that the lights are on two hours per day. If this is the case, then there were no energy savings for the test period. In fact, 84.7% more energy was used than would have been if the lights had been on only two hours per day. However, if it were the case that the lights were always on while the office was occupied, the savings due to the DaySwitch would have been 59.0% during the test phase.

The DaySwitch turned the lights off and on once per day for a majority of the days and twice on the other days. Sky conditions do not appear to have an effect on energy savings, because similar savings were recorded on both cloudy and clear days. It should be noted that all but one of the days were cloudy.

Occupant satisfaction with the DaySwitch was poor at the PLC office site. The room users thought that there was not enough light available at their work areas, and that the lights did not turn on soon enough as daylight levels fell. They did not think the lights turned off and on excessively, however.

139 Knight Law Center

The fixture in Room 139 of the Knight Law Center stayed on after we had commissioned the DaySwitch. The electrician (a different one than the one who installed the DaySwitch in PLC) said that he remained in the space for a little while after commissioning to see if anything would happen, and the light stayed on the entire time he was there. However, according to the HOBO data, the light turned off after about an hour and never came back on for the rest of the test period.

The electrician and someone from the ESBL met at the Knight Law Center to determine the problem. Everything looked as though it had been wired correctly, but it was decided to reinstall the DaySwitch. After this had been done, it began to function properly. We were not able to determine why it did not work as designed in the original installation.

The HOBO data for the Law Center during the entire test period is shown in Figure 19. Sky conditions for this period are shown in Figure 8.

We determined the baseline reading in room 139 of the Knight Law Center to be 15 fc. At night when only the light that the DaySwitch was connected to was on, the light level stayed between 14 fc and 16 fc almost all of the time. If this is the baseline, then the light should turn off when the light level is maintained at 33 fc or higher for a period of ten minutes. The light should turn back on when the light level drops below 15 fc, if only for a moment.

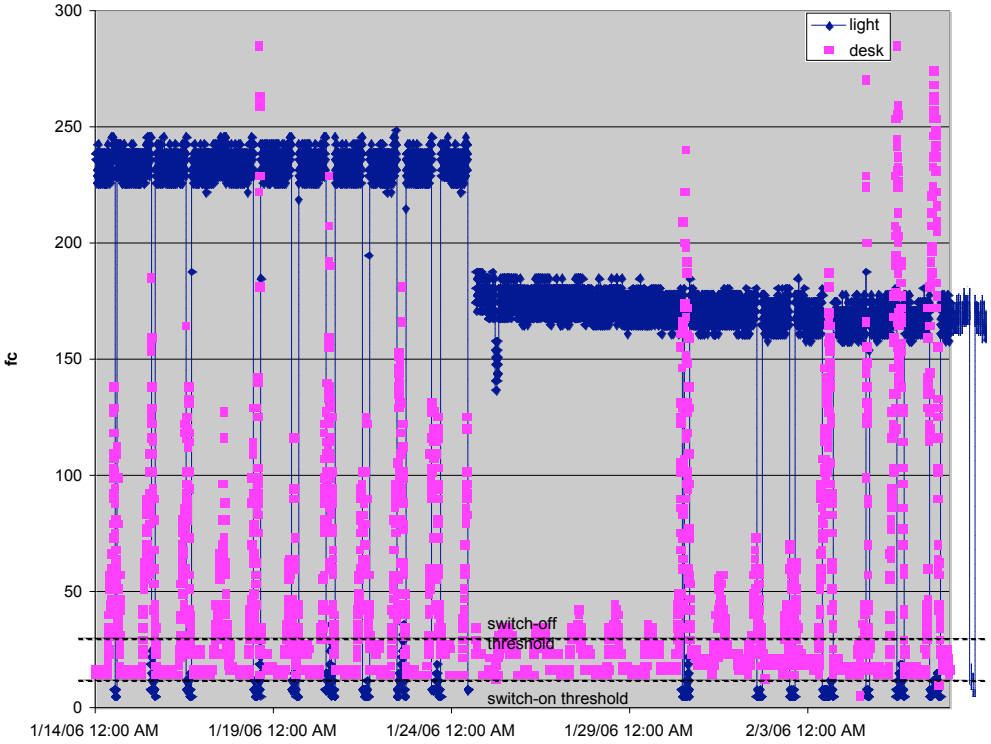

Figure 19, Illumination levels in 139 Knight Law Center from Jan. 14, 2006 to Feb. 7, 2006

It is not clear to that the DaySwitch functioned as designed at this test site. There were many instances where the behavior of the DaySwitch appears to indicate that its switching thresholds were different than what we would predict using the HOBO data. It seems that either the calibration of the DaySwitch was either improperly performed or the device was faulty, or the DaySwitch did not perform properly after calibration. Figures 20 through 32 show in detail the daily switching events for these days. Note in these figures, such as figure 20, the switching off occurred at different levels than predicted.

It was noted that when we went back to retrieve the HOBOs on 2/8/06, the shades on the window in front of the light with the DaySwitch had been lowered.

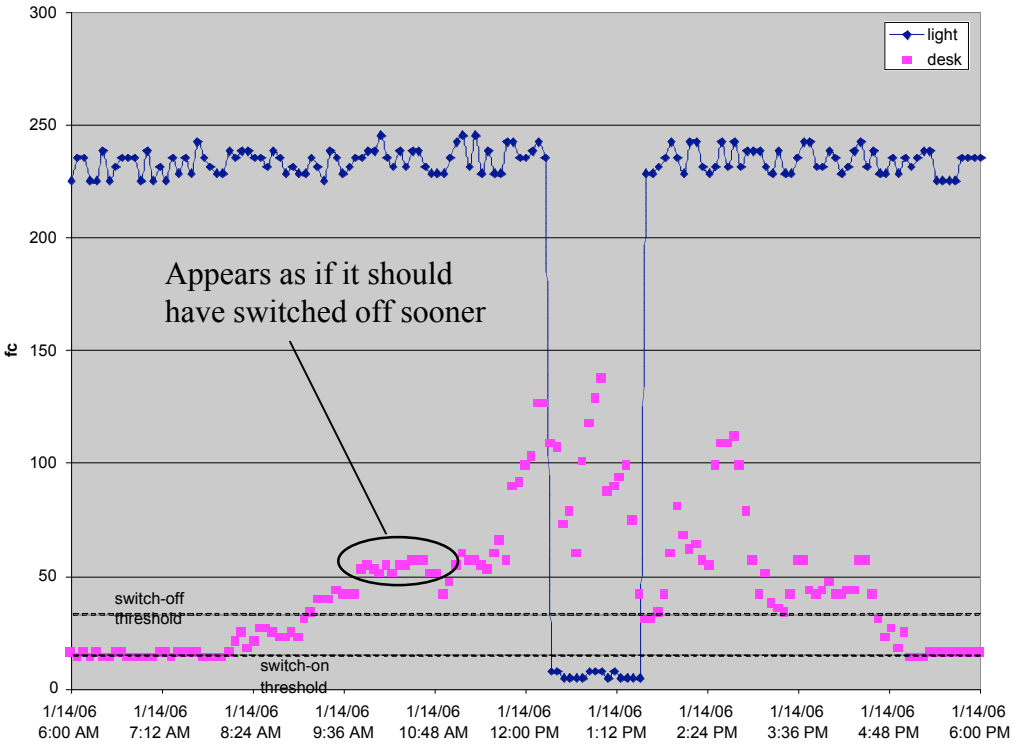

Figure 20, Illumination in 139 Knight Law Center on January 14, 2006

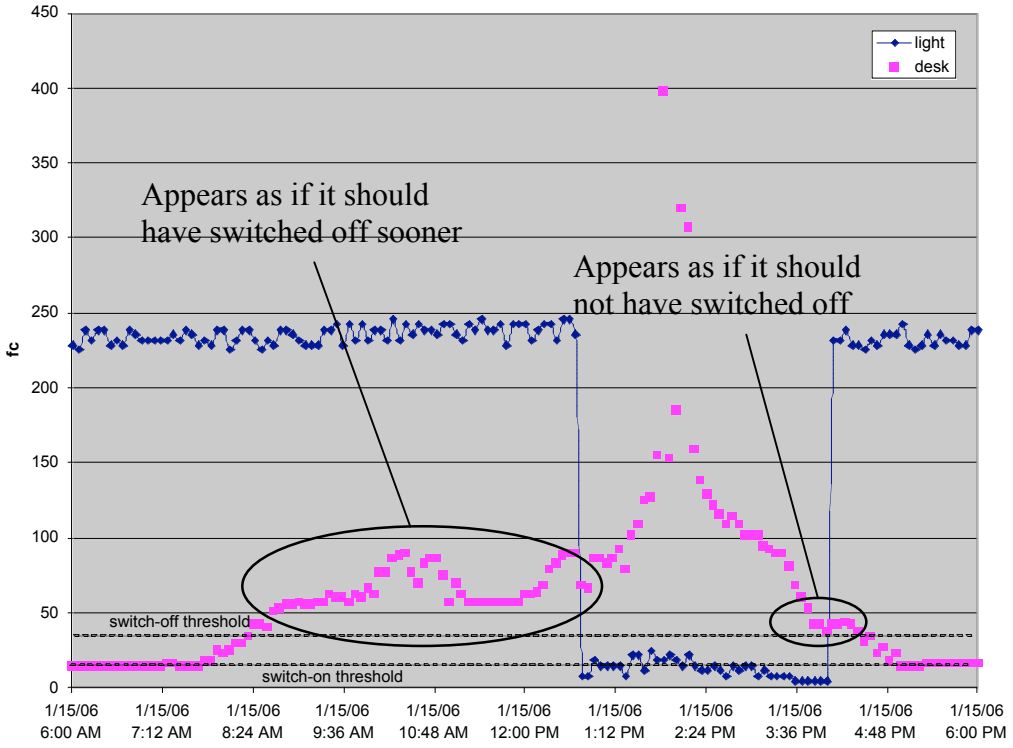

Figure 21, Illumination in 139 Knight Law Center on January 15, 2006

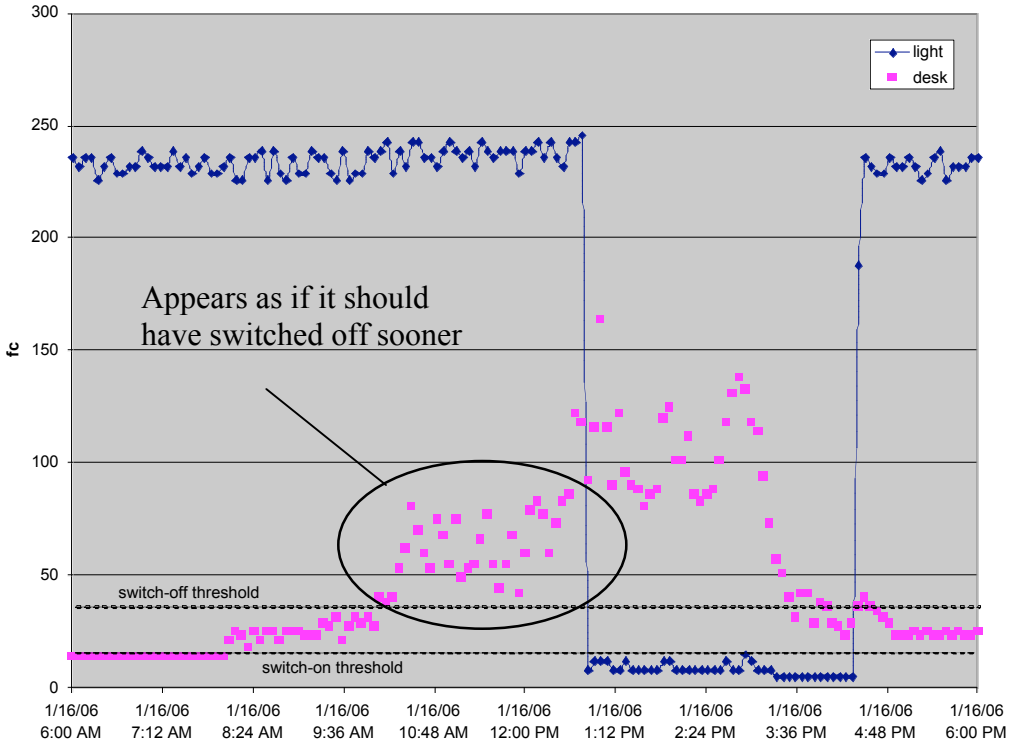

Figure 22, Illumination in 139 Knight Law Center on January 16, 2006

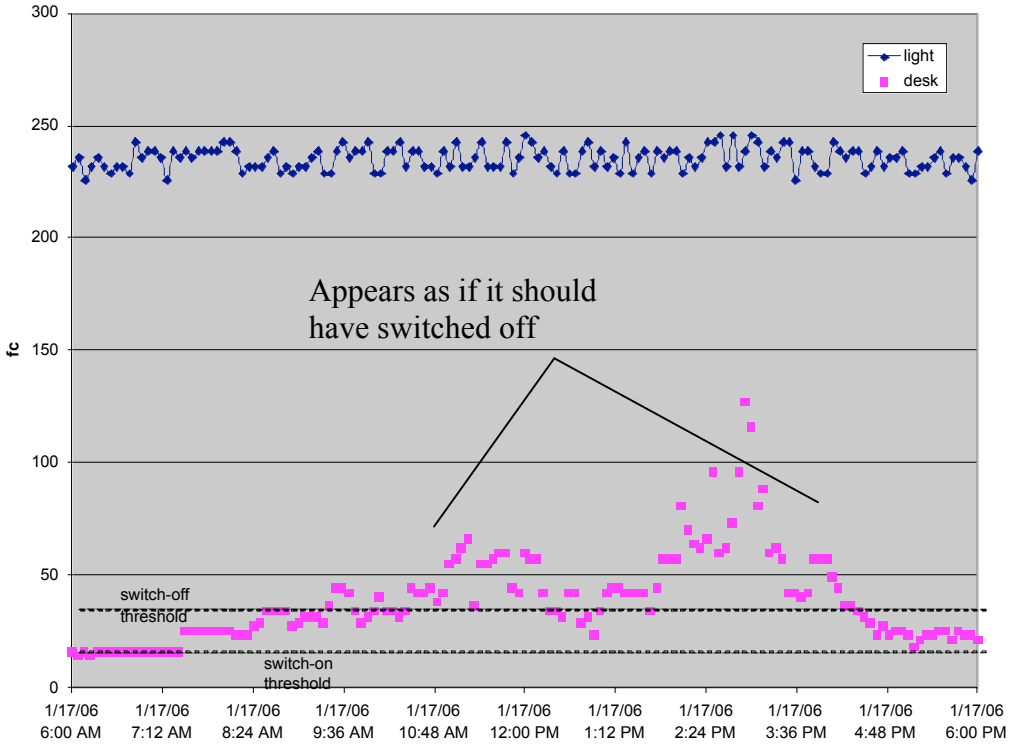

Figure 23, Illumination in 139 Knight Law Center on January 17, 2006

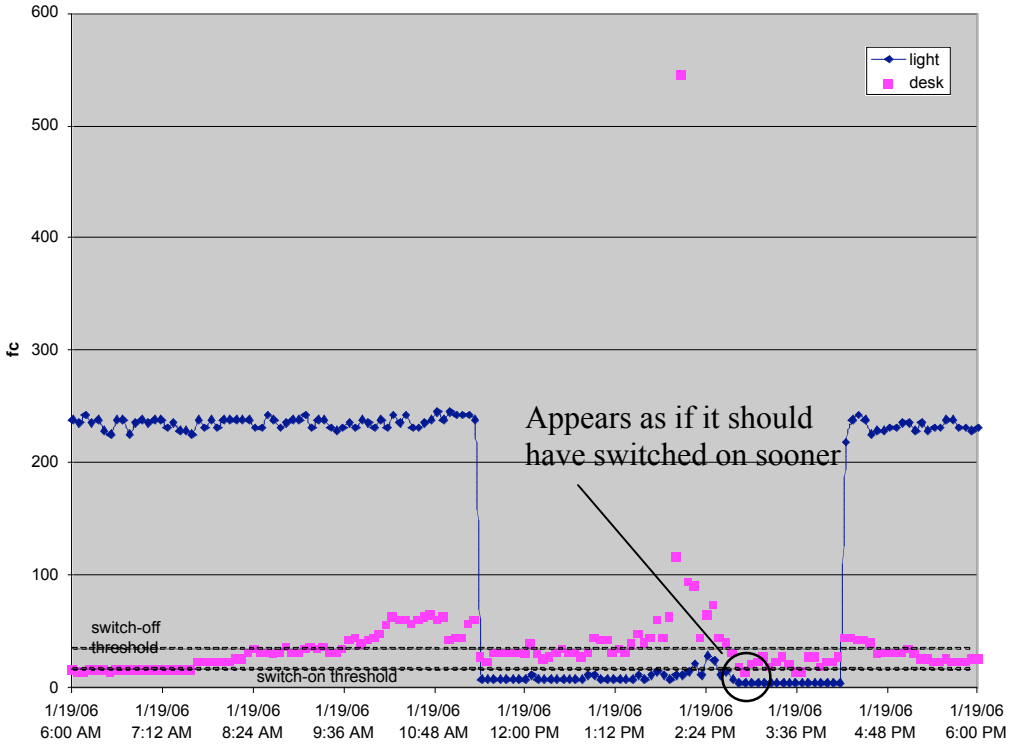

Figure 24, Illumination in 139 Knight Law Center on January 19, 2006

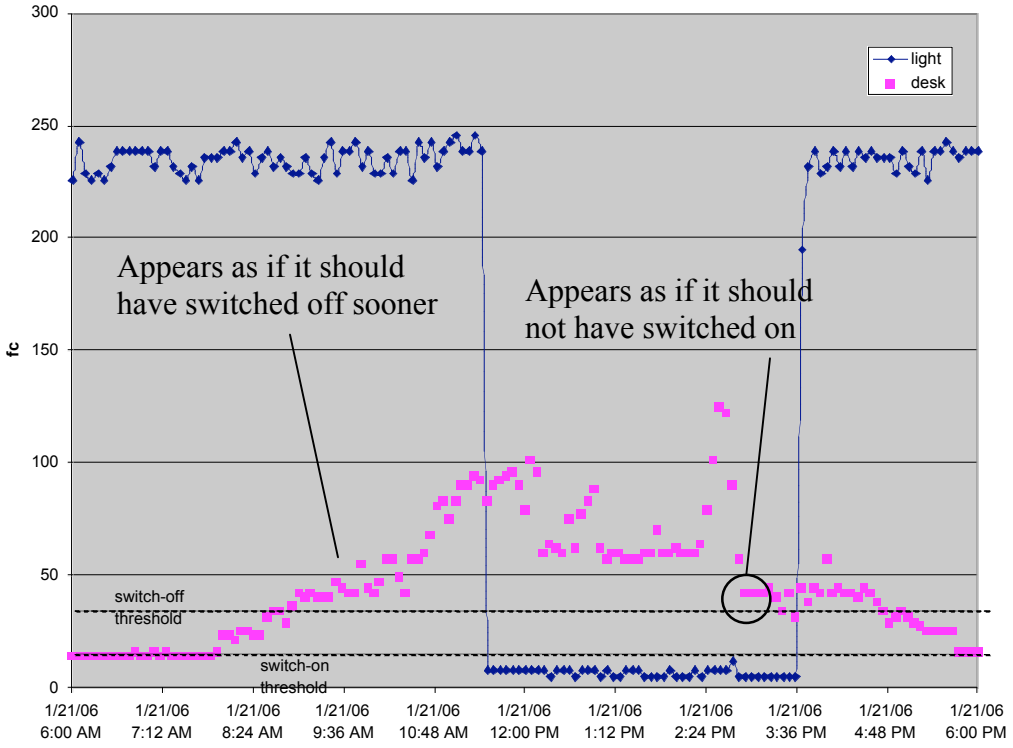

Figure 25, Illumination in 139 Knight Law Center on January 21, 2006

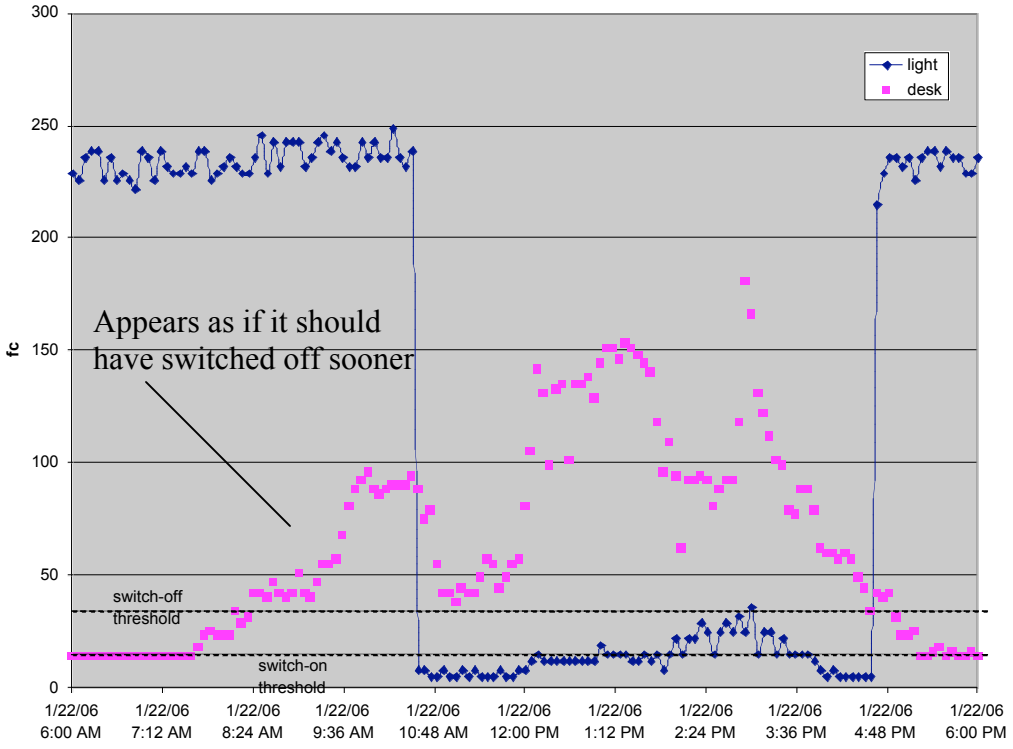

Figure 26, Illumination in 139 Knight Law Center on January 22, 2006

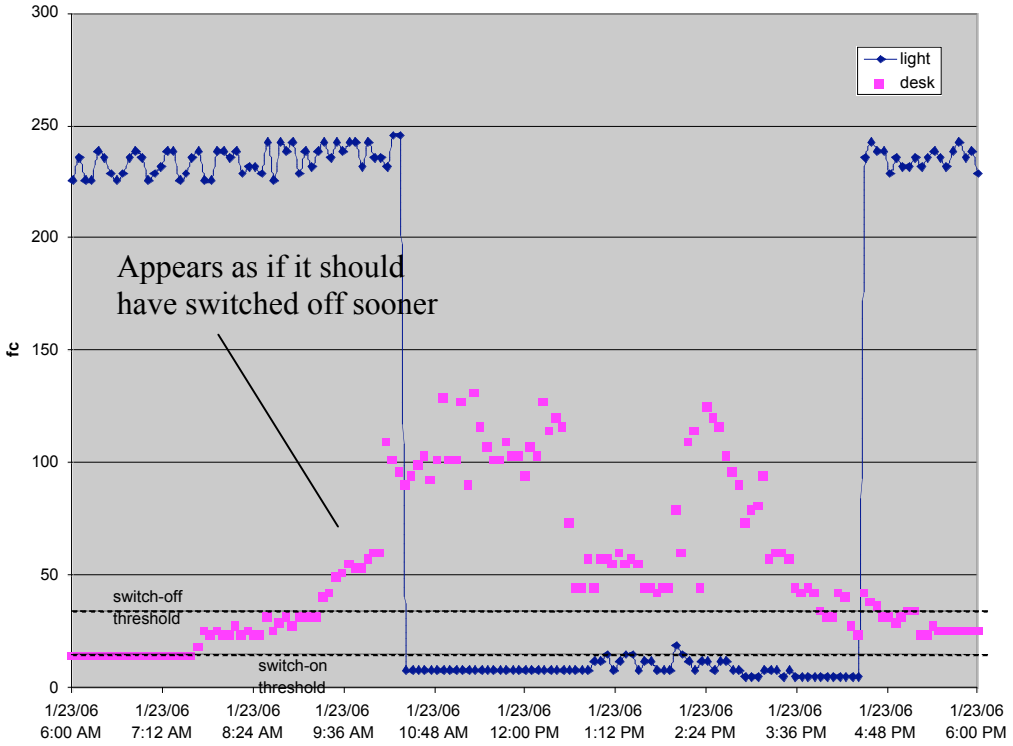

Figure 27, Illumination in 139 Knight Law Center on January 23, 2006

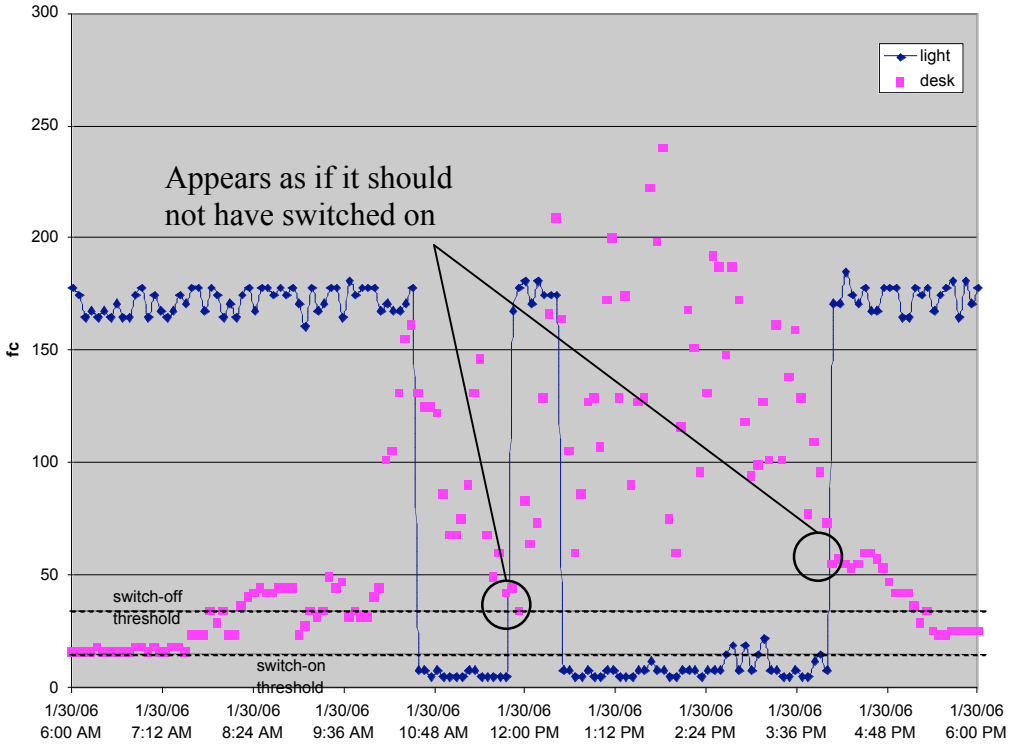

Figure 28, Illumination in 139 Knight Law Center on January 30, 2006

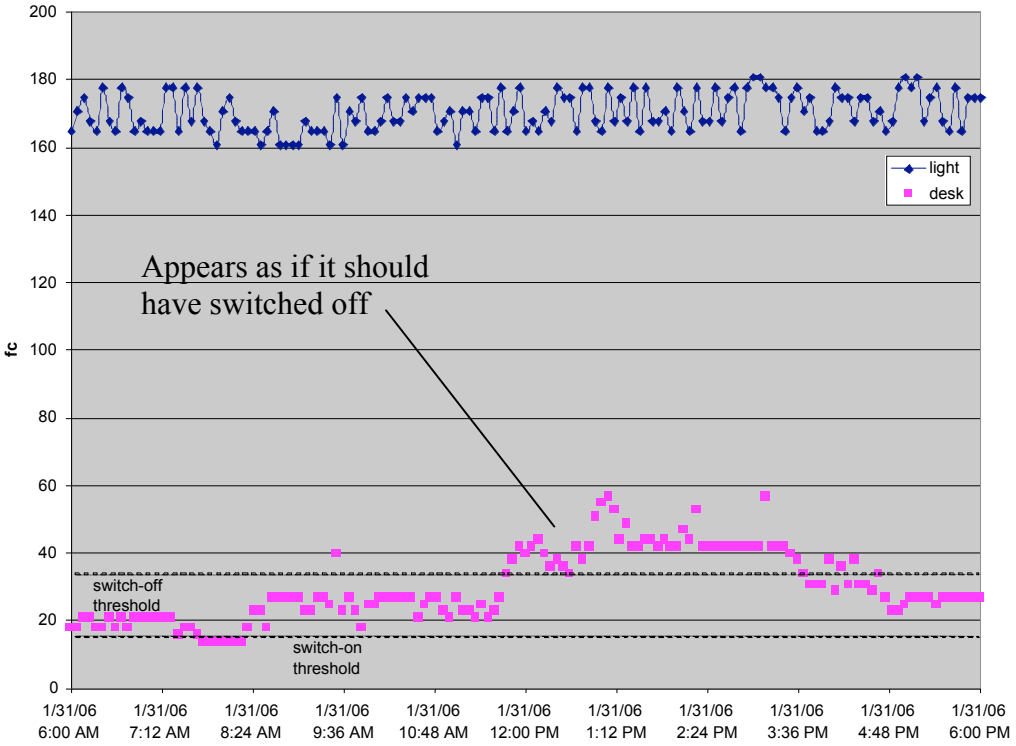

Figure 29, Illumination in 139 Knight Law Center on January 31, 2006

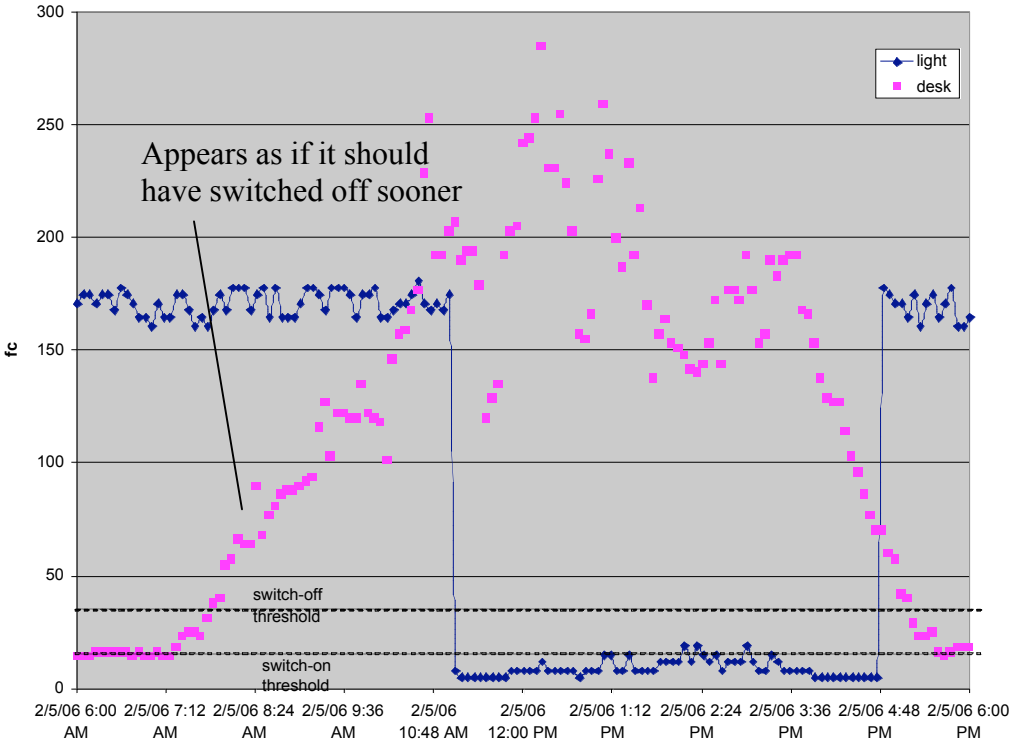

Figure 30, Illumination in 139 Knight Law Center on February 5, 2006

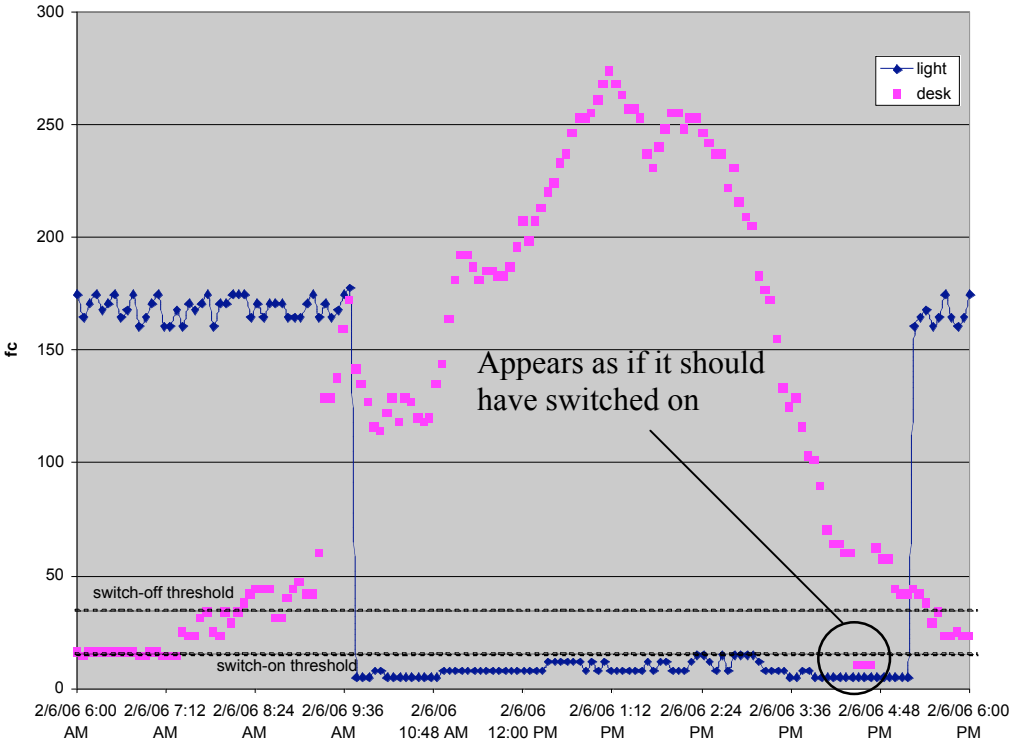

Figure 31, Illumination in 139 Knight Law Center on February 6, 2006

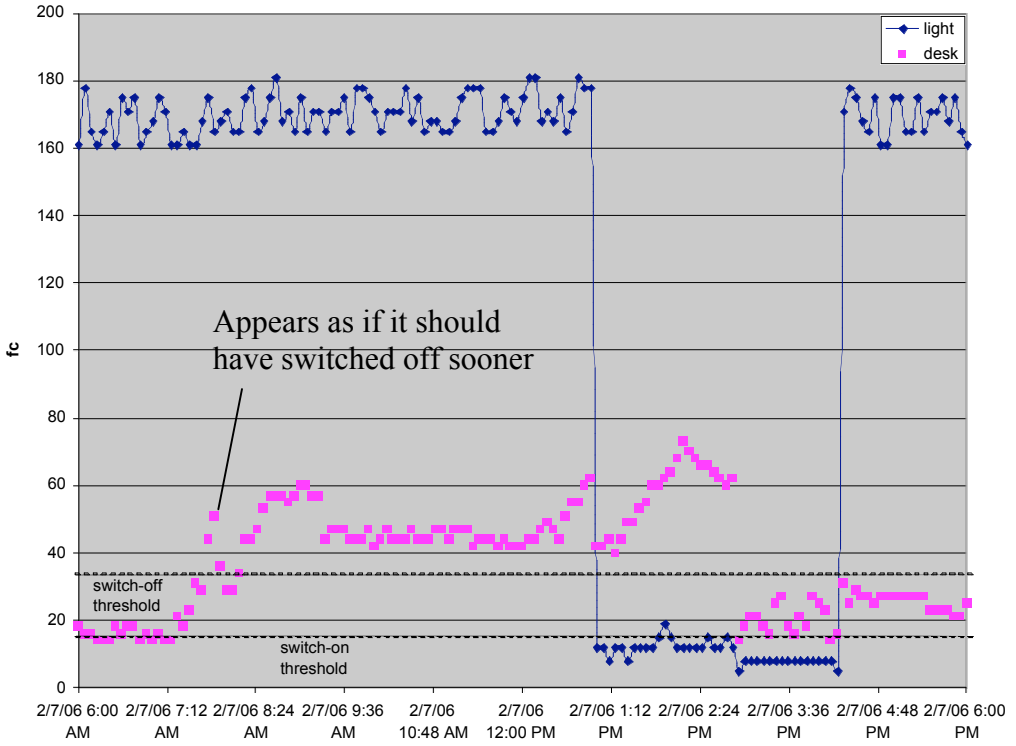

Figure 32, Illumination in 139 Knight Law Center on February 7, 2006

ENERGY SAVINGS

	139 Law School	64 W				
Date	Sky conditions	Hours on normal day	Hours off due to DaySwitch	Energy Savings (kwH)	% Savings	Times lights off/on per day
1/14/2006	Mostly cloudy/rain	12.6	1.25	0.08	9.9%	1
1/15/2006	Mostly cloudy	12.6	3.33	0.21	26.5%	1
1/16/2006	Mostly cloudy/rain	12.6	3.58	0.23	28.4%	1
1/18/2006	Mostly cloudy/rain	12.6	4.67	0.30	37.0%	1
1/19/2006	Mostly cloudy	12.6	4.83	0.31	38.4%	1
1/20/2006	Mostly cloudy/rain	12.6	6.42	0.41	50.9%	1
1/21/2006	Mostly cloudy/rain	12.6	4.17	0.27	33.1%	1
1/22/2006	Clear	12.6	6.08	0.39	48.3%	1
1/23/2006	Mostly cloudy	12.6	6.08	0.39	48.3%	1
1/25/2006	Mostly cloudy/rain	12.6	0.00	0	0.0%	0
1/26/2006	Mostly cloudy/rain	12.6	0.00	0	0.0%	0
1/27/2006	Mostly cloudy/rain	12.6	0.00	0	0.0%	0
1/28/2006	Mostly cloudy/rain	12.6	0.00	0	0.0%	0
1/29/2006	Mostly cloudy/rain	12.6	0.00	0	0.0%	0
1/30/2006	Mostly cloudy/rain	12.6	4.83	0.31	38.4%	2
1/31/2006	Mostly cloudy/rain	12.6	0.00	0	0.0%	0
2/1/2006	Mostly cloudy	12.6	3.58	0.23	28.4%	1
2/2/2006	Mostly cloudy/rain	12.6	4.08	0.26	32.4%	1
2/3/2006	Mostly cloudy	12.6	7.42	0.47	58.9%	1
2/4/2006	Mostly cloudy/rain	12.6	1.67	0.11	13.2%	1
2/5/2006	Mostly cloudy	12.6	5.75	0.37	45.6%	1
2/6/2006	Partly cloudy	12.6	7.50	0.48	59.5%	1
2/7/2006	Clear	12.6	3.33	0.21	26.5%	1

Figure 33, Energy Savings in 139 Knight Law Center

Figure 33 details energy savings for 139 Knight Law Center. The average energy savings due to the DaySwitch was 27.1% during the testing phase. Sky conditions do not appear to have an effect on energy savings, because similar savings were recorded on both cloudy and clear days. It should be noted that a great majority of the days were cloudy. The DaySwitch turned the light off and on once per day for a majority of the days, although there were some days when it did not turn off at all and one day that the light turned off and on twice. In looking at plots of the data, it is likely that the shades were closed for some portions of the testing period, particularly January

25 to January 29. We infer this because the HOBO located on the work surface recorded illumination levels throughout the day that were much lower than those recorded on other days that were cloudy and rainy.

The occupant surveyed thought that both switching and lighting levels were acceptable.

APPENDIX A: SURVEYS

Pre-installation 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 Blomquist 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? ( )

Post-test phase survey

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 controls that respond to natural light coming through the window. The purpose of the survey is to examine your reactions to this system.

Please consider the lighting 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 Blomquist 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 sufficient to allow you to properly operate this device? 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

Do you have any other thoughts about the lighting control system that was installed in this room?

_____
_____
_____
_____
_____
_____