DELTA

Portfolio

Demonstration and Evaluation of Lighting Technologies and Applications ▲ Lighting Case Studies

LED LIGHTING IN A CAMPUS BUILDING

Rosetti Hall, Siena College
Loudonville, New York

Volume 5 Issue 1

LED LIGHTING IN A CAMPUS BUILDING

Contents

Project Profile

Siena College is a private liberal arts college located in Loudonville, NY. In 2013, Siena College constructed Rosetti Hall, a 25,000 square foot, 3-story, contemporary brick building that includes classrooms, meeting rooms, and offices associated with the social sciences and humanities academic departments. The New York State Energy Research and Development Authority (NYSERDA) awarded funding to change the lighting specification from the originally specified conventional fluorescent lighting to all light emitting diodes (LEDs) and to have the project evaluated as a DELTA demonstration project by the Lighting Research Center.

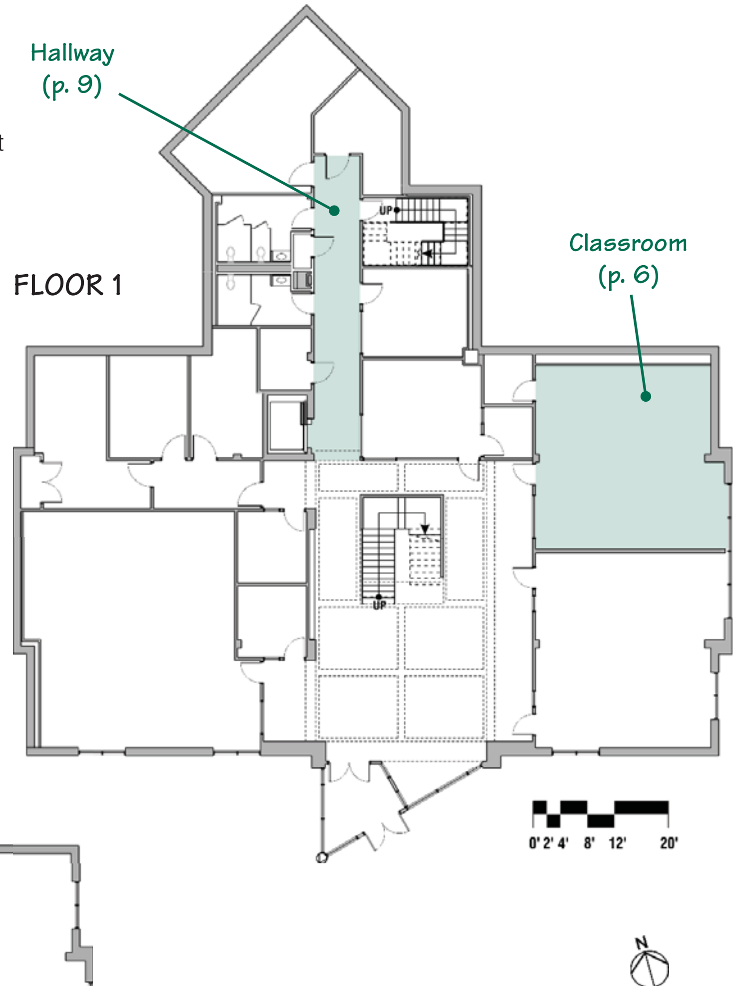
Rosetti Hall. *Photo courtesy of Siena College Marketing and Communications Office*

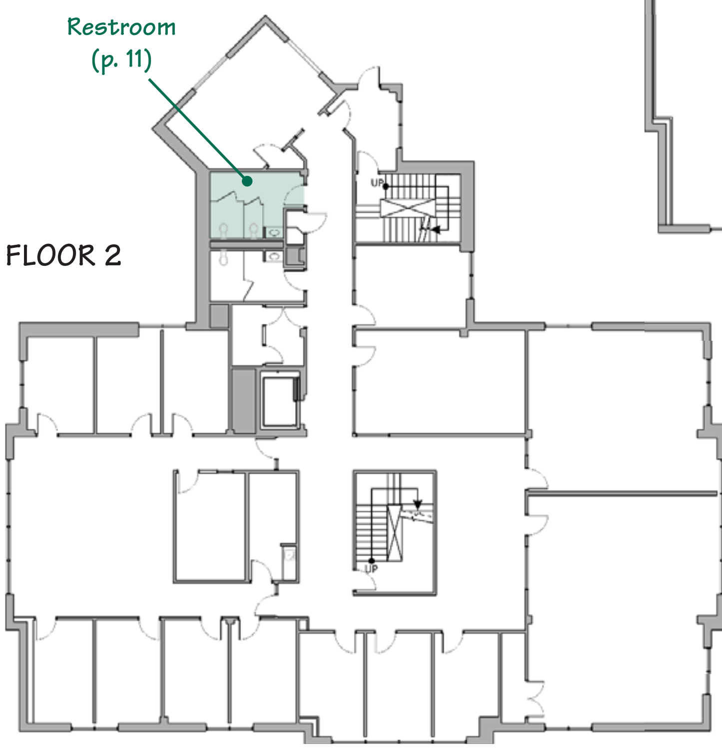
Objectives

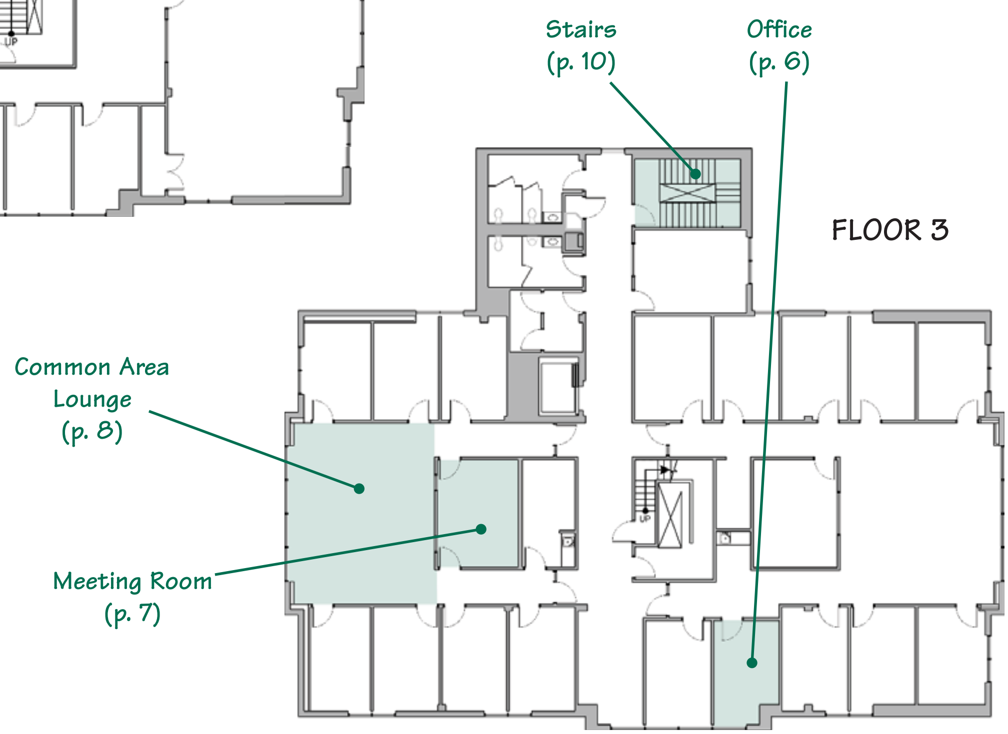
- Create a comfortable visual environment
- Provide flexible lighting to promote diverse teaching methods
- Save energy relative to the conventional fluorescent specification, in keeping with the college's philosophy of social responsibility

Floor Plans

DELTA measured light in typical campus spaces, on three floors of Rosetti Hall. Details about the lighting layout are available on the following pages.







Luminaires

The following LED luminaires were in installed in Rosetti Hall in the summer of 2013.

Direct-indirect pendant with opal lens, installed in classrooms and lounges. 4000K LEDs with uplight switched separately from downlight. Controlled by dimmers and occupancy sensors. 1065 lumens and 15 W per linear foot including both uplight and downlight.

Recessed 2x4 troffer with curved diffusers and 4000K LEDs, installed in offices, meeting rooms, and bathrooms. Integral passive infrared (PIR) occupancy sensor for auto-on and auto-off. Controlled by a dimmer in some rooms. 4900 lumens and 55 W at full light output.

Cylindrical LED pendant, 24" long and 10" diameter, installed in lounges. 4560 lumens and 48 W per pendant at full output. 4000K LEDs. Bottom edge suspended at 10'-6" above floor to match adjacent Type A pendants.

Wall sconce, matching Type C pendants, installed in lounges. 12" square x 4" deep. Bottom edge mounted 6' above floor. 4000K LEDs. 1520 lumens and 16 W each at full output.

Wall sconce, 12" square x 4" deep, installed in hallways, as well as some stairs and lounges. Bottom edge mounted at 6' above floor. 4000K LEDs. 1710 lumens and 18 W each. On continuously, unswitched.

Recessed 6" diameter downlight mounted approximately 8'-6" above the floor in hallways. 4000K dedicated LEDs, 1750 lumens and 27 W per downlight.

Vandal-resistant, wall-mounted luminaire mounted in stairs. 3900K LEDs enclosed in prismatic diffuser. Ultrasonic sensor steps down light output from full output (3564 lumens, 42 W) to the dim level (287 lumens, 5.5 W) when vacant. 37" long by 9.5" high by 3.5" deep. Mounted 6'-8" above stair landings.

Pendant strip light with 4000K LEDs, used in utility spaces. Integral PIR occupancy sensors for auto-on and auto-off. 4346 lumens and 49 W each.

Tracklight, 28° flood, 4000 K LEDs, installed in entry lobby. 810 lumens and 15 W each.

Exterior 6" diameter downlight installed at rear entrance. 4000 K LEDs, controlled by photosensor. 1500 lumens and 27 W each.

Pendant 6" diameter downlight installed in entry lobby. 4000K LEDs. 1500 lumens and 27 W per downlight.

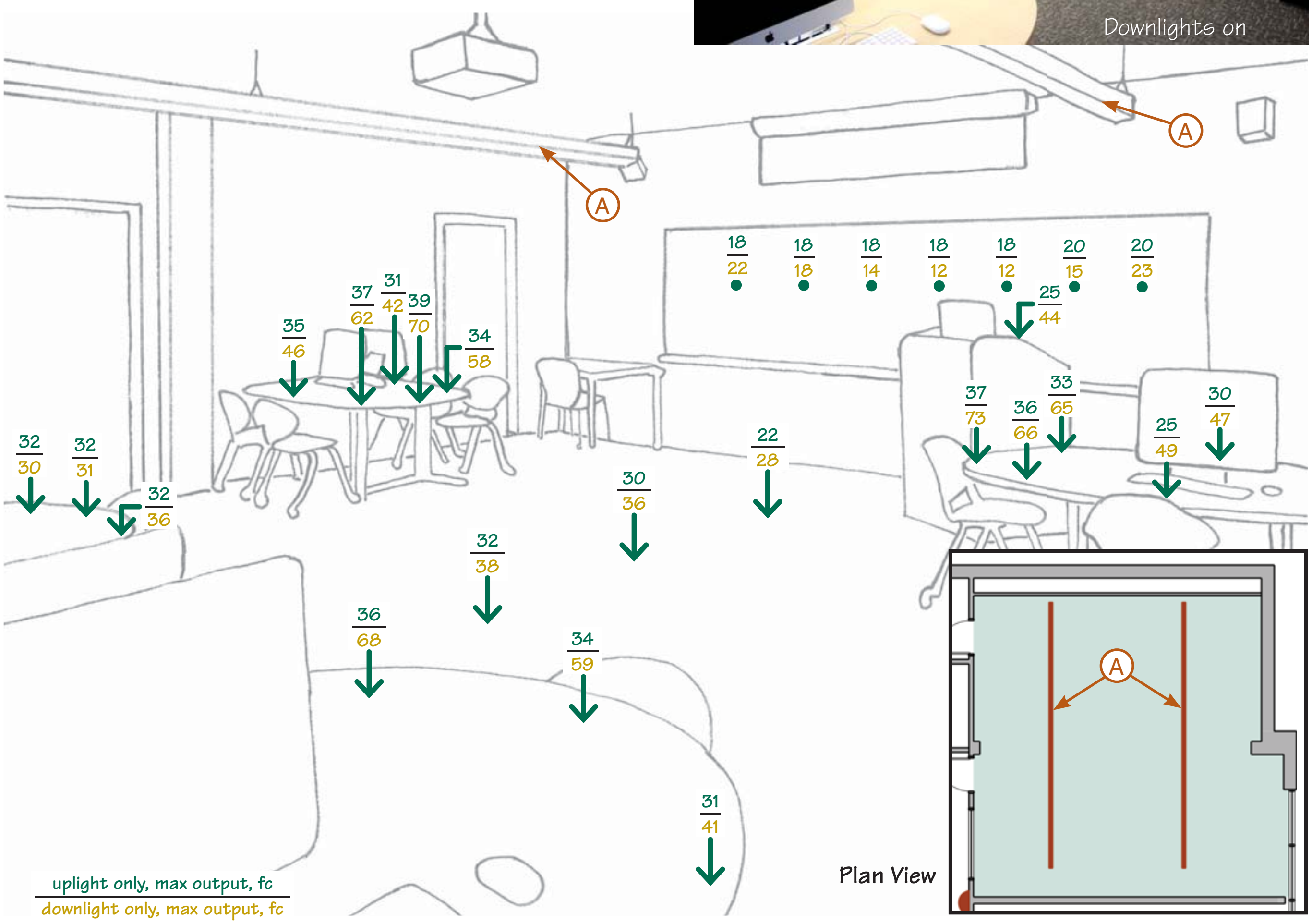
Details

DELTA measured illuminances in a typical classroom, office, meeting room, common area lounge, hallway, stairs and restroom. Measurement results do not include daylight contributions.

Classroom Photometry Results

Rosetti Hall has five classrooms, illuminated by linear LED pendants (luminaire Type A). Instructors can control uplight and downlight independently with dimmers near the whiteboard and switches at the door. DELTA measured illuminances in a classroom as shown below. Downlight was measured separately from uplight, both at full light output. Downlight illuminances on the tables ranged 30-73 footcandles (fc),[1] and uplight illuminances measured 30-37 fc. Illuminances on the whiteboard ranged 12-23 fc with the downlights on, and 18-20 fc with the uplights on.

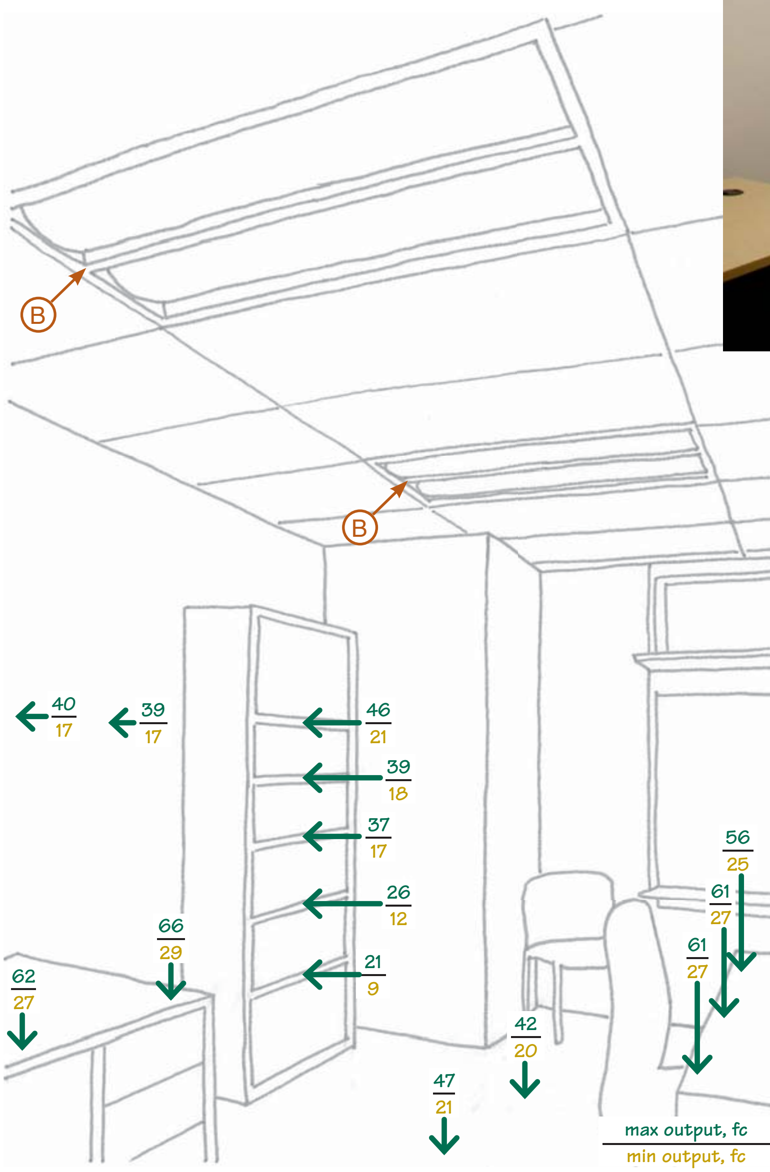
[1] 1 footcandle = 10.76 lux

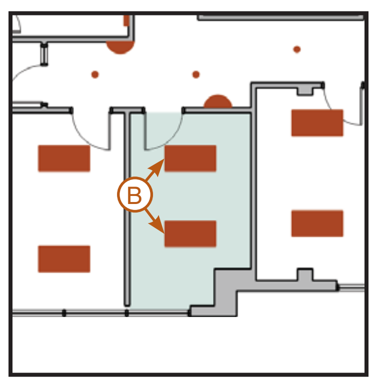


Office Photometry Results

There are 29 offices in Rosetti Hall, with most offices about 9.5' x 15' in size. Most are private offices, and a few are shared by two people (as shown below). Most offices have a window, an adjustable light shelf and mesh shades. All offices have two recessed troffers (luminaire Type B) connected to a dimmer.

Illuminances on the desks ranged 56-66 fc and 21-46 fc on the bookcase. In the office that DELTA measured, the dimmer was able to reduce light levels to about 40% of full output. One Siena employee commented that it would have been preferable to be able to dim lighting lower than 40% (see page 17).

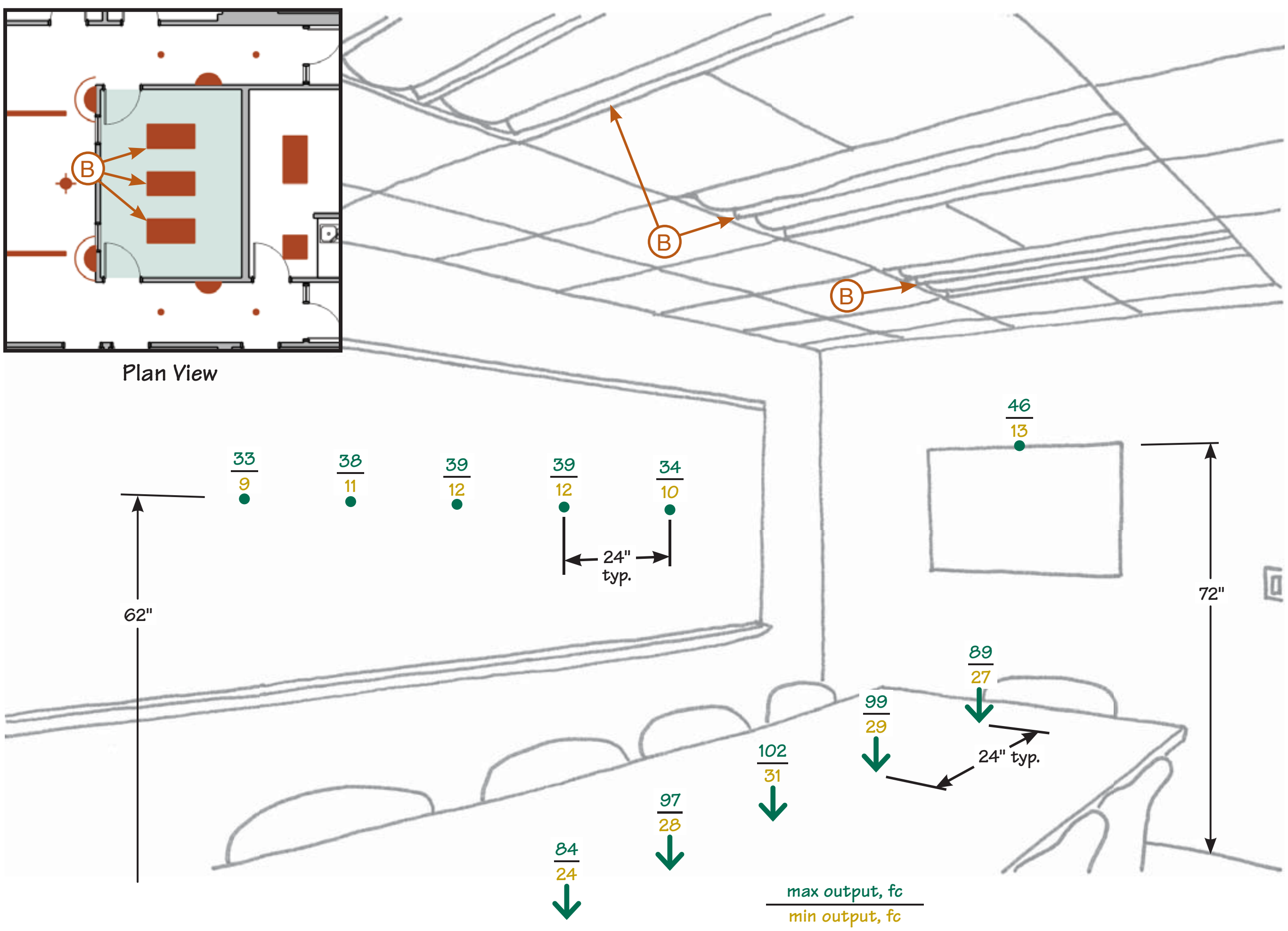




Plan View

Meeting and Seminar Room Photometry Results

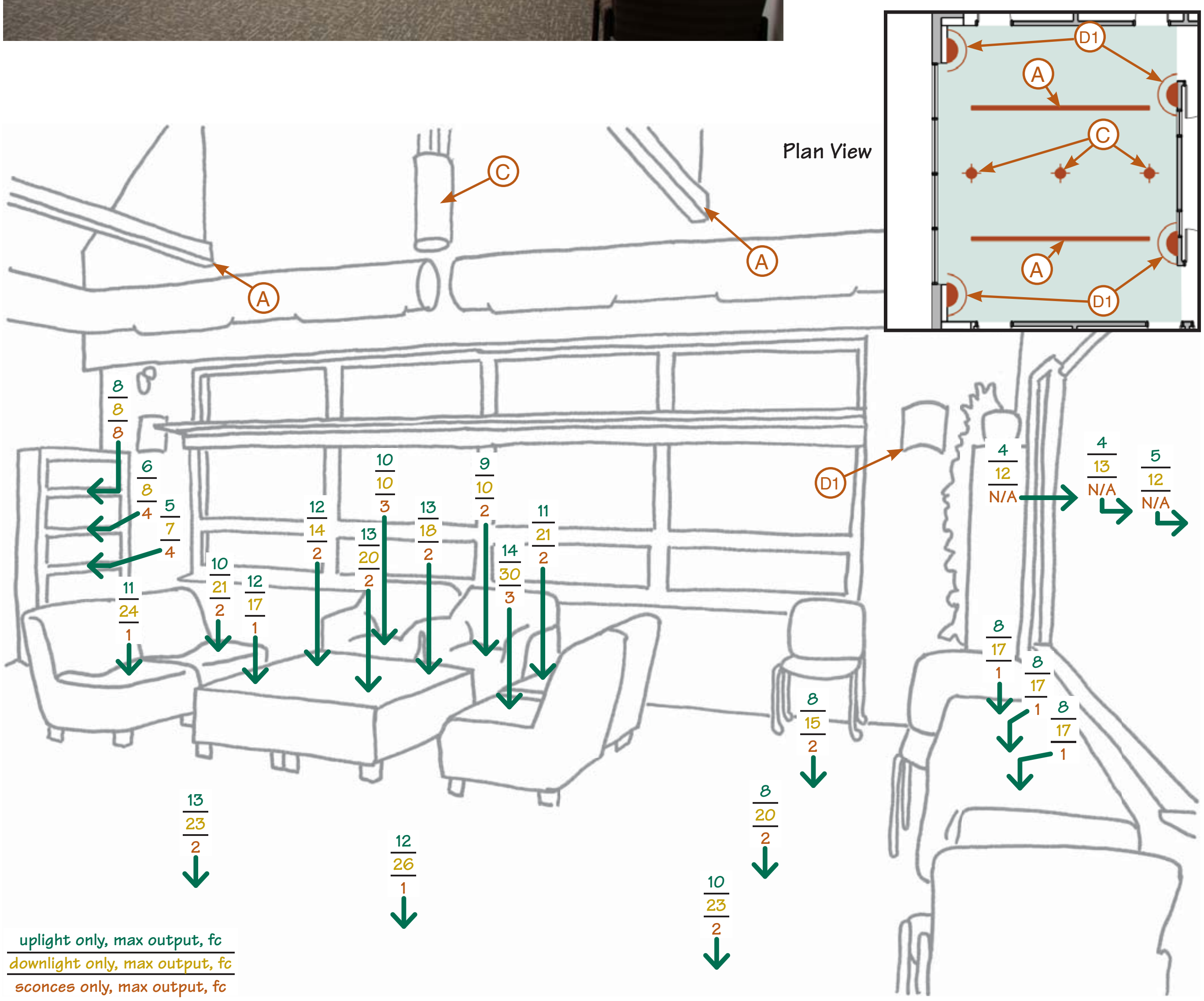
Meeting rooms and seminar rooms are also illuminated with recessed troffers (luminaire Type B) connected to a dimmer. Three meeting rooms are located adjacent to faculty offices, and are used by students and faculty. The four seminar rooms in Rosetti Hall are used for small classes and informal studying. DELTA measured illuminances in one meeting room, as shown below. Illuminances on the table ranged 84-102 fc, and ranged 33-39 fc on the whiteboard. As shown below, this dimmer was able to reduce light levels to about 30% of full output.



Common Area Photometry Results

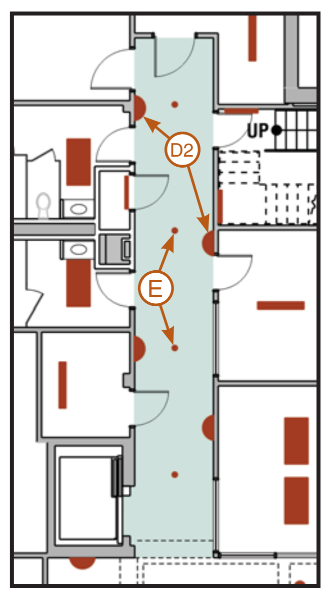
Rosetti Hall has three common area lounges: two lounges on the third floor have cathedral ceilings (see cover photo), and the lounge on the second floor has a nine-foot ceiling. These lounges are used day and night for informal gatherings of faculty and students.

DELTA measured illuminances with downlights (luminaire Types A and C), uplights (luminaire Type A), and sconces (luminaire Type D1). As shown below, the downlights provide 7-30 fc on the various surfaces. The uplights provide another 4-14 fc. The sconces contribute 1-4 fc at most points.



Hallway Photometry Results

Hallways in Rosetti Hall have two layers of light. The sconces (luminaire Type D2) are on continuously, year-round. The downlights (luminaire Type E) are controlled by conventional wall switches. Monitoring (see page 17) showed that these downlights are sometimes not turned on, even during core business hours. The downlights contribute 12-33 fc on the floor, and sconces add another 3-5 fc.

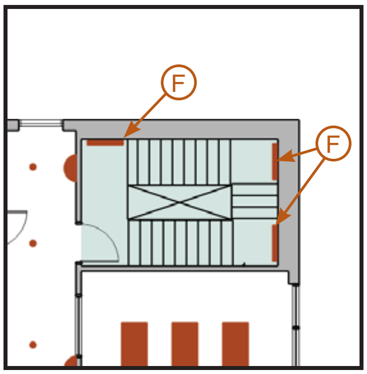


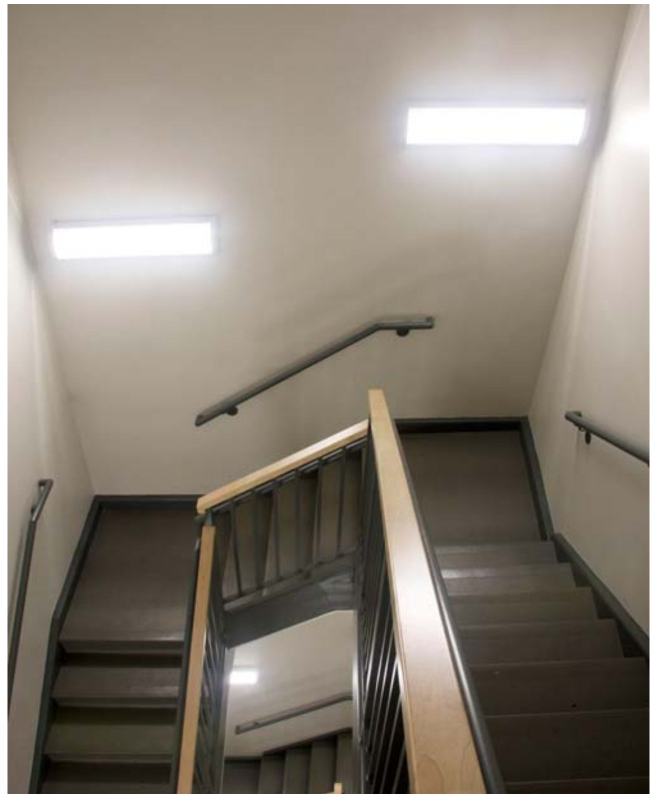
Plan View

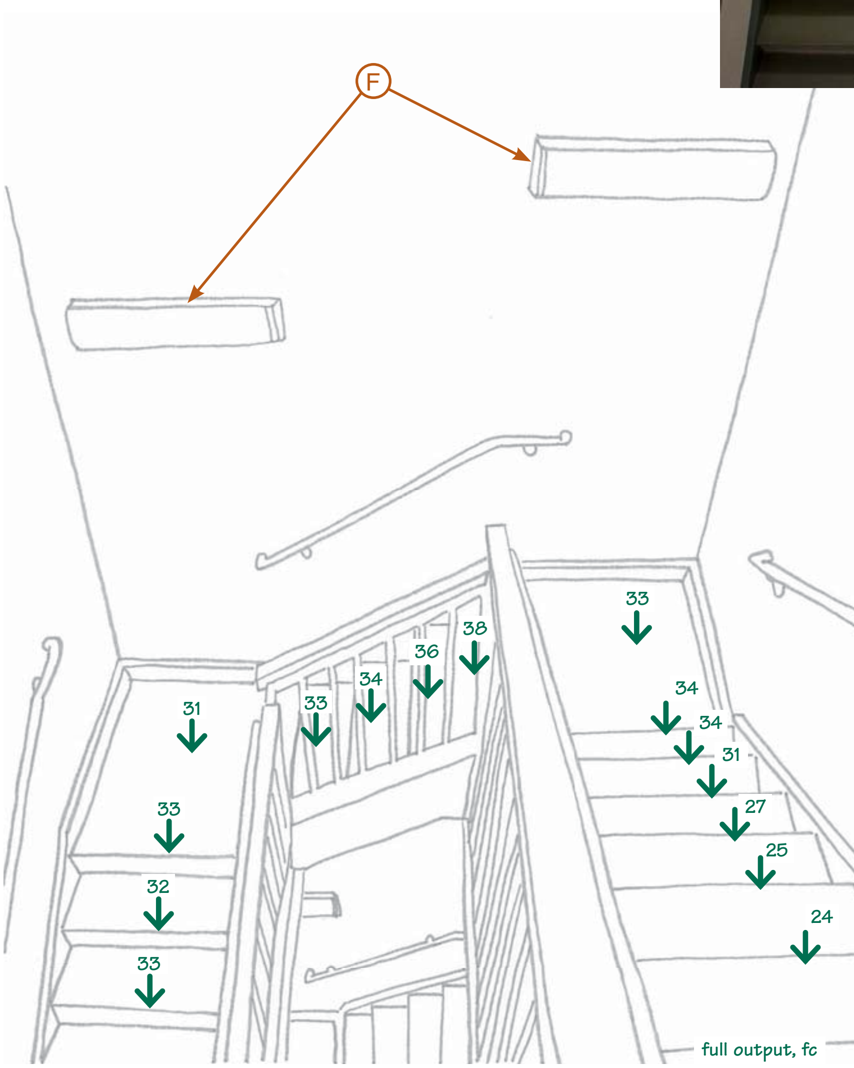
Stairway Photometry Results

Rosetti Hall has front and rear stairs. When unoccupied, integral ultrasonic sensors dim the Type F luminaires to 8% of full output. Illuminances on the stairs range from 24 fc to 38 fc at full output.

Plan View

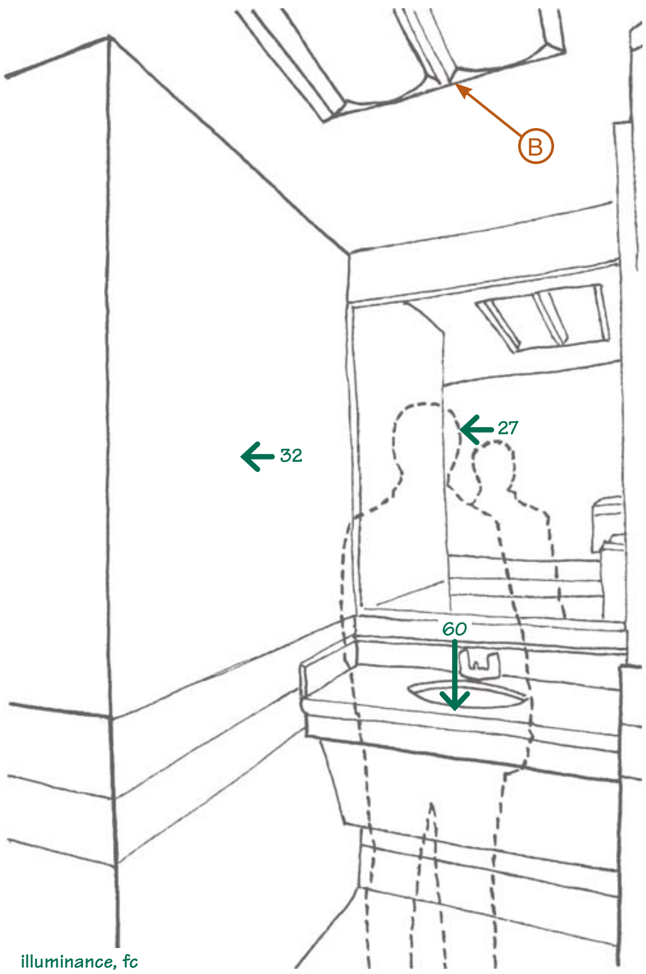




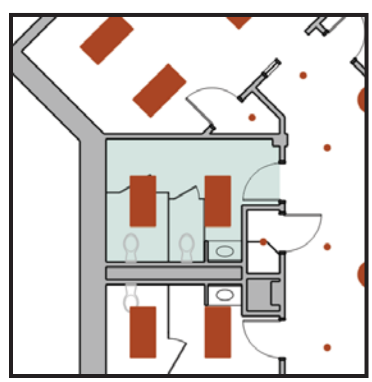


Restroom Photometry Results

Type B luminaires in the restrooms are the same as used in the offices and meeting rooms. As shown in the plan below, there are two luminaires in each restroom. Both are controlled by integral passive-infrared (PIR) sensors and not by a wall switch. Illuminances are 60 fc on the vanity counter and 28 fc on a person's face when standing in front of the counter. In the adjacent toilet area, DELTA measured 85 fc on a dispenser directly under the other luminaire, and 21 fc on a dispenser in the adjacent partition (see plan view).



Plan View



Staff and Student Response

DELTA administered questionnaires to 200 people in Rosetti Hall. The graphs on pages 15-16 show the responses by room type. Because most of the LEDs are shielded with opal diffusers and have a neutral (4000K) color temperature, most the LED luminaires are indistinguishable from conventional fluorescent lighting. Overall, the questionnaires showed that the lighting in Rosetti Hall was well-liked.

Classroom Questionnaire Results

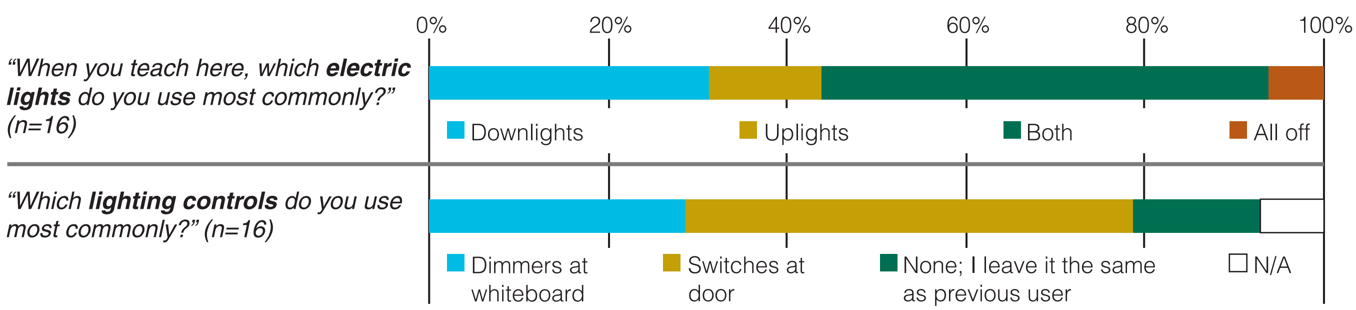
Sixteen instructors answered a detailed lighting questionnaire, and 83 students answered a brief questionnaire about the classrooms. About one third (31%) of the instructors reported that they use the downlights and 50% of the instructors use both uplights and downlights. More instructors rated the downlights as helpful for their teaching compared to uplights (56% vs. 25%). Glare was not a major concern; instructors rated both downlights and uplights as comfortable to look at. Students also found both lighting modes comfortable. Most instructors (81%) and students (64%) rated the amount of light provided by the electric lighting to be "just right." Over half the instructors (56%) thought the dimmers were "very helpful."

"I love the fact that the screen is so easy to see with just the downlights on."

One east-facing classroom would benefit from opaque shades in addition to the mesh shades.

Overall, most instructors (75%) and students (73%) thought the lighting was "better" or "much better" than other classrooms.

"I like to adjust. I like the option to turn it up. For [the] most part, I turn it on at the door, then adjust if necessary."



"When sunny, it is way too bright at the whiteboard and the [mesh] shades don't help mitigate the glare."

"I would prefer a darker environment in the front of the room."

Office Questionnaire Results

DELTA administered a questionnaire to 21 faculty and staff with offices in Rosetti Hall. The results showed that the luminaires provide enough light for most people (62%).

"The amount of light is 'just right' especially since it's adjustable."

Many people commented that they don't use the electric lighting during the day because they are satisfied with the amount of daylight from their windows.

The dimmer was considered helpful by 39% of respondents. Most people (67%) did not find the luminaires to be glary. Most people (76%) did not feel they needed an additional task light (see figure, below).

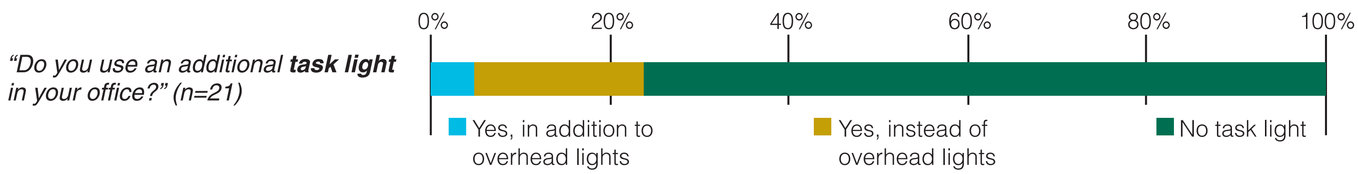
PIR occupancy sensors are integrated in each of the office luminaires; the auto-off feature turns off the lights automatically when vacant for the designated delay time period. Before the evaluation, there were frequent complaints of false-offs in the offices. After lengthening the time delay to 30 minutes, there are fewer complaints about the sensors. However, even a few months after that adjustment (when the DELTA questionnaire was administered), 19% of respondents rated the auto-off feature as "very unhelpful" (page 15).

"[The auto-off feature] is much better now that they lengthened the amount of time [delay]…"

"Sometimes it's irritating."
– An occupant describing *false-off* sensor events.

Luminaire Type B has curved diffusers that are made from flexible, lightweight material. There were a few reports of the diffusers falling out of the fixtures, causing occupant concern.

With the exception of a few LED segments failing in the first few months of operation, the lighting equipment performed as expected.



Meeting/Seminar Room Questionnaire Results

DELTA administered a questionnaire about the meeting/seminar room lighting to 61 people. Almost all (93%) thought the amount of light was "just right." Most (72%) of the respondents found the luminaires to be comfortable. While direct glare was not a concern, there was one comment about reflected glare: "I would like to turn off light adjacent to the flat screen monitor." See photo at right.

"I really like [teaching in] this room. I wish all my classes were here."

Most people thought the auto-on and auto-off sensor functions were helpful in meeting/seminar rooms. But one person commented that the auto-on feature was confusing in meeting rooms because some people still use the wall switch to turn off the lights, while others let the auto-off sensor turn off the lights. As a result, people don't know whether to use movement or the wall switch to turn on the lights upon entering.

"Because the sensor is on the fixture, people have to be trained NOT to use the switch to turn off the light; [otherwise] I'm flapping my arms!"

Many (44%) respondents considered the dimmer to be "somewhat" or "very" helpful.

Overall, most people (84%) think that the lighting in the meeting/seminar rooms is "better" or "much better" than other lighting they've experienced in similar places.

A few questions about lighting controls were also added to questionnaires in other spaces, with an additional 56 responses (see p. 14). Several people (43%) remembered noticing the lights automatically turning on, and a few (18%) said they had noticed lights automatically turning off. The rest (43%) had not noticed either, or chose not to answer. DELTA noticed a few instances in which the integral occupancy sensor for the luminaire closest to the door falsely switched on, leading to possible wasted energy. This problem could have been avoided if the sensors had a setting for "auto-off only"; however, it is not possible to disable the auto-on feature while retaining auto-off with this equipment. To avoid false-offs, the sensors closest to the doors should be masked so as not to "see" traffic passing outside of the space.

Some reflected glare was seen on the flat screen monitor.

Common Area Lounge Questionnaire Results

DELTA administered a lighting questionnaire to 19 students and faculty using the common area lounges both during the day and at night. Over half (58%) said they use the Type A and C downlighting. A few respondents used the uplighting (21%) or Type D1 wall sconces (16%). About one third (32%) didn't comment on which lights they use.

Almost all (89%) thought the amount of light in the lounges was "just right," not too much or too little. Most (79-89%) found the luminaires comfortable to look at and glare was not a concern. As shown below, most people (63%) never adjust the mesh shades.

"I never noticed the 'little lights' [sconces] before. We don't really need them because we have so much [daylight]."

Lighting controls are not centralized, not consistent in type, and are not labeled in the lounges. Fewer people found the controls to be helpful in the lounges, compared to other spaces in the building. The following controls were rated as "very helpful" or "somewhat helpful": programmed dimmer buttons (26% of respondents), Type D1 wall sconce dimmer (37% of respondents), daylight dimming (47% of respondents), and auto-off (74% of respondents). Several people commented that they never touch these lighting controls. For ease of use, controls should be clustered and labeled, or use an integrated scene controller to turn on several different luminaire types to pre-set dim levels.

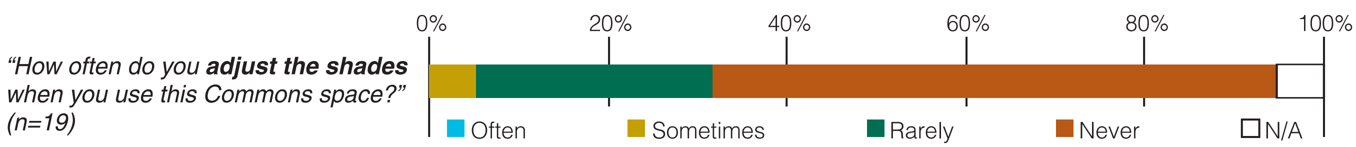
"The controls are overly complex for the space. There are so many combinations in here that we just don't even deal with it. It's just beyond their consciousness. So people just leave [the lighting in] this space alone."

Overall, most people (74%) thought the lighting in the lounges was "better" or "much better" than others they have experienced.

"Dimmers may be more useful when we have events in the future."

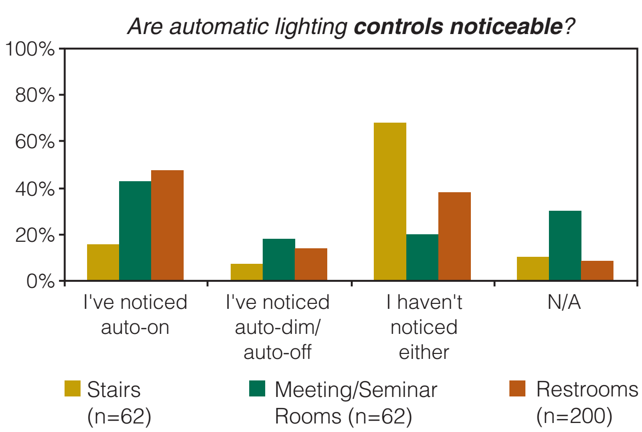
"It's better when both uplights and downlights are on."

[2] There are two sets of two programmable buttons for Type A pendants, but only one faculty/staff member has received training in their operation. The Type D1 sconces are controlled separately, from a wall-box dimmer on one side of the room. The Type E downlights leading to the lounge are controlled by a separate switch.



Stairway Questionnaire Results

DELTA received feedback about the lighting in the stairs from 200 people. Most (68%) said they didn't notice the lights turning on or dimming automatically.

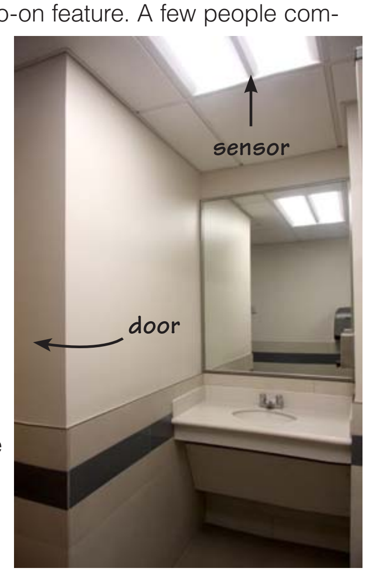


"Very slow to come on."

"[Auto-on is a]… nice feature."

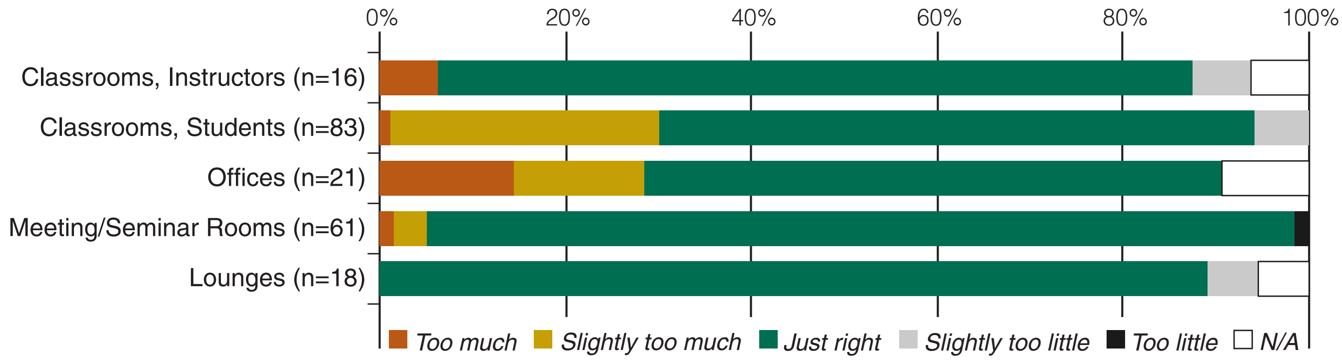
Restroom Questionnaire Results

As shown in the graph, left, DELTA collected feedback about the lighting in the restrooms from 200 people. Almost half (48%) noticed the auto-on feature. A few people commented that the lights seem to turn on slowly. Upon investigation, DELTA noted that in at least one restroom, the integral sensor was located around the corner from the opening door; if the luminaire had been rotated 180° when it was installed, the sensor would have been aligned with the door and this delay may have been shorter and less noticeable.

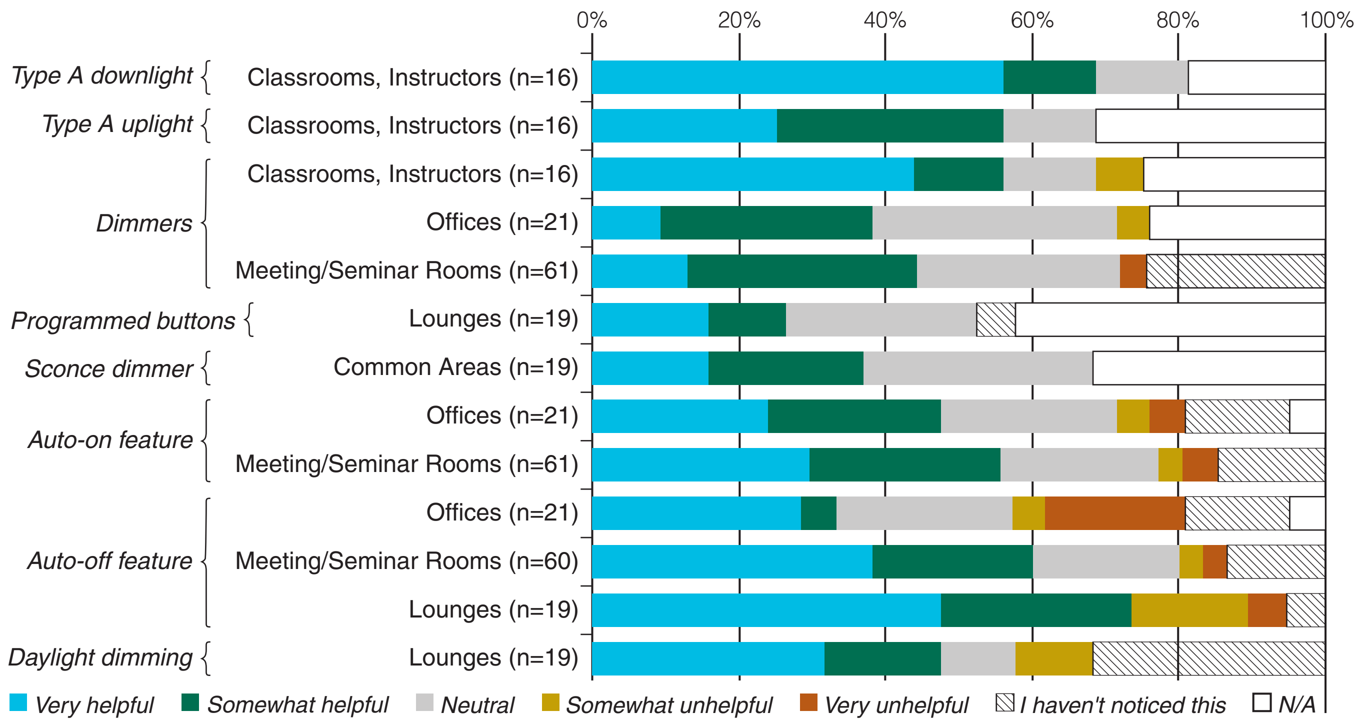


Other Occupant Feedback

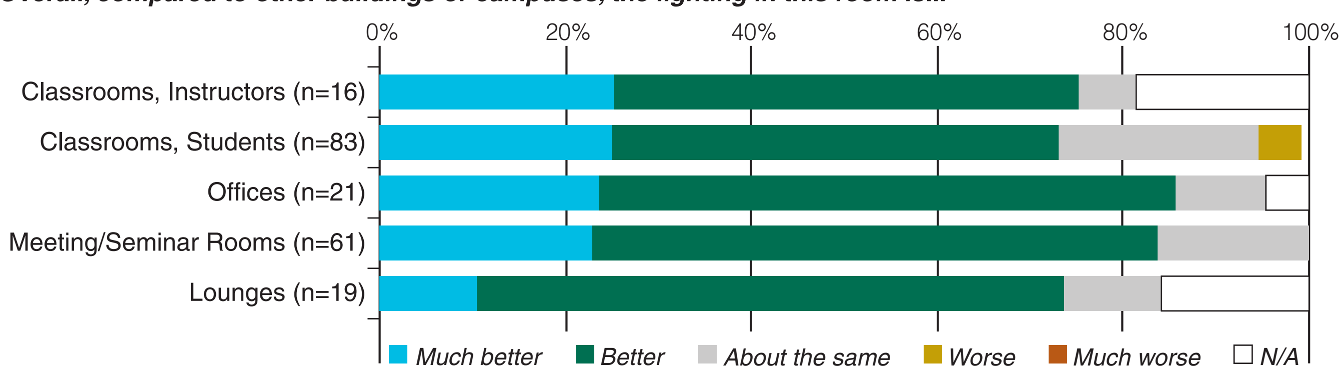
"The amount of light provided by the electric lighting is..."



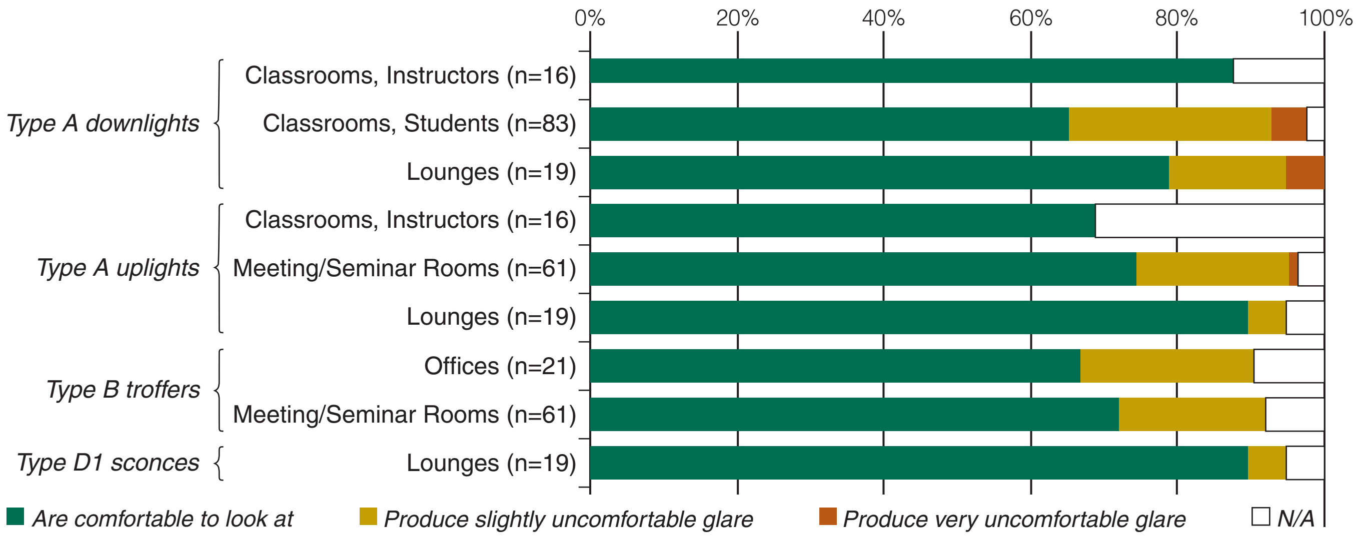
"Lighting equipment ______ is helpful/unhelpful."



"Overall, compared to other buildings or campuses, the lighting in this room is..."



Considering glare: "When ______ are on, they..."



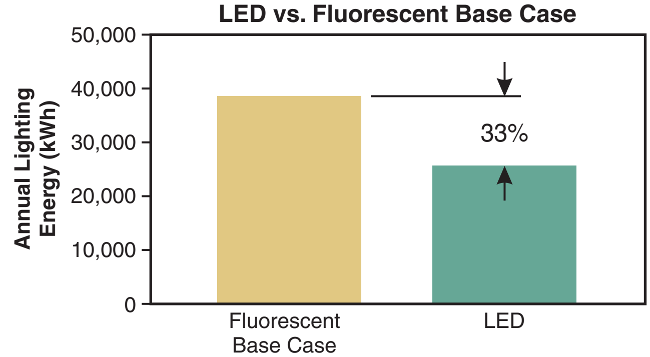
Lighting Energy Use Comparisons

DELTA monitored individual luminaires to estimate total annual lighting energy use in Rosetti Hall (see Methodology, page 19.) As shown below, energy use is significantly less than the original fluorescent specifications.[3] All LED luminaire types have lower power demand than the fluorescent specification, resulting in a lower lighting power density for all spaces and 33% energy savings (see table below).

	LED		Fluorescent Base Case		
	Average Power Density (W/ft²)	Annual Energy (kWh)	Average Power Density (W/ft²)	Annual Energy (kWh)	Energy Savings
Classrooms	1.09	5023	2.24	10,847	54%
Meeting/seminar	0.81	2405	0.85	2536	5%
Lounges	0.74	3884	1.68	7015	45%
Offices	0.77	1221	0.81	1288	5%
Hallways	0.59	6163	0.88	8717	29%
Staircases	0.87	486	1.13	2042	76%
Restrooms	1.25	906	1.34	972	7%
Other	0.50	5574	0.63	5156	-8%*
	0.74	**25,662**	**1.11**	**38,573**	**33%**

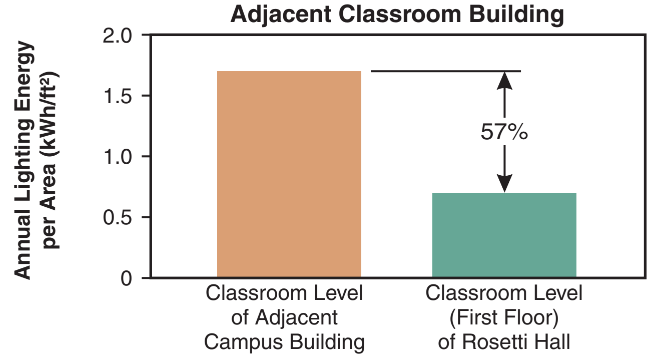
* - Slightly more energy use due to added or changed luminaires

Lighting Energy Comparison: LED vs. Fluorescent Base Case



DELTA also compared lighting energy use in Rosetti Hall to an adjacent building on the Siena College campus. Monitoring equipment was installed in electrical panels in Rosetti Hall, as well as in the adjacent building, for the same 2-week period. As shown below, compared to the adjacent building, energy use per area was 57% lower in Rosetti Hall.

Lighting Energy Comparison: Adjacent Classroom Building



[3] Both solutions would have performed well compared to a campus building operating at the maximum power allowable by the 2010 New York State Energy Conservation Construction Code (1.2 W/ft²). Power density for all the LED lighting is 0.74 W/ft². For the fluorescent solution, power density would have been 1.11 W/ft².

Controls Use Results

Classrooms: Instructors take advantage of the flexibility to control uplight separately from downlight (see table below).

	Percent (%) of Monitoring Time On	
	Downlight	Uplight
Classroom 104	20%	18%
Classroom 117	4%	12%
Classroom 120	22%	30%
Classroom 225	15%	22%
Classroom 226	32%	23%

Offices: Office lighting was used an average of 6% (and up to 20%) during the monitoring time. Dimmers appear to be used periodically in about a third of the offices.[4] The dimmers used in the offices were well-matched for operating the electronic drivers in the LED troffers; they did not cause flicker or noticeable differences between luminaires in a room. However, dimmers were only able to dim the lights to 40% of full output. The dimmer is designed for loads up to 2000 W. It is possible that for small loads, such as Type B LED troffers, the dimmers are unable to dim as low as when more luminaires are controlled. Specifiers should consult with their dimmer manufacturers to understand the implications of small load size on dimmer functionality. As a result of this project, the engineer now requires a mockup to confirm satisfactory operation of LEDs with proposed dimmers.

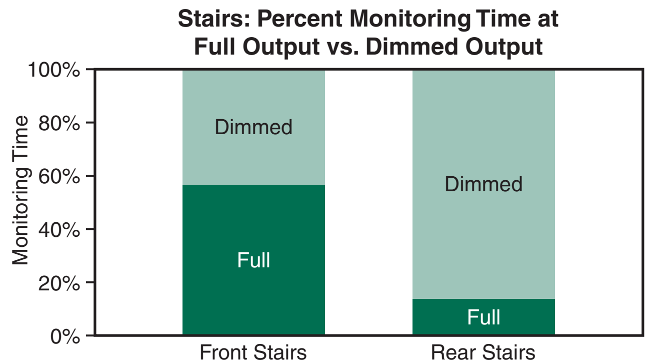
Meeting/Seminar Rooms: Lighting was used an average of 27% of the monitoring time (ranging 20%-43%).

Common Area Lounges: Monitoring data do not clearly indicate whether or not the occupants used programmed dimmer buttons to dim the Type A pendants. However, the data confirm that photosensors dim the pendants in response to daylight, on some days.[4] The ability to dim the Type D1 sconces may not be useful because they were only used at full output during monitoring; dimmers may not be necessary because these sconces provide less than 5 fc at full output. Type D1 sconces and Type E downlights in the lounges were not controlled by occupancy sensors, so these luminaires were occasionally left on overnight.

Hallways: As shown the following table, the Type E downlights on the first floor were used much less than on the second and third floors. Visitors to the first floor may not be clear how to or whether to turn on the downlights. The wall switches do not automatically turn off after hours, so they are occasionally left on overnight. Simple switches are a good choice for places with a clear "owner" such as a private office, rather than public areas such as hallways.

Hallway Location	Downlights Switched On ___% of the Time	Sconces On %
1st floor	5%	100%
2nd floor	56%	100%
3rd floor	74%	100%

Stairs: Most of the Type F luminaires turn up to full output when the stairwells are occupied. There were a few luminaires that seemed to stay on continuously at full output despite the adjacent luminaires registering no occupancy.[5] As shown below, the front stairs were more frequently used than the rear stairs during the monitoring period.



Restrooms: Sensors kept the lights in the restrooms on 14-27% of the time. Occupancy rates varied between floors. In most cases, the luminaire above the vanity counter was on more frequently than the one above the rear enclosed stall.

Low Traffic Areas: Spaces such as mechanical rooms employ Type G utility lights with an integral PIR sensor. Luminaires in these locations were on less than 5% of the monitoring time. Copy rooms requiring a key or entry code also had low usage percentages (2%-6%). Lighting in locked closets stayed on for several days at a time on all three floors; occupancy sensor wall switches in these closets require adjustment or replacement.

Entry Lobby: Type E recessed downlights in the entry vestibule were switched off by a downward-facing dusk-to-dawn photosensor; anecdotal observations and luminaire monitoring showed that the sensor cycled off-and-on repeatedly at night. This may have been due to passing

[4] See Methodology regarding dimming, page 19.

[5] Presuming upcoming adjustment, repair, or replacement, these have been excluded from the energy calculations.

car headlights in front of the building, or by inter-reflected light within the vestibule. After the photosensor was replaced and aimed to the interior of the building, the lights operated as expected at night. Type H track lighting in the entry lobby, shown in the photo below, is operated by a dimmer, without an automated sweep-off after hours; these lights were left on for days at a time during the DELTA monitoring period.

Utility Rooms: Utility rooms (with mailboxes, coffee, sink, etc.) had the same Type B troffers as other spaces in Rosetti Hall. DELTA observed instances in which the integral occupancy sensor falsely turned lights on. Monitoring data (see table at right) support the conclusion that these sensors produce false-ons and waste energy. This problem could have been avoided if the sensors had a setting for "auto-off" only; however, it is not possible to disable the auto-on feature with these integral sensors. To avoid false-offs in this case, the sensors closest to doors should be masked so as not to "see" traffic passing outside of the space.

Utility Room Luminaire Location	Time On %
2nd floor front	27%
2nd floor rear	17%
3rd floor front	30%
3rd floor rear	23%

Pollution Avoided

The estimated annual energy savings (compared to the original fluorescent specification) translate to reduced pollution.[6]

Pollution Avoided					
SO_2		NO_x		CO_2	
lbs	kg	lbs	kg	lbs	kg
14.2	6.4	5.2	2.3	7050	3198

Sulfur dioxide (SO_2) is associated with visible pollution (haze) and acid rain.
Nitrogen oxides (NO_x) are one of the main causes of ground level ozone (smog) and acid rain.
Carbon dioxide (CO_2) is a possible contributor to global warming.

Energy Cost Savings

Assuming $0.11/kWh, these energy savings translate to a savings of $1420 per year.

[6] Per EPA Calculator downloaded March 2014: http://www.epa.gov/cleanrgy/energy-and-you/how-clean.html

Energy Methodology

To sample lighting energy use, DELTA researchers installed battery-powered monitoring devices in one or more luminaires for each room, for about one week per space. Monitoring took place September–November 2013. The monitoring devices determined when lights were on and off. Hours of use were translated to percentage of time on, which was multiplied by the quantity of luminaires in each space. Siena facilities staff reported to DELTA that these usage patterns are typical of about 40 weeks per year for most circuits. For the remaining 12 weeks per year lights were assumed to be off, with the exception of the Type D2 wall sconces in the path of egress (on at full output year-round).

The manufacturer of the Type F luminaires in the staircases publishes power demand at sleep mode, thus DELTA was able to estimate reductions in annual energy use due to this dimming. In spaces with variable dimming capability, the monitoring devices gave a clue about the frequency of dimming use, but not enough information to estimate actual reduced power demand and reduced light output. Therefore most of the energy calculations assume lights operated at full output when turned on.

To compare lighting energy use in Rosetti Hall to another campus building with similar functions, panel-level metering devices were installed for two weeks in early November, after daylight savings time ended for the year. Current transformers were connected to each lighting circuit in Rosetti Hall; the resulting current measurements were multiplied by the circuit voltage displayed in the electrical mechanical room (121 V), and assumed power factor of unity (1.0). Resulting power data were multiplied by the measurement time interval (5 minutes) to show energy use. As per above, these energy usage patterns were multiplied by 40 weeks per year for most circuits. Resulting annual energy use estimate (27,119 kWh) was within 5% of the value estimated by monitoring each luminaire (25,662 kWh) per above.

The first floor of another campus building (Siena Hall, 16,050 ft^2) was monitored for the same two week period. As the comparison space was mostly classrooms, only the first floor of Rosetti Hall was used for comparison. Energy use for the first floor (excluding staircases) was divided by the square footage of the first floor (6807 ft^2, excluding staircases).

Lessons Learned

- This LED system saves considerable energy (33%) compared to the fluorescent system originally specified.
- Overall, most occupants think that their lighting is about the same as or better than similar campus spaces.
- The LED lighting is indistinguishable from conventional fluorescent lighting due to shielding with opal diffusers and a neutral (4000K) color temperature.
- The most noticeable aspects of the lighting system related to controls:
  - Integral occupancy sensors
    - Time delay in offices and meeting rooms should be lengthened to reduce complaints of false-off.
    - When luminaires with integral PIR sensors are used in restrooms, the luminaire closest to the door should be oriented so that it "sees" movement (e.g., door swing) as soon as the occupant enters the space.
    - The auto-on feature is helpful in public spaces without a wall switch (e.g., restrooms, staircases), but may lead to occupant confusion and energy waste in public spaces that also have switches (e.g., meeting rooms, utility rooms).
  - Dimmers and switches
    - Some instructors take advantage of the ability to dim uplights separately from downlights; downlighting is preferred in the classrooms.
    - Dimmers for LEDs should be specified that can accommodate the size of the load; one type of dimmer at this site did not dim very low in spaces with small loads. A mockup can confirm satisfactory operation of LEDs with proposed dimmers.
    - Controls for multiple layers of light should be clustered and labeled, or use an integrated scene controller.
    - Switches and dimmer controls may be confusing and ineffective in public spaces such as hallways and lounges; controls that provide scheduled turn-on or sweep-off may be more useful in these spaces.

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