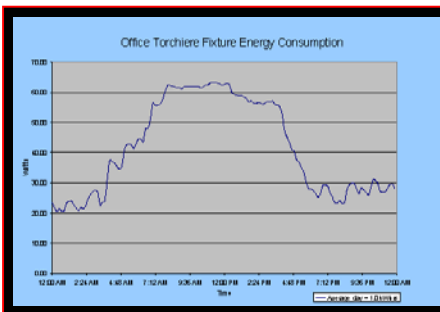
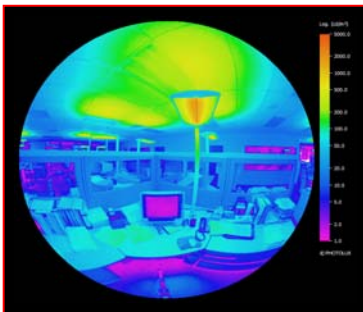


*Customer Advanced Technologies Program
Technology Evaluation Report*

The Office Torchiere Lighting System



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About the Customer Advanced Technologies Program

SMUD’s Customer Advanced Technologies (C.A.T.) program works with customers, researchers and manufacturers to encourage the use and evaluation of new or underutilized technologies. The program provides funding for customers in exchange for monitoring rights. Completed demonstration projects include lighting technologies, light emitting diodes (LEDs), residential building shell construction, indirect-direct evaporative cooling, non-chemical water treatment systems and a wide variety of other technologies.

For more program information, please visit: <http://www.smud.org/education/cat/index.html>

Introduction

When you ask most people about their office lighting, they'll shrug and say, "It's ok, I guess." Chances are that unless you are a lighting or energy services professional, lighting is not among your top concerns in life. However, if you ask the office staff at United Stationers in Sacramento the same question, most of them will give you a positive response. Why?

In January 2005, United Stationers Supply Company turned off most of its overhead lights and installed office torchiere lighting fixtures. ***The result was a whopping 86 percent reduction in lighting energy consumption!*** This technology report addresses the following questions:

- What are the differences between general (overhead) lighting and task-ambient lighting?
- What is an office torchiere?
- What lessons have we learned?
- What are some of the barriers to using this technology?
- What are the next steps for this system?

General Lighting versus Task-Ambient Lighting

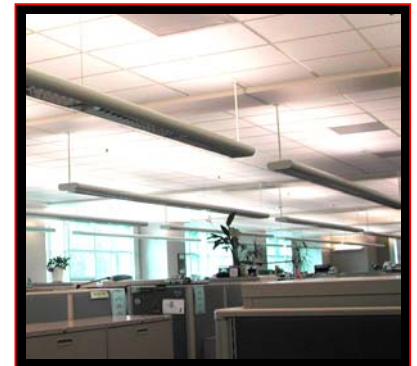
General Lighting

Description

General or overhead lighting systems are the established standard for commercial offices in the United States. If implemented properly, this strategy provides an overall even distribution of light on all surfaces within a space. Most systems are based upon four-foot fluorescent lamps and are divided into three basic fixture categories: recessed, surface-mounted or pendant-mounted. Recessed and surface mounted fixtures provide direct illumination (direct light downwards) while pendant-mounted fixtures may provide direct illumination, indirect illumination or a combination of both (see photo below).

Advantages

- Well-established manufacturers and vendors offer thousands of product choices.
- T8 and T12 fluorescent lamps are commonly used throughout the United States, so replacement lamps and ballasts are widely available at reasonable prices.
- Well-designed and installed systems provide good overall illumination and glare control.
- Maintenance requirements are well understood.



Example of a direct/indirect overhead lighting system.

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Disadvantages

- ❑ Overhead lighting systems are usually controlled via manual switches that are each connected to twenty or more fixtures. Consequently, occupants usually do not have adequate control over the illumination levels in their areas. Although illumination standards have been established for certain tasks, people in the same office often perform *different* tasks. Consider this hypothetical example:

An office worker requires enough light to read printed reports while the person in an adjacent cubicle works primarily on his or her computer and prefers much less light. Since the overhead lighting system was designed to accommodate both tasks, neither worker is satisfied, especially since the overhead lights produce glare on computer screens.

- ❑ Overhead lighting systems may waste a significant amount of energy in offices with vacant cubicles or in spaces that are commonly switched but not occupied during the same hours.
- ❑ Many offices use portable wall systems (i.e. cubicles) and reconfigure individual office spaces to meet the changing needs of their organization. Unfortunately, since relocating fixtures is expensive, the overhead lights are not usually adjusted to accommodate the new office layouts.



Overhead lighting systems are usually not adjusted to accommodate changes during minor remodels – thus leaving some workstations in the dark.

Task-Ambient Lighting Systems

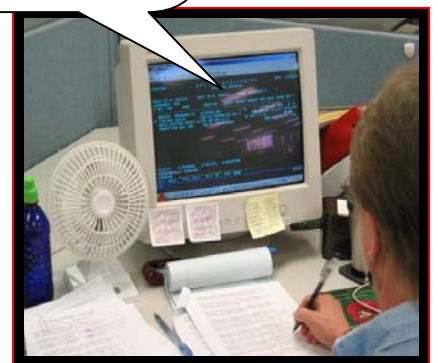
Description

Task-ambient lighting systems use a combination of overhead lighting fixtures and localized task lights. The overhead lights are designed to save energy by providing lower levels of illumination, while individual task lights (e.g. office torchieres) are used and controlled as needed by the occupants. In this approach, overhead lights are still required for common areas such as restrooms, lobbies and copier rooms.

Advantages

- ❑ Task lights provide occupants with more control of light levels within their individual office space. Surveys and end-use monitoring have shown that enabling users to control the light levels at their desks may increase overall satisfaction.

Note the images of the overhead lights on this worker's video screen.



Task lights may help alleviate glare problems caused by improperly designed overhead lighting systems.

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- ❑ Task lights may be used to supplement general office lighting in under-lit areas.
- ❑ Task-ambient lighting may provide significant energy savings¹.
- ❑ Well-designed task lights may help alleviate problems with glare from overhead lights – especially when the existing system is not designed for heavy computer usage.
- ❑ Portable task lights can be easily relocated to provide light where it is needed. This is especially important when individual offices (i.e. cubicles) are reconfigured.

Disadvantages

- ❑ Requires users to stock additional lamps, ballasts and repair parts.
- ❑ Compact fluorescent and T5 biax lamps (used in most task lights) do not last as long as 4 foot T8 and T12 lamps (10,000 hours for compact fluorescents; 20,000 hours for T8 and T12 lamps).
- ❑ Using task lights *only* may create an undesirable “cave effect” by darkening the walls and ceiling.
- ❑ Using task lights *in addition* to conventional overhead office lighting (i.e. without delamping) will *increase* overall energy consumption.
- ❑ Plug load circuits may not be able to accommodate added electrical loads from task lights (especially in older buildings).



Using only task lights can create a cave effect. Note the dark walls when only the task light is on.

Technology Description – Office Torchiere

The office torchiere is a free-standing, direct-indirect, portable luminaire designed to provide task lighting as well as general illumination. Features include:

- ❑ Energy efficient: Uses one 80-Watt, T5 biax fluorescent lamp.
- ❑ Smart controls: System includes an integral passive infrared occupancy sensor designed to turn the unit off when people are away from their desks.
- ❑ Convenience electrical outlet (controlled by the occupancy sensor).
- ❑ Portable: Heavy steel base and 6-foot power cord enables fixtures to be used in a variety of office settings.



Office Torchiere Fixture

¹ Please refer to the **Showcase Project** section of this report (page 4) for more information.

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Showcase Project

Project Address: **United Stationers Supply Company**
 5440 Stationers Way
 Sacramento, CA 95842

Background

United Stationers Supply Company is committed to saving energy and was actively considering retrofitting the overhead lighting system in its main office. This made the company an ideal candidate to participate in this research project.

The existing overhead lighting system in the open office areas consists of 60 recessed fixtures with prismatic lenses, three 40-Watt, T12 fluorescent lamps and magnetic ballasts. The lights are controlled manually via two wall switches. Although the overall illumination levels were adequate, some of the staff members in the open office areas were experiencing significant problems with glare on their computer screens.

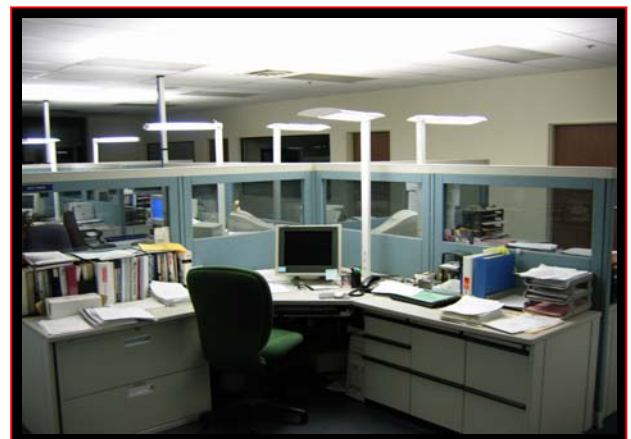
Project Description

United Stationers installed seventeen office torchiere fixtures in the open office areas. Participants were asked *not* to use the overhead lights during the test period unless it was absolutely necessary. The objectives of the study were to:

1. Determine potential energy and cost savings by comparing the energy consumption of the overhead lighting systems versus the torchiere fixtures.
2. Determine the photometric performance of the torchiere fixtures via illuminance mapping before and after installing the torchiere fixtures.
3. Obtain feedback from the users via surveys.

Savings Summary

- Cost for seventeen fixtures = \$5,495
- Estimated annual energy savings = 37,978 kWh
- Estimated annual cost savings = \$3,038
- Simple payback = 1.8 years



Administration office area at night. Note how effectively the torchiere fixtures illuminate the walls and ceiling.

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Energy Usage Comparison

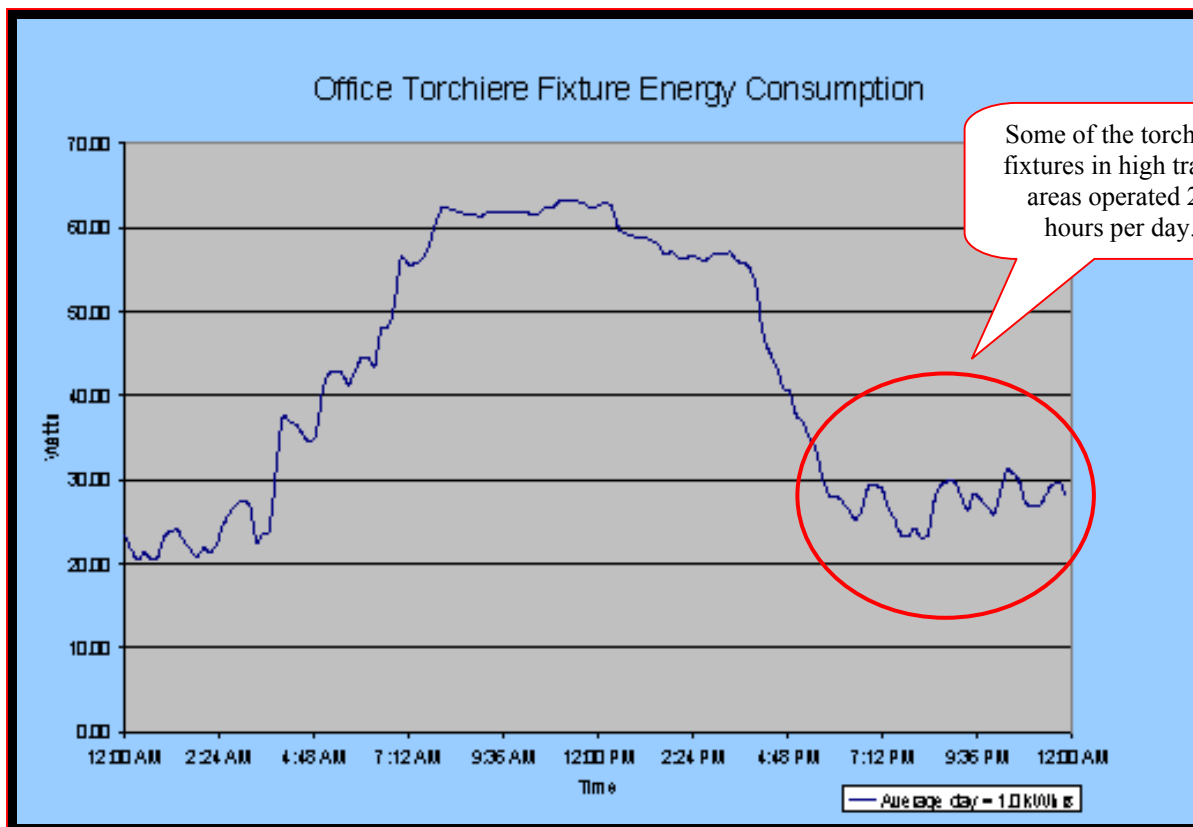
The project team used light-loggers placed within the overhead light fixtures to obtain baseline usage data. The metering results show that 83 percent of overhead lighting was on 24 hours per day and the remaining fixtures were used only an average of 9 hours per day. Since each fixture uses 136 Watts of power, the baseline energy consumption was calculated using the following method:

$$(50 \text{ light fixtures}) \times (0.136 \text{ kW/fixture}) \times (24 \text{ hours per day}) \times (250 \text{ days year}) = 40,800 \text{ kWh/year}$$
$$+ (10 \text{ light fixtures}) \times (0.136 \text{ kW/fixture}) \times (9 \text{ hours per day}) \times (250 \text{ days year}) = \underline{3,060 \text{ kWh/year}}$$

Total estimated baseline annual energy consumption = 43,860 kWh/year

After the torchiere fixtures were installed, light loggers were once again used to monitor the overhead fixtures while the torchieres were directly metered via plug-in watt-hour meters. The monitoring yielded some interesting results:

- ❑ Some of the torchieres operated 24 hours per day (see graph below). Subsequent investigation revealed that warehouse employees frequently visited the office during the night to obtain shipping orders and other needed information. The torchiere fixtures located along the main corridors may have detected these late night visitors and switched on. This could occur due to the fixture's auto-on feature. These frequent late night visits may also help explain the heavy overhead lighting system usage patterns observed during the baseline period.



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- ❑ The seventeen office torchieres used an average of 1 kWh per day (including the fixtures that were used 24 hours per day).
- ❑ The vast majority of the overhead lights were not used. Only the two overhead fixtures that were connected to the emergency lighting circuit were still used. Based upon this information, the estimated energy consumption for the torchiere fixtures would be:

$$(2 \text{ fixtures}) \times (0.136 \text{ kW/fixture}) \times (24 \text{ hours per day}) \times (250 \text{ days year}) = 1,632 \text{ kWh/year}$$

$$+ (17 \text{ office torchiere fixtures}) \times (1 \text{ kWh/fixture}) \times (250 \text{ days year}) = 4,250 \text{ kWh/year}$$

Total estimated annual energy consumption = 5,882 kWh/year

Savings calculations:

Total estimated overhead lighting system (baseline) annual energy consumption = 43,860 kWh/year

- Total estimated task-ambient torchiere system annual energy consumption = 5,882 kWh/year

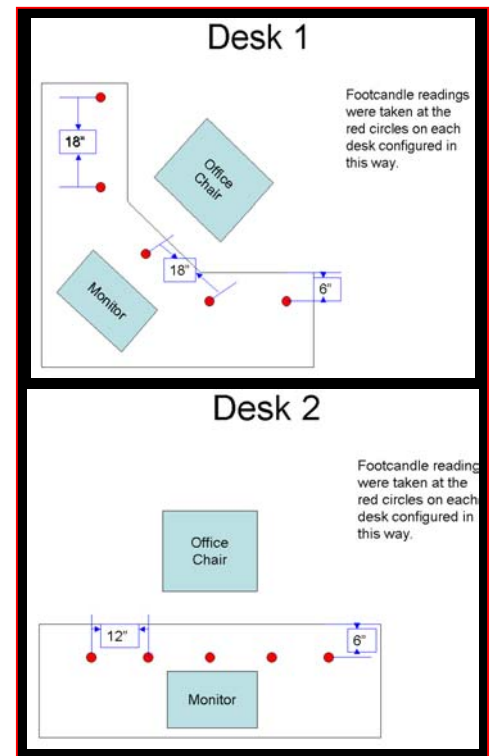
Estimated annual energy savings = 37,978 kWh/year

Bottom line: the office torchieres reduced lighting energy consumption by over 86 percent!

Photometric Performance

Scientists from the California Lighting Technology Center used illuminance meters to measure the light levels at the workstations before and after the office torchiere fixtures were installed. Since the workstations featured two different configurations, the lighting levels were measured as shown in the diagram to the right. All readings were recorded at night to eliminate any contribution from day lighting.

The results showed an average of 27 footcandles² for the torchieres and an average of 38 footcandles for the overhead lighting system. Since the Illuminating Engineering Society of North America (IESNA) recommends an average illumination level of 30 footcandles for offices, the light levels for the torchieres appear to be slightly too low. Fortunately, the averages are not indicative of the actual illumination levels in critical task areas and the employees at United Stationers spend most of their time using computers. However, in order for the office torchiere fixtures to be widely accepted in the commercial market, the next version may have to provide more light.



Illumination levels were measured at the points shown above.

²A footcandle is a unit of measurement commonly used to quantify the amount of light on a surface.

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User Surveys

The employees working in the test area were asked to complete surveys. The main objective of the survey was to obtain feedback regarding the overall design and features of the torchiere, suggestions for improvement and perceived changes in the quality of the office lighting and work environment.

Although the survey sample size was small, the responses provided valuable feedback.

“How would you rate the quality of your lighting?”

1. When employees were asked to rate the overall lighting quality in their office or cubicle before and after installation of the torchiere fixtures, their response after installation was overwhelmingly positive.

Note the significant shift from the “neutral” and “poor” ratings to “good” and “excellent” after the torchiere fixtures were installed.

Rating	Overhead lighting	Office torchiere
Excellent	15.4%	46.2%
Good	53.8%	46.2%
Neutral	15.4%	7.6%
Poor	15.4%	0.0%
Terrible	0.0%	0.0%
	100.0%	100.0%

2. Employees were asked what effect they felt the office torchiere had on various aspects of lighting in their cubicle or office.

Most of the respondents felt that the torchiere fixtures had improved lighting quality. Note the sharp contrast in responses to the “flicker” category. This may be due to the fact that some people are very sensitive to flicker while others are not.

“How did the torchieres affect your lighting?”

Aspect	Greatly improved	Somewhat improved	No effect	Somewhat worse	Much worse
Glare	4	7	1		1
Color rendition	3	5	5		
Light level	7	2	2	1	
Light distribution	8	1	2	2	
Flicker	7		6		
Other					

3. When employees were asked what features they would like to see incorporated into future versions of the fixture, a swivel head or base ranked as the most important followed by adjustable height. These features would enable employees to more easily adjust the position of the fixture.

Note that very few respondents wanted dimming capability. This is probably due to the fact that the average illumination level was around 27 footcandles.

“What features would you like to see in future versions?”

Feature	Very important	Somewhat important	Neutral	Not very important	Not at all important
Swivel head or base to allow flexibility in positioning the light over your desktop	6	6	0	0	1
Dimming controls	1	1	5	3	3
Electrical outlet re-located at or above the height of the desktop	2	3	5	1	2
Independent switching for up and down lights	1	2	5	3	2
Adjustable height	2	4	2	3	2
Choices in colors and finishes	0	3	5	3	2
Choices in styles	0	3	6	2	2

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Recommendations

The project team identified several possible improvements for future versions of the office torchiere.

- ❑ **Change lamp type** – the current fixture uses an 80-Watt T5 biax lamp. This lamp is rated for 10,000 hours - only about half the rated life for 40-Watt T5 biax lamps. Furthermore, since many commercial facilities are already using 40-Watt biax lamps for overhead systems (e.g. 2ft. x 2ft. recessed troffers), replacement lamps would be more readily available. Finally, using two 40-Watt T5 biax lamps would increase the light output by nearly ten percent.
- ❑ **Swivel head or base** – survey respondents indicated a strong desire for a swivel head or base. This feature would allow users to more precisely position the fixture to meet their needs.
- ❑ **Cubicle-mounted option** - since the office torchiere is designed to be free standing, holes had to be drilled in the desktop in order to properly place the fixture in the workstations at the test site. Although participants in this demonstration project indicated this requirement was not a problem, a better solution may be to develop a system to mount the torchiere to the cubicle walls or desktop.



Office torchiere installed in a workstation at United Stationers Supply Company.

Potential Market Barriers

- ❑ Overhead lighting systems are the established “norm” for commercial facilities. People may not be ready to make the paradigm shift required to embrace task-ambient lighting systems in lieu of overhead systems.
- ❑ The office torchiere and other task lights may not qualify for traditional energy efficiency retrofit rebate programs since they are portable plug-in devices. Utilities may require removal of some of the overhead lighting fixtures or ballasts to qualify as “permanent load reduction.”
- ❑ Those who choose to implement task-ambient lighting systems as an energy efficiency measure need to ensure that unneeded overhead fixtures are de-lamped, disconnected or removed. Otherwise, adding task lights will increase energy consumption and electricity bills.

Technology Transfer

Finelite (the manufacturer) has not yet decided whether to fully commercialize the office torchiere fixture. They plan to conduct additional field tests to see if these results and customer satisfaction levels can be duplicated. The future of the office torchiere fixture will depend heavily upon the outcome of these tests. Stay tuned.

Addendum (1-6-2006): Although the outcome of this project was very positive, Finelite has decided not to fully commercialize the office torchiere fixture.

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