



5-Lighting

Background

General

Thomas Edison invented the incandescent lamp in 1879 transforming the way we live and work. However artificial lighting has its risks as well as its benefits. Over the years many different types of lamps have been developed:

- **Incandescent Lamps** – Least expensive, most costly to operate, used for residential lighting.
- **Fluorescent Lamps** – Used mainly in commercial buildings, 3 to 4 times as efficient as incandescent lamps, last about 10 times as long as incandescent lamps, need ballasts to operate, should be used in places they will be on for a long time
 - **Compact Fluorescent Lamps** - combine the efficiency of fluorescent lighting with the convenience and popularity of incandescent fixtures, replace incandescent approximately three to four times their wattage, more attractive color temperature for residential use than before, cost more than incandescent but they last a lot longer
- **High Intensity Discharge** – Longest lasting lamp, outdoor light
- **Low Pressure Sodium** – Used where color rendering is not important, such as parking lots, very efficient

When selecting a lamp the two characteristics that are looked at most are the CRI (color rendering index) and the color temperature. The CRI is a numerical system that rates the "color rendering" ability of fluorescent light in comparison with natural daylight, which has a CRI of 100. This means that a lamp with a CRI of 91 shows colors more naturally than a lamp with a CRI of 62. Most standard "cool white" fluorescent bulbs range 60 to 75 CRI. The color temperature is expressed in degrees Kelvin (K). Noon time daylight is about 5500 degrees Kelvin. Fluorescent lamps with lower color temperatures look red; fluorescents with higher color temperatures look blue.



Daylighting

Daylighting is becoming more and more popular these days. Daylighting is using natural light for interior lighting. Using natural light makes people more productive, happier and healthier in a building. Using daylighting can suppress melatonin levels in the body. Melatonin is the hormone that makes humans tired. Melatonin is secreted by the pineal gland, a pea-size structure at the center of the brain, as our eyes register the fall of darkness. At night melatonin is produced to help our bodies regulate our sleep-wake cycles. Daylight can actually help you stay awake. Four cells in the human retina capture light and form the visual system. One type, rod cells, regulates night vision. The other three types, called cone cells, control color vision. It's known that exposure to light at night can disrupt the body's production of melatonin, which is produced by the pineal gland in the brain and plays a vital role in resetting the body's daily biological clock. According to Several very recent studies, most notably research from a team headed by Dr. George Brainard at Thomas Jefferson Medical College in Philadelphia, have identified the specific wavelengths of blue light, 446-477 nm that are crucial in suppressing melatonin production in humans.

Daylighting would be a nice feature to add to any building. Unfortunately in Florida adding windows to any part of the building especially the south side can increase the thermal load on the building immensely. Also, the sun produces 7,000 to 10,000 foot candles. Only about 50 foot candles are needed in an office setting. Having too much sunlight in a room produces dark areas and/or glare. Regions with lots of sun are not the best application for daylighting.

Although daylighting using natural light is not the best idea in southern areas with lots of sun daylight features are still needed. Lamps have been developed that better mimic daylight levels but are controlled as too not add too much glare. Full spectrum lamps, as they are called, are good for areas where natural light is not possible or would cause too many problems. Natural Full Spectrum Fluorescent lights have the proven capability to blend with natural light from windows and skylights and reveal detail and colors accurately. They can also help improve the performance and productivity of people by suppressing melatonin production.



Proposal for this Building

The proposal for The Florida State University Ringling Conservation Center is to use full spectrum bulbs in the classroom areas. Using them in classrooms where learning will occur is one of the best applications for natural light. Also, the high CRI of a full spectrum lamp will allow for better color distinction in the classrooms. Secondly, using direct/indirect fixtures in this room will be assessed. Using these fixtures will help eliminate glare and the harshness of the 2' x 2' fluorescent lamps that currently are in the room.

Current Lighting Layout

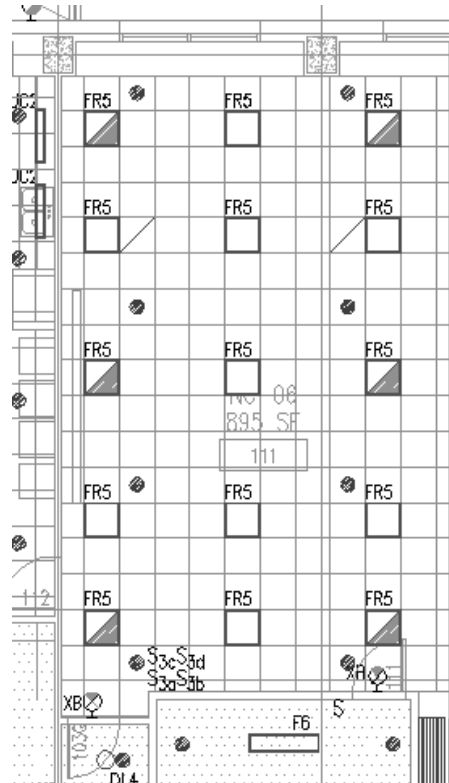


Figure 5.1 Classroom Lighting Design

The currently lighting layout uses 2' x 2' two lamp, parabolic louvered, lay-in fluorescent fixtures. In Figure 5.1 this fixtures are designated by FR5. The solid circles on the plan show



the location of the sprinkler heads (not to be confused with downlights). The room contains three way switching with four different alternatives of light configurations.

New Lighting Design

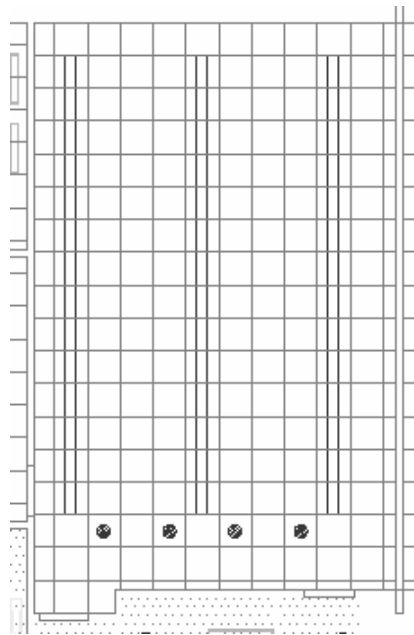


Figure 5.2 New Lighting Layout

This design would use a direct/indirect fixture and full spectrum fluorescent T8 lamps and incandescent downlights in the front of the room. The specification sheets for both the fixtures and lamps can be seen in Appendix D. The fluorescent lamps have a CRI of 85 and a color temperature of 5000K. The lamp was selected because of these characteristics. Most daylight bulbs are 6500K which leads to very blue light, which can be uncomfortable. Using a 5000K bulb lowers the CRI slightly, although 85 is a very high CRI still. The full spectrum lamp at 5000K still produces enough blue light to reduce melatonin levels while reducing the harshness of the brightness associated with the 6500K lamp. The direct/indirect lamps are tandem wired to allow for more diversity in the light levels in the room. Incandescent downlights were added to the front of the room because they provide better color rendering than fluorescents. They will provide an area for viewing artwork while the fluorescent direct/indirect will provide a good area



for actually making artwork. Since both fluorescents and incandescent were used in the design of the building the power options for both types of lamps is available. ASHRAE Standard 90.1-2004 states that a classroom must be under 1.4 W/ft². With this new design the room is approximately 1.37 W/ft². Very rarely will all these lamps be on.

Conclusions

Scientists at Thomas Jefferson University in Philadelphia and the University of Connecticut have done many studies using 5000K natural lamps. In some cases people have liked the light color they produce. In most cases, though, people have complained that they are still too bright (i.e. they are too blue). Therefore it is recommended to use the same layout as given in the section above but to use 4100K lamps (seen in Appendix D) with a CRI of 85. The incandescent lamps will still be good for viewing artwork in the front of the room and should still be used.