ALTERNATIVE LIGHTING DESIGN

LIGHTING ANALYSIS

The goal of this thesis report is to reduce energy consumption. The above mechanical system analysis is only one step in the process. Consideration must be given to the lighting system as it currently consumes 8.8 percent of the Landscape Building's energy. The current laboratory and support spaces will be examined to determine a more conservative design while maintaining adequate light levels.

The power density in these spaces varies between less than 1 W/SF and 5.9 W/SF. ASHRAE Standard 90.1-2004 outlines energy conscious power densities for specific building functions. Laboratory spaces are not explicitly called out. Therefore, these spaces will be assumed to have comparable power densities to that of hospitals. As can be seen in Table 10, the suggested value is 1.2 W/SF. Recommended illuminance levels provided by the *IES Lighting Handbook* range between 50 – 200 footcandles depending on the demand for accuracy.

The Landscape Building uses an array of 96-recessed fixtures equipped with T8 florescent lamps in laboratory spaces. There are compact fluorescent down lights over desk areas and in the entrance hallway. Support spaces typically have a combination of recessed fluorescent fixtures similar to those in the laboratory and fixtures with four u-shaped T5 lamps. Hallway areas have recessed compact fluorescent fixtures. The majority of the laboratories are exactly the same in terms of area, furniture layout, fixtures, and equipment. The support spaces literally come in three arrangements; small, medium, and large. Lab 285 and the adjoining spaces will be shown in this report as the sample calculation.

Table 10 : Based on Table 9.5.1 – ASHRAE 90.1-2004

Ligthing Power Densities	
Building Area Type	**[W/SF]**
Convention Center	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Exercise Center	1
Gymansium	1.1
Health Care-Clinic	1
Hospital	1.2
Hotel	1
Library	1.3
Motion Picture Theater	1.2
Museum	1.1
Office	1
Parking Garage	0.3
School/University	1.2
Warehouse	0.8
Workshop	1.4

CONSIDERED ALTERNATIVES

It may be beneficial for the T8 lamps to be replaced with T5 lamps. It is possible for fewer lamps to produce the same amount of lighting and maintain the same color characteristics with a smaller wattage. It is also possible that the chosen T5 lamps have a longer rated average life. This can have a direct savings in electrical consumption and indirectly save on maintenance cost because fewer fixtures are needed. Even though T5 lamps can be more expensive than T8 lamps, the possible saving may make the equipment cost worth the investment.

One other consideration is the ALTO-series lamps from Philips Lighting. These lamps are designed with sustainability in mind. "Philips Alto fluorescent lamps combine the lowest mercury with long life and energy efficiency. The lamps contain up to 70% less mercury than other lamps. This is beneficial for the environment because mercury is a highly toxic substance. On average, the ALTO-series lamps consume 25% less energy over a longer life. This benefits the owner with a decrease in annual operating costs as well as being environmentally friendly with less waste and less pollution with energy generation due to less consumption.

LIGHTING DESIGN

AGI 32-v1dot8 was used to model the lighting design for laboratory 285. Surface reflectances were assumed based on known material properties. The existing fixture layout can be found in Appendix J.

Illuminance levels were found to be between 88 and 161 footcandles on a typically lab station. Small support spaces averaged 80 f.c. and the large support space had between 77 and 105 f.c. on the lab station. While the light on the middle of the lab station is probably adequate at 161 f.c, there is room for improvement due to the lack of lighting at the ends of the station. The support spaces are not receiving the necessary amount of light in order to do critical biomedical research. It is recommended that providing closer to 200 footcandles will greatly improve the researchers' working environment.

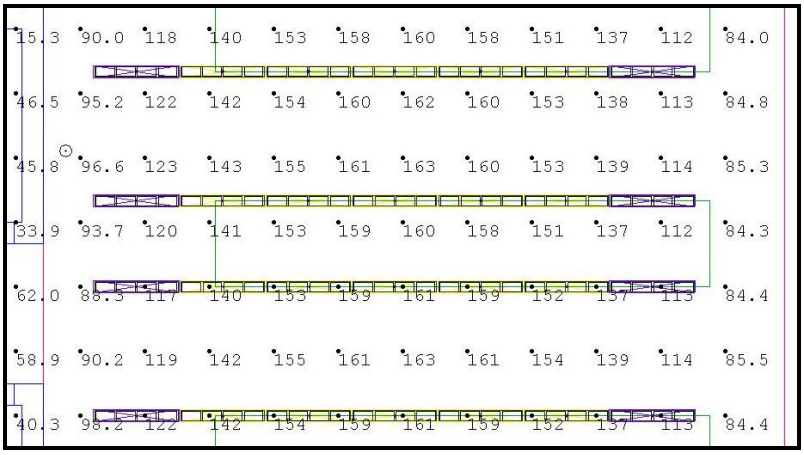

Figure 11 : Footcandels on Lab Station, Actual Design

Research was conducted to find a lamp with a greater lumens per watt ratio than the T8 currently specified for the lab. The only lamp that was found to be greater than the original 92 lumens/watt was a 98 lumen/watt T8 lamp designed by Osram Sylvania. The challenge posed by this lamp was the fact that it is eight feet long. This made the layout more complicated as it was harder to position such long lamps in rooms. Labeled as L1_A, these lamps have been placed in an array similar to that of the actual design. They directly over the edge of the lab station, and then run down the length of the room over the walking area. As can be seen in Figure 12 below, the new lamps increased the number of footcandles on the working surface and decreasing the amount of watts required by 1,228 or 17.1%

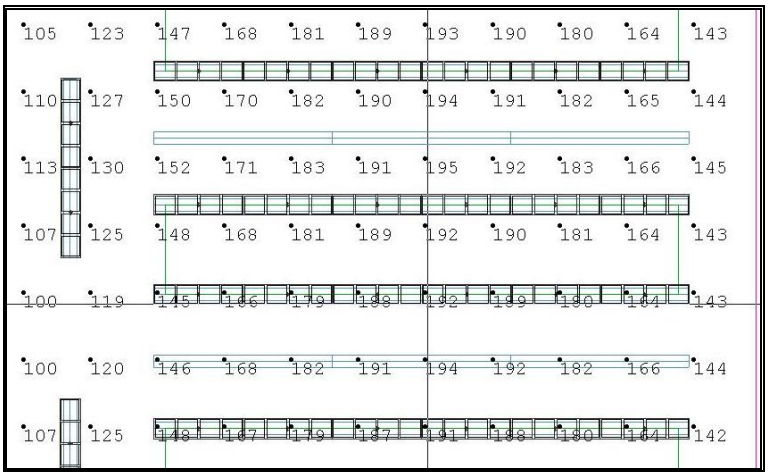

Figure 12 : Footcandels on Lab Station, New Design

The original fixtures remained in the support spaces but the 32 watt u-tube T5 lamps were replaced by half as many 40 watt standard T8 lamps. It was not possible to reach the needed illuminance level with the lumen output provided by 32 watt lamps. There are now more fixtures as a result of the original fixtures having four lamps each. Originally, the large support room had the same 32 watt T8 lamps as the lab and the same 1' x 4' louvered recessed fixtures. The new design calls for the same lamps, but with the 7" x 1' fixtures that were once in the lab. The new design provides A higher and more uniform lighting level throughout the room with less energy consumed. The entrance hallway originally had 4-6" recessed compact fluorescent fixtures which were replaced with 8Sample calculations can be found in Appendix J.

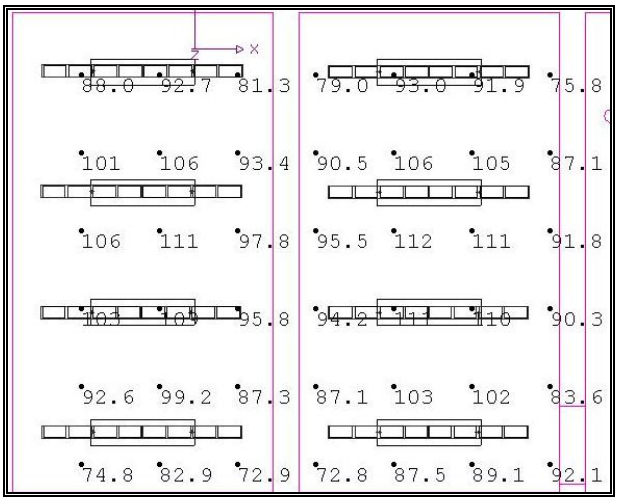

Figure 13 : Medium Support Spaces, New Design

CONCLUSION

Once Laboratory 285 and the adjacent support spaces were designed, the new design was applied to all the lab spaces. The full calculation can be found in Appendix J. Other modifications to the current lighting system were made that were not part of the Laboratory 285 calculation. The pantry, open flex, and copy supply spaces fall under the "Office" category when determining lighting power densities. The original design had those rooms at 2.84W/SF. The new design reduced that level to 1.2 W/SF. Specialized spaces such as cold rooms and isotope rooms remained unchanged as did existing shell space. The average power density is still relatively high compared to typical levels seen in office buildings and even other laboratories. This can be accounted by the high demand for precision in the research activities. More light in the spaces increases researchers' ability to perform at their highest level.

The total reduction in watts is from 199,648W to 160,933W which translates into lighting power density decrease from 2.45W/SF to 1.98 W/SF. This is a 19.4% reduction in energy cost by the lighting system alone. In addition, illuminance levels were improved either by increasing the amount of lumens or increasing the number of footcandles on the work surface.