Lillis Business Complex: The Question of Perception DRAFT

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Abstract

This study researched occupant perception of environmental quality in four case study classrooms and a lecture hall in Lillis Business Complex at the University of Oregon. The classrooms in the complex were designed to utilize daylight and natural ventilation to optimize learning and energy efficiency.

Gauging the perception of the resultant environmental quality of these rooms is an important part of the evaluation of the innovative design's success. A short anonymous questionnaire was implemented in courses held in Lillis classrooms, then compared to concurrent studies on quantitative measurements of temperature, light levels, and ventilation to gauge perceptions of environmental quality in these rooms. Evaluation of perceived environmental qualities could then be compared to industry standards for thermal and visual comfort.

The questionnaire yielded information on perception of lighting levels in the case study classrooms (rooms 162, 185, 262 and 285) which were concurrently measured for quantitative lighting levels. Opinions on thermal comfort in lecture hall 282 were also highlighted. The survey also illuminated differences in perception of thermal comfort in the abovementioned case study classrooms, especially on the north side, where the rooms were perceived to be considerably colder on the first floor (room 162) than on the second (262). Finally, perception of occupants' levels of alertness and whether their alertness was affected in any way by the environmental qualities of the room was queried.

Study of the perceptions of environmental quality of Lillis spaces, designed to optimize sustainability, energy efficiency, and support of learning activities, is a valuable way to obtain information to lend itself to the post-occupancy evaluation of the building. In a building where passive and highly sophisticated electric lighting and mechanical systems are combined, occupant awareness, knowledge and manipulation of the environment play a considerable part in the efficacy of the systems. The information collected from this questionnaire reinforces the importance of sharing knowledge with building occupants, especially where sustainable design and occupant satisfaction are concerned.

Introduction

The University of Oregon implements a rigorous policy of post-occupancy evaluation of all of its new construction. The Lillis Business Complex, which according to Environmental Control Systems Technician Donald Neet, is a "$40 million

experiment", implements a cutting edge combination of natural ventilation and daylighting strategies, coupled with sophisticated HVAC system and an innovative monitoring system. A combination of daylight and highly responsive electric lighting systems comprise the complex's classrooms lighting strategies. Natural ventilation is used for control and manipulation of temperature and air quality in classrooms.

A post-occupancy evaluation (POE) of the Lillis Business Complex was conducted by Dr. Ihab Elzeyadi of the Department of Architecture, one year after completing construction. While extensive, this POE queried participants via an online survey about their perception of conditions in Lillis Business Complex.

This particular study, then, afforded the opportunity to test, in situ, perception of light, air and thermal qualities of case study classrooms and a lecture hall in the new LEED Silver accredited building.

The study of the facility presents a unique opportunity to learn about the perceptions of environmental quality in rooms with a sophisticated combination of passive and active controls, and the effectiveness of the design in achieving human comfort.

Methodology

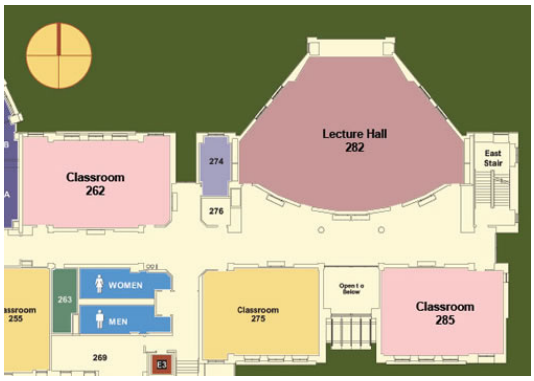
In order to obtain information on opinions of light, air and thermal comfort in Lillis classrooms, the development of a short anonymous questionnaire on environmental quality parameters was undertaken. The questions were developed using a seven point scale to match the increments of ASHRAE's standard 55-2004 for thermal comfort, and following surveys implemented in studies on office environmental quality (Vischer, 1989). The lighting qualities studied included levels of daylighting, electric lighting and glare; distraction due to automatic lighting systems was also queried. Air quality parameters queried included air movement, air freshness, humidity, temperature shifts, and drafts. Thermal comfort parameters included room temperature and personal temperature. Level of alertness and any positive or negative effect of the room's environmental qualities on alertness was also asked. Finally, the questionnaire asked for information on gender, affiliation (student, faculty, or other), and the number of weekdays spent in Lillis.

Like all studies involving human subjects, the questionnaire, while non-sensitive and anonymous, was approved by the University of Oregon's Office of Human Subjects Compliance before implementation.

Permission to conduct the survey at the beginning or end of classes held in Lillis classrooms 162, 185, 262, 282 and 285 was obtained by the instructors of those courses to ensure a greater response rate.

LOCATIONS OF FIRST FLOOR CASE STUDY CLASSROOMS

LOCATIONS OF SECOND FLOOR CASE STUDY CLASSROOMS



During the surveys, point measurements on temperature and humidity (using the Kestrel measuring device) and light levels (using a light meter) only in the front and center of each room under daylighting study. Outside weather conditions were also recorded, and the condition of electric lights and shades were also noted.

The four classrooms analyzed for emphasis on daylighting were determined to be rooms 162, 185, 262, and 285. A concurrent study on lighting levels was conducted by Sarah Chapin and Jaime Shen in these four classrooms. The survey was conducted on sunny days in February.
For Lillis 282, analysis concentrated on thermal comfort to coincide with Andy McKelvey's study on conditions in the lecture hall.

Data was analyzed both for frequency of perception of levels (coded 1-7 in each case, with extremes at each end of the seven-point scale) and percentage of survey population responding in each of the seven categories.

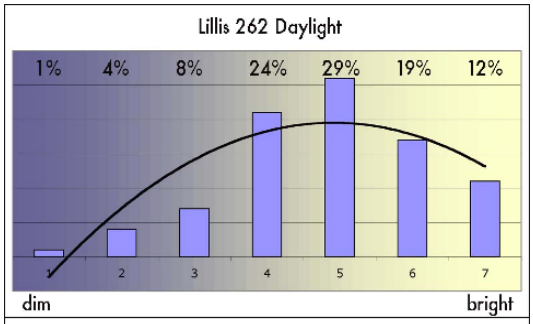
Results and Analysis

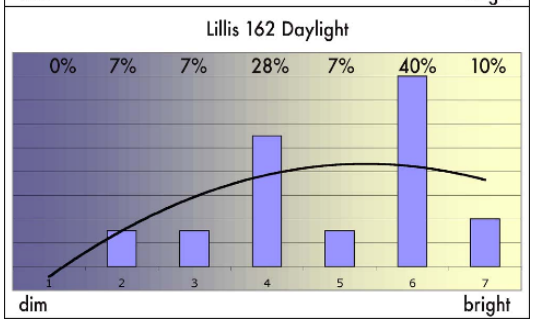
Lighting in Case Study Classrooms

In the case study classrooms 162, 185, 262 and 285, a concurrent study on daylighting was conducted by Sarah Chapin and Jaime Shen. In order to augment the "hard numbers" gathered in their study, opinions on daylighting, electric lighting, and glare levels were queried in the questionnaire. In most cases, shades were not in use, and electric lights were on; it was assumed that classrooms were in the "Lecture 1" preset as indicated by findings in the daylighting study (Chapin and Shen, 2005). All surveys were conducted on bright, sunny days on February 22 and 24, 2005 between the hours of 10 am and 4 pm. Only in Lillis 285 did there occur a change in lighting levels during the survey, when shades were deactivated. In all rooms except 162, the results are an average of opinions of two separate classes.

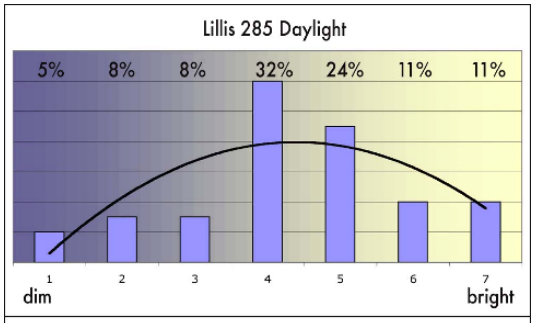
Daylighting

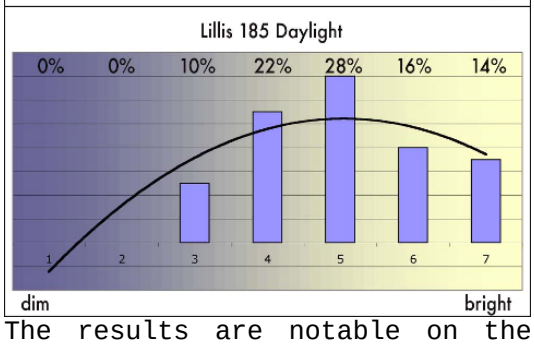
NORTH CASE STUDY CLASSROOMS





SOUTH CASE STUDY CLASSROOMS



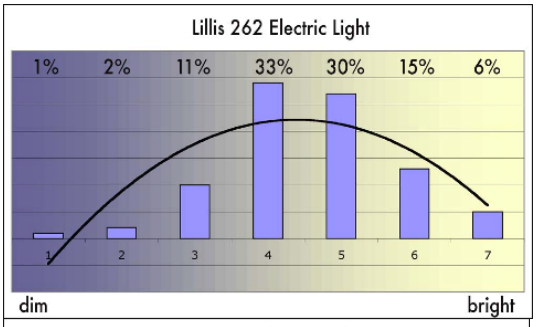


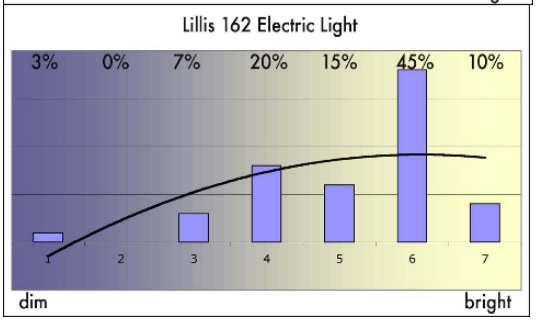
The results are notable on the north (162 and 262) and south (185 and 285) classrooms, where daylight was concerned; Lillis 262 and 185 exhibited similar trends in opinion, where it was presumed that opinions would be aligned similarly in each pair of north facing and south facing classrooms. Because direct sunlight is available on the south side, it is easy to believe that perception of daylight will be much brighter on the south side. Because the shades were down in 285 to about mid-survey, presumably respondents reacted to the shaded condition.

In the case of 162 and 262 on the north side, where no direct sunlight is available, opinions on daylight were less consistent than those on the south side in 185 and 285, but opinions were skewed on average towards “bright”, perhaps allowing us to infer that the daylight in all rooms is more than adequate.

Electric Lighting

NORTH CASE STUDY CLASSROOMS





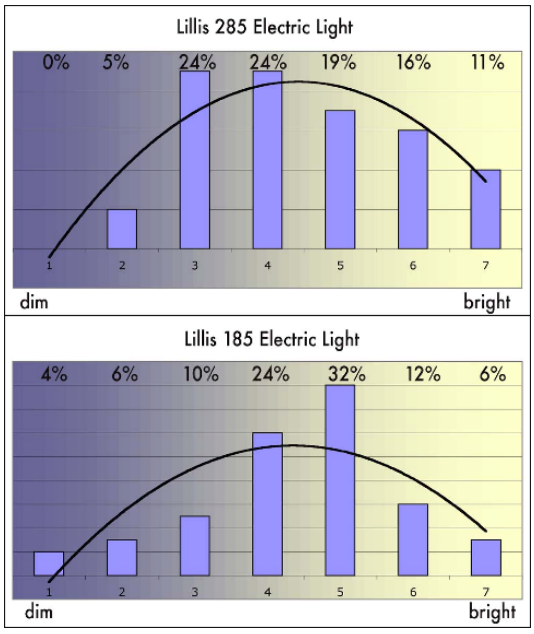
Opinions on electric lighting appeared to be distributed somewhat more inconsistently; in general opinions were slightly more variant, but generally hovered about the “4”, or neutral, position.

It is possible that the perception of relatively dim electric lighting in Lillis 285 was caused by the bright

daylight streaming in from the south, or also from the drawn shades in one of the surveys. Again, in all cases opinions demonstrate a slight trend toward "bright", perhaps indicating that lighting levels are generally adequate.

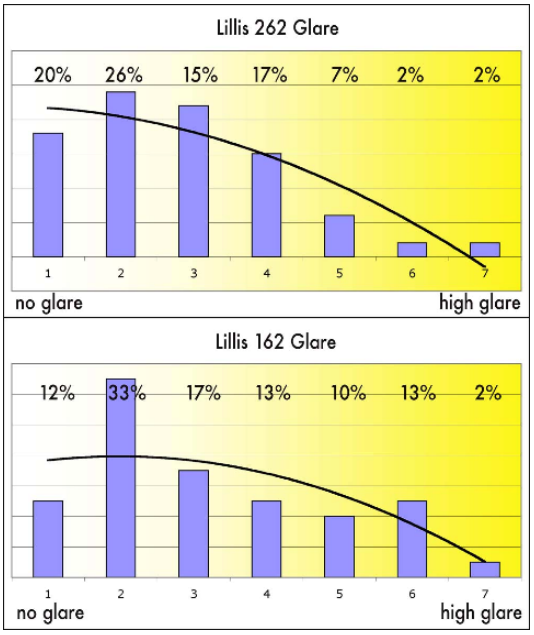
While light meter readings were conducted at the front and center of each classroom, it was determined that these readings would not be reliable determinants of overall light levels throughout each room. As indicated by the study conducted by Chapin and Shen, all rooms experienced relative variability in distribution of light. Most of the respondents in each room, however, seemed to indicate that both daylight and electric light levels were toward the "bright" end of the spectrum.

SOUTH CASE STUDY CLASSROOMS



Glare

NORTH CASE STUDY CLASSROOMS



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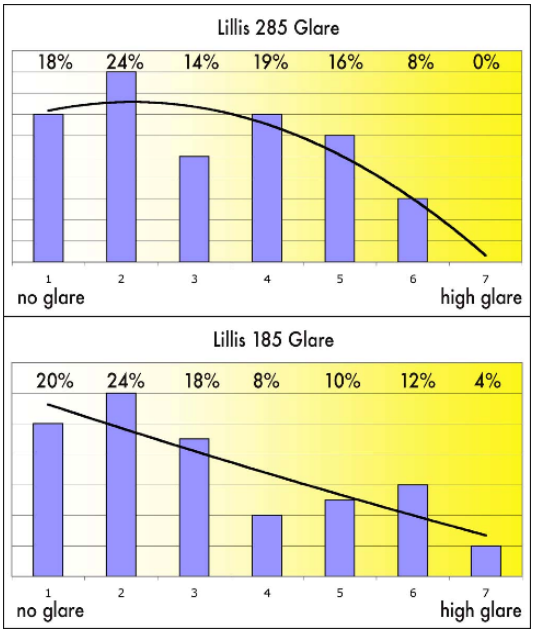
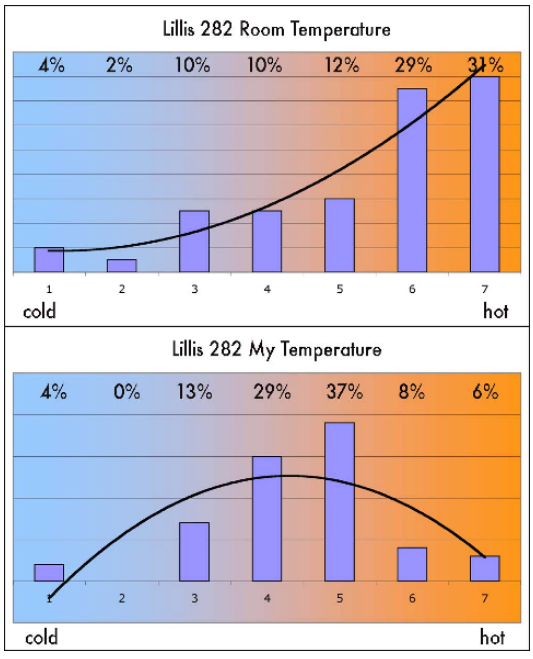


Glare appeared to be an issue in the south facing classrooms, 185 and 285, based on observations made during implementation of the questionnaire. It was observed that lighting variations were much more prominent in the southern classrooms where direct sunlight was a factor, and this was also reflected in

measurements made (Chapin and Shen, 2005). There were desk surfaces on which direct sunlight hit in some cases; this would certainly have an effect on perception of glare. It is worth noting that a definition of terms will have been helpful in making each parameter clearer to respondents. It does appear that opinions tended towards a lack of glare in all cases.

Thermal Comfort in Lecture Hall 282

In conjunction with the thermal comfort study conducted by Andy McKelvey in Lillis Lecture Hall 282, opinions on thermal comfort and air quality were taken in one class at 8:30 am on Thursday, February 24. A distinct temperature gradient was discovered in measurements conducted the same week (McKelvey, 2005), with a 4.5°F degree difference in average temperatures from the front to the back of the room.



In the case of respondents' opinions, a majority seemed to indicate that the room was perceived towards the "hot" end, but that their own temperature was concentrated between 4 and 5, skewed toward hot but still within a presumably comfortable range.

Thermal Comfort in North Case Study Classrooms

Of note in responses to the survey were thirteen individual comments on the perceived temperature difference experienced between the first and second floors of Lillis Business Complex. This was a perception indicated strongly on the north side of the building, in case study classrooms 162 and 262.

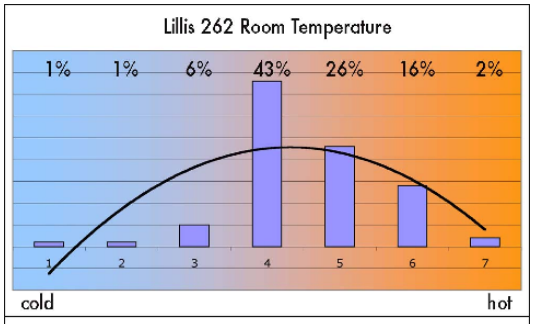
While two classes were surveyed in 262 and only one in 162, it is presumed that additional opinions will have been consistent with those indicated about the first floor, as individual opinions reflecting the perception of cold temperatures were demonstrated in 262 as well. In order to follow up on these perceptions, trending of temperatures was obtained from Donald Neet, who administers the building monitoring system at Lillis.

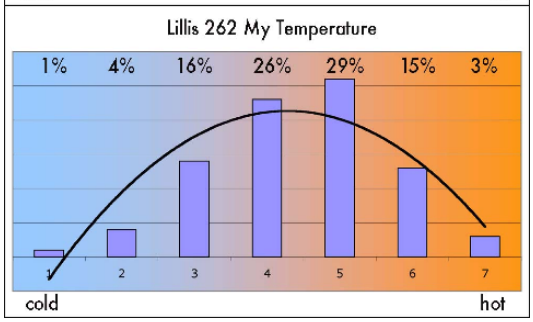
It was found that the temperature at the time of the survey in Lillis 162 was 70.75°F. The average temperature from two classes in Lillis 262 was 71.1°F. This reflects only a 0.35°F difference in temperature at the time, yet a wide difference in perception of the general conditions in each room.

It appears that there are other factors influencing the opinions of respondents concerning the northern case study classrooms;

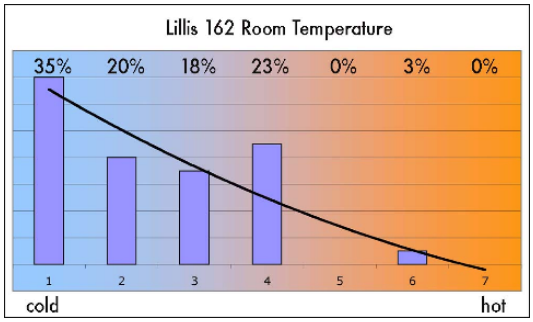
perhaps the view to the outdoors or the position of room 162 on the ground floor lends itself to the perception of cooler temperatures. Yet opinions of personal temperature indicated concentration around the neutral position, despite opinions of 162 perceived as cold. In this case evaluation of clothing levels or adaptive behaviors would have been helpful.

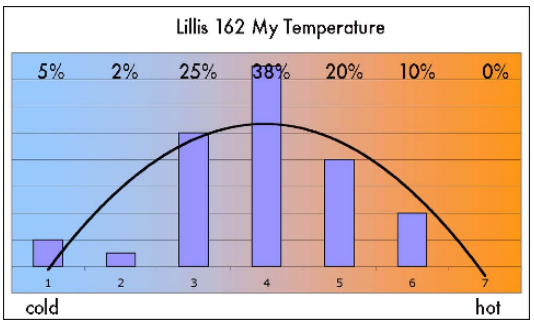
NORTH CASE STUDY CLASSROOM: SECOND FLOOR



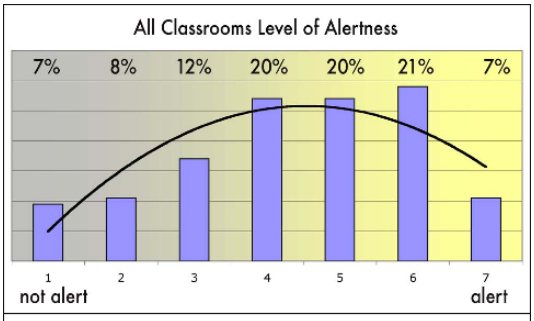


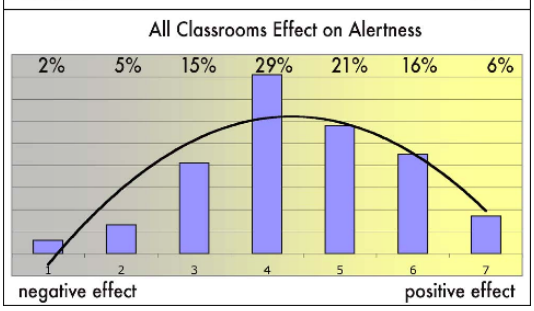
NORTH CASE STUDY CLASSROOM: FIRST FLOOR





Alertness, and any Effect by Environmental Qualities





While the variables are many in a personal evaluation of level of alertness (sleep, stress, time of day, activity conducted prior to class attendance, clothing level, caffeine, etc), respondents did indicate a strong trend toward the “alert”. The largest percentage of respondents indicated that there was no effect of the environmental qualities of the classrooms on their levels of alertness, or the neutral position 4 on the scale. However, a slight skew towards the positive would indicate that respondents are somewhat positively affected by the environmental qualities of the

rooms. Whether or not this indicates satisfaction or comfort is difficult to infer, and there were many ways in which the survey could be improved in order to gather these opinions on the case study classrooms and lecture hall in Lillis Business Complex.

There were a number of positive comments on Lillis classrooms in general by students, everywhere from comments on relative lack of knowledge by instructors on how to properly use lighting and equipment controls in classrooms, to very favorable comments on the overall quality of Lillis classrooms.

Conclusions

Gathering opinions on human comfort can certainly be a difficult process, as the variables involved are very difficult to isolate. In the case of this survey, implementation occurred both at the start and end of classes, and this issue of timing may have had an effect on the way students felt and answered the questionnaire. The survey did not include questions regarding respondents' previous activities, clothing levels, or adaptive behaviors, which might affect perception of room and their own temperatures. This kind of information would have proved very useful in further illuminating issues of thermal comfort in the lecture hall and in north facing classrooms where a distinct temperature difference was perceived.

In all cases, the questionnaire would have benefited from a follow up question as to the degree of comfort the respondent experienced with current levels of lighting, in a range from "uncomfortable" to "comfortable". The survey will have been further improved by asking respondents to write their seat number to pin point locations, to for example, correlate temperature with location in lecture hall 282 or in terms of lighting levels and glare in case study class rooms.

While the analysis of information gathered from this study concentrated on those issues approached in other case studies, namely daylighting (Chapin and Shen, 2005) and thermal comfort (McKelvey, 2005), discussion of other environmental quality parameters queried in the survey would be extremely useful. The role of gender in perception, as well as the number of days a week respondents take classes in Lillis Business Complex would also be interesting to follow up on.

It is hoped that further improvement of the survey instrument based on these lessons learned can be combined with case studies conducted in the summer months at Lillis Business Complex, where there are indications of comfort issues, especially in terms of thermal comfort, for further study.

Because the Lillis Business Complex includes innovative and energy-efficient features in building design including daylighting, natural ventilation, lighting, temperature and ventilation controls, the complex serves as a rich testing ground for perceptions of these innovative features and their effectiveness in achieving human comfort. A questionnaire on perception of light, temperature and air quality can illuminate the effectiveness of the original design intent: to use energy-

saving passive systems coupled with technology to support a sustainable, healthy and comfortable learning environment. Quantitative information on opinions of environmental quality might further assist in the evaluation of the complex, and also serve as a model for the design and planning of future facilities. Sustainable design is a growing field in architecture, in both importance and scope, as energy and material resources for new buildings diminish. Buildings which strive towards goals of sustainability should be evaluated for future improvement of standards, and for continued innovation in architectural design. It is hoped that this small study will be a step towards painting a fuller picture of the perception, and the possibilities, of sustainable design.

References

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