VITAL SIGNS IV

A LIGHTING STUDY OF THE ALUMNI CENTER AT BALL STATE UNIVERSITY
MUNCIE, INDIANA
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I. Abstract:

In the fall of 1998, the Vital Signs course at Ball State University chose the Alumni Center as the basis for a semester-long instrumented study of lighting and its effects on the building. The final goal of the project was to condense the discovered data into a report format.

In order to undertake the study, the class was divided into teams. Each team chose a space of interest. Our team chose to focus on the board room, where we would study the aspects of backlighting. We looked at visual comfort levels in the board room that are directly related to the contrasts between foreground and background light.

From an intial examination of the room in question, a primary area of study was identified and a scientific hypothesis was formulated. From that point, we developed a research method that would effectively provide us with the data that we would need.

We decided that the best way to demonstrate the levels of visual comfort and the contrasts between foreground and background was through the use of photography with a single-lens reflex camera. We positioned ourselves at three different areas in the space and studied the effects of a variety of different lighting options. The photographs show that the southeast area of the room poses the most problems on any particular type of day. In this area the shades would need to be down at all times to keep the ratio of backlighting to frontlighting at acceptable levels. For the rest of the space, visual comfort is achieved when the shades are up and the lighting is at House Full. House Full lighting consists of thirty MR-16 spotlights, thirteen wall wash lights, three table luminaires, and a cove light.

From five large windows that allow a significant amount of daylight into the room, instances of backlighting are created that are unsuitable for the types of activities for which the room was designed. The results supported our conclusion and led us to the following solutions: First, we suggest adding overhangs,

light shelves, and Venetian blinds to decrease the amount of direct lighting in the space. Secondly, the lighting should be at house full and the shades should be down on a cloudy day and up on a sunny day.

II. Introduction:

The Vital Signs course, developed as part of the Center for Energy/Research/ Education/Service (CERES) Student Scholars Program, was designed to give students of the architecture program and students of the Honors College an opportunity to undertake an in-depth look at environmental assessments. This course is taught by the architecture faculty and staff of CERES at Ball State University. The main goal of this course is to teach students to use indicative, investigative, and diagnostic levels of investigation. The subject of the Fall 1998 semester's assessments was the lighting conditions within the Ball State University Alumni Center.

The Alumni Center is a 50,000 square foot facility housed near the university's football stadium (see Figure 1). The building is used for conferences, recreation, and specific Alumni functions. It contains two meetings rooms that can accommodate up to 88 people in each, in addition to housing offices for the five major outreach programs of the University: the Alumni Association, Office of Alumni Programs, University Developement, University Relations, and the University Foundation. There are three conference rooms that accommodate 22, 16, and 12 people respectively. The Alumni Center features an assembly hall that will accommodate 486 people in addition to a conservatory that can accommodate 80, when seated. In addition to these rooms, there is a 793 square foot Board Room that can accomodate up to 48 people, with thirty people seated at the central conference table.

The board room (see Figure 2) uses a variety of lighting types including small spotlights (MR-16's) and a mixture of fluorescent and incandescent lights. The board room has been equipped with a state-of-the-art programmable lighting system. Lighting can be customized for a specific user or the user can select any one of six pre-set conditions. Terms used on the control panel include: House Half,

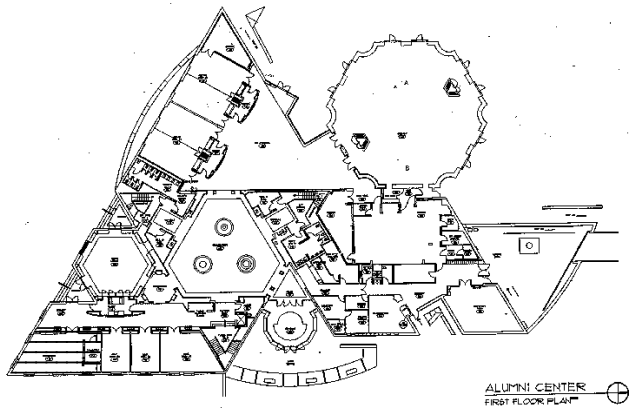


Figure 1--Ground Floor Plan of Alumni Center (board room shaded)

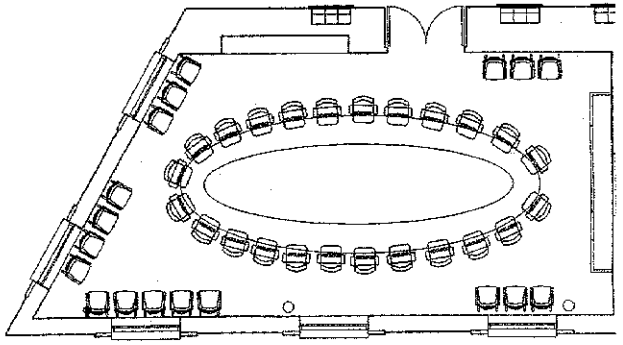


Figure 2--Plan of Board Room with Table and Chairs

House Full, Small Spots, Table, Wall Wash, and Cove Lite. There is also an option to allow a user to design a program to fit their lighting needs.

The large, central conference table (see Figure 3) was added during the construction phase to accomodate more people. In a conversation with the principal architect Tom Baker, we learned that there was very little programming criteria set in place for the board room. The idea was to have a room that would accomodate sixteen to eighteen people, in addition to having various audio-visual capabilities. Uses of the board room include meetings of different types, with the most common being for the Alumni Association and Foundation Board. The room is used mainly for high-profile group meetings. Presentation media used in the Board Room includes overhead projection systems, a dry erase board, and an audio-visual system (a rear projection and video screen). The room is located in the southeast corner of the Alumni Center. The focus of this study will be on the instances of backlighting created by the various types of lighting in the room.

Figure 3--View from the southeast corner of the board room

III. Hypothesis:

Due to the large amount of daylighting allowed into the board room from its five windows, backlighting conditions are created which are unsuitable for the types of activities for which the room was designed.

IV. Research Methodology:

A. Indicative Research

Our process began with a walk-through of the room in question on a cloudy day. Each of us used our own observation skills to better understand the room. We looked at lighting levels, shade and shadow patterns, usage, and overall comfort. During this stage of research, we found that the board room's windows created several instances of glare on the table that were distracting for a user sitting on the west side of the table. The first impressions of the room included a

shadowy cast on the table from such things as posters and handouts. The MR-16 lights created bright light for individual workspaces on the table, although they presented areas of intense light bordered by areas of dark shadow. The hanging luminaries over the center of the table had the potential to create veiling reflections on those areas of the table in the direct path of the lights. Preliminary investigations on the lighting levels in the room showed that the room is equipped to provide users with lighting arrangements to suit their needs. Before proceeding, we identified six lighting conditions that would span a wide range of light settings in the room. They are as follows:

a. No electric light with shades down
b. No electric light with shades up
c. House Half electrical lighting with shades down
d. House Half electrical lighting with shades up
e. House Full electrical lighting with shades down
f. House Full electrical lighting with shades up

For our purposes, House Half includes the twenty-six MR-16 lights only (see Figure 4: Reflected Ceiling plan). House Full includes the twenty-six MR-16 lights, an elliptical fluorescent light, and ten wall-washing lights. The shades allow 20% of daylighting to penetrate the room when they are closed.

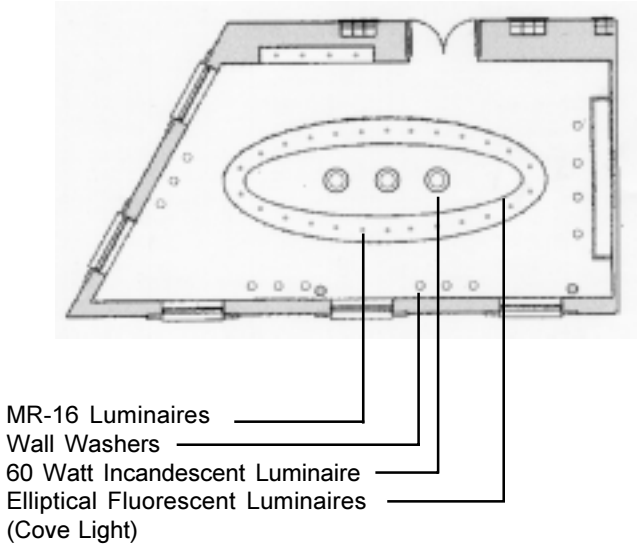


Figure 4--Reflected Ceiling Plan of Lighting

B. Investigative Research

The next step in our process was to document the effects that we observed. We chose to use a single-lens reflex camera for our photography. This method would give us a more controllable exposure when compared to using an automatic digital camera. The camera, in conjunction with a blue filter, was used with its fully manual setting enabled . The blue filter is used when photographing under electric light. Use of the filter prevents the photo from getting a yellowish tint. The filter was not used when no electric light was present. The light meter readings on the camera are focused mainly within a circle in the center of the viewfinder. Light values on the surfaces that appear within that circle are averaged by the camera to produce the correct exposure adjustment. The camera was adjusted before every exposure to allow for the the most

visually accurate results. A picture is accurate when it appears as one would normally view the scene in real life. Digital and other fully automatic cameras have a tendency to underexpose the scene in the viewfinder when there is an intense light source or high contrast scene being viewed. Because of the intense light source or contrast, the camera reads the scene as being brighter than it actually is. This segment of the research was performed on a sunny day and then again on a cloudy day. We photographed a subject at each of three positions (see Figure 5). The purpose was to observe how the lighting in the room either aids or hinders a viewer in a meeting setting.

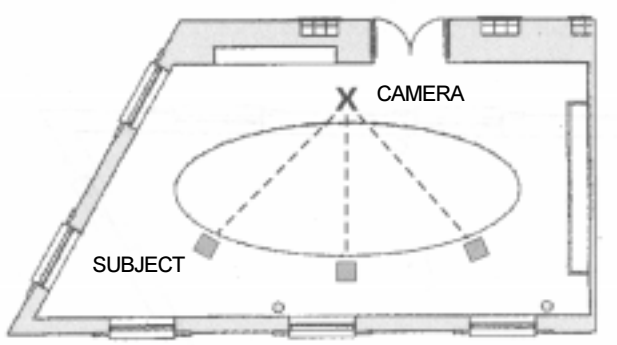


Figure 5--Position of Camera in Relation to Three Subject Seats and Windows

We chose three seats along the full length of the east side of the table in which a subject could sit. These were the positions that had the most potential problems with backlighting. The subject's clothing was neutral or a dark color such as gray. This idea was based upon the colors of business apparel that is generally worn. The camera maintained a position at the center of the west side of the table at head height and was pivoted on a tripod to face all three seating positions. From that point, the subject had his picture taken at each of the three chosen seats with each of the six lighting conditions present at each seat. The subject's head height was at four feet, measured from the floor. The photographs were then developed and analyzed. We also devised a reference system of letters and numbers for the photographs in order to be able to identify and organize them quickly.

In order to determine contrast ratios for a given scene, we used a customized computer program in conjunction with a scanned photograph. The computer program executed a task known as a pixel count. Every digital image is made up of a series of tiny dots called pixels. Each pixel has its own characteristics of value, but, when combined with other pixels, has the ability to form a recognizable image. The computer analyzed every pixel in the photographs that we chose to scan and assigned a grayscale value to each one on a scale of 1 to 255. With that information, the program generated a graph for each photograph that showed the balance of all values within the set We could then use these graphs to determine if the scene had a balanced value set (adequate visual comfort) or if the scene had high contrast (visual discomfort). We used photographs from both a sunny day and a cloudy day.

Light penetration into the room through the windows was analyzed through the use of section drawings and illuminance value plotting (see Figures 9 and 10). These diagrams were taken at a height of 3. 5 feet because, in this room, backlighting problems occur at and above this height. We used hand-held light meters to map light levels across the room in both the long and the short dimension. This research showed that the amount of light coming in the room at this height created problems with backlighting.

We spent more time in the room as observers, rather than as active researchers. This allowed us to get an in-depth view of how backlighting actually affects the users of the room.

C. Diagnostic Research

1. Isolux Diagramming--As an ititial study, we overlayed an isolux diagram on the plan of the room to visualize how and where light enters the room. Figure 6 shows the isolux diagram of the board room without any electrical light on a sunny morning with the shades up (average outdoor illuminance--5,916 footcandles). Where the lines are more densely clustered, there is a higher level of illuminance. The plotted illuminance values proved to be very interesting. The diagram graphically show how the light level drops dramatically as it nears the table. There is an abundance of light at and behind the position of a person seated at the table, but there is a significant decrease in the light level in front of the person. Without any frontlighting, this backlighting makes the scene visually uncomfortable for a viewer on the opposite side of the table looking at the seated person.

2. Light Penetration Diagramming--In addition to studying the board room in plan, we constructed section drawings to show light penetration into the room (see Figure 7). Illuminance readings were taken at intervals of two feet for the length of the room in both the long and the short direction. The sections were cut through the center of the table since it is the focus of our study. As we discoved in the isolux diagram, illuminance levels decreased significantly as they approached the table, allowing for problematic backlighting to take place.

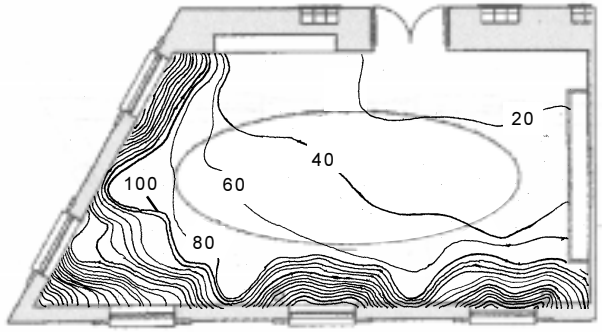
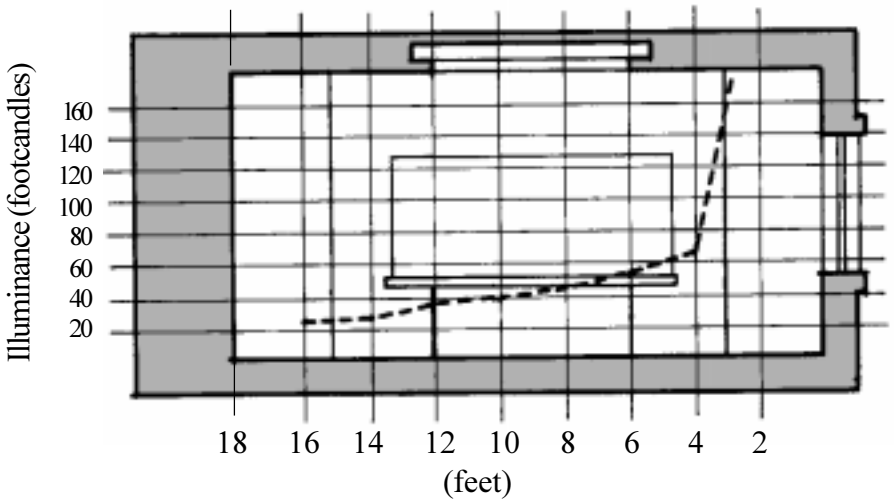
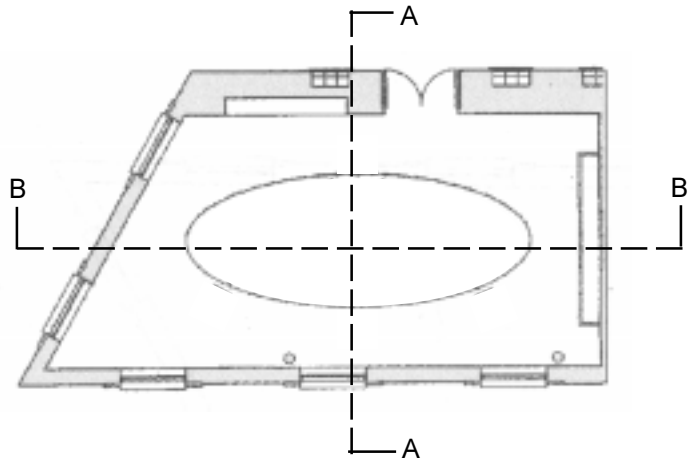


Figure 6--Isolux diagram of board room on sunny day with no electric light and shades up

Section A-A





Section B-B

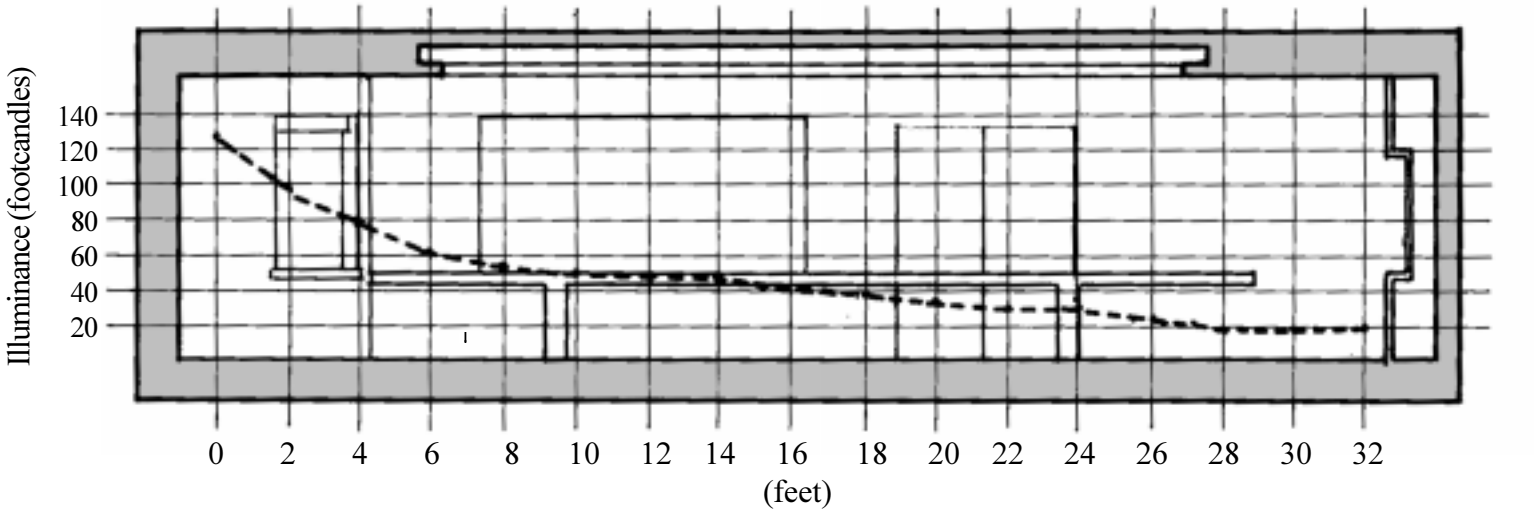


Figure 7--Light Penetration Diagrams and Key Plan for section cut location (illuminance measurements made at two foot intervals)

3. Contrast Ratio and Pixel Count--Contrast ratios were determined by using the aforementioned pixel count. The figures below show two lighting conditions--the worst possible condition for visual comfort and the best condition for visual comfort. The worst condition occurs when electrical lighting is absent on a sunny day with the shades pulled down. The most comfortable condition (drawn from our experiences in the room) happens when House Full lighting is being used on a cloudy day with the shades pulled down.

Each photograph is shown with the graph that was generated by the computer (see Figures 8 and 9). The values at the bottom of the graph indicate the value of the pixels (lower number means a darker value). The values on the left side of the graph state the number of pixels that have that value.

By looking at the graph for the worst condition, one can see that there is an abrupt change between light and dark values. There is little fluctuation between the first spike (called a Bell curve) and the second spike. One can then conclude that if the graph appears this way, the scene in reality will contain an abrupt change also. In this scene, the change occurs as backlighting.

The graph for the second lighting condition changes much more gradually from the Bell curve to the spike. The Bell curve encompasses a much broader range of values than it did during the previous condition. The scene's lighting in reality is more evenly spread.

This part of the research helped us come to the realization that visual comfort cannot be achieved through daylight alone. Daylight can provide a certain amount of lighting, but electrical lighting is needed to achieve full visual comfort by reducing the effects of backlighting.

Average Pixel Intensity: 85.13

Contrast Ratio: 12.42 : 1

Schiler states that glare occurs when the ratio exceeds 2-3 : 1. By definition, this situation more than meets Schiler's guidelines for glare.

Figure 8--Worst condition (sunny day, shades down, no electric light)

Average Pixel Intensity: 119.91

Contrast Ratio: 3.13 : 1

The contrast ratio for this lighting situation falls within a close range of Schiler's definition of visual comfort.

Figure 9--Most favorable condition (cloudy day, shades down, House Full lighting)

4. Photography--For the final step in our research, we took a closer look at the photographs that were taken. Each position was first evaluated and analyzed by itself. Then the conditions at any given position were compared to the conditions found at the other remaining positions. The comparisons show that the room, although relatively small in size, is very diverse in its lighting situations from one end of the room to the other.

In analyzing the photographs, we discovered changes in lighting, not only behind the subject, but in front of him as well. The table produces glare that combines with the backlighting to encompass the subject with both direct and indirect light. Since the subject appears to be surrounded by light, the amount of contrast increases.

Our research and documentation of the photographs is contained on the following pages. The photographs are divided into two main categories:

A. Sunny Morning
B. Cloudy Morning

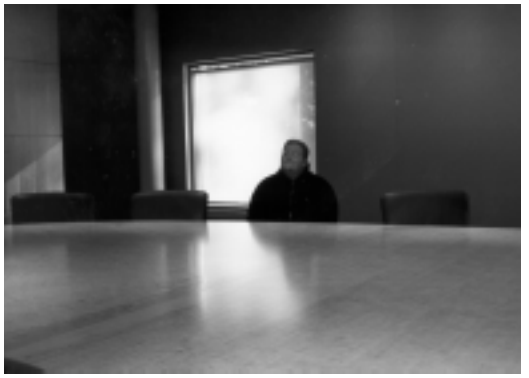
At the end of each category we have provided a narration of our findings that is divided into groups according to the position of the subject.

Position 1 (Sunny Morning, 9:20-9:40)

Shades Down

No Electric Light

House Half Lighting



House Full Lighting

Shades Up

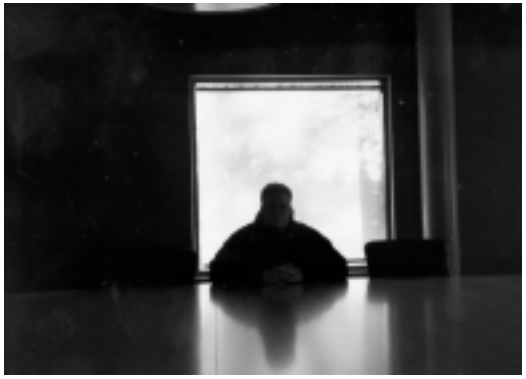
No Electric Light

House Half Lighting

House Full Lighting

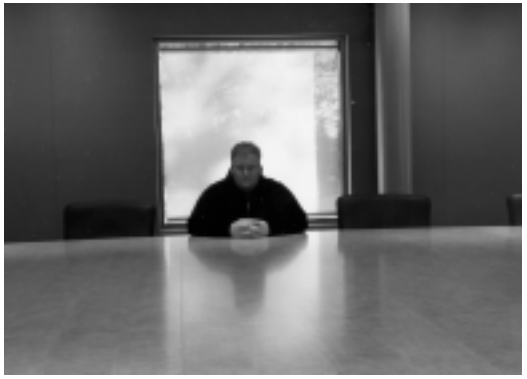
Position 2 (Sunny Morning, 9:20-9:40)

Shades Down



No Electric Light

House Half Lighting



House Full Lighting

Shades Up

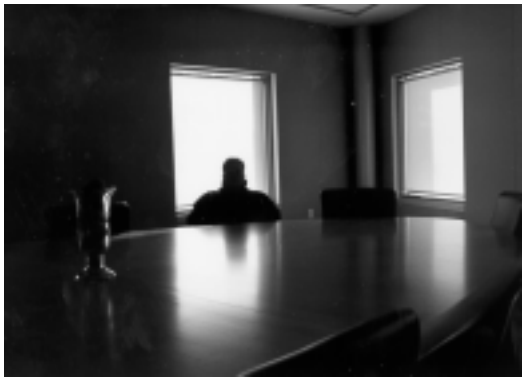
No Electric Light

House Half Lighting

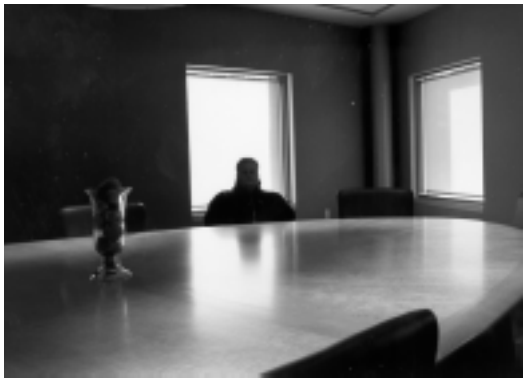
House Full Lighting

Position 3 (Sunny Morning, 9:20-9:40)

Shades Down



No Electric Light



House Half Lighting

House Full Lighting

Shades Up

No Electric Light

House Half Lighting

House Full Lighting

Position 1

This position brought the aspect of the ouside environment to our attention. After looking at the photos, we noticed that the glare on the table did not remain uniform and constant. It was always changing, dependent on the lighting conditions in the room and outside the building. When the blinds were down, the glare on the table along with back-lighting produced an undesirable effect. When the blinds were opened, however, the glare on the table became less intense. The items outside the room (trees, shrubs, etc.) were being reflected on the table. We concluded that their luminance values were closer to that of the table than the luminance of the closed shade. This yielded a less intense lighting effect. We raised the question that, if this was the case, one could assume that changing the color of the shade to a darker value could yield the same result and eliminate a portion of undesirable backlighting.

Another aspect we recognized was that the effectiveness of the lighting (House Half and House Full) could be dependent on the position of the shades (up or down). When the shades are pulled down, there was not much of a difference in the effectiveness of House Half or House Full lighting. The subject's face appeared to be illuminated in the same way with either of the two settings being used. When the shades were up, there was a sigificant difference in how the subject appears. Changing the light setting from House Half to House Full yielded a better result.

Position 2

An interesting note about this position was that the subject was completely encompassed by light. Backlighting occurred from the rear, and glare occurred off the table, framing the subject.

This position was oriented differently in relation to the environment outside the building. After we analyzed the photos, we noticed that the glare from the table was worse when the shades were up. This was the opposite of the effect seen at Position 1 where glare was less intrusive when the shades were up. Moving the subject just a few seats from the previous position changed the visible result of the same condition. From this position more of the bright sky was reflected into the room.

The effectiveness of the electrical lighting was also studied at this position. The light values on the subject's face remained fairly constant at each setting using electrical lighting. We observed that changing the lighting from House Half to House Full with the shades up improved the condition but not to the same extent that it did at Position 1. With the shades down, the condition stayed about the same when the lighting setting was switched.

Position 3

This position proved to be the most problematic. The subject is backlit not only by one window, but by two. Since the position is bordered by an east facing window and a south facing window, there was almost always a constant flow of light into the room, yielding the undesirable effects of backlighting.

Also within the visual field, two areas of glare from the table were produced by the windows. Glare was the most intrusive when the shades were up. At this position, the bright sky was fully visible and was reflected into the room.

There appeared to be little or no change in the readability of the subject's face despite changes to the lighting condition.

Position 1 (Cloudy Morning, 9:00-9:30)

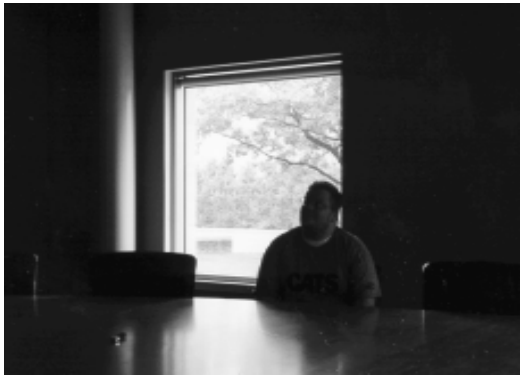
Shades Down

No Electric Lighting

House Half Lighting

House Full Lighting

Shades Up



No Electric Lighting

House Half Lighting

House Full Lighting

Position 2 (Cloudy Morning, 9:00-9:30)

Shades Down

No Electric Lighting

House Half Lighting

House Full Lighting

Shades Up

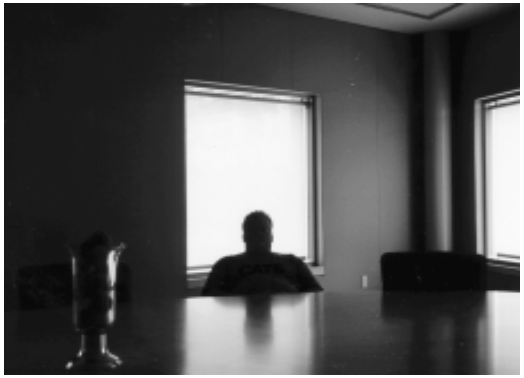
No Electric Lighting

House Half Lighting

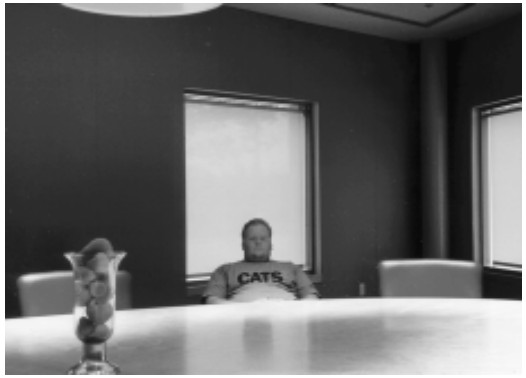
House Full Lighting

Position 3 (Cloudy Morning, 9:00-9:30)

Shades Down



No Electric Lighting

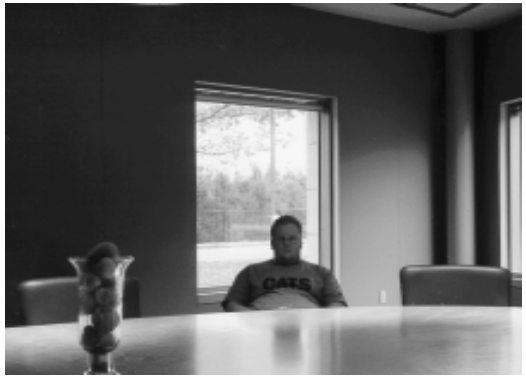


House Half Lighting

House Full Lighting

Shades Up

No Electric Lighting



House Half Lighting

House Full Lighting

Position 1

On a cloudy day, the electrical lighting in the room became significantly more noticable and effective. With no electric light, the scene was dark. As soon as House Half lighting was turned on, the subject became brightly illuminated. On a sunny day, the illumination was more gradual as lighting was added.

The glare on the table also produced some interesting results on a cloudy day. The glare was not as prominant even without electrical lighting. When House Half or House Full lighting was added, the glare became very faint and almost indistinguishable. Also, the glare on the table stayed fairly uniform as the lighting conditions changed. The outside environment was not being reflected as much since there was little direct light. Instead, the result was diffused light.

Position 2

As stated earlier, electrical light was necessary in the room on a cloudy day. At this position, the full lighting effect of the small spotlights over each space at the table could be seen. The focused light from these bulbs was very intense. With the House Half lighting enabled, the light created hard shadows on the subject's facial features. Increasing the amount of frontlighting by switching to House Full eliminated this problem by providing a more even light. The subject received light from both top and front. One interesting aspect of this conclusion was that the problem or solution depended on how the subject was seated in the chair. Hard shadows on the subject's facial features were not as pronounced as if the subject were partially reclining in the chair.

Even if the shades were open, electrical light was necessary to produce a more desirable level of visual comfort. Otherwise, the scene and the subject would be dark.

Position 3

This position was the most problematic on a sunny day; however, it improved its condition on a cloudy day. Since there was less daylight coming in through the windows, and the light was diffused, the scene was not backlit to the same extreme. However, the position remained undesirable unless electrical lighting was provided.

The glare on the table was uniform, and it was not as intense as the glare produced at the same areas on a sunny day.

V. Conclusion:

The results that we found from our investigative research allowed us to come to the conclusion that the board room needed to incorporate electrical lighting as well as daylighting to meet the needs for visual comfort.

Investigative research in the board room showed the potential for uncomfortable levels of backlighting. From this research and subsequent analysis we concluded that, despite having five large windows on its east and its south side, the board room was still dependent on electric light. In fact, it is possible that these windows are the cause of the backlighting problem. Uncomfortable backlighting occurred for viewers on the west side of the table. While this was compensated for by using electric frontlighting to balance out the contrast, we feel that there are better solutions.

By changing the contrast ratio and the brightness distributions with the use of overhangs, light shelves, and Venetian Blinds tilted up, daylight would still enter the space but would not be so obtrusive. This would allow daylight to come in at an angle and be reflected all around the room, instead of creating instances of intense backlighting. The shades could also be made of a material with a color that does not transmit as much light. In addition, we acknowledge the fact that there are other possible solutions involving the blocking of windows or the addition of a different type of window. These solutions would need further study before implementation.

However, in order to make the use of the board room space as efficiently as possible, without major spatial alterations, we have the following suggestions:

A. On cloudy days, the best lighting option for visual comfort would be to put the shades down and have the electrical lighting set to House Full.

B. On sunny days, the best lighting option for visual comfort would be to put the shades up and have the electrical lighting set to House Full.

VI. References:

Alumni Center Brochure. Ball State University, Muncie, IN. Office of University Advancement.

Schiler, Mark E. and Japee, Shweta A. 1998. The Vital Signs Class: IV. A CERES Student Scholars Program. Interior Illuminance, Daylight Controls, and Occupant Response. University of Southern California.

VII. Acknowledgments:

Special acknowledgments go to Robert Koester, Jeffrey Culp, and Robert Fisher of CERES. Professor Koester was responsible for the bulk of the course work, and he was assisted by Jeffrey Culp and Robert Fisher. In addition to the lectures presented in the classroom, a string of visiting scholars also added to the background of the course. These included Bruce Haglund, Alison Kwok, Joel Loveland, Jeff Sailer, and Marc Schiler.

We would like to express a special note of appreciation to Matt Stevenson, the building director of the Alumni Center, whose support and hard work made the research of this building possible.

Many thanks to Joseph Londt for his voluntary participation as a model in the photography segment our research.

This student team consisted of four members: Breann Garbas, Robert Helfen, Elizabeth Krucina, and Casey Steinbrecher.

Breann Garbas is a freshman majoring in pre-medicine and psychology.

Robert Helfen is a third-year architecture student.

Elizabeth Krucina is a first-year CAP student, and is undecided about her future field of study.

Casey Steinbrecher is a freshman majoring in drawing.

Appendix A: Individual Impressions and Observations

1. Group Member: Breann Garbas

Upon my first visit to the Alumni Center I made several observations about the quality of the lighting in the building. Several rooms caught my attention, with the most focus on the board room. The atrium was a rather unique room that made improved the aesthetics of the room to a great extent. It created a pleasant atmosphere that drew attention to the fact that the Alumni Center was created to be a place of entertainment for alumnus of Ball State. In my opinion, the atrium is the most pleasant use of space.

Upon a walk-through of the building, I was intrigued by the use of daylighting, although some of the office spaces that were not in direct contact with a window seemed to be oppressive and the darkened areas did not seem as pleasant to work in.

The room that held my attention the most was the large board room. Preliminary investigations showed a tendency for glare on the parts of the table opposite the windows, in addition to a large amount of glare falling on those parts of the table that were directly under the three major sources of hanging luminaries.

2. Group Member: Robert Helfen

When I first entered the Alumni Center, I never expected to find such a wide variety of spaces on the first floor. I did expect to see an atrium, however, and I was pleased to find such a comfortable space in the Conservatory. Instead of emphasizing direct light with hard shadows, the architect chose to create a softened space with indirect light. The resultant effect creates a very pleasant space to remain in and not just to walk through. The lounge/library space was totally new to me, but I found the idea to be very refreshing. There are not many buildings that have a public level with that amount of human-scaled spaces and comfort.

The board room at the end of a hallway off of the Conservatory is another one of the most interesting spaces in the building. A wide variety of lighting options can create an atmosphere sufficient for just about any activity. There are five large windows to allow for plenty of daylighting, and there is an electrical lighting system that can be customized to fit the use of the room at any given time. Multi-media aspects are also accounted for by a transitional presentation unit on one wall. The room was intriguing to me from the start. Although the room was aesthetically pleasing, I was curious to find out why such a large number of electrical lights was necessary.

3. Group Member: Elizabeth Krucina

As I approached the building from the outside, I felt an inviting nature up into the space of the building. Entering, I noticed the bright, comforting atmosphere that the conservatory provided. I really enjoyed the skylight and the amount of light it allowed in. The palm trees added a quizzical, soft touch to the space. As we proceeded up the stairs, I noticed how the artificial lighting changed the mood. It was no longer bright and relaxing like the conservatory. The view upstairs was pleasing. The open observation deck of the aerial view of the conservatory was nice. As we proceeded through the offices and work spaces, it felt gloomy and crowded. The cubicles were too close and it was hard to maneuver through the space.

Later, we descended down to the transitional walk areas, past the central conservatory, and into the board room. These grand rooms were well-equipped and visually lit up to a balanced nature. The amount of natural lighting was just as powerful as the artificial lighting in the board rooms. Next, we went to the library, and I was immediately drawn to the memorial shelves set into the walls. These display sections were well-lit and very attractive. As a whole, the room seemed to be a comfortable, relaxing room for people to chat. This room, among many others, had hidden features in the walls for design purposes. I thought this was a good idea for it allowed the important necessities to be there without being seen.

We soon went to the grand ballroom area. The conversational area right outside was well lit by the windows and doors. The pledge plaque is located here, which makes a good place to have everyone gather, have drinks, and chat before a conference or event. The ballroom, equipped with a kitchen, seemed very dark and small. I enjoyed the hexagonal shape; I just did not care for the overall space. The room is well equipped for the all the multi-media purposes, and it can be divided into the two parts. As a whole, I really enjoyed the use of the space and lighting of the building. It combines many geometrical shapes without having a significant amount of dead space.

4. Group Member: Casey Steinbrecher

The Alumni Center presented itself to me as a modern, high-tech, up-to-date building. With things such as the overall design of the building, the triangular shape and the type of materials used on the interior and the exterior, the modern style was conveyed clearly to me.

The first space I entered was the atrium with its rather large skylight and three palm trees. The amount of light allowed into the room along with the presence of the palm trees gave way to a feeling of openness. The furnishings of the room, silver metal chairs and tables arranged in a pattern radiating from the middle of the room, appeared modern and added to that high-tech feeling.

The next space that interested me was the large board room in one of the corners of the building. By presenting itself as an important meeting place, the board room seemed as if maybe it should have been placed more towards the center of the building. The elaborate lighting system in this room impressed me as well as the large wood, matte-finished table. The collaboration between the table and the lighting systems as to whether or not glare would be imminent, interested me immediately.

Appendix B: Input from Visiting Scholars

The visiting scholars gave us insight as the project progessed. Each scholar had specific information that helped shape our project. These visits enabled us to receive feedback in various specialities, and this allowed us to advance our research more specifically.

Although we did not have a team meeting with the first visiting scholar, he still provided advice that any group could not go without. Jeff Sailer, a professor of thermal biology and zoology at the University of Florida, spoke to the class about the importance of teamwork. In the beginning, we had to learn to function as a team. Jeff Sailer discussed the projects that he had been involved with and said that these could not have taken place without the use of teamwork. Alison Kwok met with us at our first team meeting. Her advice centered on the development of a personal relationship with the employees of the Alumni Center. This would increase their understanding of the purpose and methodology of our project. In addition, this would benfit us in terms of employee cooperation. In addition, upon establishing a rapport with those who actually use our space, we would be able to gain a better understanding of the problems present of the room.

Bruce Haglund discussed the importance of our hypothesis. He stressed the reasoning behind making the hypothesis as focused as possible. This would enable us to concentrate the study on specific details instead of trying to encompass a large, general area. This helped us greatly, as a focused hypothesis makes the study a detailed work instead of a mixed set of several different ideas.

Joel Loveland focused on the visual comfort on the space and light as a material. He stressed light and its importance in influencing the nature of a space. This made us curious about the effects of backlighting on the occupants of the room. In order to study this, we took photos that focused on the backlighting. Another area of focus that Mr. Loveland recommended was the contrast in the room. His emphasis on human perception led us to be more comfortable with the direction of our methodology, namely using accurate photographic images

instead of focusing on more computer enhanced technology.

Marc Schiler was our last visiting scholar. His first area of discussion was the presence of exterior light and how we should eliminate it. He offered several suggestions and then asked us how each solution would be implemented. We then discussed the uses of the MR16's and how those could be better put to use. Finally, he described how we could make our conclusion more solid and thus strongly support our hypothesis.