A STUDY OF SPECIFIC VISUAL STIMULI THAT AFFECT THE LEARNING PROCESS

A Senior Honors Thesis

by

BLAKE STEVEN GODKIN

Submitted to the Office of Honors Programs
& Academic Scholarships
Texas A&M University
in partial fulfillment of the requirements of the

UNIVERSITY UNDERGRADUATE
RESEARCH FELLOWS

April 2002

Group: Health and Education

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ABSTRACT

A Study of Specific Visual Stimuli that Affect the Learning Process. (April 2002)

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Conventional wisdom about educational facilities is that the school building simply provides the container in which learning occurs, and that the actual design of these containers has little to contribute to the real purpose of education. Many scholars of education believe that the process of learning only centers around the curriculum and instruction delivered by the educator and received by the student. Recent thinking, however, now supports the need for creative design of school facilities as tools of knowledge and instruments that positively affect learning. The main idea that supports this belief is the fact that any knowledge that a child gains in an educational facility is acquired through their five senses, all five senses. One of the most apparent senses that contribute to the learning process of a child is in fact the sense of sight. And, research of pertinent literature supports the understanding that one of the main stimuli for the sense of sight is light. The problem of this study will be to show that the architectural design of the visual stimuli of light in an educational environment can affect the learning process. It is very apparent that one of the main sources of light in an educational environment is in fact a window. Windows provide the main source of natural light, which is the most suitable type of light for almost any task, especially learning. In the past, windows were seen as a distraction to students; so today many school classrooms are without windows. The purpose of this study will be to develop an instrument that would mimic all the positive stimuli that a real window provides so that it could possibly be used as a way to instruct students.

To my mother, and to all the other teachers who educate America's youth

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A Study of Specific Visual Stimuli that Affect the Learning Process

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INTRODUCTION

Conventional wisdom about educational facilities is that the architectural environment simply provides the container in which learning occurs, and that the actual design of these containers has little to contribute to the real purpose of education. Many scholars of education believe that the process of learning only centers around the curriculum and instruction delivered by the educator and received by the student. Recent thinking, however, supports the creative design of educational facilities as tools of knowledge and instruments that positively affect the learning process.[1] Educational spaces, when properly and carefully designed, are central to any positive learning environment.[2] The knowledge that a child gains in an educational environment is acquired through their five senses, and the sense of sight is a significant contributor to this process. The problem of this study will be to show that the learning process can be affected by the architectural design of the visual stimuli of light in an educational environment. The purpose of this study will be to determine that the specific visual stimuli of light used in the architectural design of an educational environment will affect the learning process.

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[1] *Designing Places for Learning* by Steven Bingler, ed. Anne Meek, *Place as a Form of Knowledge* (Alexandria, Virginia: Association for Supervision and Curriculum Development, 1995), 23.

[2] Jerry J. Herman, *Effective School Facilities: A Development Guidebook* (Lancaster, Pennsylvania: Technomic Publishing Company, Inc., 1995), 10.

SYNTHESIS OF RELATED LITERATURE

Research has shown that intellectual potential is affected by the external environment.[3] Using research of pertinent literature the specific visual stimuli of light, color, texture, size, and motion have been presented as understood stimuli that are perceived by people.

In the realm of architecture the visual stimuli of light is understood as tone. Tone is the intensity of darkness and lightness of something seen. Without the presence of light it would be impossible to see. Darkness is noticed because of how it is juxtaposed to lightness and vice-versa. The contrast between lightness and darkness is essential to a person's perception of the environment.[4] In the field of psychology, light is defined as contrast or brightness. Brightness is not an absolute constant, it is a stimuli that is seen in ratios. Humans see something as bright because it is compared to something that is dark.[5] Educators best communicate light using the phenomenon of shadow. This is defined to children as the result of light being influenced by the manipulation of objects in the surrounding environment.[6]

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[3] Stephen M. Kosslyn and Robin S. Rosenberg, *Psychology: the Brain, the Person, the World* (Needham Heights, MA: Allyn and Bacon, A Pearson Education Company, 2001), 289.

[4] Donis A. Dondis, *A Primer of Visual Literacy* (MIT, Massachusetts: The Massachusetts Institute of Technology, 1973), 47.

[5] Kosslyn, 108.

[6] Viktor Lowenfeld and W. Lambert Brittain, *Creative and Mental Growth, 5th Edition* (New York, New York: The Macmillan Company, 1970), 43.

Color, according to architects, is the most important visual stimuli for effecting the emotions, and it also provides tremendous amounts of information about the surrounding environment. Color has three dimensions that effect how it is received as a visual stimulus: hue is the wavelength or the color itself; saturation defines the purity of the hue; and brightness defines the tonal gradation of the color.[7] With respect to psychologists, color is specified as a visual dimension called, wavelength.[8] The human eye separates the wavelengths of color into three ranges: long wavelengths, medium wavelengths, and short wavelengths. The mixing of these wavelengths is the reason humans can see an infinite spectrum of colors.[9] The information supplied to the brain as a result of color stimuli is necessary for activities such as contour detection, texture segregation, and grouping.[10] When in an educational environment, the meaning of color as a visual stimuli is explained more objectively, it is merely another way to identify specific objects in an environment. Color is not so much a way to understand and express emotion; it is a way to understand the relationships between objects in their surrounding environment.[11]

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[7] Dondis, 50.

[8] *Spatial Vision* by Wilson Geisler and Duane Albrecht, ed. Karen K. De Valois, 2nd. Edition, *Seeing: Handbook of Perception and Cognition* (San Diego, California: Academic Press, 2000), 79.

[9] Kosslyn, 100.

[10] Geisler, 95.

[11] Lowenfeld, 164.

Texture is the one visual stimuli, in architecture, that can be substituted in certain instances for the sense of touch. The intellectual meaning of a visual message that uses texture provides the same results as a tactile message that also uses texture.[12] Psychology best explains the term texture gradient as a way to communicate the sense of depth. The visual stimuli of texture when applied to a surface in an environment can better communicate depth to a person simply because the texture is more dense in the foreground and less dense in the background.[13] Educators explain texture by using the sense of touch rather than using the sense of sight. For children the actual tactile experience is best understood through texture in a surrounding environment. However, not every learner is comfortable with tactile sensations. This is where the visual stimuli of texture can be successful in a learning environment.[14]

A designer of a space best communicates the visual stimuli of size using the method of comparison. Humans perceive something as small because it is juxtaposed to something large. The visual perception of size is one stimuli that is fluid because of the continuous modifications of a surrounding environment.[15] The term size is more understood as spatial scale according to psychologists. The brain best processes the scale of objects in an environment by grouping them according to their relationship to other objects. The eye focuses on objects that are the most irregular in size when compared to

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[12] Dondis, 55.

[13] Kosslyn, 106.

[14] Lowenfield, 104.

[15] Dondis, 56.

the general scale of the human body.[16] Throughout the educational experience, the learner is made aware of the visual stimulus of size using two methods. The term, body space, refers to how a learner understands the relationship between the size of the human body as compared to the surrounding environment. The second term, object space, refers to how the learner understands the relationship between the size of other objects as compared to the surrounding environment.[17]

Lastly, the visual stimulus of motion is better defined by an architect as movement. When visual messages are communicated using movement, the perception of the surrounding environment can become distorted from reality. However, in many cases the use of movement in visual communication is one of the main forces used to help people better understand their surroundings.[18] The use of the visual stimuli of motion cues, according to psychologists, affects three characteristics of an environment: distance, direction, and speed. The human eye can detect any three of these characteristics by comparing the motion of the human body to the surrounding environment or by comparing the motion of another object to the surrounding environment.[19] In relation to education, the communication of the visual stimuli of motion is a developmental process. First, educators help learners visually understand the movement of the human body. After some time the learner can then better understand the movement of objects in the

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[16] *Visual Attention* by Jeremy Wolfe, ed. Karen K. De Valois, 2nd. Edition, *Seeing: Handbook of Perception and Cognition* (San Diego, California: Academic Press, 2000), 347.

[17] Lowenfield, 124.

[18] Dondis, 64.

[19] Kosslyn, 106.

surrounding environment. The most important concept that educators stress about the visual stimuli of motion is that motion can be controlled.[20]

Many times educational environments are not designed with the learner as the main emphasis of the design.[21] The educator and the architect must consider all the student's variances and student's needs when designing educational spaces.[22] The architectural design of visual stimuli such as light, color, texture, size, and motion are essential to the intellectual potential of a student in a learning environment.

OBJECTIVE

This study will be significant in that it will show that the architectural design of light as visual stimuli in an educational environment will affect the learning process. The hypothesis of this study is that the architectural design of light will affect the learning process in an educational environment.

SIGNIFICANCE OF THE STUDY

Windows built into classrooms can produce specific types of visual stimuli that are not only positive, but also negative to the learning process. This study was significant in that it illustrated that positive visual stimuli produced by a window emitting natural

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[20] Lowenfield, 91.

[21] *Using Cultural Information to Create Schools That Work* by Sara Crumpacker, ed. Anne Meek, *Designing Places for Learning* (Alexandria, Virginia: Association for Supervision and Curriculum Development, 1995), 31

[22] Herman, 10.

sunlight can be produced by a system that artificially emits natural sunlight, while also mimicking other positive characteristics. Some characteristics, when present without those that are negative, have the capability of affecting the learning process in a positive way.

STATEMENT OF THE HYPOTHESIS

The hypothesis of this study was that the positive visual stimuli; specifically that of natural sunlight, could be artificially produced by an instrument that could be installed into an educational environment that is without any source of natural sunlight.

METHODOLOGY

Assumptions

The instrument required for this study, had to mimic the visual stimuli of a real window in many ways. The most important of the visual stimuli produced by a real window is natural sunlight. However, this characteristic of natural sunlight is difficult to artificially produce. Another important characteristic of real window that required a great deal of consideration was the scenery produced by window. The scenery of a window may be considered negative, visual stimuli when used in an educational environment. There are possibilities that the learner may become distracted, which in turn may negatively affect the learning process of the learner. During the construction and experimentation of such an instrument, two main questions presented themselves. First, is it possible to artificially produce the positive, visual stimuli of a real window?

Secondly, can certain visual stimuli that is not only produced by a real window, but also seen as a negative to the learning process; in fact be produced by an artificial window, and in turn yield a positive affect on the learning process?

Production of the Instrument

As stated before the main objective of this study is to construct an instrument that produces artificial characteristics already naturally produced by a real window. From this point forward the instrument in question will be referred to as an, *artificial window*. Poplar wood was chosen to construct the main framing members for the artificial window. Poplar wood is a lightweight wood; making it easier to install the entire instrument onto a wall in a classroom. Four main members with nominal dimensions of 1 inch by 4 inches were collected. Two members were cut to a length of 24 inches. The other two members were cut to a length of 36 inches. The vertical members of the artificial window measure 36 inches high and the horizontal members of the artificial window measure 24 inches wide. Using figure 1, the orientation of the members can more easily been seen. As shown in figures 1 and 2, a long, narrow groove was carved out of each of the framing members. The groove was approximately 1/4 of an inch in depth. The groove on each member was carved 1/8 of an inch away from the long axis edge of each framing board. After the grooves were carved in the main framing members, the main fluorescent electrical ballasts were installed onto the center of the vertical, framing members, as shown in figure 3. The ballasts were installed in such a way that they both faced to the interior of the artificial window as illustrated by figure 4. The ballasts used in this study were rated to handle fluorescent bulbs that produce no more than thirty watts of power each. Because the poplar wood is a lightweight wood, poplar is also fibrous. This means that the ballasts had to be secured very tightly to the framing members. High-grade wood screws were used so that the heavy ballasts could be sufficiently supported by the vertical wood members. Once the ballasts were in place the fixture sockets had to be installed so that the full spectrum fluorescent bulbs could be held in place and then receive the needed electrical power from the ballasts. The fixture sockets came in pairs and each fixture socket had to be mounted approximately 36 inches away from their counterpart so that the bulbs were securely held once they were installed. Represented by figure 5, it can be noticed that a secondary framing member measuring: 1 ½ by ½ by 22 ¼ inches, was used so that the fixture sockets could be lined up more accurately before they were installed into the artificial window system. As shown in figure 6, once the fixture sockets were secured to the secondary framing members, those members were then secured to the main horizontal-framing members used in the construction of the main window box. Each pair of fixture sockets had to be separated from one another with adequate distance so that the light that is emitted by the full spectrum bulbs could be uniformly distributed throughout the interior of the artificial window as illustrated by figure 7. At this point, the two main vertical members and one of the horizontal members were joined together using wood screws, as shown in figure 8. The next step as illustrated in figure 9, was to secure the rear reflective wood panel measuring, 37 ½ inches in height and 24 inches in width, to the back of the three framing members that are already joined. This forced the artificial window to become square and plumb. This also added strength to the entire window system. As shown in figure 10, a small 1/2 inch hole was drilled in the lower part of one of the horizontal-framing members. This allowed space for the main electrical cable to enter the interior of the artificial window so that it could be wired to the ballasts. Figure 11 is a basic wiring diagram that illustrates how the fixture sockets were wired to the ballasts, which in turn were then wired to the main electrical cable. The main electrical cable is what will carry the electricity from the wall receptacle to the full spectrum bulbs. Once the wiring is completed, the bulbs were then tested. Then the opaque plexi-glass measuring, 36 ½ inches high and 23 inches wide, could be installed using the grooves that were carved into the main framing members as seen in figure 12. The opaque plexi-glass allows the light from the full spectrum bulbs to be more diffused throughout the artificial window. This in turn will make the artificial light seem more realistic like natural sunlight. As figure 13 illustrates, the final horizontal framing member was secured to the top of the artificial window. It fit into a slot that was created by the two vertical framing members and the rear, reflective paneling; all of which were already in place. Once the final horizontal framing member was in place, the rear, reflective wood panel is then removed so that the full spectrum bulbs could be installed. This was done so that the bulbs had no risk of being broken during the main construction of the instrument. When rear panel was opened, and the artificial window was oriented to look like what is represented in figure 14. It was realized at this point that the fluorescent bulbs, when fully powered for an extended period, emit a specific amount of heat. If this heat were not allowed to escape from the interior of the artificial window, it would have feasibly damage the bulbs themselves. With that realization present, 3 ½ inch holes were drilled through the top horizontal framing member, as shown in figure 15. This allowed the heat to escape as it rose. Another 1/2 inch hole was drilled at the bottom of the left, vertical framing member. This hole shown is opposite the one that was drilled for the electrical cable, shown in figure 10. These two lower holes allowed cooler air to enter the artificial window and then force the hot air emitted by the bulbs to then rise. During the main testing phase of the artificial window, it was discovered that the full spectrum bulbs were not powering up consistently. When the bulbs were installed with a traditional fluorescent fixture the metal finish of the fixture created an electromagnetic field that assisted in the power-up stage of the bulbs. So, as represented by figure 16, long metal strips, measuring about 1 ½ inches in width, were affixed along the inside of the rear reflective paneling. As illustrated in figure 17, small pieces of wood were affixed to the plexi-glass on the front face of the window. These wooden members were arranged to give the appearance of window mullions. This helped the artificial window to seem as though it had four glass windowpanes. A simple curtain rod was installed onto the top edge of the front face of the artificial window, as shown in figure 18. Hanging curtains from this rod will also assist in the process of helping the artificial window seem more realistic. Finally, the characteristic of scenery was applied to the artificial window. A realistic photograph of scenery that would normally be seen from a window was printed on a large format 24 inch by 36 inch sheet of vellum. Vellum is partly transparent so that light can pass through the paper, much like slide film. The sheet of vellum was this affixed to the inside of the plexi-glass cover. When the full spectrum lights were turned on the light passed through the vellum and gave the illusion of a landscape as seen from a real window.

FURTHER IMPLICATIONS

For this study, the goal was to develop the instrument so that it would look as realistic as possible when compared to the characteristics of an actual window. However, due to the limited time restraints allowed for this specific study, many other possible developments for the artificial window were not fully explored. One major characteristic that has a great deal of possibility for development in the future is circadian rhythms. This is the natural rhythm created as the earth orbits around the sun. The fact that day and night are on a consistent pattern is very important to the well being of human existence. Educational environments, such as classrooms, that are without windows, do not give learners exposure to these circadian rhythms as the day progresses. This can cause the students to have problems understanding seasonal changes, the passage of time, and most importantly can cause depression among the students. With further study, it may be possible to explore an electrical system that will allow the full spectrum lights to dim and brighten as the day progresses, and in turn allowing the artificial light to match the circadian rhythms of natural light. This instrument may have many implications in the way of assisting with the learning process that takes place in a classroom setting.

CONCLUSION

The purpose of this study was to determine that the specific visual stimuli of light, when used in the architectural design of an educational environment could affect the learning process. In this study, certain characteristics that are produced naturally by a real window because of natural sunlight were explored to see if it would be possible to create a system that artificially produced those characteristics. The specific characteristics of natural sunlight and scenery were explored with detail. Within the timeframe of this study, it was possible to construct an instrument that in fact could produce those specific characteristics. With relation to the learning process, such negative characteristics as noise and visual distractions can be more controlled with such an instrument. This study has proven that an artificial window can be produced that will affect the learning process. Even though the specific characteristic of scenery is seen as a distraction to the learning process, when applied to a real window, it can in fact be controlled by an artificial window, in such a way that it can possibly be used to assist the instructor in the learning process. This example shows that what may be considered a distraction to the learning process may in reality be a positive for the learning process, when it is controlled.

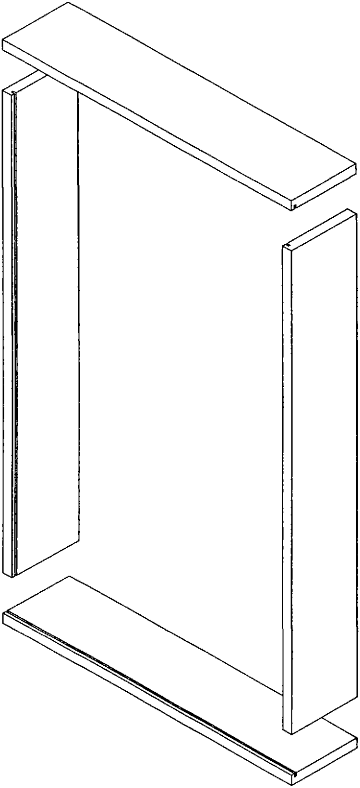


Fig. 1. Orientation of Framing Members.

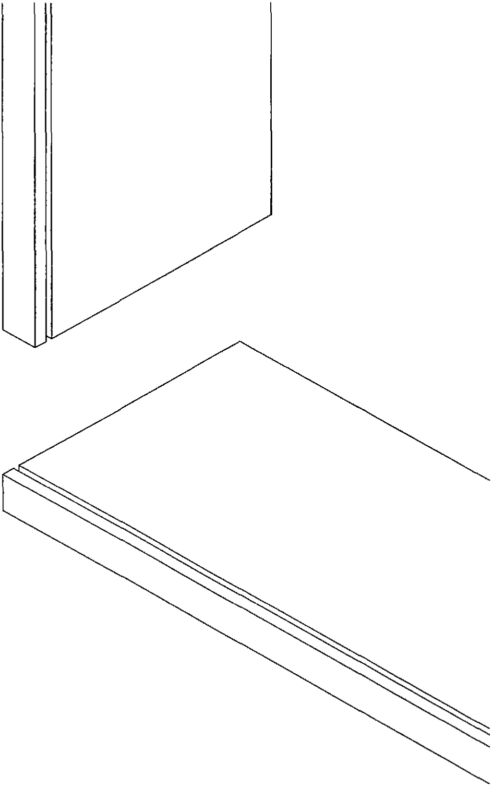


Fig. 2. Carving of Groove.

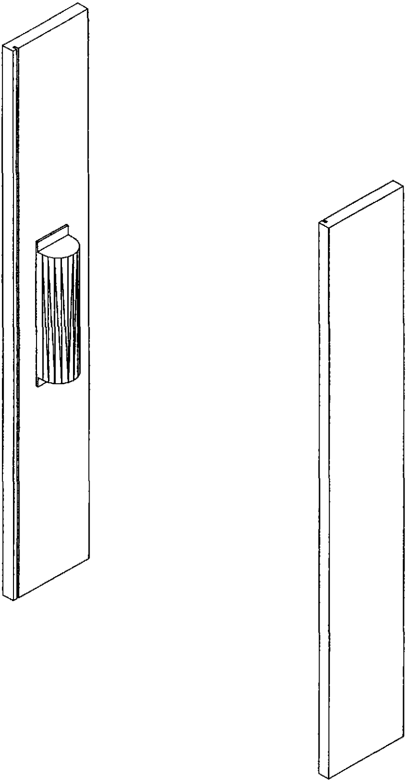


Fig. 3. Installation of Ballasts.

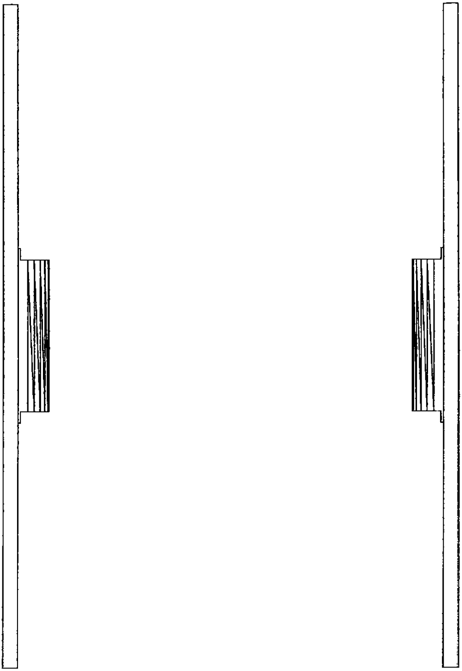
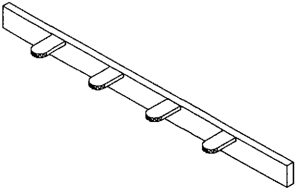


Fig. 4. Position of Ballasts on Framing Members.



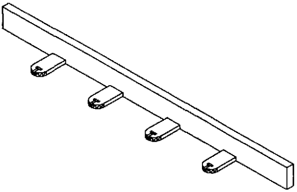


Fig. 5. Configuring Fixture Sockets.

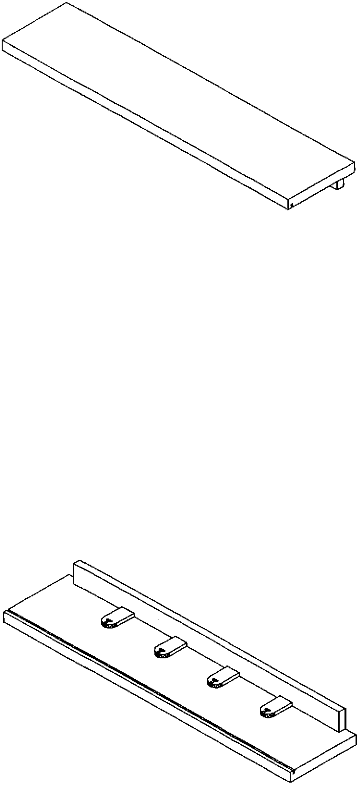
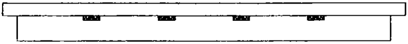


Fig. 6. Affixing Fixture Sockets to Horizontal Framing Members.



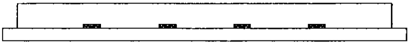


Fig. 7. Configuring Horizontal Framing Members with Fixture Sockets.

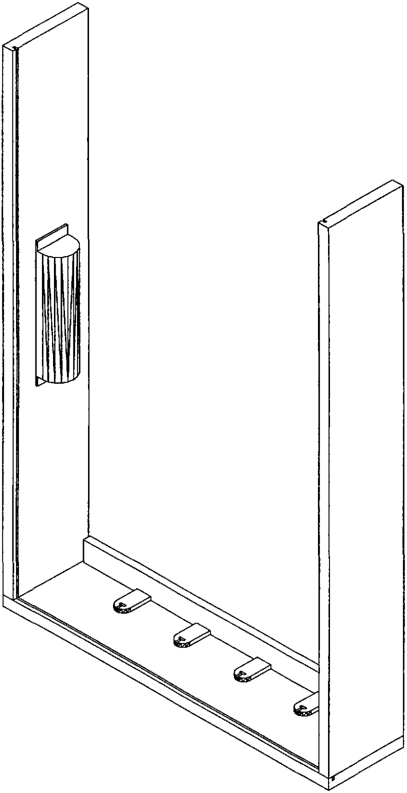


Fig. 8. Construction of Three Sides of Artificial Window.

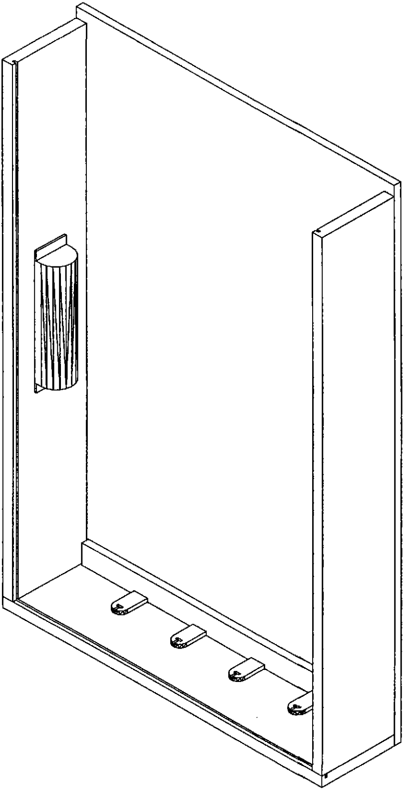


Fig. 9. Installation of Rear, Reflective Panel.

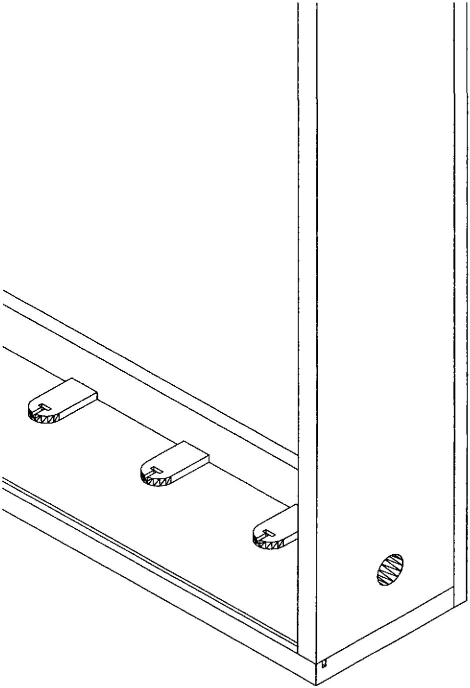


Fig. 10. Drilling of Hole for Main Electrical Cable.

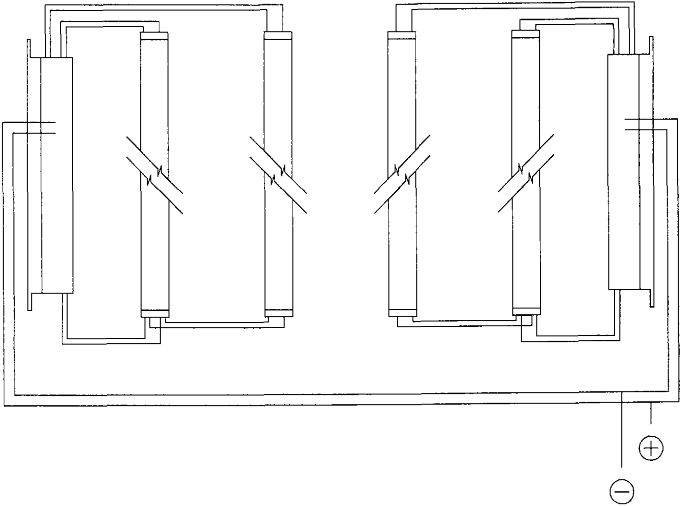


Fig. 11. Wiring Diagram for Fixture Sockets, Ballasts, Electricl Cable.

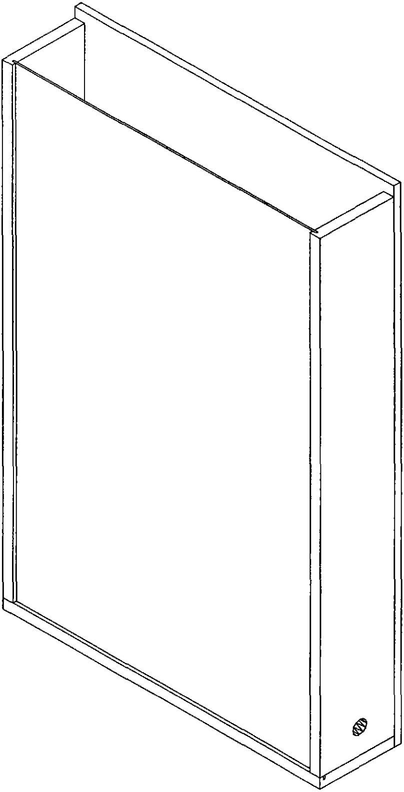


Fig. 12. Installation of Plexi-Glass.

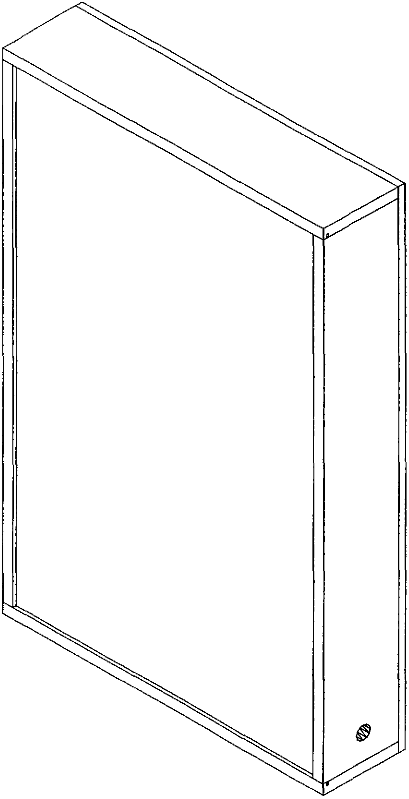


Fig. 13. Installation of Final Framing Member.

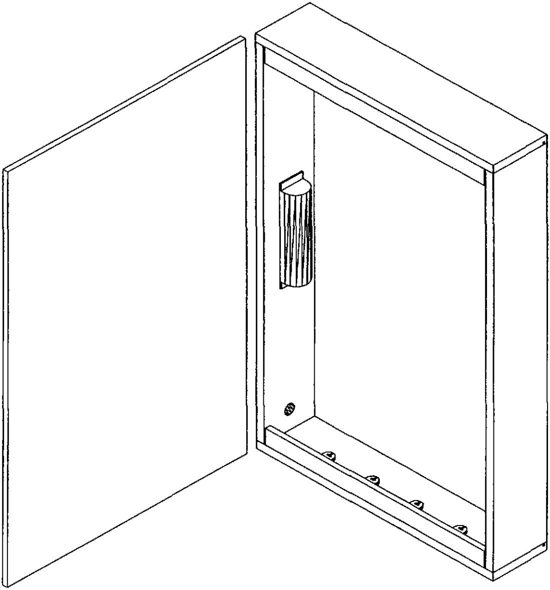


Fig. 14. Removal of Rear, Reflective Panel.

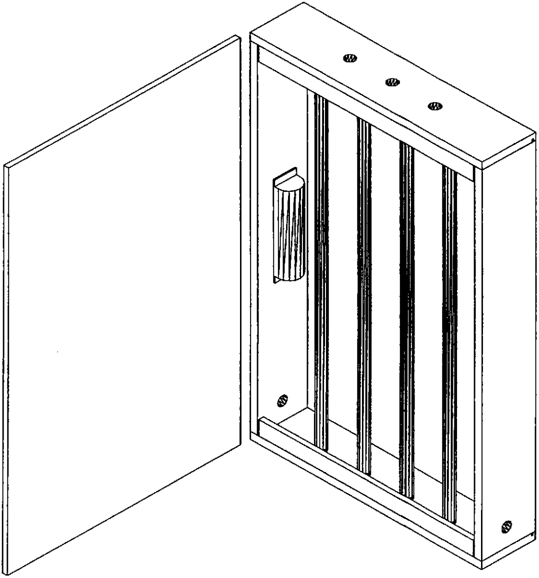


Fig. 15. Installation of Full Spectrum Bulbs.

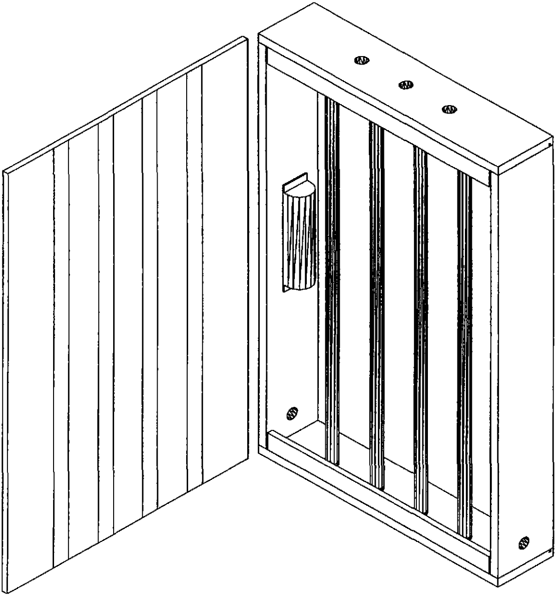


Fig. 16. Installation of Metal Strips.

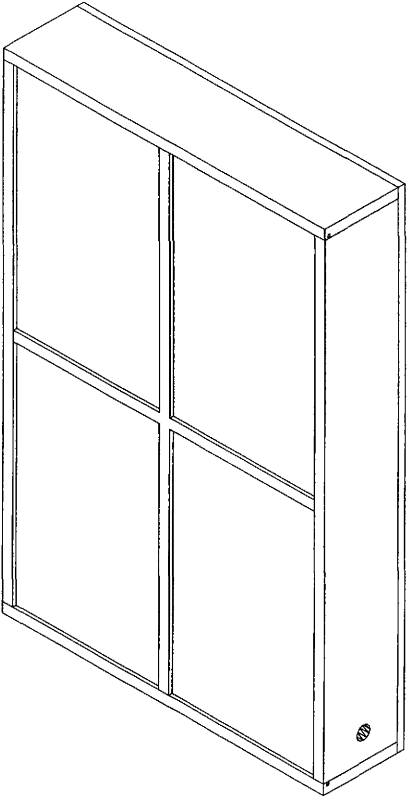


Fig. 17. Installation of Window Mullions.

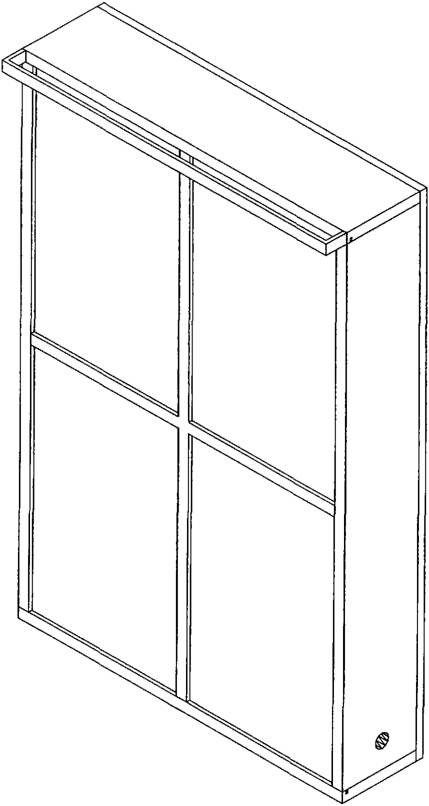


Fig. 18. Installation of Curtain Rod.

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