A CASE STUDY OF DAYLIGHTING – HOW FOUR DIFFERENT STRATEGIES WERE EVALUATED AT ANDREW H. WILSON ELEMENTARY SCHOOL

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ABSTRACT

Andrew H. Wilson Elementary School was significantly damaged in 2005 by Hurricane Katrina. The original school building was built in 1909 and had been a center of Broadmoor community in New Orleans until Katrina. A main goal of renovations and new additions to the existing school was to achieve 30% energy efficiency below ASHRAE 90.1-2004. Daylighting and building shell envelope improvement were two major strategies to achieve the goal. Due to the existing building's historic nature, constraint from the urban setting and limited size of the site, a 3-story-addition classroom wing and a 2-story-addition cafeteria and gymnasium were designed with three (3) different daylighting strategies. In addition, a major portion of the existing building faces east and west which drove another unique daylighting strategy. Furthermore, the existing building is a historic building that any exterior window treatment or daylighting devices could not be added. Floor-to-floor heights of existing building were very limited which gave the designer more challenge in coming up with daylighting strategies. This paper illustrates how four different daylighting strategies were evaluated and implemented in the project.

1. INTRODUCTION

The Andrew H. Wilson Elementary School is a public charter school in New Orleans. The existing building had been serving the children and community of the Broadmoor neighborhood since 1909, until 2005 when the historic building was flooded and damaged during Hurricane Katrina. Recovery School District of New Orleans decided to rebuild 5 "Quick Start" schools before the master plan was finished and Wilson School was selected as one of the five in 2007. The school has been designed to be a 96,000-SF, pre-K to 8th grade school on the existing 1.9 acre block in the neighborhood. The project includes cafeteria, gymnasium, art, music, computer, library, and administration facilities. The building space is equally divided between renovated and new construction, and the entire school will exceed the new FEMA flood regulations.

Fig. 1: School after Hurricane Katrina

2. PROJECT GOALS

The project had clear goals when the design started.

- Setting a new standard for New Orleans Schools
- Revitalizing a significant historic structure
- Child-centered community friendly facility
- School as a teaching tool
- High performance "green" design

- Shared community facilities
- Collaboration among neighborhood

The Recovery School District required LEED Silver rating and 30% more energy efficient than ASHRAE/IESNA 90.1-2004 standard. The design team set design strategies to exceed the requirement and daylighting was the first and the most critical strategy that the team reached to a consensus on. Innovative Design's data has indicated that daylighting would contribute about 19% reduction in energy consumption in new schools. Although the existing building is equal to the new addition, and the orientation of the existing building was not optimal – 2/3 of classrooms facing east and west and 1/3 facing north - the design team set the target to achieve 15% energy consumption reduction through the daylighting. The following explains the evaluation of different strategies and how they are applied to the spaces.

3. DAYLIGHTING STRATEGIES EVALUATION AND DESIGN CASES

Daylighting design has to be holistically considered when a project begins the design phase. Building orientation, existing landscape and streetscape, neighboring buildings are key site constraints that affect the overall daylighting site scheme. As the building design moves forward into space layout, it is also important to consider space depth, ceiling height, function of the space, used hours of the space and types of tasks in the space. This case study project had various challenges in the design. Existing building is a historic building that required maintain existing aesthetics on the exterior which meant no changes or added elements on the fenestrations. In addition, existing building occupied ½ of the site perimeter on west and north sides of the block. A new addition therefore was placed to the south and east ends of the block and the design team determined to locate most frequently used teaching and working spaces such as classrooms and offices to the south building. Then Cafeteria/Multi-Purpose assembly space was located on the first floor of east end wing and the gymnasium was strategically placed above the Cafeteria because roof top monitor daylighting strategies could be implemented in such a high volume space that does not require lower windows.

The new addition had to be connected to the existing building at all three floor level while new FEMA's 100-year flood plain after Katrina got raised 2 feet from the existing first floor level. The design team had a challenge to work within the given floor-to-floor height while 2 feet at the first floor was lost due to the new flood plain. This challenge drove decisions of space placements in the new addition.

Fig. 2. South Elevation

3.1 Low Ceiling, South Facing, Small Spaces

Small spaces that don't require a high ceiling were placed on the first floor in the new addition to compensate 2 feet height loss as mentioned. Holistic thinking in daylighting, functions, structural options were all thought out by the design team. It was concluded that placing administrative office suite on the first floor was the best. In the suite, mostly occupied offices were placed on the south side and irregularly occupied spaces such as iterant teachers offices and a conference room were planed on the west end. Flat concrete slab was selected to maximize the ceiling height. In individual offices and spaces with shallow depth, south-facing clerestory windows with exterior light shelf and blinds-between-glass were used. Although the blinds-between-glass reduces 40% of daylighting compared to clear glazing windows with an interior light shelf, it worked out fine because there was no space for the interior device and the daylit spaces were only 12 feet deep. Blinds were specified to optimally block direct sunlight while it reflects it into deeper space.

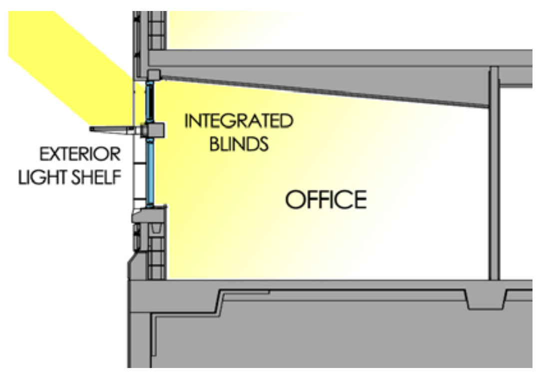

Fig. 3. Office section

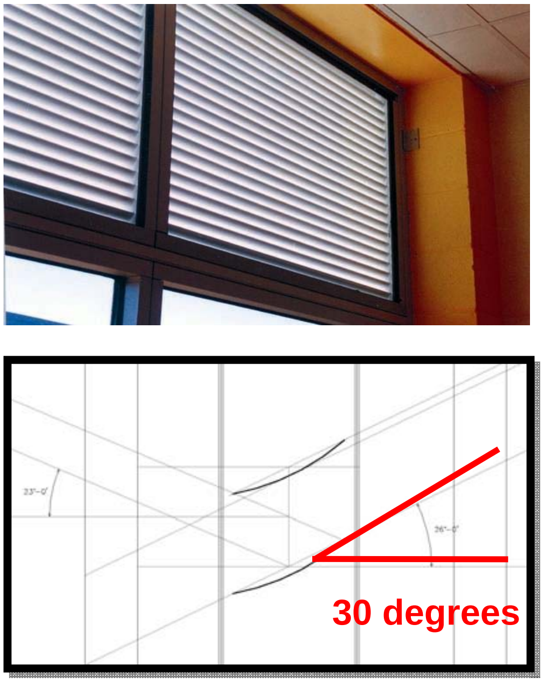

Fig. 4. Daylighting strategy for low ceiling, south facing, small spaces – blinds-between-glass

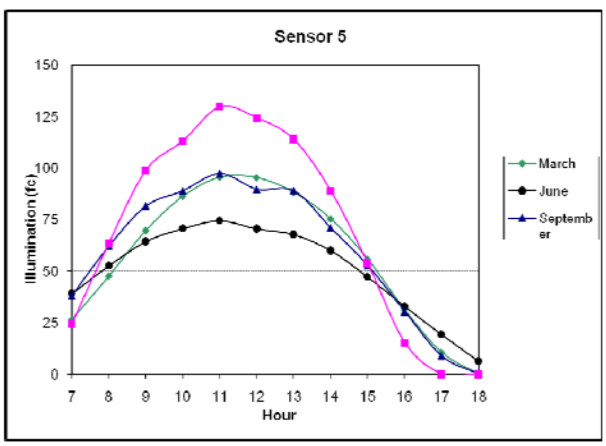

Fig. 5. Daylight simulation in an office

3.2 Low Ceiling, South Facing, Large Spaces

After deciding the administrative suite, there are academic spaces to be located. Recognizing that the 3rd floor will have no limit in height, Computer Lab and Media Center were chosen to be on the 2nd floor because they also don't require high volume of spaces. Also the fact that daylighting requirement in computer labs and media center are not as high as typical classrooms helped this decision. Computer labs require only 25 to 30 footcandles and Media Center also has spaces that require around 25 foot candles such as computer work area, book stack area and quite reading area with task lights. Only large reading and gathering area in Media Center required 50-60 footcandles. Strategically designed media center would satisfy the light levels through the daylighting. In these two spaces, south-facing clerestory windows with exterior & interior light shelves were used.

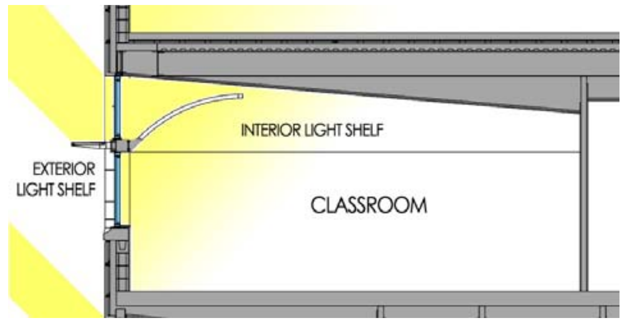

Fig. 6. Computer Lab section

A curved interior light shelf strategy has been used at two other schools previously and proved to be working great to block the direct sunlight and distribute into deeper spaces. A curved, acrylic panel light shelf with highly reflective, sloped ceiling panels help daylight distribution.

Fig. 7. Interior and exterior light shelf mock-up

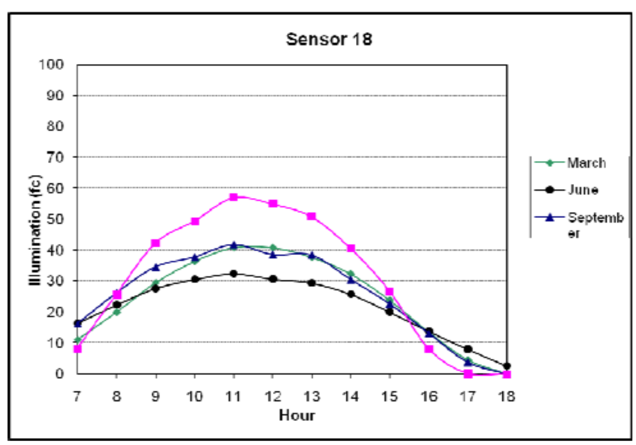

Fig. 8. Daylight simulation in Media Center

Fig. 9. Rendering of Computer Lab

3.3 <u>High Ceiling, South Facing, Large Spaces</u>

On the top floor of the new addition, Music and Chorus classrooms were placed to satisfy not only the acoustical volume requirement but also daylighting requirement for 50 foot candles. Roof top monitor was a strategic choice to meet both requirements. Combined exterior & interior light shelves and roof monitors with fabric baffles were used. Gymnasium is also located on the top floor of the new addition. Two roof monitors are placed for daylighting.

Fig. 10. Roof monitors at new addition

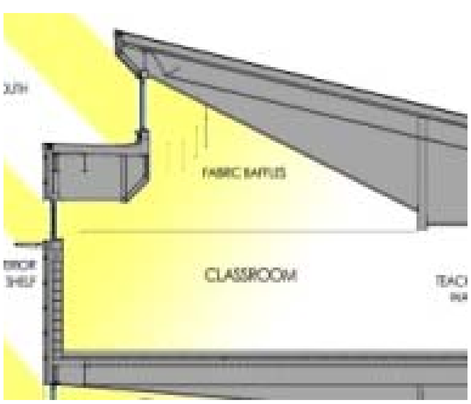

Fig. 11. Music classroom section

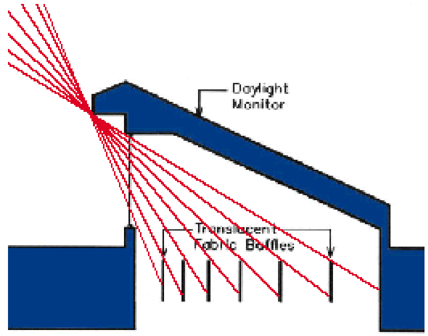

Fig. 12. Roof monitor section

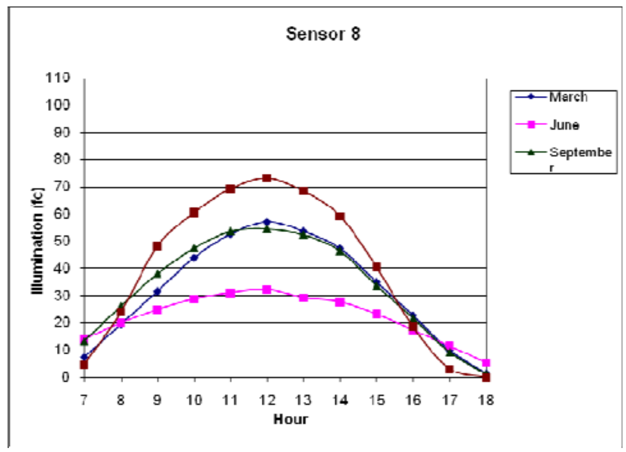

Fig. 13. Daylighting simulation in Music classroom

Fig. 14. Rendering of Gymnasium

3.4 <u>East and West Facing Classrooms</u>

In existing east and west facing classrooms, we were limited with existing window opening size and window profiles due to historic preservation requirements. No exterior treatment could be added and the profile of existing window frames and mullions had to the same on the new windows. 45 degree angled vertical fabric baffles with sloped interior light shelf that is anchored to the lower horizontal mullion of the window is adopted. Angle and spacing of the fabric baffles were determined by a careful glare control study and daylighting simulation so that the low angle sunlight does not create any discomfort while it provides high quality daylighting.

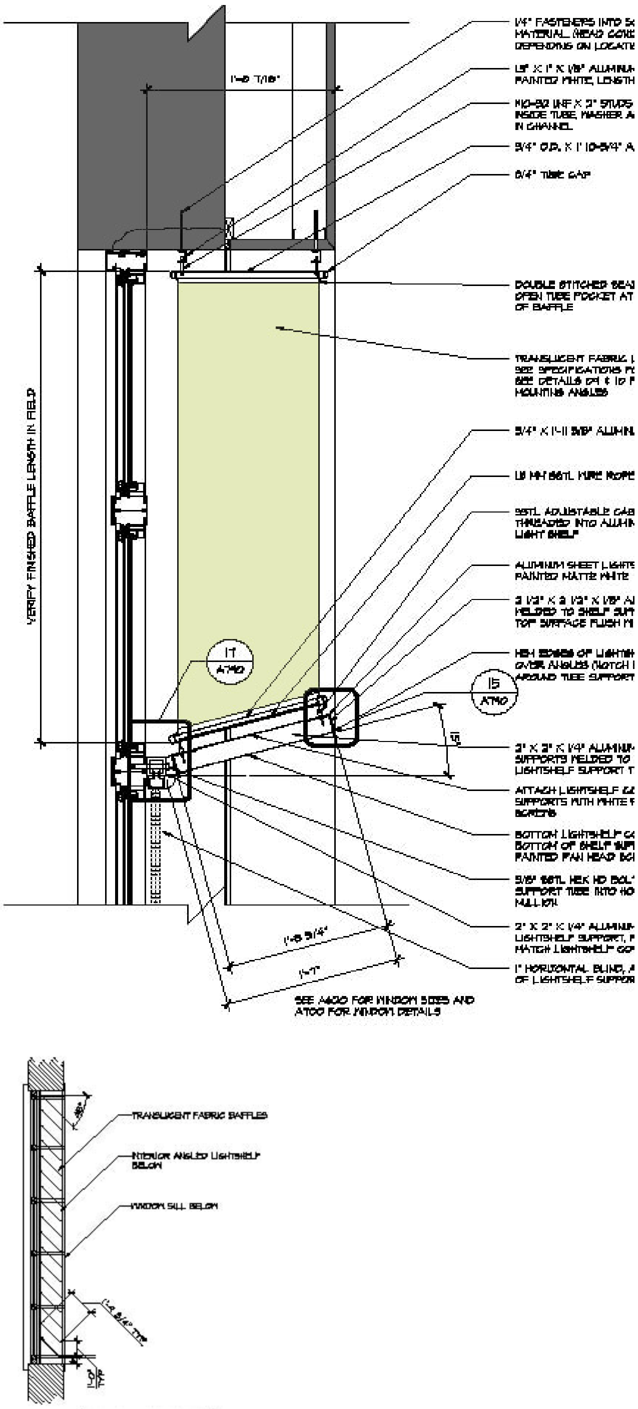

Fig. 15. Vertical Baffle Section and Plan Details

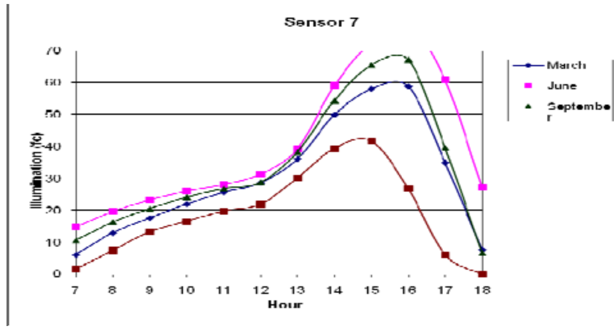

Fig. 16. Daylighting simulation in west classroom

Fig. 17. Rendering of west classroom

4. CONCLUSION

Although the existing building was not appropriately oriented and there were several restrictions due to the historic preservation requirements, the project still could achieve great amount of daylighting in most occupied spaces. The success was the result from holistic design approach that the design team placed spaces considering daylighting, function, restrictions, orientations, all together strategically. Fig. 18. Illustrates how much daylighting contributed toward 2030 Challenge goal. According to eQUEST simulation, the daylighting reduced energy consumption from 41.6 kbtu/sf/yr to 35.0 kbtu/sf/yr that is approximately 16% relatively or 13% in overall compared to ASHRAE/IESNA 90.1-2004 base case model (51.1 kbtu/sf/yr).

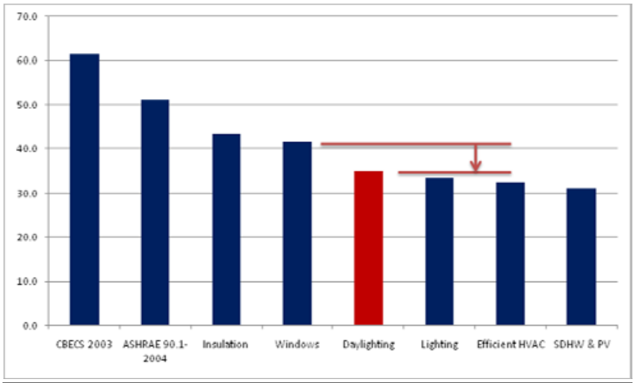

Fig. 18. Contribution of daylighting toward energy saving

5. ACKNOWLEDGEMENTS

HMS Architects, New Orleans, Louisiana, is a co-architect of the record of the project. All renderings on this paper are provided by HMS Architects.