Proposed Title:
Passive Heating and Lighting—A Case Study Using the MS&T 2009 Solar House

Submission Type:
Research

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Description:

In 2013, the domestic production of energy in the US only satisfied 84% of the total energy demand; we, as a country are using more energy than we can produce (Joyce and Repice, 2014). As of 2010, the United States was responsible for 19% of the world's energy consumption with 22% and 19% consumed by the residential and commercial sectors, respectively. In both residential and commercial sites, the predominant energy use comes from space heating, while space heating, space cooling, and lighting combined form the majority of the energy use (Building Energy Data Book, 2012).

Based on the recent energy statistics, it is necessary to optimize the usage of the sun for environmental and economic reasons, and thus it is important to design buildings with passive heating and lighting in mind. Carefully located windows as well as exterior building attachments help create a comfortable indoor environment and temperature by distributing heat and light. To combat the high levels of energy use, we will examine louver shades, commonly known as solar shades or solar louvers, and light shelves.

Solar louvers and light shelves serve as passive cooling, shading, and lighting mechanisms. Studies have been done to confirm the cooling and shading effectiveness of solar louvers and the lighting and shading effectiveness of light shelves; studies have also determined optimal sizing, orientation, and materials of the two building attachments. Because space heating has the highest energy cost in the residential and commercial sectors, this research examined the effectiveness of solar louvers and light shelves as a passive heating mechanism. As part of this ongoing case study this research provides some of the methodology being used. The first method examines a physical scale model using the Sun Path Method. A second comparative method was used to compare the results further quantifying the results of the first method through a computer simulation software known as EcoTect. The third method is an implementation of temperature sensors in the Solar House with an Arduino control system. Based on the generated results the data is used to compare the effectiveness and efficiencies of light shelves and solar louvers.

Although the primary goal of this research project was to examine light shelves and solar shades as passive heat exchange mechanisms, the research found that both of those building attachments are far more effective instruments for shading and cooling. There is minimal visible difference in the analysis grid maps comparing daylighting in our EcoTect simulations for any of our light shelves, louvers, or combination thereof. From the Sun Path Model, minor differences were detected in the light shelve and base house and a larger change between the base house and the louver house. Again, this difference originated from the shade created. When analyzing the results of the sun path method the louvers provided minimal benefit to the homes interior conditioning as a result of the roofs design.

References:

"Buildings Energy Data Book." *Buildings Energy Data Book*. US Department of Energy: Energy Efficiency and Renewable Energy, Web. 26 Oct. 2012.

Joyce, M., & Repice, R. (2014, June 2). Domestic production satisfies 84% of total U.S. energy demand in 2013. Retrieved July 14, 2014, from US Energy Information Association website: http://www.eia.gov/todayinenergy/detail.cfm?id=16511&src=Total-b1