Energy Performance of Daylit Schools in North Carolina

Michael H. Nicklas
Gary B. Bailey
Innovative Design
850 West Morgan Street
Raleigh, North Carolina, 27603

ABSTRACT

The following study analyzes the energy performance and cost of daylit schools designed by Innovative Design in Johnston County, North Carolina. The analysis compares the first-year energy performances of the Clayton and Selma Middle Schools and the K-5 Four Oaks School with similar but non-daylit schools in the County. The two daylit middle schools were completed in the spring of 1993 and the comparison year was July of 1993 through June of 1994. The Four Oaks School was completed in August of 1990 and the first year of collected data was 1991-92.

In addition to the three daylit schools listed above, cost information is also provided on two other daylit schools designed by Innovative Design - the Durant Road Middle School (Wake County, NC) and the Clayton Elementary School (Johnston County, NC). The Durant Road School was completed for the opening of the 1995-96 school year and first-year energy data is not yet available. Clayton Elementary is now under construction and nearing completion.

The K-5 Four Oaks School was constructed on an existing campus when the majority of the old school burned. Escaping the fire were classroom facilities that still serve the needs of the middle school students and a gymnasium which was integrated into the new K-5 construction. The renovated gymnasium as well as the cafeteria and outside athletic facilities are shared by both the K-5 students and the middle school students.

The two daylit middle schools are very similar in design, both based on a prototype design that incorporates extensive south-facing roof monitors. However, the Selma Middle School is approximately 22,000 square feet smaller and houses 150 less students. The Durant Road Middle School, although much larger, also includes many of the same design features incorporated in the Clayton and Selma Middle Schools. However, Durant utilizes both north and south facing roof monitors. The Clayton Elementary School is considerably different in design but also utilizes south-facing roof monitors as the major daylighting strategy.

In all cases, translucent fabric baffles are suspended in the lightwells to eliminate any direct beam radiation from entering into the work area below. Light sensors are used at each of the schools to stage the backup lighting. All of the schools are designed to achieve in excess of 70 footcandles, through daylighting, over two-thirds

of the time the schools are occupied. Each classroom is also equipped with shades that can be used to darken the spaces and override switches to increase lighting levels. Although the shades and lighting override switches provide occasional functional benefits for individual classrooms, they are also the source of reduced daylighting benefit in certain classrooms.

The schools used in the comparison had, at the time of the analysis, the following characteristics:

- the majority of space at each school was air-conditioned;
- the schools were within the same County (a several county region was used in comparing cost of construction);
- the majority of the space within the school was being utilized; and
- the grade levels were similar.

CONCLUSIONS

The most obvious conclusion is that daylighting, even excluding all of the productivity and health benefits, makes sense from a financial investment standpoint. The daylit schools in the study indicated energy cost reductions of between 22% to 64% over typical schools. With paybacks on all the new daylit schools below three years, the long term benefits to a school system are enormous. In North Carolina, a 125,000 square foot middle school that incorporates a well integrated daylighting scheme is likely to save $40,000 per year over what is typically constructed. And, if energy costs go up by 5% per year, the savings on just this one school, over the next ten years, would exceed $500,000.

From an analytical standpoint, it also appears wise to assume that:

- even though the school program calls for a nine month schedule, anticipate the school will be occupied for twelve months;
- public spaces (i.e., gymnasiums, cafeterias and libraries) will be utilized considerably more than is needed to fulfill just the students' class needs;
- internal loads due to computers and other electrical equipment will greatly exceed amounts typical of previous years;
- new requirements for fresh air make-up will drastically impact energy consumption;
- indoor temperatures, if individual room controls are provided, will routinely exceed 70_F in the winter and 76_ in the warmer months; and
- that the daylighting performance, even though controlled by light and motion sensors, will ultimately be determined by the teachers and, in particular, the schools' principals that greatly influence attitudes.

The complete research paper is available at:
http://www.innovativedesign.net/energyperformance.htm