

SIX KEY WAYS TO REDUCE AUDITORIUM CONSTRUCTION AND OPERATING COSTS

Facility planning experts who specialize in high school construction have identified a number of key areas in which both initial construction costs and ongoing operating costs can be reduced for auditoriums and performing arts facilities. These savings can be quite significant and may have a substantial impact on the size, type and quality of the auditorium or performing arts facility that a school is able to build, after taking into account its existing budget and the amount of such savings.

According to the U.S. Department of Energy's Building Technologies Program, the ongoing operating costs for new high-performance schools, which are designed to save energy and reduce environmental impact, can be 50% less than those in traditionally-designed schools. Further, the Department of Energy notes that renovating existing schools to replace outdated systems (such as inefficient boilers, lighting, etc.) can save up to 30% annually in operating costs. In addition, if done properly, upfront construction costs can be significantly reduced as well. The auditorium design is an important component in trying to achieve those savings, since auditoriums can be expensive to construct and operate.

In particular, when you are considering either building a new auditorium or renovating an existing one, you should focus on the following six areas when seeking to realize these savings:

1. Reducing Lighting Costs by Using More Efficient Lighting Fixtures – Since electric lighting can typically account for 30 to 50 percent of a school's electric power consumption, the efficiency of a facility's lighting system significantly impacts on a facility's operating budget. As a result, even modest efficiency improvements to the existing lighting system can mean substantial savings in electricity costs. Typical ways of achieving these efficiencies are:
 - Installing High-Efficiency Lighting Systems – You can install high-efficiency lamps, ballasts, lenses and fixtures in order to reduce electricity usage – specifically, you should consider installing T-8 fluorescent, compact fluorescent or metal halide lighting fixtures and minimizing the use of incandescent fixtures. For instance, if a facility uses T-12 fluorescent lamps, changing to more modern T8 lamps and electronic ballasts can reduce the rate of energy consumption for those fixtures by approximately 35 percent. For auditorium lighting, it makes sense to use these newer systems for work lights and for lecture set-up areas, as well as other areas of the auditorium. In addition, many auditoriums are using more LED lighting systems, which were initially used just for aisle and exit lighting, but are now also being used for wall lighting and area lighting (note that such LED systems have the added advantage of having very low ongoing maintenance costs).
 - Funding the Installation of these High-Efficiency Systems – In many cases, the local utility company, in conjunction with federal and state energy savings programs, will fund some or all of the costs of installing new high-efficiency systems – in other cases, the District might qualify for a private foundation grant for this type of installation. To the extent that the local utility or any other entity won't fund the installation of these systems, you can use the operating savings to fund the upfront installation costs. The District will reap the continuing benefits from the reduction in lighting costs for many years to come.

- Installing Appropriate Lighting Controls – You can install occupancy sensors and time clocks to ensure that existing lighting systems are properly adjusted to meet the school's actual lighting needs while avoiding waste. This can be especially important for auditoriums, which typically go unused for the vast majority of time that the facility is open and therefore don't need to be lit for large periods of the day. In addition, to the extent that the auditorium has access to natural light, you can also install dimming sensors, which will automatically reduce the lighting levels when natural daylighting is available .
- Optimizing the Number and Location of Light Fixtures – Lighting fixture and switching plans should be developed for the auditorium that provide flexibility for lighting only the areas of the auditorium that are in use. In some cases this might mean installing low-level ambient lighting throughout the seating area of the auditorium, supplemented by task lighting for those areas with higher lighting needs, such as the stage area or the front entrance area.
- Installing Low Maintenance Lighting Systems – As part of this effort to reduce lighting expenses, consider using long-life lamps to reduce ongoing maintenance costs. One approach being used frequently in auditoriums is the conversion to LED lighting systems, which are noted for long-term reliability. This alternative often results in much lower ongoing maintenance costs. As newer LED lighting systems are becoming more versatile and installation costs are starting to drop, these systems are starting to be applied throughout the auditorium, in addition to their traditional use for aisle and exit lighting.
- Other Ideas for Savings on Lighting – For more information in this area, the website for the U.S. Department of Energy's Building Technologies Program offers information about improving the energy efficiency of various types of buildings, including school systems (see www.eere.energy.gov/buildings).

2. Reducing Heating, Ventilation & Cooling Costs for the Auditorium – The heating, ventilation, and air conditioning (HVAC) system is one of the largest energy users in the most high schools. This is especially true in those regions of the country, such as the Northeast, where heating and air conditioning costs can be quite significant (i.e., in that area, HVAC systems are typically responsible for 50%–60% of the energy consumed in schools). As a result, making even modest improvements in the efficiency of this system can yield relatively large savings in a high school's annual operating budget. In addition, seeking appropriate efficiencies can result in a reduction in the initial acquisition costs of the mechanical and electrical systems by reducing the required size of the systems. Primary strategies to achieve these efficiencies include the following:

- Reducing HVAC Usage During Periods in Which the Auditorium Isn't in Use – Since many auditoriums may go unused for 90-95% of the time, it is wasteful to heat or cool that portion of the facility at normal levels when the space is not being used. Efficiency can typically be obtained through the use of programmable thermostats. Occupancy sensors can also be installed to reduce ventilation air requirements when the auditorium is unoccupied. In addition to using motion detectors and other types of occupancy sensors, many Districts have installed carbon dioxide (CO₂) sensors to monitor and control the ventilation requirements of their auditoriums (e.g., they increase the amount of fresh air pumped in when the sensor indicates that carbon dioxide levels are high and decrease the flow when the sensor indicates that carbon dioxide levels are low). The accuracy of the various sensors should be checked and calibrated as necessary.

- Choosing High Efficiency HVAC Systems – It is important to select an HVAC system that has a high energy efficiency rating, which is achieved in many current models through high efficiency boilers, motors and variable speed drives and fans with direct digital control systems for greater accuracy, performance, and energy savings. Although these systems often cost more initially, efficiency results in ongoing operational savings throughout the entire life of the system.
 - Using Existing Software Programs to Weigh the Relative Cost Advantages of an Energy Efficient System – A number of helpful software tools are available to help in selecting the most appropriate type of system for a facility – in particular, an energy analysis computer program can be used to simulate the hourly energy needs of the facility based on more efficient systems and estimate the monthly and annual energy usage and costs. This allows the life-cycle economics of the design to be evaluated and compared to more traditional, less efficient HVAC systems.
 - Choosing the Proper Size for the School's HVAC System – In addition to choosing the type of HVAC system that is most appropriate, the system must be correctly sized for a facility and its likely requirements, including giving appropriate consideration to the auditorium and its impact on the overall facility. If you choose an over-sized system, it will cost more in upfront purchase cost, and if you choose either too large or too small a system, ongoing operating costs will be higher since the system will not be operating at peak efficiency.
 - Using Natural Ventilation – To the extent possible, consider the use of natural ventilation for the auditorium, as well as the rest of the facility, to reduce ventilation costs. Whether this particular option is viable for your facility will depend on the region of the country, since some temperature and humidity levels are more conducive to this approach than others.
 - Displacement Ventilation Systems – A vertical displacement ventilation or thermal displacement ventilation system should also be evaluated for its usefulness. This method uses natural convection forces to reduce fan energy and to lift existing room air up and away from the breathing zone of people in a particular room. Typically, when using this method, air flows initially from the lower sides or corners of the room and spreads across the room floor; then, as the air is warmed by people and other heat-producing objects in the room (such as lighting and equipment), it rises upward and is continuously lifted up and out of the room via vents in the ceiling. These systems also have the advantage of being quieter than more conventional, high-velocity ventilation systems.
3. Installing High-Efficiency Electrical Distribution Systems – Installing a high-efficiency electrical distribution system can have an impact on both initial system purchase costs and ongoing energy costs. The design of the auditorium, with its high electrical power requirements, can have a big influence on the selection of an appropriate system. Note that an inefficient electrical distribution system can result in line losses of up to 3% or 4%, as well as degraded power quality and similar problems (such as the introduction of wasteful harmonics).
- Installing a High-Voltage Electrical Distribution System – Consider the advantages of a high-voltage distribution system, while balancing both the upfront cost and the operational savings due to reduced line losses. For instance, it may be preferable to deliver power at 208/120 volts versus 480/440 volts.
 - Installing Properly-Sized Transformer – The transformer must be properly sized to

fit the facility's load, to keep losses to a minimum, and to optimize transformer efficiency.

- Other Electrical Distribution System Considerations – There are many other considerations for installing these systems, and you should make sure that a professional engineer or consultant takes into account both the performance requirements of the facility, as well as the original and ongoing costs of these systems when building or renovating a facility. See the U.S. Department of Energy's "Energy Design Guidelines for High Performance Schools" for a listing of additional considerations.
- Providing Adequate Cooling for the Electrical Distribution Systems –You should provide adequate ventilation and cooling of these systems to prolong the functional life of the electrical distribution system.

4. Gaining Efficiency in Auditorium Construction and Operating Costs by Reducing the Overall Footprint Required for the School – There are innovative auditorium systems which allow for conversion of a portion of the school's existing auditorium space into usable classroom space, which reduces the total amount of classroom space required for the school, and thereby results in a reduction in the school's initial construction costs and ongoing operating costs.

- Installing a Turntable Divisible Auditorium (TDA) System – A turntable divisible auditorium (TDA) system (which has been installed in over 65 different locations by the Macton Corporation) can rotate portions of the auditorium seating area to create separate teaching rooms when the full auditorium is not in use, thus increasing the total amount of classroom space available. A study on this type of system was conducted by BLRB Architects, P.S., on the two TDA's installed at the 600-seat auditorium at Kentlake High School located in Kent, Washington. The study concluded that the installation of the TDA's at this school resulted in a 6.3% cost reduction in overall construction costs, as a result of the elimination of duplicative auditorium and classroom space. This is in addition to the ongoing operational cost savings that are inherent with the installation of this type of system. Note that while the TDA project at this school is fairly typical, the actual cost savings for a particular school project may be higher or lower than these amounts, depending on the specifics of that project (such as the size of the auditorium and the size of the TDA's involved).
- Examples of Current TDA Systems – In addition to the fact that TDA systems have been installed in over 65 different locations, they have also been installed recently in some high profile schools, including the recently-completed School of the Future in Philadelphia. The School of the Future was planned as part of a joint effort by the Microsoft Corporation and the Philadelphia School District (with architectural design by The Prisco Group), after extensive research was done on the optimum ways in which a school facility should be designed and managed. The facility was designed to be technically advanced, environmentally friendly and architecturally attractive, while remaining within a school district's traditional capital and operating budget. More importantly, this state-of-the-art facility was intended to serve as a model that can be used by other school districts who are seeking better ways to meet the needs of their students while dealing with tightening school construction budgets. The auditorium in that school consists of a 500-seat, 8,500 square foot performing arts center – in the rear of that auditorium, two separate TDA systems can rotate within a few minutes, by a simple push of a

button, to create two completely independent teaching or performance rooms (each of which has seating for about 100 people). These two rotated rooms are walled-off from the rest of the auditorium and have sound-isolating materials built into the walls, providing excellent sound isolation from the auditorium. In addition, the school's auditorium was built with an adjacent parking lot and set off from the rest of the school, which makes the general auditorium, as well as the two separate rooms created by the TDA systems, more accessible to the local community for meetings and other local community needs, without interfering with normal school operations.

- Alternative Solutions to TDA System – There may be other approaches to converting this auditorium space to classroom space, such as using movable walls or curtains to section off a portion of the auditorium for use as alternative space, such as classrooms. While some school systems have tried this approach, the problems they have encountered with these alternative solutions include:
 - Acoustical Quality – The alternative classroom space created by movable walls or curtains lacks the acoustical isolation performance that is realized with a TDA system. In particular, movable walls or curtains typically lack the degree of sound-isolation that you have in a TDA system, thereby causing this alternative space to perform poorly.
 - Ability to Have Permanent Teaching Stations – The alternative classroom space created by movable walls or curtains lacks the ability to have a permanent teaching station located in that space (i.e., teachers are required to stand in the aisle of an auditorium and therefore can't have a desk or other materials permanently installed). With the TDA system, on the other hand, the back of the TDA, which is not a part of the auditorium seating area, has a permanent area to support instruction, such as teacher desks, science demonstration islands, etc.
 - Maintenance Issues – The alternative systems of movable walls and curtains typically have much higher maintenance requirements and maintenance problems. This is in contrast to a TDA system, in which there is limited annual routine maintenance required and maintenance problems are much less frequent.
5. Sharing Auditorium Costs with Other Entities by Increasing Alternate Uses of the Facility – One of the best approaches to reducing auditorium costs and affording the type of facility needed at your school is to find other organizations who will share the costs of construction and ongoing operation.
- Sharing Costs with Local Community – High schools are increasingly used by their communities for uses other than purely educational ones. In many cases they are also being used as community centers and performing arts centers during the week at after-school hours (and in some cases during school hours when these areas can be closed off from the rest of the school) as well as on weekends and holidays. The auditorium, with its large open space, is often a significant part of this sharing. Shared use increases community support for education in general and for any bond issue needed to fund the construction of a new high school. There are numerous examples of local governmental entities or community groups sharing in the initial construction costs and ongoing operating costs in proportion to their use of the facility. Alternatively, some communities build the auditorium so it can be separately accessed by the public and not through the school – this

allows the auditorium to be easily closed off from the rest of the school during those times in which it is not needed by the school and then made available for community use.

- Getting Increased State Funding – With some innovative auditorium systems, some of the existing auditorium space can be classified as usable classroom space, which in some states entitles the District to a higher reimbursement rate from the state on upfront construction costs (e.g., in California, there is a distinction made between auditorium space and classroom space in the amount that gets reimbursed by the state). A turntable divisible auditorium (TDA) system rotates portions of the auditorium seating area to create separate teaching rooms when the full auditorium is not in use, thus increasing the total number of teaching stations available. To the extent that a state reimburses the costs of building classroom space at a higher rate than it reimburses the costs of building auditorium space (which many states do), using a TDA system can increased state funding for a school project.
 - Renting Out the Auditorium for Various Evening or Weekend Events – Another way of defraying the costs of an auditorium is to consider renting the auditorium for special events. In many newer auditoriums, there is often a food service area adjacent to the auditorium, which increases the attractiveness of these auditoriums for event use, since food service can be provided to these events. In some instances the auditorium has been located on the perimeter of the school facility with separate outside entrances so that public access can be provided during school hours, while at the same time restricting access from that space to the rest of the school building for security reasons. One consideration in doing this is to possibly limit the use of the facility to certain responsible third parties (i.e., permit its use for corporate conferences or learning events, but restrict it from being used for certain types of concerts, etc.), in order to limit the wear and tear on the auditorium space.
6. Hiring an Architect and/or Consultant who is Focused on Cost Reduction – Perhaps the most important thing you can do when evaluating whether to build a new auditorium or renovate an existing one (either as a stand-alone project or as part of an overall construction or reconstruction of a school facility), is to make sure that the architects, engineers and/or consultants you hire to help you through this process are focused on delivering a building that provides the best value. While most will profess to be very focused on economy, you need to make sure that they are able to “walk the talk”. As part of this, when you are hiring an architect or consultant, ask about how they would seek to reduce upfront construction costs and ongoing operating costs for this facility. They should have many useful cost-saving suggestions. The best consultants for the project will help the owner secure the best balance among the project objectives of great quality, reasonable cost, and timely completion.

This report was commissioned by the Macton Corporation, which has been actively involved in the construction of innovative auditorium systems for the last four decades. If you have any questions on some of these topics or would like our assistance in finding the names of experienced design consultants or architects who can further assist you in this area, please feel free to contact Tony Mesa, Macton's Product Manager for this area, at (203) 267-1500, ext. 25, or email him at tmesa@macton.com.

Information Sources Used for this Paper

The information sources used for this article include, among others, the following (some of which may be helpful to refer to in further exploring the topics discussed above):

- Article on "Critical Elements and Building Blocks", published on the website of the High Performance Schools Exchange of the Northeast Energy Efficiency Partnerships (NEEP) – see www.neep.org.
- Published materials from the U.S. Department of Energy's Building Technologies Program (see www.eere.energy.gov/buildings).
- "High Performance School Construction Guidelines", published by the National Renewable Energy Laboratory (see www.energycodes.gov/news).
- U.S. Department of Energy's "Energy Design Guidelines for High Performance Schools", dated June 2002.
- Article on "Tips for Implementing a School-Wide Energy Efficiency Program", published on the website of the Alliance to Save Energy's Green Schools Program (see www.ase.org/greenschools/newconstruction).
- "Illinois Resource Guide for Healthy, High Performing School Buildings", published by the Illinois Capital Development Board of the Illinois State Board of Education, dated February 2006 (see www.cdb.state.il.us/schools/HealthySchoolsGuide.pdf).
- "Collaborative for High Performance Schools (CHPS) Best Practice Manual: Volume IV, Maintenance and Operations" (see www.chps.net/manual), published by the Collaborative for High Performance Schools (CHPS), dated 2004.
- Written report from BLRB Architects, P.S., on the construction cost savings on two turntable divisible auditorium systems installed at the 600-seat auditorium at Kentlake High School located in Kent, Washington.
- Published materials from the National Clearinghouse for Educational Facilities at the National Institute of Building Sciences (which is funded by a grant from the U.S. Department of Education) (see www.edfacilities.org/rl/construction_costs).

To learn how you can integrate a TDA into your next educational facility, please email us at: TDA@macton.com, call us at **800-334-TURN** or visit www.macton.com/tda.



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