Building Acoustics: A key part of the whole building design process

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A Project's Competing Priorities

Whether you are working on a project for the Federal Government or the private sector, odds are sustainable design and security are competing priorities, along with overall project cost control. A 2003 BOMA[1] (Building Owners and Managers Association International) report indicated security-related expenditures were one of the fastest rising expenses among building managers from 2001 to 2002. The U. S. government sector showed a 29% increase, while private sector properties showed a 14.3% increase.

The green building movement is sweeping through both the public and private sectors, fueled by the desire to have building projects be more responsive to the environment, use less energy, increase functionality and boost occupant productivity. Complementing these goals is the desire to achieve a U.S. Green Building Council[2] (USGBC) Leadership in Energy and Environmental Design (LEED ™)[3] certification for the building project. Acoustics is one of the most overlooked issues in building design – It must be addressed in concert with the other key design objectives and integrated into the overall building design early in the process, or it will be relegated to scrapping for a few left over dollars with things like carpet upgrades.

The Whole Building Design Approach vs. Conventional Building Design

Conventional building design tends to be linear with little interaction between the parties involved in the project. It is like a relay race where the architect creates a design and hands it off to the engineers who design their systems (sometimes independent of each other) and then pass the design off to the contractor. This approach fails because it is unable to deliver "high performance" buildings – ones that optimize energy efficiency, incorporate appropriate security measures and achieve peak occupant productivity, all within the prescribed budget. Employing conventional design can also result in poor energy performance, harmful environmental impact, higher operating and maintenance costs, and unacceptably higher noise levels.

To achieve a successful building design, it is not sufficient to optimize the building's subsystems. It is critically important to address all key design objectives during the concept stage. In the whole building design approach (sometimes called integrated design), all members of the project team – architects and engineers, special consultants (e.g. acoustical), planners as well as contractor, building owner, occupants, and maintenance staff are involved in the project development process from the start. One way to accomplish this is to hold a charette. A charrette is a focused and collaborative

brainstorming session held at the beginning of the project. The charrette process encourages an exchange of ideas and information and allows truly integrated solutions to take form. Team members are encouraged to "cross fertilize" and address problems beyond their field of expertise.

Whole Building Design Objectives

What are the key design objectives? The Whole Building Design Guide (WBDG)[4], an online resource and Internet Portal created for the Federal Agencies by the Sustainable Buildings Industry Council (SBIC)[5] to improve their building designs, identifies these as the most important design objectives:

- Accessible
- Aesthetic
- Cost-effective
- Functional
- Productive (for the building occupants)
- Secure/Safe
- Sustainable

Where applicable, historic preservation is also a key design objective.

In the WBDG article[6], "The 'Whole Building' Design Approach," Don Prowler stated, "The fundamental challenge of 'whole building' design is to understand that all building systems are interdependent. Through a systematic analysis of these interdependencies, a much more efficient and cost-effective building can be produced. The choice of a mechanical system, might, for example, impact the quality of the air in the building, the ease of maintenance, Global Climate Change, operating costs, fuel choice, and whether the windows of a building are operable. In turn, the size of the mechanical system will depend on factors such as, the type of lighting used, how much natural daylight is brought in, how the space is organized, the facility's operating hours, and the local microclimate."

Building Acoustics Must Not Be Overlooked

With the current emphasis on sustainable design and building security, decisions can be made that could create significant noise impact if acoustics is not considered in conjunction with other design issues. A project's cost increase to accommodate security features, along with a somewhat longer design process to evaluate sustainable design opportunities can mean noise control features are left out or completely overlooked. The resulting high noise levels can lead to a less functional facility and less productive occupants. The secret to successfully incorporating noise control into the project is for you to show the project development team they can control noise while meeting their security and sustainability goals, in some cases without incurring additional cost.

Incorporating Acoustics into The Whole Building Design Approach

To achieve a building design that is accessible, aesthetic, cost effective, functional, sustainable, secure, productive for its occupants and has an acceptable acoustical environment, incorporate noise control into the project concept phase as part of the integrated, whole building design approach. How do we do it? Here are some examples.

Site: Earth berms between access roads and the building can act as a barrier to traffic noise while providing a blast protection barrier. Storm water retention ponds strategically located between roadways and the building can mitigate blast effect by distance while reducing traffic noise by distance.

Roofs: Vegetated or green roofs[7] provide insulating qualities that decrease energy costs, reduce storm water run-off, lower rooftop temperatures (the urban heat island effect), and reduce noise impact on the building from above, while extending the life of the roof.

Glazing: This is one of the most important elements in the design of the building envelope. Windows must provide views and daylighting to the occupants, while rejecting heat, mitigating blast, and reducing noise from external sources. Specifying glazing that does all this can be expensive, but not considering any one of these parameters can result in costly change orders with the potential of the building not being able to meet its intended design goals.

Daylighting: Daylighting of offices and classrooms can mean eliminating suspended acoustical ceilings leading to unacceptable, highly reverberant spaces. You must assist the other project team members in recognizing the need to replace the ceiling's lost sound absorption capacity with an equivalent value on the walls and in the partitions.

Building Envelope: Employing concrete or masonry in massive walls to absorb and retain heat for later release (thermal mass[8]) can also reduce the noise from highways and railroads if the noise source and optimum solar gain are on the same side of the building. According to the Portland Cement Association[9] cast-in-place concrete, precast concrete, insulating concrete forms (ICF) or concrete blocks embody thermal mass characteristics that moderate heating and cooling peaks and lower HVAC requirements. To qualify for Recycled Content credits in LEED™ many designers incorporate supplementary cementitious materials like slag cement, silica fume or fly ash into concrete mixes.

Onsite emergency power generation: The noise impact of choosing the location and type of onsite emergency power generators must be considered along with protecting it from unauthorized access/sabotage. A renewable energy source of onsite power like photovoltaics can deliver the necessary power without creating any noise.

HVAC: Coordinate the location of air intake/exhaust louvers to meet Department of Health and Human Services (DHHS)[10] "Guidance for Protecting Building Environments from Airborne Chemical, Biological or Radiological Attacks" with the optimum location of louvers to reduce the effects of exterior noise entering the occupied spaces through the HVAC system.

Classrooms: According to SBIC, High-Performance School Buildings[11] boost student health and productivity, conserve energy and water and other natural resources, and save schools and communities money. An ideal learning environment incorporates daylighting in the classroom, along with thermal comfort and appropriate ambient sound levels for ideal listening conditions. Showing intent to comply with the ANSI/ASA[12] Standard

S12.60-2002, “Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools” means that you are aligned with the high performance school buildings guidelines.

Mass Notification: Mass notification and personal alert systems are being incorporated into facility design from office buildings to embassies and from multi-level living quarters to cafeterias. Ensure the building’s and the site’s acoustical characteristics do not mask the sound emitted from these critical warning systems.

Is Whole Building Design Cost-Effective?

A project developed through a whole building design approach should cost no more to construct than one developed utilizing standard design procedures. However, the whole building approach may result in additional design costs due to expenses associated with additional coordination meetings, interdisciplinary computer modeling, etc.

If there are additional design costs, are they worth it? Most often, yes. For example, projects designed using the linear conventional approach often require numerous changes during construction or retrofit after it is completed. These required changes could be very costly and cause critical delays. If owners cannot afford to do it right the first time, how can they afford to fix it or do it again?

Conclusion

Acoustical consultants and noise control engineers – learn about products and systems that can perform double (or triple) duty; get invited to the project charette; advise the other project team members about the consequences of overlooking acoustics during project development; and show the team how to achieve acoustical goals simultaneously with their project’s sustainable design and security goals.

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