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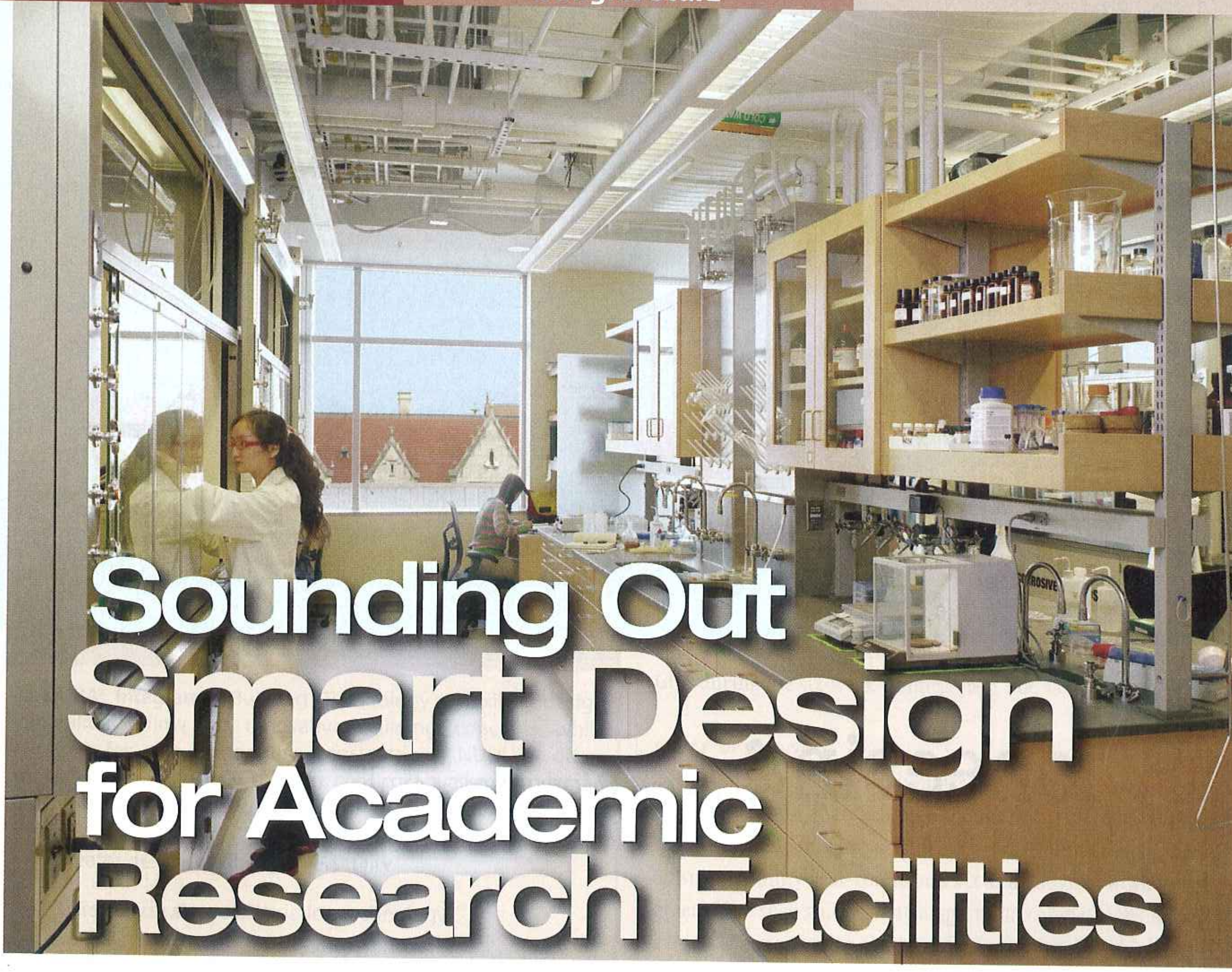

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Sounding Out Smart Design for Academic Research Facilities

State-of-the-art academic research facilities must include specialized design considerations for acoustics and noise and vibration control.

Academic research facilities are specialized spaces and therefore require unique design for acoustics and noise and vibration control, especially when sensitive equipment is in use. Whether inside or outside, common vibration and noise sources — such as the building's mechanical systems, road traffic, or a subway line — can have a detrimental effect on sensitive lab equipment. What do college planners need to consider when designing a research facility? How do acoustical considerations factor into the design and cost of a new lab? By addressing architectural acoustics and noise and vibration control early in the design process, a research facility can be a comfortable and productive place to work.

Academic research facilities are unique in terms of space planning, architecture, and acoustics. University labs often house a large mix of uses that need to coexist within a building. While commercial research facilities may have an entire building with similar types of spaces, academic research facilities are a mixture of laboratory space, classrooms, lecture halls, offices, and perhaps common social areas. Due to these varied uses, there are three major concerns that architects and institutions should consider when designing academic research facilities: architectural acoustics and sound isolation, mechanical noise and vibration control, and structural vibration due to environmental sound and footfall.

In general, common laboratory facilities without extremely sensitive equipment don't present significant sound isolation issues between adjacent spaces. For a high percentage of college and university laboratory spaces, ordinary metal stud and single-layer gypsum board demising constructions are fine and further design accommodations are not necessary. But for areas where noise- and vibration-sensitive research is conducted, the facility will have special acoustic and vibration design needs. A college planner would be well served to understand the details and requirements of the research program in order to design the lab space accordingly.

Environmental Vibrations

Environmental vibrations, such as from exterior sources, are the most noticeable and challenging to address. A bumpy road or speed bump just outside the building, rail lines running nearby, or a punch press in the adjacent building are common sources of environmental vibration, especially in an urban setting. These environmental vibrations should be addressed and can be mitigated with an appropriate design. Successful mitigation strategies might involve locating the acoustically sensitive space in a "sound-isolated" zone, or even in a corner of the building away from such sources. For more comprehensive upgrades, the design may include structurally isolated slabs or floor constructions that reduce the transmission of vibrations to the entire building (an extreme example) or to a particular room (more common). There may also be occasions where localized isolation, provided by pneumatic isolation tables, might be sufficient for a smaller application.

Laboratory spaces also need to include a reasonable level of sound absorption to control ordinary laboratory activity sound, control laboratory equipment noise, and make the spaces feel acoustically comfortable. Labs should be designed from the onset with sound-absorptive treatments, which are typically incorporated at the ceiling level. Once a laboratory is occupied and in use, acoustical treatments are much harder to implement. People often consider labs that do not have acoustical treatments to be loud and uncomfortable, and others, who are concerned with productivity in labs, feel that acoustical comfort is an important aspect of the researchers' productivity. There are many sound absorptive treatments available — from conventional acoustical ceiling panels to ceiling products for exposed structures — that provide the desired level of sound absorption.

Mechanical Systems

Mechanical systems that serve the building are sources of noise and vibration, both internally and externally. It is key to locate major mechanical equipment plant rooms well away from areas that house very vibration-sensitive equipment and research. Fortunately, mechanical system vibration control is easy to manage. To accomplish this, the important design elements include a good basic vibration isolation system for mechanical equipment, large ducts, and pipes, all of which are well conceived, well specified, and properly installed. With reasonably good space planning, conventional isolation systems that use springs, neoprene mounts and hangers, etc., are usually sufficient for avoiding vibration transmission to sensitive spaces. Heroic isolation schemes and equipment are not usually needed for typical mechanical systems in modern facilities.

Noise emissions from the supply air fan discharges and intakes of exhaust fans must also be considered. Attenuation is typically needed to control the fan noise transmission to the occupied lab spaces via the duct systems and to avoid breakout noise issues in occupied spaces near mechanical equipment. Ductwork designed for low-pressure air distribution on the room side of terminal boxes/valves should result in acceptable airflow noise levels.

Exterior Noise Levels

Lab buildings located on campuses or near residential neighborhoods typically need to meet desirable exterior noise emission levels. Sound attenuation should be planned for large air intakes and exhaust discharges, and designers should plan on space for such treatments. Planning and programming exhaust

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systems to operate at reduced capacity during off-peak hours is a very favorable way to operate the system at a reduced noise level. Air-cooled equipment (especially air-cooled chillers) are a common source of community noise concerns, and these should be designed and incorporated with great care and sensitivity for facilities in residential areas. Noise emissions can be controlled with treatments such as noise barrier screens, low-noise fan blades, and the use of variable fan speed controls, though these can be very costly to implement. Research buildings may also involve cooling towers, which are significant noise generators to the outside. Similar noise control should be applied to this equipment when it is anticipated that neighbors may be adversely impacted by noise.

Regarding mechanical noise generated by a building, there is a new trend in noise control and lab system design that has resulted in the use of more energy-efficient and lower airflow HVAC systems. This design direction affects both interior and exterior noise emissions because there are fewer fans that operate at lower capacity and pressure. With academic institutions scrutinizing their energy costs, schools are willing to spend more on upfront equipment/system costs in order to gain future energy cost savings; this change in the equipment is in turn lowering the noise generation of systems for the building's occupants and neighbors.

Footfall Vibrations

Finally, and of special concern in both general and sensitive labs, is the issue of footfall-induced vibration: the vibration from people walking in the building. Conceptually, designers need to remember that the slabs are similar to very thick and heavy trampolines; the slabs will move ("bounce") when people move around on them. Plans that locate very vibration-sensitive equipment on a concrete slab on-grade are ideal, as this lessens the slab vibration and is more cost effective than locating very sensitive equipment on above-grade structures. When on-grade placement is not possible, structural vibrations from footfalls often determine the design solution for a project. For example, shorter structural spans will help to stiffen the building and achieve lower vibration levels, but the structure will need to include (and physically accommodate) more columns. To stiffen the building and control vibration, college planners should expect more support structure (steel, concrete, depth of structure) in the building than is required for structural strength alone. To minimize cost, the designers and owners should identify concise zones where particularly sensitive equipment will be located, so that large areas of the building will not require designs of such a stringent structural vibration standard.

By clearly identifying the program goals and criteria of a research facility early in the design process, college planners, designers, and acoustical consultants can work together to translate special noise and vibration requirements into the physical systems that need to be considered for architectural mechanical and structural planning. CPM

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