



COMPLEX SCPA REQUIRES CREATIVE STRUCTURAL DESIGN

In the fall of 2010, the School for the Creative and Performing Arts (SCPA) will open the doors of its new facility in Cincinnati's historic urban district, Over-the-Rhine. Over 1300 students and faculty will enjoy state-of-the-art classroom spaces, upper level dance studios, three theaters, a set production shop, and a third floor gymnasium. From the earliest stages of design, SCPA presented an impressive combination of structural challenges. It was no surprise then that Steven Schaefer Associates, recognized for its technical expertise and creativity, was chosen to engineer the project. The design team for the \$72 million project included architects [CR Architecture + Design](#) and [Moody Nolan Inc.](#), as well as theater consultant Bill Conner. Steven Schaefer Associates' engineers John Ashbaugh and Greg Riley, as well as detailer Jay Benzing, tackled a number of structural issues, including controlling vibrations from fourth-floor dance studios and a third-floor gymnasium; designing for acoustically isolated, professional quality theaters; and supporting a 120,000-pound capacity, professional quality stage rigging system.

Dance studios on the fourth floor, as well as the full-size third-floor gymnasium, required a structural design to minimize floor vibration and deflection. Even routine footfalls from walking can cause problem vibrations if not addressed in design, but rhythmic activities such as dancing pose a more significant challenge, and one that is not easily quantified. Complicating the design for vibration was the presence of theater space below much of the dance studios, resulting in minimal columns and long span floor beams and girders. We ruled out a separate and isolated structure to support only the fourth floor dance studios. This approach would have eliminated the risk of vibration transfer to adjacent spaces, but would have resulted in increased costs due to additional lateral bracing and columns, as well as the architectural complications of incorporating such additional members into the floor plan. Instead, our engineers decided on a practical balance of cost and effectiveness: structural isolation joints were constructed at critical locations to provide separation between the dance studio slabs and adjacent slabs, and stiff castellated beams were used to support the dance studio and gymnasium floors. Even then, using the recognized published analysis methods for vibration control, no solution was available that did not dramatically affect architectural floor plans, mechanical systems, as well as increase construction costs. Recognizing that the design for vibration is not an exact science, we sought additional consulting from Virginia Tech professor Dr. Thomas Murray, author of the American Institute of Steel Construction (AISC) Design Guide 11: *Floor Vibrations Due to Human Activity*. Murray's insight allowed us to take advantage of additional damping not discussed in Design Guide 11, helping the castellated beam design to meet Design Guide 11's vibration criteria.

The new school naturally includes state-of-the-art theaters. The largest of the three theaters includes a balcony level and an extensive network of catwalks above the stage and theater. In the early stages of design, Steven Schaefer Associates, in collaboration with [Turner Construction](#), ruled out the use of precast concrete to frame the balcony. They chose structural steel supporting a concrete slab on metal deck, due to its lower cost and better constructability. Acoustic requirements for the theaters provided additional structural design challenges. The largest theater is surrounded by other, noisy spaces, including a kitchen, cafeteria, set production shop and corridors, as well as bustling city streets outside. In order to achieve acoustic isolation, we worked in tandem with the architects and acoustics expert, Stan Roller. A building expansion joint was constructed around the majority of the theater, as well as a double wall around the stage and a portion of the theater, and concrete slabs over the roof. In particular, careful attention to detailing was required to reduce sound from the adjacent set production shop transmitting into the stage and theater. Acoustics at the 300-seat theater also posed structural



challenges. In order to minimize sound transmission into the theater space, a separate level of structural framing supports the theater's ceiling and sprinklers.

A focal point of the building's design was the 80 foot tall space directly over the larger theater's stage, referred to as the "fly space". Within the fly space, theatrical scenery, curtains, and other items will need to be supported over the stage by a 120,000-pound capacity manually-operated counterweight rigging system. Linesets extending through slots in the steel-framed fly grid located 70 feet above the stage, are supported by loft blocks under hung from roof beams, and are balanced with weights manipulated by theater technicians. Rather than extend the masonry walls surrounding the stage up to the roof, as is common in theater construction, we decided early in design to use cold-formed steel stud walls above the proscenium level and concentric steel-braced frames within the stud wall space for lateral support. This reduced the cost of the supporting stage floor framing and foundations, as well as minimized the seismic load on the fly space, all while not compromising acoustics.

Steven Schaefer Associates relied heavily upon its division Entertainment Structures Group (ESG) for technical guidance in designing support for the complicated rigging system. ESG is a national leader in the structural engineering of theater rigging systems; they offered a depth of knowledge and conceptual perspective that were indispensable in the design stages of the project. CR Architecture + Design project manager Jeff Dodge appreciated this contribution to the project, "Their staff understood the issues germane to theater structures and were always ready with effective solutions everywhere design challenges presented themselves."

The School for Creative and Performing Arts facility is a new landmark in Cincinnati; it will remain a source of pride for the entire community for years to come. The design team enjoyed the challenge of bringing the vision of the design to reality. Through careful attention to detail and a willingness to consider innovative alternatives to conventional solutions, we were able to balance the function, cost, and design requirements. As Dodge commented, "Steven Schaefer Associates' support of the design and thorough detailing were indispensable as the project proceeded through the difficult phases of planning such a complex facility." Once again, our expertise and creativity make for the best design.