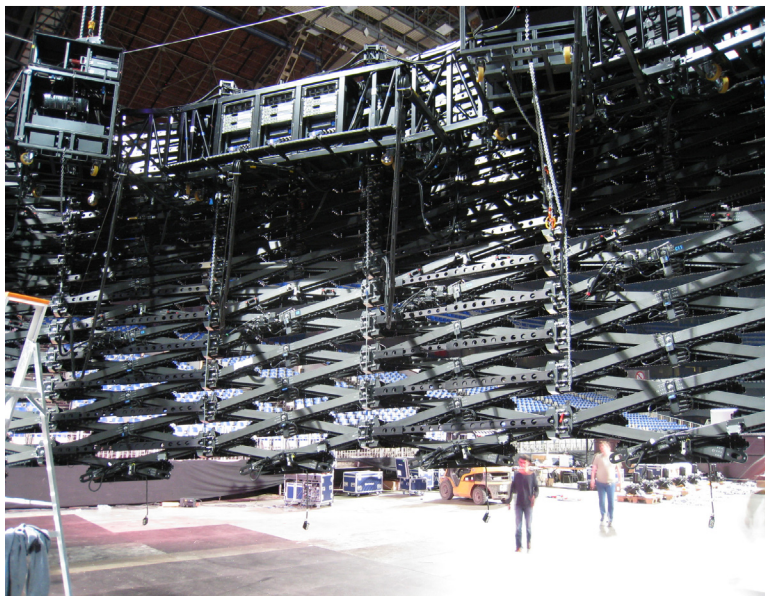
What's *Cool* in STEEL?



Top: Expanded to its 73-ft height, this 500,000-pixel video screen gave everyone in the audience an up-close view of U2 in concert.

Inset: A 32-ton customized mechanism allowed U2's giant, cylindrical screen to expand and contract as a scissor-like system, changing from a solid, 23-ft-tall cone to a 72-ft-tall screen of 888 LED panels in just 90 seconds.

DYNAMIC STEEL FRAMING ENABLED THE ROCK GROUP U2 TO MAKE A DAZZLING VIDEO DISPLAY PART OF ITS CONCERT TOUR.

U2's Transformable Steel Screen

BY CRAIG SCHWITTER, P.E. AND CRISTOBAL CORREA

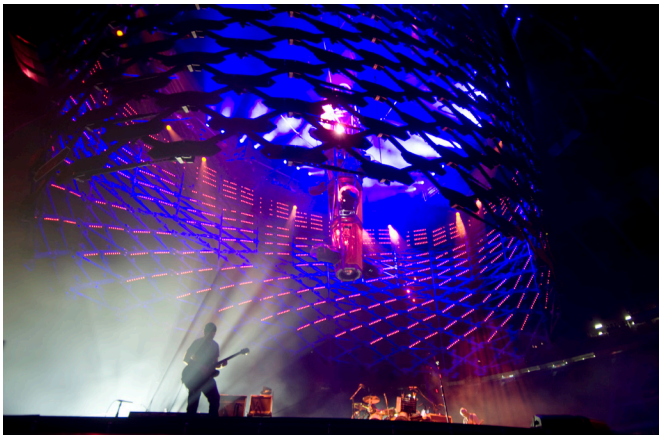
FOR THE LAST 35 YEARS, U2, the Irish rock band sensation, has been captivating audiences with stellar musical performances and stunning visual effects. The band's 360° Tour was no different. The centerpiece of the tour was a huge transformable video screen suspended from the center of the stage that enveloped the band and allowed all audience members to have an unobstructed 500,000 pixel high-resolution view of the show.

While large video screens are a common feature of arena-style rock concerts, the 3,800-sq.-ft. LED expanding video screen, constructed primarily of stainless steel and aircraft aluminum, marked the first time a moving screen of this scale was built for a concert tour. The screen featured an elliptical video display that was approximately the size of a tennis court.

To enable the screen to change its size and shape, Buro Happold's structural engineers created a 32-ton customized mechanism, which earned the firm a 2011 Diamond Award for Excellence in Special Projects from the American Council of Engineering Companies of New York (ACEC New York). This mechanism allowed the giant, cylindrical screen to act as a scissor-like system of 888 LED panels that expanded and contracted. In just 90 seconds, it could change from a solid, 23-ft-tall cone to a 72-ft-tall transparent grid during the band's performances.

The screen, designed by Innovative Designs and its parent company Barco, along with Hoberman Associates, Inc., required a system durable enough to last the rigors of an 18-month tour and able to be assembled in eight hours and disassembled in just six hours.

The structural engineers overcame multiple technical challenges to ensure that the 50-ton screen, with video elements and support truss included, could maintain operability during moderately high winds and remain intact during very high winds, be portable and minimize weight and cost.



A dynamic steel frame designed by Buro Happold engineers enabled the 3,800-sq.-ft video screen to rapidly expand to 73 ft height, taking its place as the centerpiece for the U2 360° Tour.

The video display broke down into 96 individual panels, which were arranged in four horizontal 700-lb tiers of 24 units each.

Among the complex structural challenges, the project had a complex geometry and countless moving parts, yet had to be designed on a fast-track basis. The engineers also had to address issues of tolerance, durability and robustness for a portable screen that had to be transported and reassembled almost on a daily basis.

To make it transportable, the display broke down into 96 individual panels, in four horizontal tiers. Each of the four tiers consisted of 24 units and weighed about 700 lb. The tiers were suspended from a central truss, which was then suspended from the primary superstructure using eight winches. The winches lifted the screen vertically and worked in unison with 40 chain hoists to maintain the screen's stability while it moved seamlessly during its transformation.

Buro Happold's structural engineers had to compare the cost and complexity associated with the number of hoist supports with the total weight of structural elements. They also had to consider the implication of this weight on material cost and portability. The solution was a system of hub stabilizers—hollow aluminum tubes with circular perforations—that connected to every other panel at the structure's most vulnerable points, where the corners of the diamond-shaped LED panels met. These stabilizers were less expensive and weighed less than non-perforated materials. They also kept the LED panels in place by preventing their pins, which were attached to the arms of the structure, from moving up or down.

The engineers created numerous analysis models using Autodesk Robot Millennium and SolidWorks COSMOS software to investigate different support and loading conditions, as well as the resulting stresses and member sizes on the screen, and to be certain that the structural behavior of the screen during its dramatic shape change could be safely executed. These models represented different deployment stages to evaluate varying stresses in the screen and investigated how the loads would migrate as the screen opened and closed. Furthermore, the engineers prepared for various emergencies, such as hoists or individual components failing while it was in motion.

"Buro Happold is known for innovative solutions to complex projects," said Erleen Hatfield, principal at Buro Happold. "And this project was no different. Projects such as these involve sophisticated structural systems in which every element has to be precise, and if one does not function properly the whole project will not succeed. In addition, our engineers had to make sure the exposed structure did not detract from the aesthetic and drama of the moving screen. The system for this project operated perfectly throughout the wear-and-tear of the tour."

The proof was in the experience of the spectacle itself. A key moment of each show was the huge roar that happened when the screen started to shimmer, then extended down for the first time and enveloped the band. As the music and images on the screen interacted, the audience realized it wasn't a typical static jumbo screen, but it was actually a part of the performance. MSC

Photos courtesy of Buro Happold and Barco.

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