Global Presence

The Daily Planet, a massive steel-framed globe, provides North Carolina's capital city with a new, worldly icon.

BY DON HOWARD

DOWNTOWN RALEIGH, N.C., recently saw the opening of a new structure that would make Clark Kent and Lois Lane proud.

The structure is the SECU (State Employees' Credit Union) Daily Planet, a four-story, steel-framed sphere whose cladding resembles a globe while the interior contains a surround screen that can be viewed from theater seating on the first level and balconies on the second an third floors.

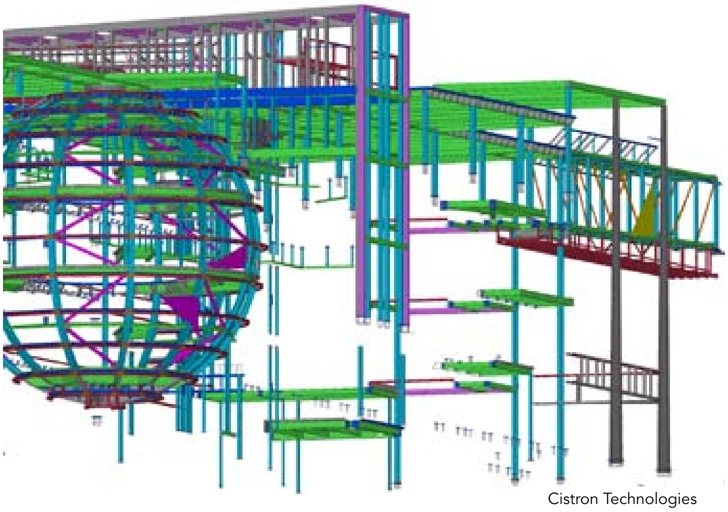
It serves as the centerpiece of the new Nature Resource Center (NRC), an 80,000-sq.-ft facility that connects the North Carolina Museum of Natural Sciences (MNS) with the North Carolina Department of Environmental and Natural Resources (DENR) office building via skywalks. These buildings form the Green Square Complex, a sustainable development promoting environmental stewardship to the general public. The Daily Planet is attached to the NRC, and visitors can go back and forth between the two structures on three different floors.

Along with the spherical shape of the Daily Planet came design challenges. "One of the biggest challenges of the NRC project was the complex geometry and math of The Daily Planet," said Tom Trevathan, president of the project's fabricator, North State Steel. "No right angles, no parallels and ever-changing degrees of intersections. The requirements of total bolted connections made this project special. The fact that we only had to make one field modification—especially considering all the stages, platforms, hangers and other grillage connected inside this sphere—was a testament to the fine work of our fabrication crew." While wide-flange shapes (W14×109 radial columns) were bent the hard way (along the strong axis), rectangular HSS shapes were rolled off-axis to form latitudinal surfaces for attachment of the exterior skin system. Screen access catwalks at the second and third floors serve as bracing as well as flooring. The globe has a fourth floor framed with wide-flange shapes covered with bar grating to provide access to lighting. In all, the Daily Planet includes 150 tons of wide-flange, HSS and plate girders.

Entry to the Daily Planet from the NRC created another challenge, as it did not allow the use of full horizontal tension rings at all the floor levels. As the steel vertical ribs arc under the equator of the Daily Planet and into its southern hemisphere, the lack of restraining elements would tend to magnify the stresses in the ribs to a point where the shapes required would be uneconomical. The solution to the discontinuities in the tension rings was to introduce arcing trusses in the planes of the ribs and the continuity of the rings by connecting to the floor plate and providing tensile rebar. Even with the trusses in place, as the rib elements become more horizontal, the stresses magnify. Were the ribs to terminate at the south pole of the sphere, the stresses within these elements would again require an uneconomical steel shape. Because of this, the ribs terminate at the first floor level rather than at the South Pole of the globe, which falls below the ground plane.

Miscellaneous framing fleshes out the continuation of the sphere below the first floor. Since the South Pole rests below grade, the first floor cantilevers within the sphere. Built-up curved steel sections (1½-in. web and 3-in. x 14-in. flanges) attach the globe's framing to the concrete structure at the corner of the building. These sections cantilever through each other, providing the skeleton on which the first level and sphere construction rest.

Natural lighting within the NRC is achieved via an HSS-framed atrium. Rising above the surrounding building, the central atrium divides the building into roughly equal east and west pieces and is enclosed on all sides by glass. Thin, angled (wide flange-framed) bridges cross the atrium at three levels.



Cistron Technologies

▲ A Tekla model of the Daily Planet and other portions of the structural framing.

▼ Framing for the bottom of the four-story globe structure.

All photos: Courtesy North State Steel

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The Daily Planet can be accessed from the Nature Research Center at three levels.

Traditionally, an isolation joint would have been introduced between the east and west sides of the building so that they could move independently from each other. However, as the central atrium is the most public space within the museum, noticeable isolation joints at the floor levels were not permissible. Instead, the floors were modeled using finite element software, and the bridges and bordering structure were reinforced to resist the loading imposed upon them.

Because the bridges were located away from the north and south faces of the building, the potential for differential movement between the two sides remained. Being mindful that the walls were constructed of glass panels, it was decided that the atrium structure should be separated from that of the surrounding building. Separating the steel from the concrete structure made it possible to remove the interior columns. The atrium structure rests on the north and south faces of the concrete structure. The east and west sides of the atrium are tall, long-span, sloping Vierendeel frames spanning from the north to the south, and the panel points of the frame align with the glazing system.

The HSS atrium columns and frames used full-penetration welded internal stiffener plates. Using bird-mouthed joints allowed access for welding the stiffeners. The four corner columns were shop-filled with concrete after fabrication; 6-in.-diameter access holes were cut on one face of the HSS between stiffeners and were pumped full of concrete. After the concrete cured, additional HSS was shop-welded to the assembly to cover the access holes. The Vierendeel trusses (tapering from 14 ft, 11 in. to 18 ft, 8 in.) were then shop-assembled to mate to the bird-mouthed joints. At 91 ft, 6 in. long, they were shipped in two pieces each.

The final challenge of the project was the pedestrian bridges. The Museum Bridge—supported by a box truss with WT12 x 88 top and bottom chords and back-to-back angle bracing—ties the MNS to the NRC. With a clear span of 80 ft, it cantilevers over two wide-flange bents, 30 ft apart, to form a 150-ft connector containing a roof walkway with exhibits. It spans a city street that could be shut down at different times, so erection sequencing was relatively simple. The bridge connecting NRC to the DENR Office Building was a different story. Spanning McDowell Street, a U.S. Highway, erection time was limited. To put the 90-ft-long Pratt-style bridge (W8×40 beams for the top and bottom chords, HSS 8-in. x 8-in. x ¼-in. verticals and 3-in.-diameter rod bracing to form a full box truss) in place, the street was closed down at 8:00 p.m. on a Friday night and had to reopen by 5:00 a.m. the following Monday; delay charges of $5,000.00 per hour would accrue after that time. Fortunately, it was put into place with four hours to spare.

The NRC opened on April 20 and hosted nearly 50,000 visitors during the 24-hour grand opening. Whether they realized it or not, the seemingly simple sphere they walked through was anything but. The detail model for the Daily Planet, created in Tekla, won first place in the complex structure category at the Tekla Annual meeting in India last year—a global success for a global project. MSC

Architect
O'Brien/Atkins Associates, Durham, N.C.

Structural Engineer
GKC Associates, Durham, N.C.

Steel Team

Steel Fabricator
North State Steel, Greenville, N.C. (AISC Member/AISC Certified Fabricator)

Steel Detailer
Cistron Technologies, Inc., Mooresville, N.C. (AISC Member)

Bender/Roller
Chicago Rolled Metal Products, Chicago (AISC Member)

Construction Manager
Clancy and Theys, Raleigh, N.C.