A new steel assembly at NC State provides higher learning opportunities for building teams working with AESS requirements.

# TOWER of Technology

BY STEVE WYLIE

**NORTH CAROLINA STATE UNIVERSITY** and its hometown of Raleigh have done a lot of growing over the past four decades.

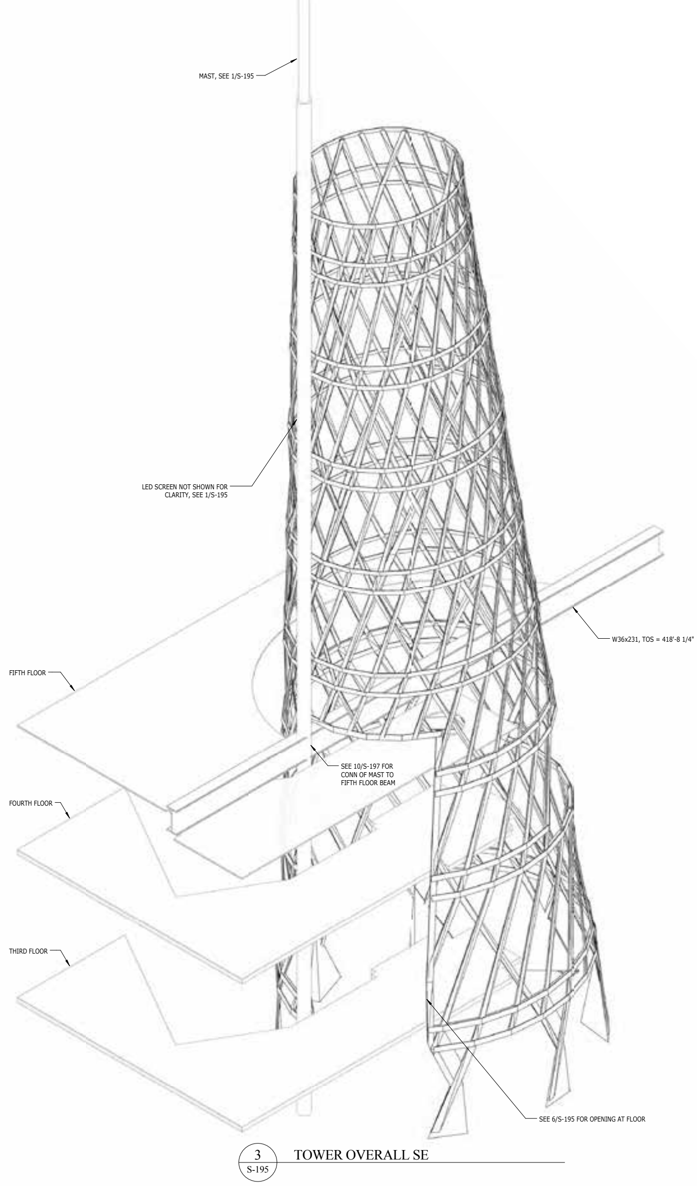
In 1972, when NCSU opened its Talley Student Center to serve as the hub of campus life, the student body was 14,000 and North Carolina's capital city was home to around 120,000. In the years since, Raleigh has grown into an established hot spot for young professionals and the high-tech businesses that hire them, and has more than tripled in population to 430,000. And NCSU is now the largest university in the state with enrollment approaching 35,000. A raft of campus construction projects ranging from libraries, student housing and academic and research facilities have naturally followed, including renovation and expansion of the Talley Student Center.

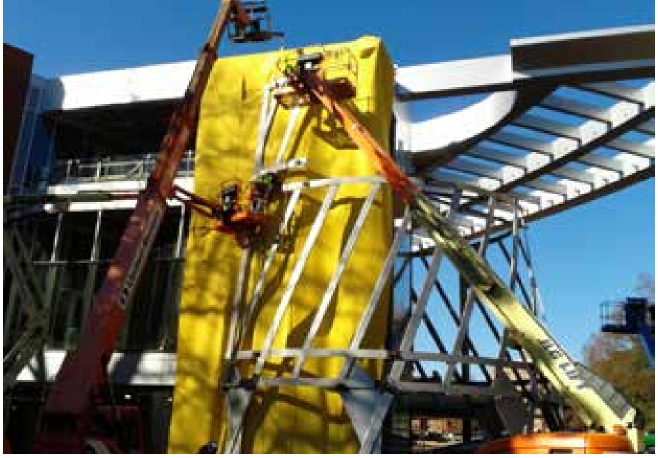
The focal point of the newly expanded building is the Technology Tower, a decorative 150-ft-tall, 130-ton steel structure anchoring the building's northeast footprint. Resembling a radio tower as well as the lattice masts found on early 20th century warships, the tower begins in an ellipse with a long axis of almost 40 ft and rises in an oblique cone to a terminating ellipse at the 115-ft level before continuing to 150 ft in a single, round hollow structural section (HSS) mast. Contained within the tower is a three-story glass elevator structure leading to walkways connecting to the main building at each of the primary levels. Ultimately, the tower penetrates the building's main roof structure, as the roof cantilevers 60 ft over the tower base.

## Leveling Up

The main section of the mast is HSS18×0.375 from ground level to the 130-ft point; HSS14×0.250 from 130 ft to 145 ft; and HSS10×0.250 from 145 ft to 150 ft. Contract structural drawings for the tower included not only elevation drawings and plan views of the tower ellipses at ten different segment heights, but also framing plan notes defining how the main sweeps and counter-sweeps would be located from level to level. According to the notes, each ellipse level would divide into 24 equal sweep segments with an assigned numerical value and with points consistently located at the major and minor axes at all levels.

From the bottom ellipse to the top, each of these rectangular HSS sweep sections would transition 11 spaces counterclockwise per that numerical value. Eight rectangular HSS counter-sweep sections were assigned alphabetical values (A through H) and transitioned 13 spaces clockwise from bottom to top ellipse. (Both the main sweep and counter-sweep sections are HSS10×2×⅜ at the base, and HSS sizes graduate down to HSS6×2×¼ at the top ellipse for the main sweeps and HSS8×2×¼ for the counter-sweeps.) All points in between, per the framing plan notes, were to be "interpolated along the surface created by the aforementioned procedure." These instructions from structural engineer STEWART helped reduce much of the guesswork with regard to estimating the sweeps and counter-sweeps.



▲ The 150-ft-tall Technology Tower anchors the northeast footprint of NC State's Talley Student Center.

◄ The tower intersects with the main building at each level and houses walkways and an elevator.

◄◄ **Opposite page:** A view of the tower in Tekla.

▼ It begins in an ellipse with a long axis of almost 40 ft and rises in an oblique cone to a terminating ellipse at the 115-ft level before continuing to 150 ft in a single mast.

Specifications for architecturally exposed structural steel (AESS) presented another opportunity to reduce confusion and ease the way for the tower's fabricator, MIG Steel Fabrication (steel for the main building was fabricated and erected by AISC Members CMC Structural and Buckner Companies, respectively). In alignment with requirements outlined in Section 10 of the AISC *Code of Standard Practice*, the project manual's Section 051213 clearly identified the Technology Tower as AESS; specified fabrication, handling and erection requirements; and outlined a path for pre-installation conferences, mock-up procedures and testing. An additional note gave the architect, Duda | Paine Architects, authority to "observe AESS in place to determine acceptability relating to aesthetic effect."

Early preconstruction meetings between MIG and STEWART addressed BIM coordination as well as sharing the Revit model with the detailer, Anatomic Iron; other topics included breaking the tower sequences into leg sections, component ring layers and mast sections for ease of fabrication, shipping and erection. The team used a Trimble 3D laser scanner at the site to coordinate the as-built conditions of the building with the tower model in Tekla as well as the architect's model. The information from the scan led to adjustments in the locations of the tower footings to ensure correct clearance of the building roof, elevator tower and walkways.

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## Local Bending

When it came to bending the steel, strict tolerances were adhered to, but it became apparent during production that even a fractional degree of under- or over-rolling of a sweep or counter-sweep tube section would result in a cascade of attachment issues, especially at the horizontal bars. Consultation between MIG and bender-roller Paramount led to an inventive solution, which ultimately proved to be time-saving as well. While primary rolling of members continued to be done at Paramount's facility in California, the company shipped a custom-made rolling device to MIG's Tennessee shop, along with two operators, to tweak pieces on the spot. This alleviated the bulk of fit-up issues as well as reduced the fabrication time of each layer from over five weeks down to three weeks.

The legs of the tower were shipped with the tops prepped for CJP welds to the first ring layer. The eight layers were fabricated individually and cut into shippable sections, and each of the rings included horizontal rolled plate bands welded to the 24 rolled tube sweeps and eight rolled tube counter sweep members. The first ring measures just over 19 ft in height, rings two through seven measure 13 ft and the eighth ring is 5 ft. Each ring section comprises separate erectable panels of four sweeps and one counter-sweep.

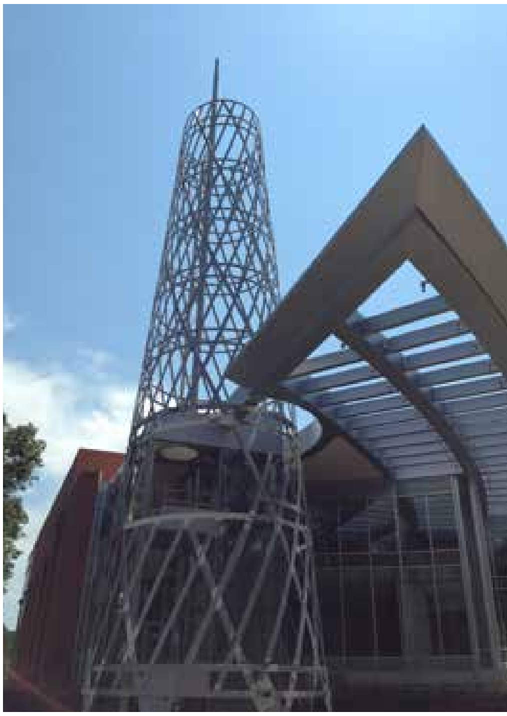
Each tower leg required individual layouts for a main sweep and counter-sweep supported by a curved 2–in.-thick plate, plus ⅜–in. plate to form a triangular solid appearance. The total number of rolled sweep and counter-sweep tubes numbers 288, plus various tube headers for openings for the elevator walkways and a future pedestrian bridge; an additional 250 pieces form the horizontal elliptical rings. All of the sweeps and counter-sweeps at the first connection to the base, as well as all of the ring sections, are CJP welded, with all visible cuts and welds ground smooth after inspection. Above the first connection, all the tube ends are bolted and the rings were CJP welded in the field. In total, approximately 232 CJP welds were made in order to erect the legs and eight ring layers, plus another 150 (approximately) to attach the mast section and openings; the number of shop welds approached 3,500. Mockups of the sections proved indispensable in facilitating analyses and communication during progress visits by Duda|Paine and STEWART. This led to decisions that simplified erection, including allowing field bolting of tube end connections that would otherwise require additional field welding and touch-up.

The first ring sections that were put together in the shop required a great deal of clamping and pulling to get the tube sweeps in alignment. Some of the gaps were substantial, but all were able to be brought into alignment in the shop. When these first sections were cut for shipment and delivered, the erector had to do the same process in the field. (The last section on the first layer had a 14-in. gap, but since the issue had already been overcome it in the shop, they knew they could overcome it in the field—with enough clamping and pulling.)

## Carefully Coordinated Coating

To fulfill the tower's AESS requirements, roughly 11,000 sq. ft of surface area was blast cleaned to SSPC-SP6 and a three-part coating system (from Sumter Coatings) was applied: an organic, zinc-rich epoxy primer (2-3.5 dry mils), a gray epoxy mastic (5-7 dry mils) and a metallic silver high-performance polyurethane finish coat (3-4 dry mils).

While the paint system was shop applied by an outside vendor, all parties understood that substantial application in the field would also be necessary. Detailed schedules took into account local weather patterns in order to apply the paint system at the job site under optimal temperature and humidity conditions—especially tricky for applying a three-coat system to a high concentration of field con-



The total number of rolled sweep and counter-sweep tubes numbers 288, and an additional 250 pieces form the horizontal elliptical rings.

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nections on a very visible and approachable structure. In addition, relatively minor changes in humidity and temperature, including ambient material temperature, would result in a less-than-uniform appearance to the metallic silver finish. Since these conditions required an almost daily assessment of local weather, a process was eventually established by MIG, a local paint vendor and the design team whereby the paint vendor mobilized to the site on demand whenever weather conditions were optimal.

AESS has grown into a common feature in building design. While some fabricators may continue to see it as a risk not worth taking, the chance to increase their expertise—as well as improve their bottom line—awaits those willing to establish standard processes and techniques for meeting its specific challenges. This was certainly the case for MIG and the Technology Tower project. ■

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**Considering AESS?**

This was MIG Steel Fabrication's first experience with such a complex AESS project. If you're considering a project of similar AESS scope, here are some suggestions and questions to consider:

- Are the project specifications for AESS in alignment with Section 10 of the *Code of Standard Practice*? Do they clearly address requirements for special fabrication, handling and erection of AESS?
- What are the requirements for pre-installation conferences, mock-up procedures and testing? If these are not addressed in the specs, the fabricator should have recourse to include them in order to facilitate communication and address quality issues prior to installation.
- Will outside vendors be required to complete the AESS project? If so, are there clear protocols in place to reconcile quality issues if and when they arise?
- Include a budget for contingencies. Unforeseen challenges happen on every project, but AESS may require implementing completely unique solutions.
- Learn to be flexible. Thinking outside the box and meeting the challenges of a complex AESS project can reap great knowledge and experience dividends applicable to future projects.