Full House

STORY AND PHOTOS BY GEOFF WEISENBERGER

Future engineers pack UNLV's Thomas and Mack Center for the annual National Student Steel Bridge Competition.

LAS VEGAS IS TRADITIONALLY PACKED on Memorial Day weekend. The usual four-hour drive from Los Angeles can take more than twice that long, the airport is mobbed, and the taxi lines are a major hassle—although quite entertaining as well.

Away from the chaos and revelry of the Strip, a different type of intensity was on display this past Memorial Day weekend in Vegas—and it was focused on something a bit more productive than the activities typically associated with Sin City. While everyone else was in town on vacation, college students—around 550 of them—were doing something constructive. More specifically, they were building steel bridges.

The occasion for such prolific, focused activity in such a leisure-oriented locale was the National Student Steel Bridge Competition (NSSBC), which took place at the University of Nevada, Las Vegas' Thomas and Mack Center. "We truly came into this determined to be like no other, and we exceeded all expectations," said Vik Sedhev, UNLV engineering student and 2009 NSSBC student director.

In all, 46 teams of university-level civil engineering students from the U.S. and Canada assembled, displayed, and tested their creations in the annual contest. The teams are narrowed down from nearly 200 teams that participate in 18 conference competitions around the country.

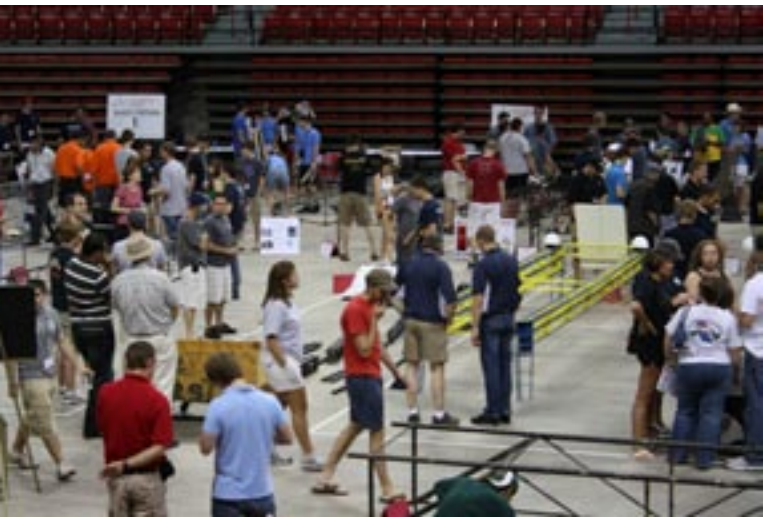
"At this level, they really know what they're doing," said John Parucki, who has been the head judge of the competition for the past 15 years. "We get the cream of the crop every year, and they get to compete against each other. You can't get any more real-world than this."

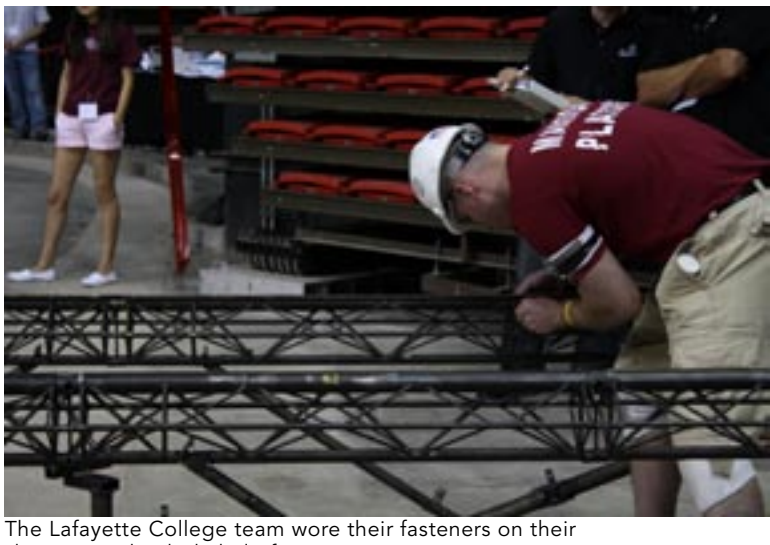
NSSBC is a joint effort between AISC and the American Society of Civil Engineers. It started as a regional competition in the upper Midwest in the mid-1980s and grew into a national competition by 1992. Generally, the top three teams from each conference competition make it to the national level. And improvement between the two levels is the norm more than the exception.

"Once the top teams get back from regionals, they really get to work to improve their scores," explained Scott D. Schiff, professor of civil engineering and director of the Wind and Structural Engineering Research Facility at Clemson University. "Most teams can cut 10 to 25% off of their construction time by improving their connections, developing new assembly schemes, and just practicing for countless hours so that every movement is memorized."

Three teams at this year's competition built their bridges in under four minutes, and several others weren't too far behind; the majority of the field finished in under 15 minutes.

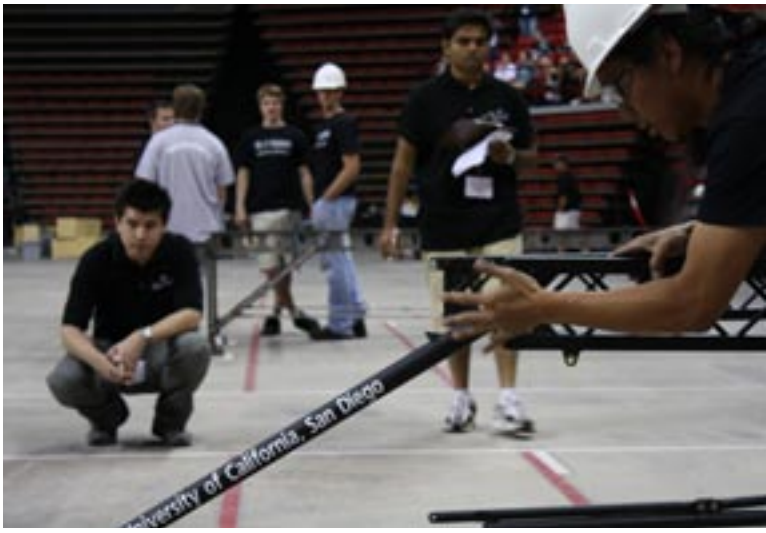
But construction speed is only one of six categories in which the bridges are judged. Stiffness, lightness, economy, display, and efficiency are also assessed, and the best combined score across all six categories wins. Every year, the design parameters change slightly to meet the Problem Statement, which this year called for teams to create a scale model of an attractive and functional replacement for a century-old highway bridge spanning a scenic river. In past competitions, above-deck steelwork was part of the program, but this year everything had to remain below the deck. Also, this year's bridges were required to be 20 ft long and capable of carrying 2,500 lb.





The Lafayette College team wore their fasteners on their sleeves—with a little help from magnets.

The bridge has left the building (top). Kansas State's team performing load testing (bottom).



Gray and flat with X-bracing was just one of many bridge styles (top). The University of California, San Diego's team in action (bottom).

Prep Work

Students design and build the bridges themselves and begin the whole process months in advance. The assembly is practiced over and over until it is perfected; in many cases, teams will assemble their bridges more than 100 times.

"We design our bridge in the fall semester, we fabricate it for one week over winter break, and practice construction in the spring semester," explained Alex Pschorr, a co-chair for the University of Wisconsin–Madison team. "We tried to determine how many times we practiced putting in together, and we counted over 120 construction runs (dress rehearsals)."

In some cases, the design changes at the last minute—before the regional competition and sometimes even between the conference and national competitions. "We actually had our bridge built a month before regionals, then decided to scrap the entire truss and throw it away," noted Eric Gunderson, North Dakota State University's co-captain; NDSU has won the competition five times in the last 10 years. "We designed and fabricated a new truss for regionals in less than two weeks. That bridge got us to Vegas and with a few more minor changes after regionals, we were ready to compete at nationals. It took us two bridges to get it right, but in the end we got what we wanted."

One team, California Polytechnic – San Luis Obispo, put approximately 1,500 hours into their bridge design and construction. "We redesigned the entire bridge after regionals, when we realized the design flaws the bridge had," said Mike Ginther, the team's captain. "The construction team spent the last three days before the competition practicing, going through 15 to 20 run-throughs building the bridge."

In fact, Ginther was so involved with the project that it became inescapable, even in sleep. "Most of my ideas for the bridge came to me while I was sleeping," he said. "The last six months, all my focus was on the bridge."

It's On

The two-day competition began on Friday, which involved the most arbitrary segment, the display judging. The Rules Committee—made up of 10 volunteers from the steel industry and academia—made their rounds and decisions on which entries they found most aesthetically pleasing. (So did I.)

Walking amongst the entries was like walking through a museum of bridge design. The sheer variety of colors, styles, and designs was amazing, especially given the parameters to which the teams must adhere. Several bridges were painted; many were decked out in school colors, while the University of Hawaii at Manoa's bridge was metallic purple. Bridges were constructed with a variety of framing types, including joists, trusses, box trusses, HSS, or any combination thereof. Some were Spartan while others were elegant; some were simple while others were complex. And of course, there was flare. The University of California at San Diego's entry sported silver tridents, and Kansas State University's name plate (every bridge is required to display the school's name) featured the school's well-known wildcat logo.

Teams raced against the clock in the build portion of the competition.

From Museum to Racetrack

While Friday offered an opportunity to look over the bridges at a leisurely pace and observe the students in a somewhat relaxed setting, Saturday was a different story and featured the most exciting part of the competition: the timed construction of the bridges. Whatever preconceived notions I had about a bunch of engineering students building bridges were replaced by what felt more like a swim meet—and the venue, a college basketball arena, only added to the atmosphere. Students raced back and forth between their material staging areas and the bridges in an effort to beat the clock. They yelled encouragement and directions to one another—as did "coaches," from the sidelines. And many teams even had their very own cheering section in the stands, typically comprised of the rest of the team.

Here's how it works: Teams are compiled of 10-20 members, although only four or five get to build. The judges—there are almost 50, many of them local and all involved in the steel industry in some form or fashion—referee all areas of the competition except for the aesthetics portion.

The competition takes place in a designated (by tape) area, the build station; there were five build stations in all, so at any given point, you could watch five teams competing at once. Teams—who must wear safety gear such as hard hats and construction boots throughout the competition—lay out their bridge materials at one end of the build station, the staging area. At the other end of the station is the assembly area. Once the clock starts, the runners (there are one or two) run the members across an open area, one by one, to the assemblers. As the assemblers put the bridge together, the runners go back and forth between the assembly and staging areas until the bridge is complete. The action is much like that of a relay, except instead of handing off the baton, the runners are handing off steel. Each runner has to wait outside of the assembly area until the assemblers finish connecting the previous piece, before handing over the next piece; it can be a waiting game on both ends. The ideal assembly scenario is when a runner hands off his piece and the assembler has it in place and is ready for the next piece right when the runner returns with it, in a continuous fluid process.

Verbal encouragement isn't only motivating, it can also be crucial. Shouts of: "Watch that pier!" "Check the bottom chord bolts!" "Bolt in the water!" and similar guidance can be heard throughout. "In the heat of battle, it's easy to forget things," said Mike Engestrom, a member of the NSSBC Rules Committee and technical marketing director with Nucor-Yamato Steel, one of the event's sponsors.

As this year's competition featured a "river" (also designated by tape), the team members were not allowed to step into it and were penalized if they did so. Fasteners had to be held by the assemblers in a pouch. There was a lengthy discussion over what constituted a "pouch" at the team captains' meeting, which took place the night before. Two teams came up with the idea of taping magnetized strips to their arms in order to have easier access to their fasteners.

When the bridge is complete, the clock stops. This year's fastest time was delivered by State University of New York (SUNY) Canton, which came in at just over three minutes. However, in some ways, the clock doesn't stop with the construction portion. Additional time may be added due to penalties given during the load test, much like a hurdler being penalized for knocking down a hurdle even if he crosses the finish line first. Violations include items such as a nut falling off its bolt during transport to the load testing area or a nut not being fully engaged—or again, stepping or dropping something in the river. Hence, while teams strive for the fastest assembly, they must also account for a *quality* assembly. (Erection time plays a factor into another of the competition's categories, construction economy, which also is determined by the number of builders and the number of temporary piers used.)

Surveying Strength

Following the construction portion, teams put their bridge's strength to the test at the load stations, where lateral and vertical

load testing is performed. Safety supports are placed below the bridge, should one happen to collapse. For the lateral test, a load of 75 lb is placed on one side of the bridge and a "sway target" is established on the other side, then a 50-lb lateral pull is applied at the sway target and the sway is measured. Sway must not exceed 1 in., or the bridge does not pass the test.

Vertical load testing begins by having the team members place two decking units near opposite ends of the bridge and adding 100 lb to each of them. From here, 1,150 lb is added to one unit. Two targets are established longitudinally at the center of the decking unit, on either side of the bridge. Downward vertical deflection is measured at both targets. Next, 1,150 lb is placed on the other decking unit. There's only one target at this end. (It too is established longitudinally at the center of the decking unit, but only on one side.) The absolute value of vertical deflection at this target that occurs from when the load is added to the first unit to when it is added to this one, is measured.

Unfortunately, even at the national level, failures can occur. It happened to one of this year's teams when a weld failed during the load testing. Factors such as a bridge's design changing between the conference and national levels can introduce last-minute mistakes that prove costly during the moment of truth. While discouraging in a competition setting, mistakes can be learned from and provide motivation and caution for future competitions and, eventually, the real world. As Parucki put it, "Failures can be 'eureka' moments."

Weighing In

The last step for the bridge is to undergo a weight test. Simply put, the lightest bridge wins this category (although penalties can be assessed based on factors from the other portions of the competition). To weigh the bridges, they are placed on what could be described as a four-part scale—one for each footing.

Weight also plays into the final category, structural efficiency; aggregate deflection from the vertical load test also factors into this category.

Final Results

In the end, the sum is the whole of its parts. Sacrifices in one area might lead to advantages in others. While timing and cost are important, "Being able to construct the design—that's what's most valuable," said NSSBC judging veteran T. Bartlett Quimby, an associate vice provost at the University of Alaska Anchorage.

SUNY College of Technology at Canton, after placing first in two categories last year, won the overall competition this year. NDSU took second, while Lakehead University came in third.

While it's certainly nice to win, the competition is really about preparing future engineers for the real world. According to UC Davis team member Tyler Hickox, "I have learned much from my experience with [the competition] and have incorporated many new ideas into what I will make my senior thesis."

"The competition is an invaluable part of my college career," said Eric Michal, project manager for the University of California – Berkeley team. "Not only are we able to apply the classroom knowledge we learn, but working and managing a group of individuals is greatly beneficial for what is to come in the real world—not to mention an unbelievable and unforgettable experience." MSC

For the full results of the overall competition and the individual categories, visit ***www.aisc.org/steelbridge****. Also, the 2010 NSSBC will be hosted by Purdue University May 28-29 in West Lafayette, Ind. The 2010 rules will be posted at the above link this August.*