Brigham Young University hosts beautiful weather and the 25th edition of the National Student Steel Bridge Competition.

PROVEN in Provo

STORY AND PHOTOS BY GEOFF WEISENBERGER

BYU hosted this year's National Student Steel Bridge Competition over Memorial Day weekend.

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ON THE FRIDAY of Memorial Day weekend, the sky over Provo, Utah, was about as blue as it can get.

The high altitude, utter lack of humidity and mostly sunny conditions made the upper-70s temperature seem warmer, though not in a bad way.

And on the wide expanse of Cougar Field, a green space on the campus of Brigham Young University (BYU) in the shadows of the Wasatch Range to the east, hundreds of college students had assembled nearly 50 bridges for the National Student Steel Bridge Competition. Now in its 25th year, the NSSBC tasks students with building 1:10 scale all-steel bridges as quickly and efficiently as possible. Today is the display portion, where the assembled bridges are evaluated on overall appearance and aesthetic merit by the judging team. This is the stress-free portion of the competition. Saturday is a different story.

Saturday is when the competition's more anxiety-inducing components take place: construction speed, stiffness (which includes vertical and lateral loading tests) and weighing. In addition, the economy and efficiency categories factor in these other segments.

▲ The Michigan Tech team.

▼ Illini hard hats, all lined up.

▲ Scouting the competition's connections.

▼ Students and their bridges basked in the sun for the display portion of the competition.

The students mill about the bridges, answering questions, looking at their peers' work—perhaps to get ideas for next year's competition—soaking up the sun and generally enjoying the beautiful day. Frisbees are abundant, as are confidence and hope. Today, everyone is still in it.

In Contention

One of this year's expected contenders is the Michigan Technological University (better known as Michigan Tech) team, which traveled from its home in Houghton, Mich., a town of nearly 8,000 on the Keweenaw Peninsula, the uppermost peninsula on Michigan's Upper Peninsula. The team is made up of 15 students, 13 of which flew while two braved the roughly 1,600-mile journey in the van, along with the bridge components.

It's not atypical for a team to be this size, though only up to six are allowed to compete in the construction/build portion. The rest are available for the other portions of the competition and are also involved in the design and fabrication of the bridge and its components.

But it's the construction team that has the biggest commitment, explains Joseph Schmitt, a senior engineering student at Michigan Tech and the team's captain, noting that there are no understudies. "We make sure not to do anything stupid or get sick before the competition," he laughs. (But he's not kidding.)

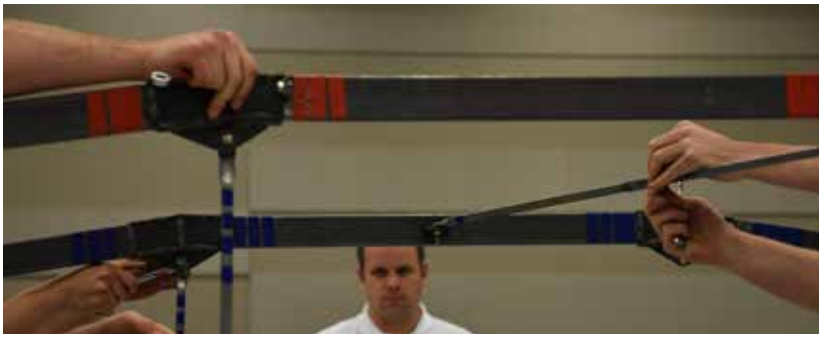
On Saturday morning, the teams unload their bridge components, tools, hard hats and other equipment, which generally arrive in rolling crates, decorated with school colors. One by one, they queue up outside the loading dock of the Provo Convention Center, a few miles from BYU, which plays host to the remaining categories. Many national competitions are held in sporting (basketball) arenas, and while the floor area here—which includes six vertical loading stations, five build areas, three lateral loading stations and a weigh station—is the same size if not slightly larger than typical arena floors, it doesn't feel that way as there are no stands. Spectators—family members, fellow team members and others—are relegated to a 5-ft wide space around the competition floor, making for an intimate yet intense competition environment.

▲ Western Kentucky's striking powder-coated components.

▼ Several teams like the University of Florida used rollers of some sort to project their bridges over the river.

▲ The lateral load test.

▼ Tightening up the final connections.



Rookies of the Year

Every team has its own expectations for the competition.

Some are in it to win it all. Others hope for victory in one particular category. Still others want to post a better time than last year or perhaps make a respectable return to the national stage after not qualifying for a number of years. And every now and then, a team makes its debut at nationals and simply wants to demonstrate that they deserve to be there.

This year marked Southern Methodist University's first time at the national competition. And in fact, the team has only been in existence for five years.

"Two students started the team five years ago, and we've been building it ever since," explains Alexandra "Alex" Yauch, the team's captain. "We were eliminated during regionals the last four years for one reason or another—one year our bridge was 2 in. too long, the next it was 500 lb and last year our fabrication was delayed by several weeks. But everything came together this year."

The team consists of eight members, most of whom are seniors. The six that made the trip to the competition all participated in the build (and all, coincidentally, speak Spanish). Yauch is the only returning member from last year's team.

The team is one of the last to compete and puts their bridge together in just under 33 minutes (28 minutes, not counting penalties), then completes the lateral and vertical load tests. Next, it's on to the weigh station and after that, SMU has completed its first-ever national competition.

And now that they've had a taste of the big leagues, next year's returning members want to keep the momentum going.

"Now that we've been to nationals for the first time, we are excited to take the tips and techniques we learned back to the fabrication shop to make a better bridge," says Yauch. "It really opens your eyes to all the innovative ways different teams strive for the same goal. I'm graduating, but I can't wait to see what next year's team comes up with!"

Clemson's dramatic lift over the river.

Precisely measuring deflection following vertical loading.

Testing for levelness following the build portion.

The board test looks for elements projecting above the deck.

The construction speed portion takes place first. Once a team signs in, it is assigned a build area and stages its tools, bridge elements and fasteners in preparation for its turn. Everything is precisely placed in the materials area, like surgical instruments. This area, like the rest of the build station, is designated by tape. The setup varies year by year, and this year there is a river in the middle, and the supports must only touch one of two piers on either side of the river.

Once the clock starts, team members collect their fasteners and run back and forth between the material staging areas to the spot where they assemble their bridges, starting, of course, with the supports. The floor seems particularly slippery this year, and many teams take some practice runs to get accustomed to skidding to a stop, much like a tennis player on a clay court. Several teams designate a member to document their build via a GoPro attached to a hard hat.

Michigan Tech is 15th out of 48 in the build order. As the team waits outside the loading dock, they go over notes, discuss strategy and generally try to simultaneously psych themselves up while also keeping each other calm.

"You're always jittery, no matter how many times you've practiced," says Bailey Ramler, a returning builder from last year's team.

When their turn comes, the six Michigan Tech designated build team members set up, do some jumping, stretching and high-hives, plus a lap around the build area, warn each other about how slippery the floor is and give each other a last-minute pep talk. "Take your time," advises Schmitt.

Wait, what? It's a timed competition. Speed is of the essence.

But it's not everything. There are penalties for infractions such as stepping in the "water," dropping a bolt, stepping outside of the build station or letting a vertical support slip off of a pier. So while a team wants to build their bridge as quickly as possible, they also want to do so with as few penalties as possible. If the judges have an issue or the team requires a clarification, the clock is stopped and, if necessary, the rules committee is consulted. (One case in this year's competition involved a bolt issue with a bridge. Following an appeal, the committee determined that a bolt was not in full contact with its components, and the team was given a penalty.) Once everything is cleared up, the clock starts again and the team continues to build the bridge.

There are various approaches to building the bridges. Some teams build the entire thing on one side of the river, then find a way to get the far support over the river and onto the opposing pier. These included various rolling devices and a drawbridge approach to connect one side to the other. Perhaps the most dramatic and death-defying approach was taken by the Clemson team, who constructed the bridge on one side of the river then pivoted the entire thing, with one support planted on the near-side pier, and swung the opposite end over the river. While this technique certainly demonstrated some real showmanship, it also involved a certain amount of danger, and multiple judges commented that such a technique would be addressed in future competitions. Nevertheless, it was within the rules this time around, and certainly garnered some (unofficial) points for resourcefulness, as well as kudos from some of the other teams.

While several teams went with this "build it all on one side then figure out how to get it across the river approach," most took the approach of splitting the build team up on either side of the river and coming together in the middle. Michigan Tech adopted this latter strategy. With Schmitt off to the side of the build area, scrutinizing his team and offering encouragement or advice, much like a basketball coach on the sidelines during a big game, the team pulls off a very respectable time of just over six minutes. There is a sense of pure joy amongst the team as they whoop and congratulate each other.

Prep Work

While the build takes place in a matter of minutes, getting to the national competition takes a lot longer. First, it's a matter of assembling a team, and sizes range from four to 20-plus

members (again, up to six members can take part on the build team, though at least one team only used three—which can increase build time but also factors into the efficiency and economy scores). While some teams, like Colorado School of Mines, trend toward upperclassmen—every year, their team is composed of only seniors as part of a senior design project—others take the opposite approach.

"We try to recruit members as freshman, so that they're involved throughout their whole college career," says Schmitt. "We work on keeping people interested during that first semester, especially the younger ones. But once they make it to a competition, they're hooked." Longevity of another sort is also sought after. Schmitt points to the tallest member of the Michigan Tech team, laughing (but again, not kidding), "He was picked first because he can reach that bolt in the very middle without falling into the river."

For the Michigan Tech team, preparation for the competition starts at the beginning of the fall semester. The bridge is designed and modeled, steel is ordered by Thanksgiving, preliminary fabrication is performed before the winter break if possible and fabrication is typically 90% completed by spring break. All welding and fabrication are performed by team members, who pass down their skills to the younger members.

"The competition is a wonderful learning experience," says Judy Liu, a professor with Oregon State University's School of Civil and Construction Engineering, which will host next year's competition in Corvallis. "Students engage in a project from conceptual design to construction and then get to load test their designs! They gain hands-on experience in fabrication and build their project management and teamwork skills."

"Teams from across the globe meet in the spirit of friendly competition to present their bridges and perform tightly choreographed construction," says Paul Richards, faculty advisor for host BYU. "This type of experience is more valuable than anything they can get in class."

Scouting is part of the process as well (especially during the display portion). Schmitt explains that taking notes on another team's bridge is one thing, but copying an entire bridge is generally frowned upon. "Everyone pays a lot of attention to the other teams and what worked for them," he says, noting that his team's bridge is fundamentally the same design as in years past, with slight modifications to address the rules, which are updated every year.

More than 200 teams end up participating in 18 regional competitions; the seven international teams in the competition this year are assigned to geographically appropriate regions. The best teams from each region then go on to the national competition, and regions vary in size and competitiveness (the discussions about this are much like the arguments that tend to flare up about the various conferences during college football season).

A bridge's design can evolve throughout the year, even following regionals, and Schmitt notes that

▲ A bridge achieves a perfect landing after being projected over the river.

▼ Oregon State will host next year's competition.

▲ West Virginia prepares for the build portion.

▼ The University of California, Berkeley, overall winners in 2008, 2012 and 2013.

The University of Michigan, racing to complete their bridge.

Getting started. Vertical supports must only touch the pier.

A "superieure" bridge.

Texas A&M, getting started on their build.

All components must fit in the box.

Western Kentucky's display category winning bridge.

The rules committee discusses an appeal.

The Michigan Tech team takes a warm-up lap.

Reaching over the river. Height can definitely come in handy.

Starting the build.

Waiting for the next category.

Setting the fasteners.

Applying load, 25 lb at a time up to 2,500 lb.

High-fives before the build.

Disaster strikes.

And the Winners Are…

Mere hours after the competition was the awards dinner, and students quickly went from comfortable duds to formal attire.

In honor of NSSBC's 25th year, Bob Shaw, its founder, gave a short presentation.

"It's amazing to think that the competition has grown from just three Michigan schools—about 30 students—to the size it is today, and also how it's reached students and schools around the world," he said.

Following the presentation, the winners for each category were announced. The University of Wisconsin–Platteville won the construction speed category with a build time of 2.62 minutes (roughly 2 minutes, 37 seconds). (To get an idea of just how fast that is, the second-best time, posted by Youngstown State University, was just under 6 minutes, and the slowest time was nearly 44 minutes; anything over 45 minutes results in a disqualification.) The team also won the economy category. The University of Florida had the lightest bridge, at 113 lb, as well as the most efficient bridge. Western Kentucky University, with its graceful arch and enviable red powder-coated finish, won the display category. The stiffness category, a combination of the lateral and vertical load tests, was won by George Mason University.

And the overall prize went to École de Technologie Supérieure of Montreal, with Cal Poly San Luis Obispo taking second place and the University of Florida coming in third. Aside from the display category, ETS placed no lower than 12th in every other category and was actually in the top five in three of them. For the full results, visit **www.nssbc.info**.

"When the students gave Bob a standing ovation at the banquet, it was clear the significance that this event holds for their careers and their lives," said Nancy Gavlin, AISC's director of education. "And once again, they demonstrated this with their inventive, practical and beautiful steel bridges."

his team even cut out a few components between regionals and nationals. The goal is to achieve the perfect balance of a bridge that's light and quick to construct—without sacrificing stability—in many cases designing right up to the limit. It's a long road from the beginning of the school year to this point, and it requires a lot of commitment, patience, trial and error and practice.

Loading Up

But after making it to nationals—and especially the minutes immediately following completion of the building portion—it's all worth it. Following the build, the judges inspect Michigan Tech's bridge—making sure it's level and that all the connections are tight—then the team waits until a lateral load station opens up. Once it does, they carry it over and weight is applied to the side of the bridge to test lateral stability. Tech's bridge passes with flying colors—only ½ in. of deflection—and then it's on to the vertical loading station.

Plastic paint barrels are stacked upside-down under the bridge for safety purposes, then a six-sided die is rolled to determine where the 2,500 lb of weight—in the form of 100 25-lb angles, added one at a time—is applied. When the die is rolled, the team isn't thrilled.

"We rolled the worst-case scenario, which is to have all of the weight applied in the middle of the bridge," explains Nick Toomey, a former team captain. "Last year, two bridges failed in the station next to us. With one of them, a bolt failed. It popped right off, and you could hear it skitter across the floor."

Only three team members are allowed to apply load, so he stands outside of the station, along with his other teammates, and watches the angles pile up on his bridge, one by one. One member picks up and hands the angles to a second member, who sets them with the third member on the opposite side of the bridge. "This one," repeats Schmitt, who is receiving the weight on the opposite side of the bridge, each time pointing to one of the piles that are accumulating on the bridge, in an effort to apply the load evenly. There's a palpable feeling of relief as the pile of angles to be added dwindles, and his teammates pick up and begin to set the last angle. "Careful," Schmitt says as he receives the angle and begins to set it down. There's a pause, everyone inhales and then… disaster. The bridge collapses, toppling to one side and sending the angles onto the floor. It's an automatic disqualification.

A few minutes later, it would be determined that the bridge buckled laterally, which set off a chain reaction in which a handful of connections and welds failed.

But right now, the team is stunned. After quickly confirming that no one was hurt, Schmitt calmly exclaims, "Well… now we know what not to do next year."

And that's what the competition is about: perseverance and learning. (Two other teams learned the same lesson, as their bridges also failed the vertical loading test.) You can build on years of experience, spend countless hours perfecting the design, practice building your bridge over and over and over, check and recheck every detail, and at the end of the day one little design flaw—and perhaps an unlucky roll of the die—can bring it all crashing down.

"But this is why we hold the competition," says Larry Kruth, one of the rules committee volunteers. "It's a learning opportunity that these kids will take with them for the rest of their lives."

But even shortly after such a disappointing result, the team is able to recognize that it brought a damn good bridge to the competition.

"If that hadn't happened, I honestly think we would have won it all," says team member Jeremy Dziewit, with no trace of sarcasm or jest in his voice. And he very well could be right. No doubt, he and his returning teammates will be looking forward to bluer skies next year—and another chance to win it all. ■