Concrete Canoes Make a Big Splash in New Orleans

University of New Orleans hosts the Seventh Annual National Concrete Canoe Races

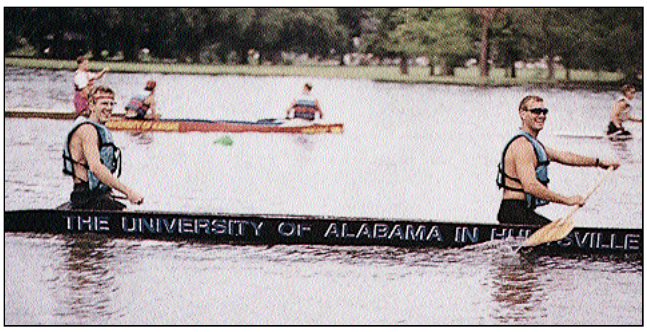
All photos courtesy of Master Builders Inc.

Paddles at the ready position mean that this qualifying heat of the women's sprint has just started.

BY ALLISON CAWOOD

Students from the United States and Canada converged upon New Orleans, June 23-26, for the Seventh Annual American Society of Civil Engineers (ASCE) National Concrete Canoe Competition. Through academic and athletic competition, students from 21 universities vied for $9,000 in scholarship money offered by the competition sponsor, Master Builders Inc. To get to the national races, each team had to win at its regional competition in the spring.

The University of Alabama in Huntsville (UAH) won every event in the national competition, taking home first place overall and a $5,000 scholarship for its undergraduate civil engineering program. This is the first time in the history of the national competition that one school placed first in every division in both the academic and athletic portions. The University of California at Berkeley took second place and a $2,500 scholarship, and the University of New Orleans (UNO), host school to the conference, took third place and a $1,500 scholarship. South Dakota School of Mines and Technology (SDSMT) and Clemson University received plaques for finishing fourth and fifth, respectively.



Jeff Lindner and Charles McDowell have reason to be happy—the University of Alabama in Huntsville took first place in every portion of the competition.

The competition scores are based on academic *and* athletic performance. The academic judging (60% of the overall points) is made up of four categories: design paper (25%), oral presentation (15%), display board (10%), and the finished canoe (10%). The design paper, with the heaviest weighting of any component, is where students showcase their innovative ideas on paper. Students can use text, pictures, and graphics to show how their canoe was constructed and what they did differently than

other participants. The paper has a maximum length of ten pages and must include an introduction; a discussion of the hull design, concrete mixture selection and properties, and construction techniques; a project management/cost assessment; and a description of the canoe's innovative features.

Students are given 15 minutes for the oral presentation—five minutes to set up, five minutes to present, and five minutes to answer grueling questions from the judges.

The display board is a visual representation of the first five sections of the design paper. Students can use photographs, charts, models, and whatever else seems appropriate to present the details of their canoe to the judges and spectators.

The finished canoe is judged on its surface finish, the quality of workmanship, aesthetics, and name selection, as well as its consistency with the design paper, oral presentation, and display.

The athletic portions of the competition (40% of the overall points) are men's and women's distance races (a 600-meter triangular course), and men's, women's, and coed sprints. The sprint races are 100 meters out, a 180-degree turn, and 100 meters back. The turn is a very crucial portion of the sprint races, and canoes that can make tight, fast turns usually show up in the top five.

Since the shortest distance between two points is a straight line, it is also important that the canoe tracks (stays on course) well. This ability (or lack of it) depends on the canoe bottom. A V-bottom boat tracks well, but turns slowly because it has a lot of surface area underwater. A flat-bottomed boat turns well because there is less of the boat underwater, but it doesn't track as well. The ideal situation is a combination of these two designs.

The team at Clemson University summed up the value and the appeal of building a concrete canoe: "No design class can match the challenges presented or the experience gained through this project."

For more information on either building a concrete canoe or sponsoring a team, contact Michael Peralta of ASCE at 800-548-2723, ext. 7667.

Allison Cawood is a five-time veteran of the national concrete canoe races. She is an intern with The Aberdeen Group and will receive her degree in civil engineering from Northern Arizona University in December 1994.

1994 Participating Schools

Several schools appear at the national races year after year, but that doesn't mean there isn't room for some new competition. The schools listed in bold type are the top five schools in 1994.

A canoe by a school name denotes five or more years of participation at the national level; a paddle indicates a first-time participant.

Clemson University
Michigan State University
Oklahoma State University
Pennsylvania State University
Rutgers University
South Dakota School of Mines and Technology
United States Military Academy (West Point)
Virginia Polytechnic Institute and State University
Washington State University
Western Kentucky University
University of Alabama - Huntsville
University of California - Berkeley
University of California - Los Angeles
University of Houston
University of Illinois - Urbana
University of Kansas
University of Maryland
University of Massachusetts - Lowell
University of Minnesota
University of New Orleans
University of Sherbrooke
University of Texas - El Paso

History

Regional concrete canoe races started in the 1970s, and the first national competition was held in 1988. National competitions have been held at Lake Lansing, Mich. (1988), Lubbock, Texas (1989), Buffalo, N.Y. (1990), Orlando, Fla. (1991), Fort Collins, Colo. (1992), Sacramento, Calif. (1993), and New Orleans (1994).

The length of the winning canoe hasn't changed significantly in the last seven years, but the weight has decreased dramatically (Figure 1). This decrease is due to several factors, including increasingly sophisticated use of admixtures, the development of lightweight aggregates, and a change in the national rules, effective since 1993, that allows nonmetallic reinforcement.

It is harder to see an overall trend in the race times (Figure 2). The winning women's time has been slower than the winning

Defender

By Christelle Hendren Lindner

The University of Alabama in Huntsville competed in its first concrete canoe competition in 1986 with a 450-pound, 12-foot-long canoe. That year, we placed last in the regional competition. Since then, our performance has dramatically improved. We have won at the regionals and advanced to the national competition six times. Because we won the 1993 National Concrete Canoe Competition, we christened this year's canoe *Defender*. Our goals for 1994 were to improve hydrodynamic performance and structural integrity while maintaining a relatively lightweight canoe. The finished canoe, 19.5 feet long and only 80 pounds, was not only the lightest canoe at the 1994 competition, but also the longest.

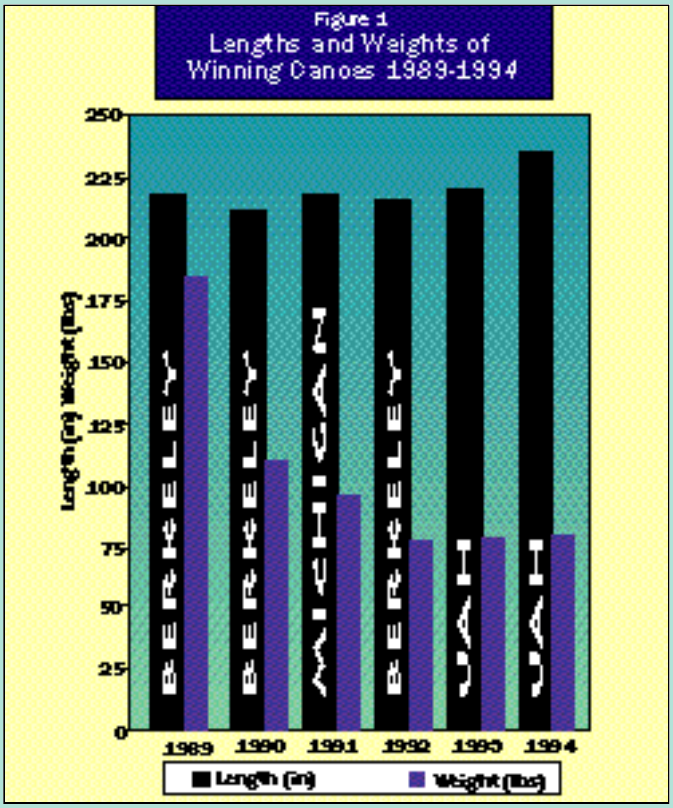
A redesign of last year's hull improved hydrodynamic performance. The canoe was lengthened from 18.3 feet to 19.5 feet to increase the theoretical hull speed and improve tracking. Three thwarts were added to reduce torsional loads and maintain dimensional stability during paddling.

Our efforts focused on developing a lightweight concrete/reinforcement composite design. For the primary reinforcement, we chose graphite-fiber tape based on its high strength-to-weight ratio and placement properties. Graphite tape is five times lighter and ten times stronger than steel and can be easily contoured to any shape.

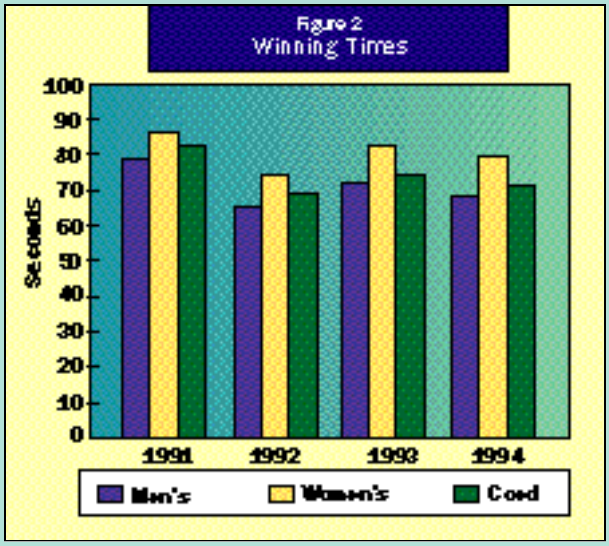
To achieve a lightweight concrete with the desired strength properties, several aggregates and admixtures were investigated. Significant progress was made when perlite (manufactured from expanded volcanic mineral), lightweight sand, and microballoons (microscopic silica spheres) were combined to create a lightweight fine-aggregate blend. This combination provided a high strength-to-weight ratio without compromising workability and finishability. A superplasticizer was used to reduce the water demand and increase workability. An air entrainer was used to increase workability and reduce weight. Synthetic fibers were added to ease the requirements for the primary reinforcement.

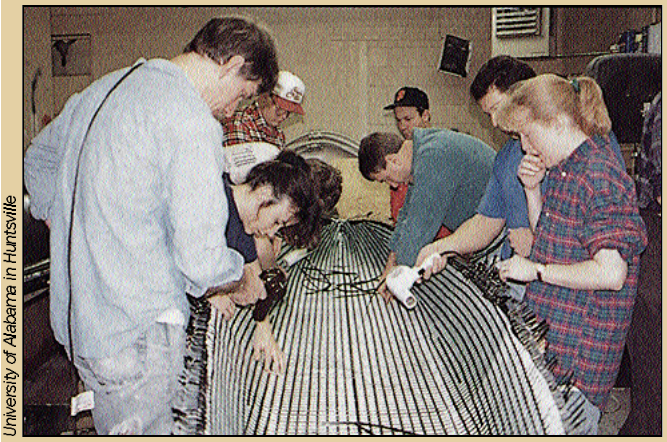
A total of 45 concrete mixes were batched and tested. The concrete mix chosen for *Defender* had a unit weight of 65 pounds per cubic foot and a 28-day compressive strength of 2490 psi. A high apparent water-to-cement ratio of 0.83 was required due to the high absorptivity of the lightweight aggregates.

We built a male mold for the canoe by mounting plywood cross sections onto a wood strongback, and gluing foam insulation between these sections. The male mold was used to produce a fiberglass female



men's time, and the coed time is always between the men's and the women's. There is a gradual decrease in all the sprint times. Possibly 1995 will see the first sprint race completed in less than a minute.





University of Alabama in Huntsville

The reinforcement mesh was formed by layering graphite tape in the female mold, and extra reinforcement was added in areas of maximum stress. Blow dryers were used to make the tape more pliable.

mold that resulted in a dimensionally accurate, smooth canoe exterior.

The formation of the graphite reinforcement was similar to basket weaving. Graphite strips were cut from a 3-inch-wide, 0.005-inch-thick tape using a specially fabricated tool. Gunwales were formed by wrapping a 0.375-inch-diameter nylon rope with graphite tape and attaching it to the lateral layers. The thwarts were formed in a similar manner.

We cleaned and waxed the female mold, then placed the concrete in two layers. The first layer of concrete was placed in the female mold to a thickness of 0.05 inch, as indicated by depth gauges. The graphite mesh was placed over the concrete and forced into it. We placed the second layer of concrete over the reinforcement and forced it into the mesh. The surface was troweled to obtain a relatively smooth finish. Foam insulation board was placed in the first 24 inches of the bow and stern for flotation.

We moist cured the canoe for 28 days at 80° F. However, sanding on the interior began only seven days after concrete placement. We removed the canoe from the female mold after 14 days by forcing compressed air through predrilled holes in the mold. Voids were filled with a portland-cement-based patching compound. After 28 days, the canoe was allowed to dry thoroughly. We obtained a high-quality, smooth finish by alternately priming and painting the canoe with black acrylic enamel several times.

At the 1994 National Concrete Canoe Competition, we took first place in every category. We attribute this success to extensive hull design and concrete research, the application of graphite reinforcement, and the dedication and contribution of the students and faculty.

Behind the Scenes

Western Kentucky University

1994 is only the second year that students at Western Kentucky University (WKU) have built a concrete canoe. They had a budget of just $110 to build this year's concrete canoe, which made two things necessary: donations and ingenuity. The first can be attained through perseverance, alumni support, and a little bit of luck. Ingenuity, however, is not so easy to come by. Fortunately, the students at WKU had a large supply and, with the help of over $200 worth of material donations, were able to get to the national level of competition at $4 *under* their budgeted amount of $110. This ability to meet their budget means that the students at WKU didn't always take the easiest solution to a problem, the mark of good civil engineers.

University of Minnesota

With a seven-day strength of 5040 psi, the concrete made by the University of Minnesota had the highest compressive strength as reported in the design papers. Derrick Dasenbrock, a graduate student at the University of Minnesota, attributes this in part to the school's past experience with high-early-strength concrete. The concrete used last year had a 28-day compressive strength of over 8000 psi, but it proved to be too heavy for a racing canoe. Students eliminated silica sand from the mix, which drastically reduced the unit weight of the concrete. The unit weight of the 5040-psi concrete is 84 pounds per cubic foot.

Final Mix Proportions (pounds per cubic yard)

Type III cement	869.4
Microsilica	70.2
Water	378
Superplasticizer	20.25
Ceramic spheres	939.6

University of New Orleans

1994 is the first year that the host of the conference was also a competitor, and the University of New Orleans (UNO) showed that this wasn't a handicap. UNO placed in the top five in every race and in two of the academic categories, earning a third-place finish overall. Dewey Gros, a member of the canoe committee, attributes this success to organization and a lot of planning. One key factor was that everybody involved didn't try to both host the conference and build the canoe. There was a conference committee and a canoe committee, and the heads of the committees met with each other to ensure communication. Gros said that one of the major benefits of hosting the conference was the interest it sparked locally among faculty, students, and sponsors. Actually witnessing a national competition is much more exciting than just hearing about it, and more people are expected to participate next year as a direct result of exposure to the conference.

University of California - Los Angeles

Although students at the University of California - Los Angeles (UCLA) have been building concrete canoes for several years, 1994 is the first year they made it to the national races. Despite their inexperience at the national level, UCLA placed second overall in the academic portion of the competition. They were, however, unable to place in the top five in any races. Project director Peter Yee said this was due to lack of practice rather than a poor canoe design. Many students at UCLA and around the country find it difficult to coordinate school and work, and finding additional time to practice paddling is sometimes impossible.

University of Sherbrooke

The University of Sherbrooke is located in Quebec, Canada. Veteran concrete toboggan racers, the students at Sherbrooke were intrigued by an article about the concrete canoe races. They contacted ASCE for more information, received permission to attend the national races as guests (not eligible for the scholarship money), and started to build their first concrete canoe. Aside from their own canoe, the Canadian students had never seen a concrete canoe until the national races. To get ideas for the canoe design, Sherbrooke examined Olympic canoes and sought the advice of an Olympic canoe builder. Eric Perreault, captain of Sherbrooke's canoe team, said their toboggan-building experience didn't really help them to design the canoe, but it did help them know whom to approach for money and supplies.