"Canoe Cements a Place in History"

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The idea of a concrete canoe may sound like a contradiction in terms, but how about one whose material is geared to be outer-space worthy, and whose conceptual design is so unconventional that it was once incorrectly applied to a bridge that consequently sank?

Yep, this is no ordinary canoe. In fact, the most pedestrian thing about it is the concrete part.

Concrete canoes are not new; universities throughout North America have participated in concrete canoe competitions for at least 14 years.

But there's never been a successful one built designed to achieve its natural resonance, and that's leaving
many a structural engineer completely floored.

"A lot of people would say 'You're nuts,'" said Robert Vaughan, a structural engineer at Marshall Space Flight Center.

Structural engineers are taught to avoid building anything that may come into contact with a matching natural resonance. To do so is to invite disaster.

Natural resonance describes the minute vibration frequency that every object has. If you get two objects sharing an exact natural resonance, it can lead to those vibrations being excited into stronger ones.

A famous example of this gone wrong is the Tacoma Narrows Bridge in Washington state. The bridge was inadvertently designed with a natural resonance equal to the vibrations created by the wind gusting through the narrows.

On November 7, 1940, the wind blew with a fluctuating force that was exactly in resonance with the frequency of the bridge. The equal vibrations of the wind and the structure of the bridge caused the bridge to roll, buckle and ultimately collapse.

Some may be wary of getting into a canoe, concrete or not, if it were designed to operate when excited in this way.

"It's operating on a paradigm. The prevailing concept is turned completely backwards," Vaughan said.

But according to Dr. John Gilbert, faculty adviser at the University of Alabama in Huntsville, where the canoe is being built: "Half the great ideas people have come up with have come from people not thinking in the normal way."

To achieve resonance, without falling apart, the canoe, known as Survivor, has to be made from concrete.

The concrete is made up of a mix of Portland cement, glass micro-beads (microscopic hollow spheres), latex, acrylic fortifier and water.

Mix these in the right proportions, allow the mixture to dry for 12 hours and presto -- you have concrete so flexible that it will bend and snap right back with nary a crack.

"Our biggest claim to fame is that our concrete just doesn't crack," Gilbert said. "We can get more flexibility from this material than they can get in the aerospace industry."

With this flexibility, the team hopes to push the 22-foot canoe to its natural resonance of 6Hz (six vibrations per second).

"If our boat reaches this, it'll start to flex and the side walls will bend in together and then apart -- like butterfly wings," Gilbert said.

"What we try to do is attain this natural resonance and then utilize the energy it creates and turn it into forward propulsion," Gilbert said.

"The boat bends and deflects with very little energy input," Vaughan added. "You can cause something to move with very little energy input and then use the energy produced for something positive. It's a
very innovative and bright approach."

The canoe, which weighs 76 pounds, took six months to build and cost $1,200, is built around a mesh frame made up of graphite. The cement is thinly applied over this mesh, "a little thicker than the diameter of a pencil," Gilbert said.

Gilbert admits that he still has a long way to go with the canoe. "We still need to do a lot of engineering and testing. I'm not saying that we are there yet. It's virgin territory but the underlying value of the technology is evident. It opens new horizons."

Despite Gilbert's reservations, Survivor has fared well in competition, finishing first against 24 other teams in the 2001 ASCE/MBT National Concrete Canoe Competition held last month in San Diego.

"We won because we utilized the boat's natural resonance. The other teams had not looked into using this, although I am sure they will now," Gilbert said.

Gilbert is also very confident of the future of the canoe. "Before, it was thought of as ridiculous with no benefits at all but I believe it's going to be the boat that will make the difference on who gets silver and who gets the gold at the Olympics," he said.

"Our boat can travel up to 14 feet per second. This is lightening speed compared to a regular canoe, which can go about 8 feet per second. An Olympic race canoe can probably go one-half foot per second faster than us," Gilbert said.

Others are not so confident of the canoe's Olympic prospects. "If we raced them over a straight-line course, his boat would be left for dead," said Charles Luckman, sprint program director for USA Canoe/Kayak.

"It's a great project but it's primarily an engineering project. We have years of research in hydrodynamics behind us," he added.

Canoe designer John Winters agrees. "They are not likely to replace conventional canoes because they are not light enough and are quite fragile," he said. "Once the competition is over they often end up in the landfills."

While the material may not have an assured future in canoe building, Gilbert believes it may have a more important role in store for it: Space travel. "In space ... you want to be able to get where you want to go and take as little as possible with you."

"Imagine you have a large structure in space -- like a satellite -- made of this material," said Vaughan. "You could construct it to operate at its natural frequency and use the energy this produces for propulsion."

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