



Riding the Waves

Surfski riding on a wave

Computer simulation helps design a more stable, better-draining surfski with less drag.

By ANSYS Advantage Staff

Surfskis are long, narrow, light kayaks with an open cockpit designed to be paddled in heavy surf. Red7, a South African surfski manufacturer, introduced a surfski that was popular with elite paddlers because of its speed, yet its appeal to recreational sportsmen was limited due to stability issues. Red7 contracted with Intelligent Fluid Solutions (IFS), an engineering consultancy based in London, U.K., to help improve the stability of the company's products without reducing speed in the water. Another goal was to improve how fast water drained from the cockpit.

One key attribute of an ocean surfski is the ability of the nose to right itself after being submerged when padding down the face of a wave. IFS consultants used ANSYS CFX fluid dynamics software to simulate the nose of the boat entering the water as it rides over the crest of a wave. The consultants looked at a large number of different designs to determine the magnitude of the resultant forces, with the goal of generating the largest possible resultant force pulling the nose out of the water. They also looked at alternate designs for appendages that create a low-pressure zone underneath the hull to pull water out of the drain.

The result of the engineering efforts was a surfski with dramatically improved wave-riding ability and faster drainage without compromising speed. Rob Mousley, a

world authority on surfski paddling and reputable boat critic, stated in a product review of the resulting Red7 Pro70 surfski on www.surfski.info, "Whereas in other skis I'm sometimes cautious about plunging straight down the face of a big wave, I was able to launch myself down into some huge holes, and the nose, while it would dip momentarily under the water, would pop straight out again."

Fastest Way to Travel in the Surf

A surfski is typically 5 meters to 6.5 meters (16.5 feet to 21 feet) long and 40 centimeters to 50 centimeters (16 inches to 20 inches) wide. The kayaks are very fast when paddled on flat water and the fastest paddled craft for traveling over ocean swells. There has recently been a huge growth in ocean surfski racing in the United States, Australia, New Zealand and other Pacific countries.

Red7 was the first company to mold surfskis in one piece using vacuum infusion molding to eliminate the structural joint between the deck and hull. This reduces the weight of the craft by 15 percent; it also increases stiffness and eliminates the danger of the seam's cracking or delaminating.

IFS began its redesign work by laser scanning the existing design, then using the resulting point cloud to produce a solid model. The solid model was then used to

generate a fluid dynamics model with 3.5 million tetrahedral elements resulting in 670,000 numerical nodes. “We have been working with ANSYS CFX software more than 20 years. And we have experience with most of the leading software packages,” said Jim Shaikh, managing director of IFS. “I prefer ANSYS CFX because its fully coupled solver requires less memory and fewer iterations to solve very large and complex models.”

Modeling the Boat Riding a Wave

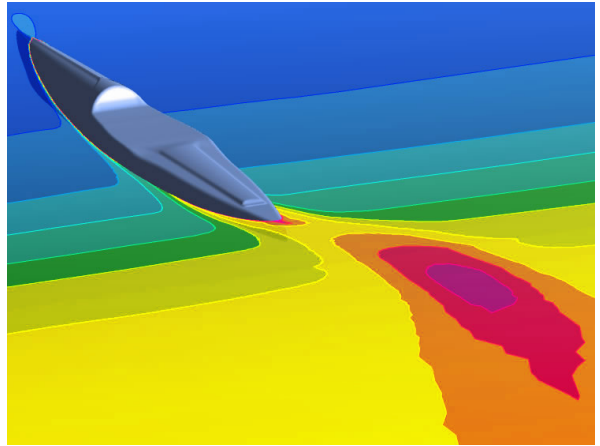
David Hartwanger, the IFS director of South Africa Operations, used the fluid dynamics model to simulate a 4 meter (13 foot) surface wave traveling at 6.84 meters (22.44 feet) per second by applying a momentum source to the domain to produce a steady-state flow field. The simulation mimicked the nose of the boat entering the water. The results of the simulation predicted the resultant forces acting on the nose. The analysis showed that the forces acting on the initial design tended to pull the nose down further into the water. As the nose moved down, the forces pulling it down increased to an even greater level.

Hartwanger created a numerical measure to summarize the ability of the boat to right itself. He used the fluid flow simulation to calculate the drag of the boat, which is the sum of the wave drag, skin friction drag and pressure drag. The wave drag is caused by the need to expend energy to push the water out of the way of the hull as the boat moves through the wave. Skin friction drag is caused by the contact of the water with the outer surface of the boat. Pressure drag is caused by the fact that a surfski creates a low-pressure zone in its wake.

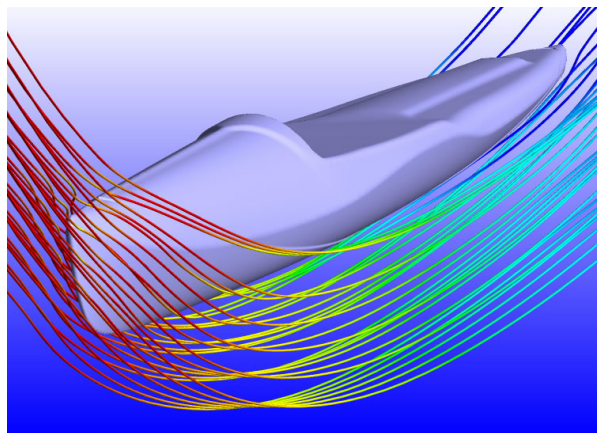
Hartwanger used the results of these simulations to generate some approximate formulas that estimate the effect of key boat design parameters on stability and drag. Then he utilized a genetic optimization tool to generate populations of new designs. The fluid dynamics-based formulas were used to evaluate the fitness of each generation by calculating its stability and drag. Then the fittest members of each generation were reproduced to create a new generation of designs. The best designs produced by this method were then subjected to a full-blown fluid dynamics simulation to evaluate their stability and drag to a much higher degree of accuracy.

Substantial Improvement in Stability

“ANSYS CFX technology helped us understand how the shape of the boat affects the pressure and forces that



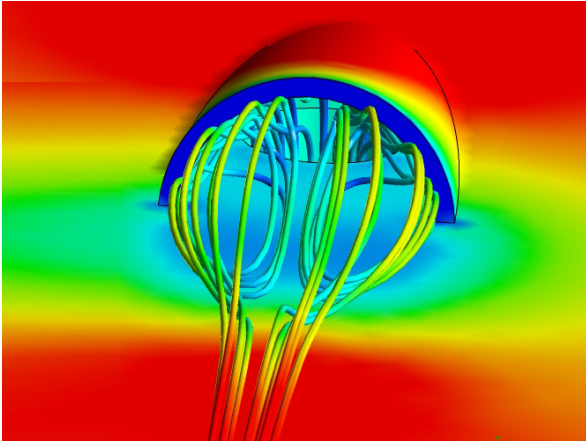
Simulation designed to evaluate stability of original design



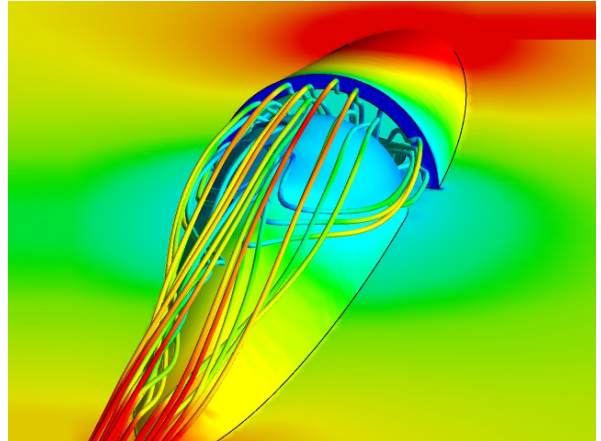
Fluid dynamics-optimized design offers greater stability

determine its stability,” Hartwanger said. “The most significant change is that we reduced the longitudinal curvature of the boat, commonly called the rocker. While the general feeling in the industry is that increasing the rocker improves longitudinal stability, the fluid dynamics simulations demonstrated that this is not the case. We also changed the cross section of the nose to generate a larger righting force.”

Customer feedback has confirmed a significant improvement in the wave-riding ability of the updated design. Dale Lippstreu, another noted surfski paddler, commented, “I have done two Millers Runs on the new Red7 and have found the stability quite astounding. Astounding because the ski has the narrowest hull and possibly the least rocker of any ski I have paddled.”



Original drainage appendage



Optimized drainage appendage with bullet-shaped scupper

Improving Drainage

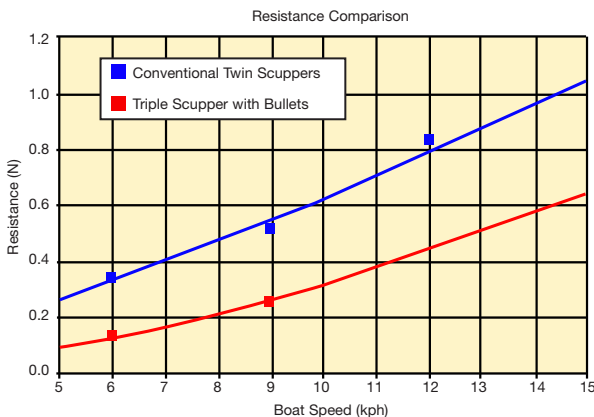
Another key attribute of a surfski is the ability of the cockpit and footwell to drain quickly when they become filled with water. In general, drainage is achieved by creating a passage from the cockpit and footwell to the water and then using a shape on the underside of the ski to create a low-pressure zone that allows the water to drain. Most surfskis provide good drain performance at high speeds. The challenge is to develop a drain that will work well at low speeds. Fluid dynamics simulation was used to evaluate the performance of the existing drain.

The simulation results gave IFS consultants ideas for improving drain performance. They generated four

additional design iterations. The resulting design is the first in the industry that uses bullet-shaped protrusions aft of the scuppers (drains). This approach reduces the minimum operating speed required to drain the boat by 30 percent while also reducing appendage drag by 50 percent.

Again, customer feedback confirmed the outstanding performance of the new drain design, which is now featured on the full family of Red7 surfskis. Surfski athlete Mousley said, "Once or twice, of course...it sank into the crest of the wave and the cockpit filled with water. But, this ski has no fewer than three big drain holes in the bottom of the cockpit, all with the Red7 'bullet' that makes the drainage so effective. And it works: I have never seen a cockpit empty so quickly. The water drains literally in seconds. In my experience, all skis will fill the cockpit with water occasionally (especially when paddled by a less-than-elite driver), and it's reassuring to know that the cockpit will drain fast — otherwise you can find yourself wallowing, trying to accelerate a suddenly heavy ski onto the waves."

Peter Mote, a champion paddler and member of the Red7 design team, concluded that the company is extremely pleased with the improvements that have been achieved with fluid dynamics. "There has been a huge improvement in the stability of the boat from where we started to where we are now," Mote said. "Many of the top racers who use our boats have improved their times with our latest designs. And sales have substantially increased all over the world." ■



Optimized drainage appendage reduces drag

Reference

www.surfski.info