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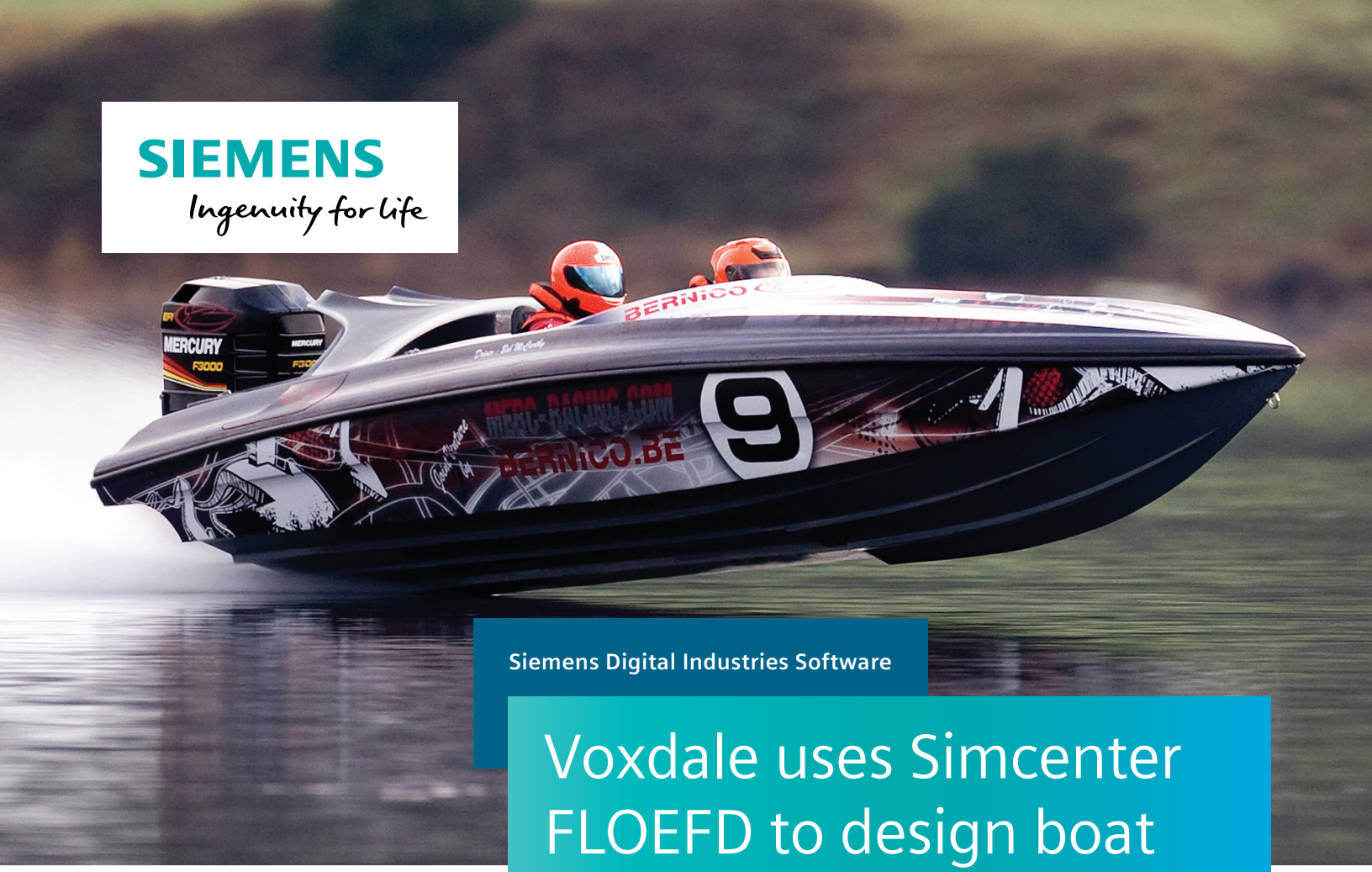

Siemens Digital Industries Software

Voxdale uses Simcenter FLOEFD to design boat that shatters world speed record

Executive summary

This white paper examines how Belgian engineering consultant Voxdale helped speedboat manufacturer Bernico International design a speedboat that would break the world speed record. This was accomplished by simulating the design of a new Formula 2 class boat through the use of computer-aided engineering, computer-aided design, and the 3D CAD-embedded computational fluid dynamics tool Simcenter™ FLOEFD™ from Siemens Digital Industries Software.

Koen Beyers, Voxdale

Abstract

In 2009, Voxdale performed a complex surface geometry modeling of the Bernico F2 boat as well as mechanical integration and engineering, structural optimization, thermal engine management, lightweight material selection, design for cost and assembly as well as flow analysis in Simcenter FLOEFD to deal with aerodynamics. The end result was a boat that shattered the 100 miles per hour (mph) barrier with a stunning world-record time of 103.6 mph or 166.7 kilometers per hour (km/h).

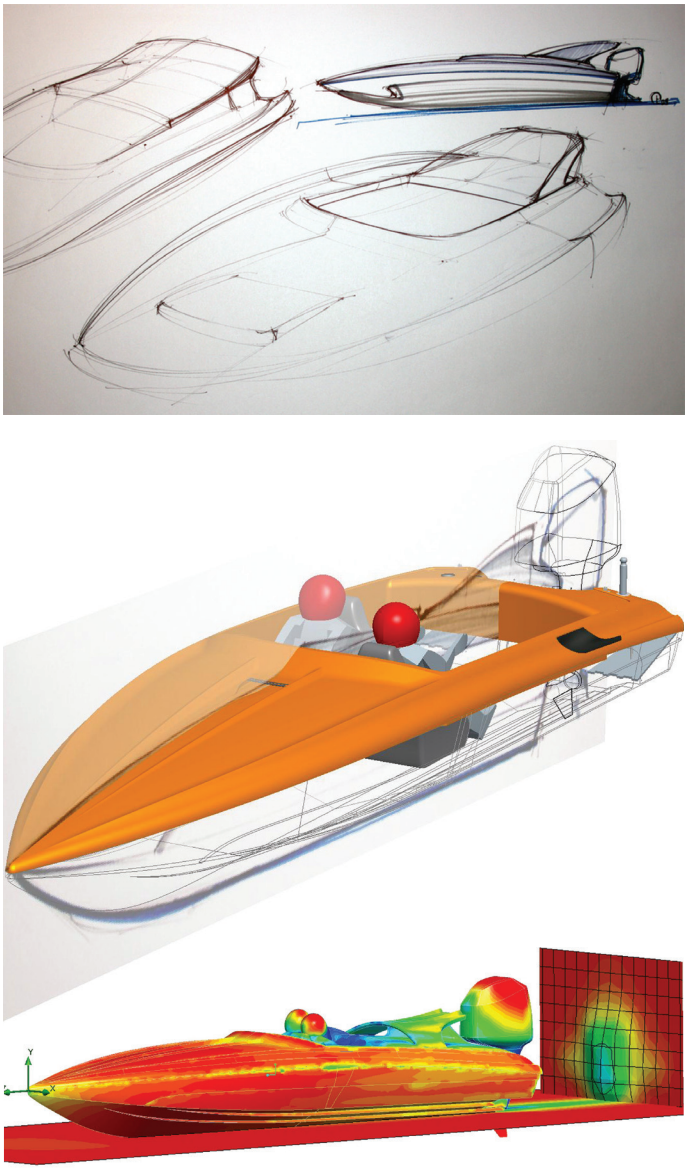

Figure 1. Voxdale F2 speed boat design process: Brainstorm and conceptual design (top); Architecture and SDX (center); and engineering optimization (bottom) – PTC Creo and Simcenter FLOEFD.

When leading Belgian speedboat manufacturer Bernico International approached Voxdale in 2008 to design an innovative Formula 2 class boat to break the world record and clear 100 mph, a new approach was needed. With a combination of PTC computer-aided design (CAD)/computer-aided engineering (CAE) tools, including the 3D CAD-embedded computational fluid dynamics (CFD) tool Simcenter FLOEFD from Siemens Digital Industries Software, we embarked on this challenge.

The rationale behind Voxdale's approach

F2 racing boats are very expensive and typically there is no time or budget for physical prototyping in any design process. The ideal scenario is to "build and race" and there is not a classic development path for such a process (for example, an alpha version, a beta version, a 0 series and/or a release version).

For Bernico, successfully designing a new F2 boat would be essential for future cruiser boat sales. Bernico gave us a simple set of target specifications for the new F2 boat:

1. 300 horsepower (HP) outboard engine
2. Top speed of 160 km/h (100 mph) with an acceleration of 0 to 100 km/h in 6 seconds
3. Cruise at 97 percent above water for good aerodynamics
4. No rear deck and minimal turbulence in the cockpit

In 2009, we started the project by taking the Bernico F2 boat design, which could reach speeds of 157.1 km/h (97.6 mph), and 3D scanning the hull and body to reverse engineer the prior design in CAD/CAE as a baseline (figure 1). We then did a CFD simulation on the baseline CAD geometry before brainstorming several parametric outside-the-box ideas which we could virtually test in the software and perform design optimization. With the Creo Simulate™ structural analysis tool from PTC Creo®, we could also conduct concurrent structural analysis of our boat designs to yield the optimal solution, which we would recommend to Bernico. Within our familiar PTC Creo environment, we did a complex surface geometry modeling of the boat, mechanical integration and engineering, structural optimization, thermal engine management, lightweight material selection, design for cost and assembly, as well as flow analysis in Simcenter FLOEFD to deal with aerodynamics.

CFD simulation helped shave off drag components throughout the new boat's shape. We looked at the boat pilot's helmet shape to produce less flow separation and drag. We used a National Advisory Committee for Aeronautics (NACA)-shaped duct to create an overpressure in the cockpit area so there was less turbulence created. At the rear deck splitter and deflector plate, we evolved our aerodynamic design (figure 2) so there was a positive lift on the rear deck and a low flow separation behind the outboard motor. We created a drag reduction from our baseline geometry of 240 Newton (N), designed the boat for a positive torque on the rear deck of 450 Newton metre (Nm). Upon completion, we managed to get to within 3 km/h of our predicted top speed. Moreover, our design had better acceleration than we needed, more stability and better driveability than what we started with.

This Voxdale-designed Bernico F2 boat broke the 100 mph barrier at Coniston Water in the United Kingdom's Lake District during the annual Power Boat Records Week on its first outing in November 2009 with a stunning world record time of 103.6 mph or 166.7 km/h [1]. Its excellent naval architecture, functional design, optimized aerodynamics, low fuel consumption and lightweight materials proved to be a successful combination. Bernico quickly commercialized the boat design and a Cruiser edition was made available in 2010, with three orders being taken during the Coniston Powerboat Records Week.

What did we conclude from this exercise? Some boat designs are hard to test but easy to simulate, and CAD/CFD/CAE simulation certainly stimulates radical innovation and leads to workable solutions that yield performance improvement and ultimately, in this case, a world record-breaking result.

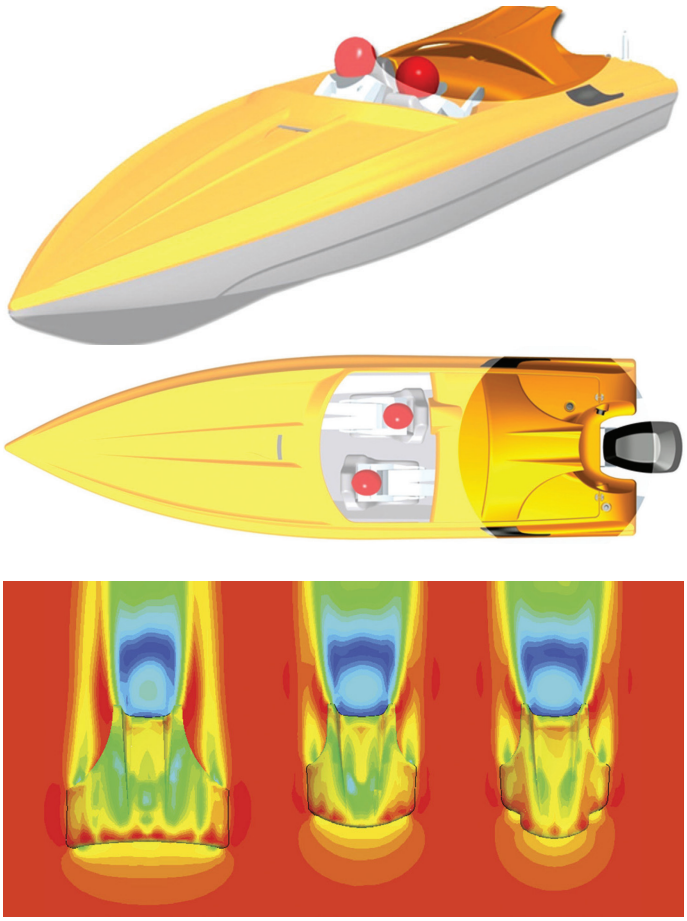

Figure 2: Evolution of the rear deck deflector and splitter unit.

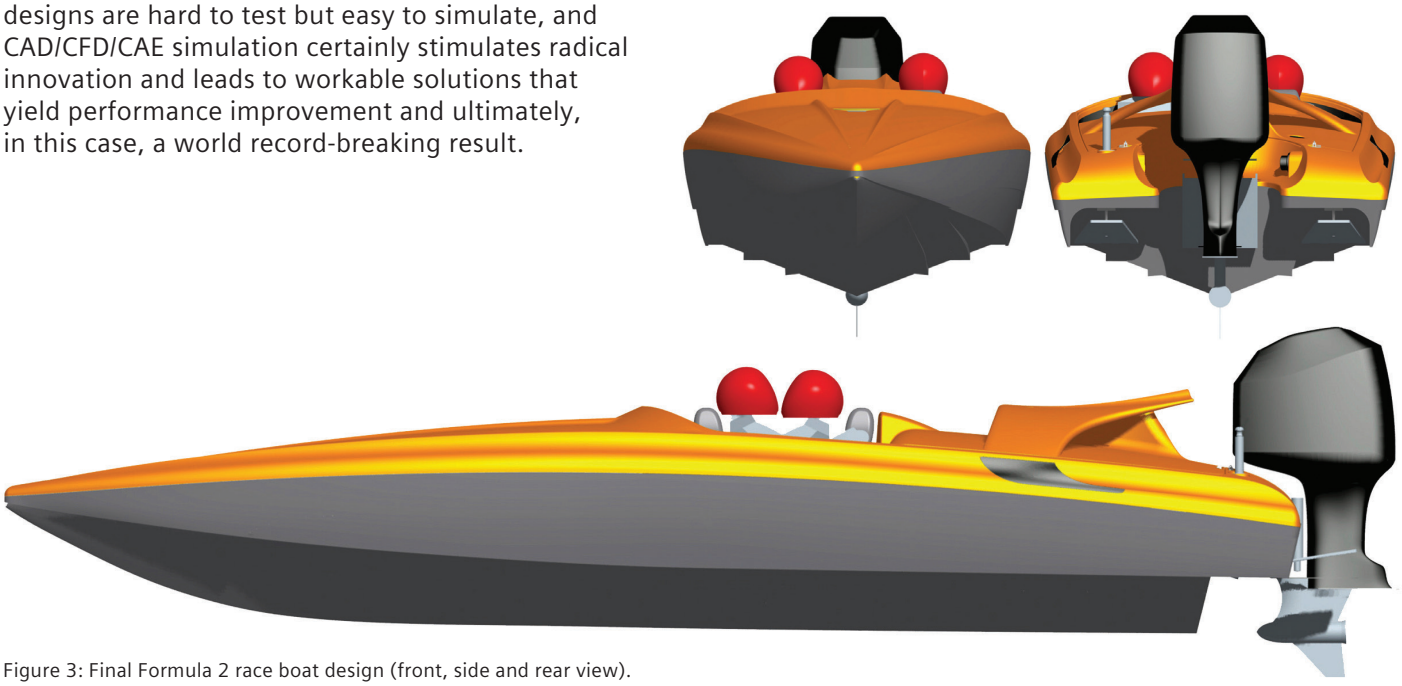

Figure 3: Final Formula 2 race boat design (front, side and rear view).

Figure 4: Record-breaking F2 Bernico boat on Coniston Water in November 2009 with superimposed hull pressure contours from Simcenter FLOEFD simulation prediction.

References and more information

1. Coniston 2009 Powerboat Records Week, Monohull record-breaking 103 mph video: http://www.youtube.com/watch?v=_WBggHZaWCk
2. http://www.voxdale.be
3. http://www.bernico.be
4. https://www.facebook.com/voxdalebelgium

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