The A to Z of Breaking a World Water Speed Record

It's not every day that a World Record is broken and in speed-sports it's indeed a very rare experience. To do it both safely and cost effectively requires meticulous planning, solid engineering design and quality manufacturing, plus a balance between taking calculated risks versus the accrued speed benefits to be gained.

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Figure 1. Voxdale F2 Speed Boat Design Process - Brainstorm & Conceptual Design (left) Architecture & SDX (center) and Engineering & Optimization (right) - Pro/E, ISDX, AAX, FloEFD

When Voxdale was approached by leading Belgian Speedboat manufacturer, Bernico International, to design an innovative Formula 2 class boat to break the then world record in 2008 and the 100 mph barrier, a new approach was needed. With a combination of PTC CAD/CAE tools, including the 3D CAD-embedded CFD tool FloEFD from Mentor Graphics, we embarked on this challenge.

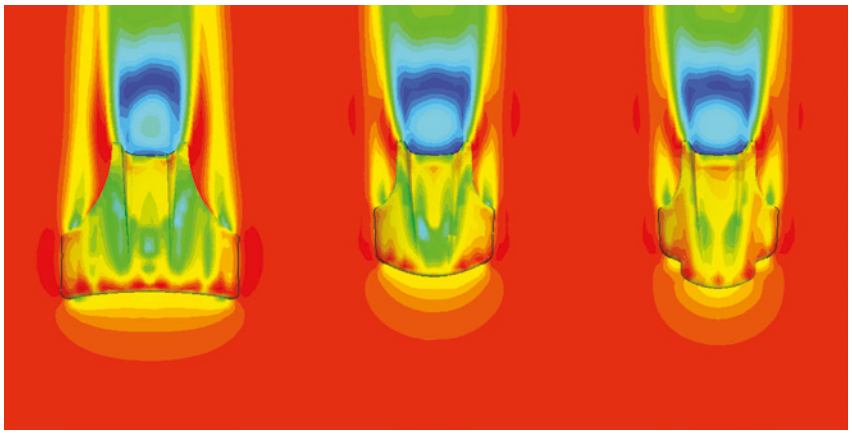
The rationale behind our approach was simple — F2 Racing Boats are very expensive, and typically there is no time or budget for physical prototyping in any design process. The ideal scenario is to 'build and race' and there is not a 'classic' development path for such a process (for example, an alpha version, a beta version, an 0 series and a release version...)
For Bernico, the success of the design of a new F2 boat would be commercially essential for subsequent sales of 'cruiser' boat sales. Bernico gave us a simple set of target specifications for the new F2 boat:

1) 300 HP outboard engine;
2) Top speed of 160km/h (~100mph) with an acceleration of 0-100 km/h in six seconds;
3) Cruise at 97% 'above water' for good aerodynamics, and
4) No rear deck and minimal turbulence in the cockpit.

We started the project in early 2009 by taking the then 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 (see Figure 1). We then did a CFD simulation on the baseline CAD geometry before we could brainstorm several parametric out-of-the-box ideas which we could virtually test in the software and do some design optimization. With the Pro/Mechanica structural analysis tool 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 Pro/E environment we therefore did complex surface geometry modeling of the boat, mechanical integration and engineering, structural optimization, thermal engine management, light-weight material selection, design for cost and assembly, as well as flow analysis in FloEFD to deal with aerodynamics.

CFD simulation helped us to 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 therefore drag. We used a NACA shaped duct to create an overpressure in the cockpit area so there was less turbulence created, and 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. In total we managed to create a drag reduction from our baseline geometry of 240 N, designed

Figure 2. Evolution of Rear Deck Deflector & Splitter Unit



the boat for a positive torque on the rear deck of 450 Nm and when it was built we managed to get to within 3 km/hr of our predicted top speed. Moreover, our design had better acceleration than we needed and crucially more stability and better 'driveability' than what we started with.

This Voxdale-designed Bernico F2 boat broke through the 100 mph barrier at Coniston Water in the UK's Lake District during the annual Power Boat Records Week on its first outing in November 2009 with a stunning World Record of 103.6 mph or 166.7 km/h (Ref 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 from early 2010 with three orders being taken on the spot during Coniston 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.

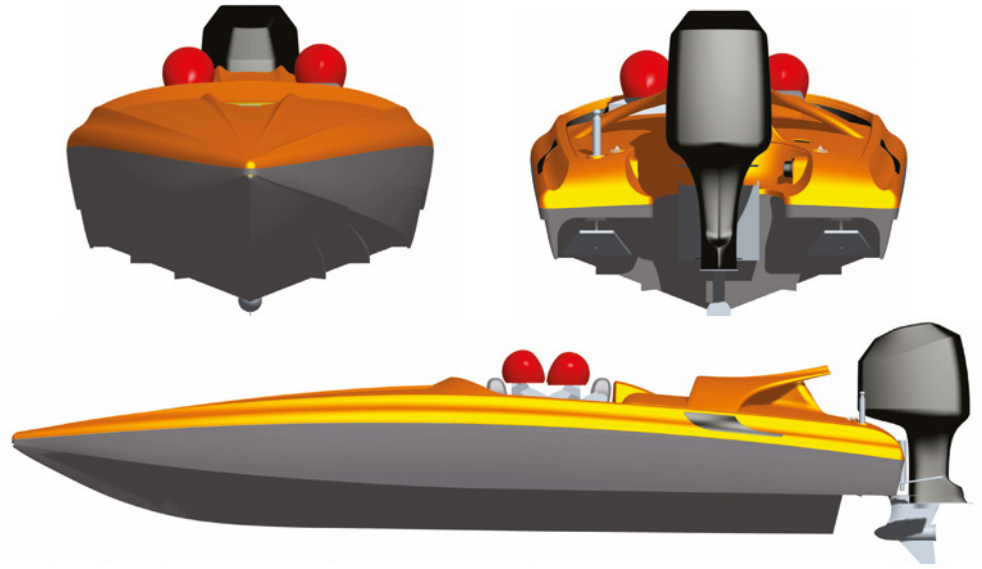


Figure 3. Final Formula 2 Race Boat Design (front, side and rear view)

References & More Information:

1) Coniston 2009 Powerboat Records Week Monohull Record Breaking 103mph run's video: http://www.youtube.com/watch?v=_WBggHZaWCk
2) http://www.voxdale.be
3) http://www.bernico.be
4) https://www.facebook.com/voxdalebelgium

Figure 4. Record Breaking F2 Bernico Boat on Coniston Water in November 2009 with superimposed hull pressure contours from FloEFD simulation prediction