

SIEMENS

Ingenuity for life

Marine

Land Rover BAR (Ben Ainslie Racing)

Land Rover BAR uses Siemens PLM Software to help develop a race boat for the 2017 America's Cup

Products

NX, Teamcenter, Femap, Fibersim, CD-adapco

Business challenges

Design a catamaran that can win the 35th America's Cup
Ensure stability and safety
Launch it within 30 months

Keys to success

Integrated design, analysis and simulation tools
Speedy generation of possible shapes
NX open scripting enables workflow customization
Teamcenter manages all technical data and documentation

Results

Time saved by simultaneous multiple analyses
Potential damage avoided through simulation of complex composites
Optimal design process for 3D printing
Clear markup for manufacturing ensures accuracy

Siemens PLM Software solution enables complex design and analysis to help optimize sailboat performance for one of the world's most revered sailing prizes

The America's Cup challenge is well underway

In the middle of 2014, the Land Rover BAR team began a 2 1/2-year timetable to design, evaluate and verify an ACC

(America's Cup Class) catamaran. Crucially, teams are not allowed to launch their America's Cup Class catamarans until 150 days before the first event of the 2017 America's Cup Qualifiers. The bulk of design, analysis and performance testing must be completed on much smaller-scale test models. The Land Rover BAR team is using NX™ software and Teamcenter® software from product lifecycle management (PLM) specialist Siemens PLM Software. NX and Teamcenter provide an integrated virtual environment for digital



Results *(continued)*

Efficiencies gained from operating within one environment

Tools support innovation and continuing improvement

Nimble response to competitor developments



“We use our sophisticated tools to open up fresh opportunities.”

Martin Whitmarsh
Chief Executive Officer
Land Rover BAR

“With geometry, aeroelastic optimization and structural analysis all in NX, we can run a sweep of imaginary deformed shapes and pick out the trends of what we want to achieve.”

Simon Schofield
Design Manager
Land Rover BAR

modeling and simulation. Software implementation, training and support services are being provided by Siemens PLM Platinum Partner Majenta PLM.

The odds are stacked against any new entrant winning the America's Cup, but for Land Rover BAR past statistics do not matter. What counts is the prospect of bringing the America's Cup home to Britain for the first time since the inaugural race took place in 1851. Sir Ben Ainslie, Olympic medalist and 34th America's Cup winner, does not underestimate the scope of the ambition. “It is a really big challenge



on all fronts. We have established a new team from scratch; we have the right philosophy and the right design tools and we are catching up with existing teams; yet we are operating under tremendous time pressure. That's the toughest aspect.”

At the pinnacle of sailing technology

Martin Whitmarsh, chief executive officer of Land Rover BAR, underlines the technical challenge: “Performance differentiation is usually created by shaping a hull to reduce drag; enhancing the way in which keel and rudder systems create a ‘righting’ moment; and using the sails for maximum thrust. These principles still apply to the America's Cup, but only one percent of the surface area of the boats is actually in the water when they are racing. Aerodynamic considerations therefore become supremely important, especially as these boats can go 2.8 times the speed of the wind.”

The design team must produce a light and efficient system that can cope with enormous loads yet remain within the margins



“NX remains at the heart of what we do...”

Andy Cloughton
Chief Technology Officer
Land Rover BAR

of safety. For Land Rover BAR, the use of NX and Teamcenter is critical for simulating the performance of the daggerboards (retractable keels); evaluating the aero-elastic capability of the wing; defining the behavior of composite materials; modeling the hydraulic systems; optimizing development processes; and streamlining workflows.

For Sir Ben Ainslie, team principal and skipper of Land Rover BAR, the only way to validate the design process is to go out on the water. “The sailing crew is a delivery mechanism for the designers. We are constantly fine-tuning the boat by sailing it and providing feedback to the design team.”

The fastest boat wins

By the start of 2016, testing was fully underway and the America’s Cup Class wing-foiled catamaran was in development. “The design team is very focused on

launching the race boat, which we are allowed to do at the end of the year,” says Andy Cloughton, the team’s chief technology officer. “Before then we expect to work our way through several sets of daggerboards designed for different conditions.”

The shape of a daggerboard dictates how effective it is in converting forward motion into lift and Land Rover BAR relies heavily on the ability of NX to produce hundreds of geometries at the press of a button. “Automated geometry and speedy shape generation are particularly important to us when working on the daggerboards,” says Simon Schofield, designer, Land Rover BAR. “We can quickly assess different shapes then confirm range of motion and check for clash.”

Likewise, the fixed wing sail, which acts as the engine of the boat, is crucial to speed.

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Andy Cloughton
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Under the rules of the race the wing has to weigh at least 450 kilograms and must be a certain shape when in dock. Passive deformation, which may sometimes enhance performance, is only acceptable when out on the water; on the other hand, some sailing conditions call for a stiff wing. The Land Rover BAR designers really need to understand the limits of what is both possible and desirable. They have therefore coupled a fully detailed 3D model of the wing using NX, with a high-level stick model developed with Femap™ software, and a detailed composite model created using the Fibersim™ portfolio of software for composites engineering (the laminate modeling and draping toolset integrated with NX). This combination of models is being used with computational

fluid dynamics (CFD) analysis tools from Siemens PLM Software.

Simon Schofield explains: “The scripting capabilities of NX have allowed us to create a user interface for the CFD coding and set up an aeroelastic simulation process entirely within NX. With geometry, aeroelastic optimization and structural analysis all in NX, we use NX Nastran to run a sweep of imaginary deformed shapes and pick out the trends of what we want to achieve; we need to know if it is possible to produce a shape using NX and still meet the rules. Having everything in one environment really speeds up our productivity because we are not transferring files in and out.”

Predicting response and resilience

Land Rover BAR is also utilizing NX scripting capabilities to assist in simulation of the behavior of composite layers and understand how they degrade under stress. Cloughton explains, “Our laminate analysis process enables us to get answers very quickly. We are still fine-tuning it, using the power of NX scripting and open capabilities to customize workflows, remove clicks and improve efficiency. As a result, we have been able to improve the way in which we send information to the shop floor. We can send laminate drawings or we can send flattened patterns that allow the manufacturer to set up automatic pattern generation and cut directly, guaranteeing precision.”

Realizing the dream boat

Together, NX and Teamcenter enable a complete and comprehensive development process from concept to the surface of the sea. “The ability of NX to generate geometries quickly and easily is fundamental because every question we ask ourselves starts with geometry,” says Cloughton. “Everything stems from a robust CAD model. Only then can we analyze weight and behavior; produce renderings to show the sailing team the

controls and displays; or print plastic samples for the sailors and shore crew to check.”

Use of the analysis tools integrated with NX enables the design team to optimize the structure of metallic parts made through the additive manufacturing method. Claughton explains, “We are looking at the workflow for additive manufacturing. Rather than designing a component for normal machining, we plan specifically for 3D printing by starting with an envelope of material on which we mark boundary areas and attachment pins. Even with such topological optimization the end result can still be extremely complex but, with NX, we have smoothing tools that allow us to manipulate the models further and make them practicable to build.”

By annotating 3D models with NX PMI (product and manufacturing information) mark-ups, the design team can convey the exact manufacturing requirements of a 3D model to downstream partners. This detailed guidance is carried through to drawings for suppliers who require 2D data.

Reassuring control and consistency

Land Rover BAR uses Teamcenter to manage all technical files and documents so that specifications, design calculations, analysis data, simulation results and material properties are in the correct order and associated with the right CAD models. The team’s use of Teamcenter controls the release process and governs all workflows leading up to manufacturing. This enables 15 to 20 people to collaborate very closely on the same model.

Claughton notes, “Teamcenter is doing all the things it is really good at: maintaining a secure CAD vault, controlling the issue of drawings and feeding them out to the supply chain.



“Teamcenter condenses everything into one single environment. Now that we have a library of parts and established workflows, we do not always have to start from scratch. Each boat moves on from the last and we frequently use the clone tool to clone particular parts or subsystems and quickly try out a different approach. From one baseline, we can run two or three different threads of development and then bring them back together.”

It is not only the shape of parts that is constantly changing; analysis methods also vary according to the specific requirements of each stage of development. Because the use of Teamcenter enables Land Rover BAR to control the flow of engineering data throughout the organization, the team can fully audit progress, enabling the team to see exactly what has been done at every stage. “We can go back with confidence and see exactly how a design began or understand an analysis decision,” says Claughton. Within Teamcenter is the complete provenance for every component and each configuration of the boat. All the individual parts on the 2016 test boat will have a complete bill of materials (BOM). “Good control of the BOM is extremely important for several reasons,” explains Claughton. “The component count on these boats is very

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Solutions/Services

NX

www.siemens.com/nx

Teamcenter

www.siemens.com/teamcenter

Femap

www.siemens.com/plm/femap

Fibersim

www.siemens.com/plm/fibersim

fibersim

Star-CCM+

www.cd-adapco.com

Customer's primary business

Land Rover BAR is a commercial sporting team led by Olympic gold medalist and 34th America's Cup winner, Sir Ben Ainslie. Launched in June 2014, the team's long-term aim is to bring the prestigious America's Cup back to Britain, where the first challenge was held in 1851 off the Isle of Wight. land-rover-bar.americascup.com

Customer location

Portsmouth
England

Partner

Majenta PLM Limited

high; the shore team needs to be able to keep track of each configuration of the boats, and perhaps most critical is the fact that prior to each race we need to submit design substantiation documents to demonstrate class rule compliance."

Speedy maneuvering

In the technologically driven environment of Land Rover BAR, the engineering team dictates the tests that the sailing team must conduct. The team's mission control center has a live video link to the test boat and designers can see exactly what is happening as they assess data received from the various sensors positioned around the boat. Sailing can then be followed by a thorough and informative debriefing session for sailors and engineers.

"We are always streamlining our processes to avoid repetition of effort and free the engineering team to focus on the actual design. NX remains at the heart of what we do, enabling us to continue refining geometry and systems even as we are building components," concludes Claughton.



Whitmarsh adds, "We use our sophisticated tools to open up fresh opportunities, which often means that the designs become more complex as we seek new levels of performance." In the play-off between speed and stability, Sir Ben Ainslie is absolutely clear about what matters to the crew: "There is a sweet spot and we will inherently feel when the boat is right. That is still a long way off and if we get to 100 percent before actually racing, then we are not pushing hard enough. Our aim is to find another five percent when we really need it."

Siemens PLM Software

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