DASSAULT SYSTEMES

MARINE & OFFSHORE CASE STUDY

ORACLE TEAM USA

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ORACLE TEAM USA

Challenge:
ORACLE TEAM USA needed to design, build and test two boats based on entirely new, untested design specifications in less than three years to defend the 34th America's Cup.

Solution:
The team chose Dassault Systèmes' **3D**EXPERIENCE® platform, including CATIA for virtual product design, ENOVIA for collaborative innovation, and SIMULIA for realistic simulation to develop boats for the most technologically advanced America's Cup ever.

Benefits:
The **3D**EXPERIENCE platform enabled ORACLE TEAM USA to rapidly develop, test and perfect its cutting-edge boat designs in a collaborative virtual environment that fostered sharing and leveraged the skills of its global teams. In a miraculous comeback, ORACLE TEAM USA won the 34th America's Cup by quickly devising a design solution to improve the boat's speed.

The world's most avant-garde sailing race event has its roots planted firmly in history. The America's Cup sailing competition dates back to 1851, when a race around the Isle of Wight in England was won by a radical looking schooner named America. Since then, the America's Cup has become arguably the sport's most prestigious competition, attracting the world's foremost sailors and yacht designers.

When ORACLE TEAM USA won the 33rd America's Cup in February 2010, the team brought the America's Cup home to the United States and automatically became the Defender of the 34th America's Cup.

That is when one of the greatest technological challenges in the history of sailboat racing began.

Technology has transformed sailboat design and racing – and nowhere is that more evident than in America's Cup racing. "The America's Cup is a technology game today," said Jimmy Spithill, helmsman and skipper for ORACLE TEAM USA. "There's an incredible amount of technology that goes into designing and building the fastest, lightest, strongest boat we can."

NEW DESIGN CHALLENGES

For the 34th America's Cup, two new classes of boats were specified: the AC45, a smaller, wing-sailed multihull boat for the America's Cup World Series regattas leading up to the 2013 America's Cup; and the AC72, catamarans with a hull length of 72 feet, topped by a wing sail measuring almost 3,000 square feet (260 square meters), for the Louis Vuitton Cup challenger series and America's Cup finals in the summer and fall of 2013.

Teams were allowed to build two versions of the AC72. Each team had to design and build its own AC72, based on what it had learned from sailing the smaller AC45, which ORACLE TEAM USA designed on behalf of the America's Cup community.

"It became clear that the complexity of the AC72 was far beyond what we had seen previously with older America's Cup boats," explained Christoph Erbelding, senior structural engineer with the team, who previously worked in the automotive and aerospace industries. "That complexity was what led us to **3D**EXPERIENCE."

CHOOSING THE 3DEXPERIENCE PLATFORM

"In America's Cup racing, it has been typical for designers to use their own favorite software," Russell Coutts, CEO of ORACLE TEAM USA, said. "After we won the 33rd Cup, we chose Dassault Systèmes because we wanted to have a fully integrated design program. This Cup campaign was the first time where we had a coordinated approach to design technology."

Instead of deploying individual software solutions, ORACLE TEAM USA used Dassault Systèmes' **3D**EXPERIENCE platform, including CATIA for virtual product design, SIMULIA for realistic simulation, and ENOVIA for collaborative innovation, which provides a shared database and design processes for ORACLE TEAM USA's global group of designers and team members. "We used software from Dassault Systèmes to go all the way from conceptual design to production," Coutts said.

The design team used CATIA to model each aspect of the boat in the virtual world, quickly and efficiently. "What's nice about using the **3D**EXPERIENCE platform as a designer is being able to quickly get from a concept to a finished part," Aaron Perry, design engineer on ORACLE TEAM USA, explained. "It allowed us more freedom in the initial stages of design to really explore what's important."

That exploration is just one part of a collaborative effort that involved everyone on ORACLE TEAM USA. The **3D**EXPERIENCE platform enabled team members to share ideas through the virtual design process.

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DESIGNERS AND SAILORS WORKING TOGETHER

The 3D model developed in CATIA brings the design alive for the entire team. "In almost every meeting, we showed our design to a room full of sailors, designers and builders, all of whom had their own perspectives about what the design needed to accomplish," Perry said.

With the 3D model projected on a large screen, sailors felt like they were on the actual boat. They could see if hydraulic hoses or other mechanical systems would interfere with their activity on the boat. Spithill concentrated on whether or not he could see the bows of the catamaran's hulls, or see through the wing. He imagined where the crew members would be during actual critical maneuvers.

"Vision is very important on this sort of a boat," Spithill said. "**3D**EXPERIENCE gave us vision into the realities of sailing a boat that didn't even exist yet.

"The best way for the crew to evaluate what would – and what wouldn't – work was to use **3D**EXPERIENCE," he continued. "We spun it around. We saw where everything needed to fit. You just couldn't get that kind of vision without these tools."

Erbelding added, "From concept to detail design to testing to manufacturing, the **3D**EXPERIENCE platform really eased and inspired the process between what the sailor wanted on the boat and what finally got built down the road."

PLAN, MANAGE, TRACK AND CONNECT

The collaborative value of the **3D**EXPERIENCE platform did not begin and end with the crew in San Francisco. It encompassed members of ORACLE TEAM USA from New Zealand, Europe and the U.S.

"America's Cup teams typically are spread across multiple locations," Erbelding said. "We had people working in different time zones on different projects that are often overlapping. Without the integrated **3D**EXPERIENCE design platform, it would have been a big challenge to keep all the data synchronized and make sure everybody was working off the latest set of data."

The team used ENOVIA for multi-site collaboration and design data management. "ENOVIA enabled us to have everyone up to date, working from the most current designs and drawings, regardless of where they were around the world," Erbelding continued. All the details of the 3D model could be translated into the manufacturing process, ensuring precision and accelerating production.

The collaboration continued even after a day of sailing. Designers would take the crew's feedback, make changes to components, and start production immediately.

"We never stopped looking for a better way," Spithill said. "**3D**EXPERIENCE enabled us to keep going back and questioning things, looking at modifications. Continuing to develop the boat and make it faster was a never-ending quest."

© ORACLE TEAM USA / Photo: Guilain Grenier

Due to a short time frame to design, test, and manufacture the AC72, ORACLE TEAM USA's design team benefited from using the **3D**EXPERIENCE platform during meetings with the sailors to explore immediate improvements to the boat.

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REALISTIC SIMULATION SAVES TIME

The three years between the 33rd and 34th America's Cup did not give the designers and engineers a lot of time to design, build and test the boat. In fact, teams were allowed only 30 days of training and testing before February 2013 on their first AC72 design so ORACLE TEAM USA relied on virtual testing with SIMULIA to capture issues within the design prior to build.

"The America's Cup allows such a small timeframe to design and build that you really can't afford to do any real hardware testing on a large scale," Erbelding said. "SIMULIA was a strong tool to simulate and optimize all parts and systems in the boat to ensure they're light, stiff and strong enough to stand up against anything they need to endure on the water."

IMPROVING THE FAN EXPERIENCE

ORACLE TEAM USA used the **3D**EXPERIENCE platform to enhance the experience of America's Cup racing enthusiasts – and non-enthusiasts – around the world.

"The entire America's Cup has focused on advancing our sport and engaging a younger audience with the hope of generating new fans," Coutts said. "Television production and high-quality images already coming from fixed cameras on board the AC45s have brought the sport closer to the public. So we designed the AC72 with the TV broadcast in mind."

Fans can go to the ORACLE TEAM USA website and see the 3D model of the boats. During the America's Cup match, on-board cameras enabled viewers to see the crew at work during the races themselves.

"In the past, the America's Cup has been pretty closed," Perry acknowledged. "But with our ability to share 3D renderings, we exposed more viewers to America's Cup racing than ever before. It was a fantastic educational tool that helped us reach out and build more interest in the Cup."

PUSHING BOUNDARIES IN DESIGN, PERFORMANCE

3DEXPERIENCE helped ORACLE TEAM USA build the fastest, strongest boat it could create, pushing the boundaries of sailing performance. The AC72 is among the fastest boats ever sailed around a racecourse.

During the Cup, the boat reached a top speed of 44.98 knots (52 mph) with an average top speed of 31.92 knots (37 mph). Members of ORACLE TEAM USA use the word flying — in part, because of the wing-like sail, and in part because at racing speed, the AC72 lifts almost entirely out of the water, referred to as foiling.

It is no small coincidence that Dassault Systèmes' **3D**EXPERIENCE applications were first developed and refined to serve the global aerospace industry, and that those solutions continue to drive aerospace innovation today. Dassault Systèmes' expertise in aerospace design translates to two critical design elements of the AC72: the airfoil-like wing sail and the high-tech carbon

composite materials used throughout the rest of the boat.

"The composite modeling ability in CATIA and testing in SIMULIA were crucial to our ability to optimize the composite structures in our boats," said Erbelding. "All parts on America's Cup boats are optimized to minimize weight while still maintaining strength." CATIA also enabled manufacturing engineers to map out both finished parts and layout in one step, which accelerated production.

The AC72 boats race at speeds approaching three times the speed of the wind that propels them. Stresses are enormous. "When the boat is sailing across the wind, lifting out of the water, there are enormous forces — 30 to perhaps 50 tons of compression load on some of the rigging elements," Coutts explained. "There is just no room for error."

KEEP ON BELIEVING

Commencing in early September, the 34th America's Cup was the makings of a compelling (and yet unbelievable) Hollywood script. After starting down 4-0 in the standings, ORACLE TEAM USA was forced to use its postponement card to regroup.

"Early on in the competition, it was obvious that our boat was not up to competition, mainly in the upwind course," Andrew Gaynor, design engineer at ORACLE TEAM USA, said. "As a group, we had to sit down and come up with solutions quickly."

The team started to race better and won three races against Emirates Team New Zealand, the winner of the Louis Vuitton Cup, but by mid-September the relentless challengers dominated the opening series 8-1 (ORACLE TEAM USA started the Cup down two points due to a pentaly enforced by a jury of international sailing experts). Gaynor credits ORACLE TEAM USA's first setback in October of 2012 when after only nine days of sailing, the boat capsized and damaged the wing sails and hull as good practice for what was to come.

"It took many months of reconstruction to get that boat back on the water after it capsized, so we relied heavily on our 3D modeling and 3D analysis in **3D**EXPERIENCE to bridge the gap between what we would have learned sailing the boat," Gaynor said. "So when we again found ourselves with our backs against the wall, we fell back on that knowledge base in the design space to assess what was going to make the boat faster and at what expense and what risk."

Decisions were made by the sailing team to sail the boat differently, which required changes on the boat to accommodate their idea. "The balance was not quite right when sailing upwind," Gaynor said. "In order to make it better, we had to either do major modifications to the wing and the boat or we could trim the wing differently. This meant shifting the aero center back in the boat without structurally changing the boat or wing."

The design team examined the boat and wing models with the **3D**EXPERIENCE platform to see how the loads would affect both areas of the boat. They found it was feasible to make the suggested changes. Gaynor shared, "Our typical

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— Christoph Erbelding, Senior Structural Engineer
ORACLE TEAM USA

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ORACLE TEAM USA triumphantly won the 34th America's Cup 9-8 by winning the final eight consecutive races against challenger Emirates Team New Zealand.

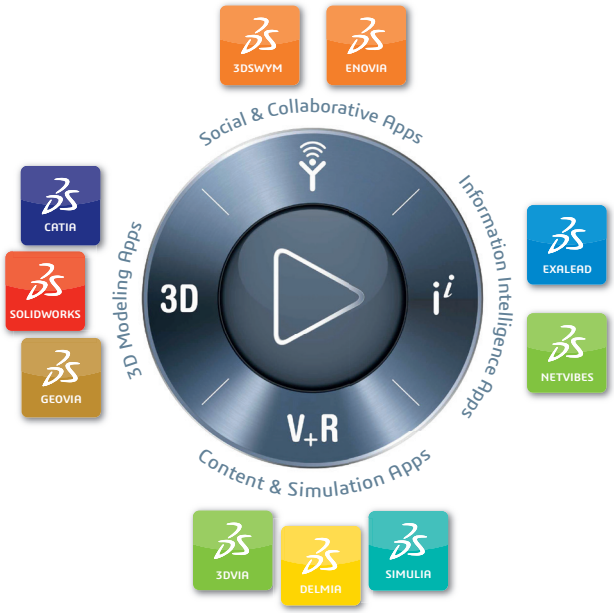
upwind boat speed was at 20-22 knots before the series started, and at the end of the series, the speed increased to almost 33 knots."

WINNING THE 34TH AMERICA'S CUP

ORACLE TEAM USA was confident in its AC72 designs, thanks to the collaborative, virtual design experience enabled by the **3D**EXPERIENCE platform. By looking at all plausible solutions and acting quickly to improve the boat design, ORACLE TEAM USA triumphantly won the 34th America's Cup 9-8 by winning the final eight consecutive races.

"Winning the America's Cup was one of the coolest things I've ever been involved in, especially as an American with an American sailing team," Gaynor said.

"The design and engineering of our boats are right up there with aerospace design and engineering," Coutts concluded. "We pushed the limits and we're enormously confident in what we've built together. Working with Dassault Systèmes gave us confidence before we ever left the dock."



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