Blue Sky Solar Racing

Places first among Canadian teams with DS PLM

Overview

Challenge

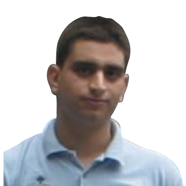
Evaluate a large number of designs to reduce drag and weight while increasing power, and ultimately optimize the solar car.

Solution

Blue Sky Solar Racing used CATIA and ENOVIA Digital Mock-Up (DMU) to evaluate many design iterations and quickly generate models for computational fluid dynamics, and to define wiring requirements early. CATIA Composite Design was used to optimize composite parts.

Benefits

Blue Sky decreased drag by 22% and increased the power of the solar array by an impressive 4%, creating one of the top cars in its class.



"For 2009, we plan to model the entire vehicle as a single CATIA assembly, managing all the data in ENOVIA SmarTeam, so that we can comprehensively survey opportunities for improvement before we build."

Andreas Marouchos, Managing Director, Blue Sky Solar Racing

BLUE SKY SOLAR RACING
University of Toronto

Crossing a continent powered only by the sun

Every two years, a special field of cars competes in the Panasonic World Solar Challenge, crossing the Australian continent powered by nothing but the sun. Teams research, build and design vehicles capable of completing the 3000 km journey from tropical Darwin in the Northern Territory to cosmopolitan Adelaide in South Australia.

The University of Toronto Blue Sky Solar Racing team's fifth-generation car, Cerulean, competed in the 2007 challenge, finishing first among all Canadian entries and fifth overall in its class. The team, which consists of undergraduate and graduate students and alumni volunteers, leveraged Dassault Systèmes Product Lifecycle Management (DS PLM), including CATIA and ENOVIA Digital Mock-up (DMU), in its designs. Team members are committed to demonstrating the viability of alternative energy technology and the practical benefits of a multidisciplinary approach to solving problems. Dassault Systèmes is a sponsor of the Blue Sky Solar Racing team.

Evaluating 60 designs in a few hours

The critical challenge in developing a competitive solar vehicle is optimizing its power-to-drag ratio. The solar panels are arrayed across the top of the body to maximize sunlight collection. They must be oriented directly toward the sun to increase the power they generate, but this often increases drag, compromising efficiency. Many design variables must be considered to optimize this tradeoff, including the baseline shape, track width, wheelbase driver positioning and others.

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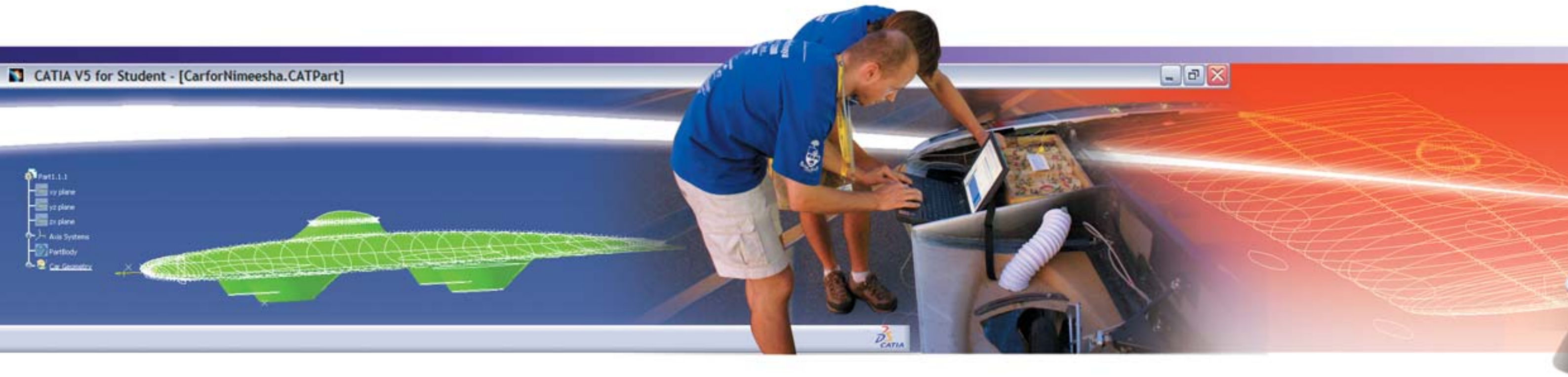

"We used CATIA Design Tables to create 60 different design variations in less than six hours, compared to 120 hours that would have been required using the traditional approach."

Amy Bilton, Chief Aerodynamicist,
Blue Sky Solar Racing

Amy Bilton, chief aerodynamicist for the 2007 car, needed to analyze many different alternatives to optimize the design. She estimated that it would have taken about two hours to create each design iteration by manually modifying the CAD geometry. Instead, she developed a CATIA Design Table that incorporated each of the key design variables. Then she simply typed in the values of each variable for the iterations she wished to explore. CATIA automatically generated the resulting models.

Using a programming language designed for engineering applications, Bilton created a routine that read the design parameters from the spreadsheet. It calculated the area available for solar arrays on the top of the vehicle and the resulting power. She also used a computational fluid dynamics software program to calculate the drag on the CATIA solid model. After completing each design iteration, she modified the model and moved steadily toward her goal of maximizing the power-to-drag ratio. Amazingly, she generated 60 design iterations in about five hours, approximately a 96% time savings compared to conventional methods.

Wiring harness design reduces shell and chassis weight by 3%

Solar vehicles have a large number of power and signal wires. Wiring harness design is critical because the holes that must be cut for the wires have a significant impact on the weight and structural integrity of the aerobody shell and chassis. The signal wires are also highly sensitive to impedance, so their length must be closely controlled.

On the 2005 car, the electrical wiring was done at the very end of the design process. This meant that the mechanical engineers did not know where the wiring holes would be, so they had to overdesign the shell and chassis. They also had to make last-minute design changes to overcome impedance problems.

On the 2007 car, the team used CATIA electrical applications, including Electrical Library 2, to create and place electrical components, Electrical Harness Installation 2 to bundle harnesses, and Electrical Wire Routing 2 to route the wires through the created bundles. The CATIA electrical applications made it possible to design the wire harnesses at the same time as the mechanical structures.

"Thanks to CATIA, the mechanical engineering team knew in advance what size and where holes would be needed to accommodate the wiring harness," said Dmitri Stepanov, who is chief engineer for both the 2007 and 2009 cars. "This made it possible to optimize the design of the shell and chassis to make them lighter."

Each time the Blue Sky engineers repositioned components, CATIA automatically calculated the amount of wire required by the new configuration. This made it possible to choose a configuration that substantially reduced the amount of wire. The software also calculated the length of each wire so the engineers could easily predict its impedance and reposition components where necessary. The reductions in the weight of the shell, chassis, and wire provided a 3% reduction in the total mass of the vehicle, compared to previous cars. In highly competitive solar racing, a 3% reduction in mass is a significant difference.

"CATIA Design Tables provided a competitive advantage by enabling us to evaluate a large number of design iterations in the limited time on hand," said Andreas Marouchos, managing director of the 2007 car. "CATIA wiring harness design tools helped us reduce the weight of the vehicle. CATIA Composite Design helped reduce the weight and improve the margin of safety of our composite parts. These improvements helped us finish the World Solar Challenge in fifth place in our class and first among six Canadian competitors."

Building on success with more DS PLM solutions

In the 2009 car currently in development, Blue Sky Solar Racing plans to increase its use of the CATIA ergonomic workbenches to improve driver performance and safety. "The 2007 car was a two-seater, but the 2009 car will be a one-seat design that will be more challenging from an ergonomic standpoint," Marouchos said. "The ergonomics capabilities built into CATIA make it easy to define a driver and manipulate him or her during the design process to optimize vision, crush zones, and egress in the event of an accident. The measurements of the driver can easily be changed to determine how different people would interact with a particular design."

The team's experiments with CATIA on the 2007 car were so successful that "our plan is to model all of the mechanical and structural components of the 2009 car in CATIA," Stepanov said. "We already used this approach on the axle hub of the 2007 car using the ENOVIA Digital Mock-up functionality in CATIA, and it allowed us to reduce weight and the number of parts." DMU allows users to see parts in an assembly to better understand their relationships and identify potential improvements.

"By viewing a 3D master model, we will be able to achieve similar savings throughout the entire vehicle," Stepanov said. To build a master model of the entire car will require significant product data management capabilities, however, so the Blue Sky team is adding ENOVIA SmarTeam to its design arsenal for the 2009 car.

"ENOVIA DMU helped us reduce the weight of an axle assembly by helping us better understand how the various parts interacted with each other."

Dmitri Stepanov, Chief Engineer, Blue Sky Solar Racing

ENOVIA SmarTeam will control the CAD and related product data files, preserving all the native CATIA links and references, in a secure electronic vault that will eliminate the risk of unauthorized modification or accidental deletion.

ENOVIA SmarTeam will manage and store all of the versions and variations studied by the designers and allow multiple designers to simultaneously work on the same parts or related parts with full knowledge of what their teammates are doing, updating modifications "on the fly" to avoid any inadvertent loss of edits. ENOVIA SmarTeam also will allow the team to create a hierarchical product structure representing the entire car as a single digital model, which will help identify and exploit additional opportunities for design improvement.

"The master model will help coordinate the work of our team of designers, who are by necessity working in different places at different times," Stepanov said. "We are expecting to see substantial time savings by eliminating time spent searching for the right version of a design file and time spent correcting errors, such as when someone makes a change to the wrong version of a file. We only have the time and money to build one vehicle, and CATIA and ENOVIA SmarTeam, along with our analysis tools, are ensuring that this one vehicle is the best we can possibly build."

> "The CATIA electrical applications enabled us to define the wiring requirements in the early stages of the design process, making it possible to reduce the weight of the shell and chassis by 3%."

Dmitri Stepanov, Chief Engineer,
Blue Sky Solar Racing

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