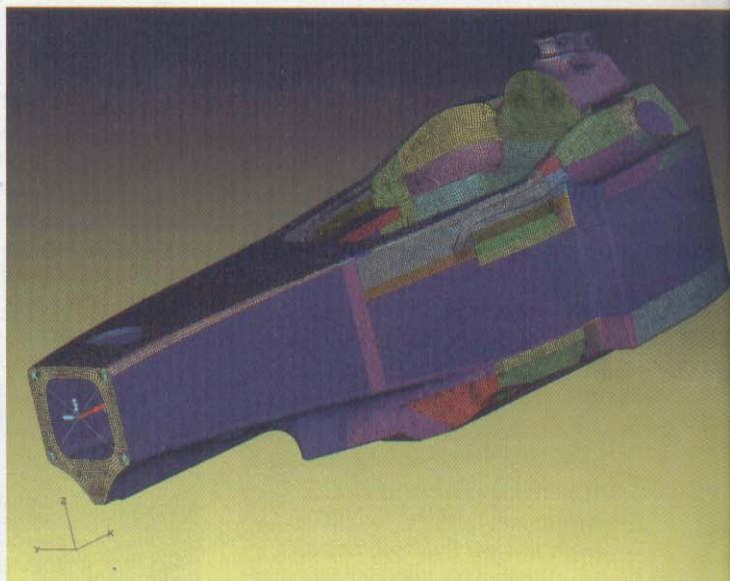


## FEA for performance

**Minardi F1 Team** is not the biggest of the **Formula One** racing teams, but that is exactly what provides the drive and motivation to find technologies that not only neutralize this disadvantage but also give an edge in making a better racecar. Founded by Gian Carlo Minardi in 1979, the team made its Formula One debut in 1985. It scored its first championship point in 1988 with a 6th place in the Detroit F1 race and celebrated its 300th Grand Prix in August of 2003. However, Minardi hit a dry spell in the late 1990s, and for several years did not score any championship points.

Things began to change when UK-based Australian businessman Paul Stoddart bought the team. Seeing his mission as preserving the distinct Minardi character in the Formula One paddock, he ushered in a new wave of technical expertise. The team's record began to improve, and in 2001 and 2002, Minardi



The Minardi F1 Team worked with Italian-based system integrator SmartCAE to evaluate Noran Engineering's NEiNastran to improve simulation of its designs and reduce physical prototyping.

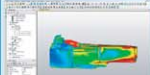
### Minardi Formula 1 and NEiNastran... A winning combination.



See what NEiNastran can do for you.



"We have chosen NEiNastran after an extensive and detailed internal benchmark, comparing the result, the performance, and the features of the solver developed by Noran Engineering Inc. with those of our former FEA platform. Full compatibility, accuracy, along with the professionalism and quick turnaround of the tech support from Noran Engineering and SmartCAE were the main reasons why we selected NEiNastran as our FEA software for the future."  
-Paolo Marabini, Structures and Calculation Chief Engineer at Minardi F1 Team



#### THE CHALLENGE

Formula 1 racing is about pushing the envelope in performance without compromising vehicle integrity. Success depends on being able to solve numerous complex engineering analysis problems on a tight schedule, and insure driver safety – all within budget constraints.

#### THE SOLUTION

NEiNastran accelerates Minardi's development cycle with powerful analysis capabilities that allow them to design and optimize with insight and confidence. Reliable and accurate results successfully get them through carbon composite prototype fabrication and an extensive battery of crash, impact, structural safety and performance tests to a final design.

#### THE OPPORTUNITY - TRY AT NO COST

Noran Engineering can meet your product development needs with FEA software and support that solves your toughest problems and fits within your budget. We're so sure that you'll see the value in NEiNastran that we invite you to test drive it for 30 days at no charge. Visit [www.NEiNastran.com](http://www.NEiNastran.com) to get your evaluation copy today.



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**NEiNastran**

...Turning your ideas into reality with engineering software for design, analysis and simulation.

scored World Constructors' Championship points and improved its overall competitiveness.

In 2004, Minardi began to study how it could improve the structural design of its F1 racecars. An important aspect of that was how to enhance the chassis for safety and performance without incurring the massive costs that physical testing imposes. While Minardi engineers had started using FEA, they felt they were not getting the full potential out of the technology. The team began a six-month test with **Noran Engineering's** NEiNastran in an effort to improve the analysis and simulation of the design and cut down the huge investments they were making in physical prototypes.

"Minardi needed a much more comprehensive system that combined carbon-fiber design elements with 3-D solids [and] could be tested accurately and precisely in FEA," said Simone Ragionieri of **SmartCAE**, an Italian-based system integrator that worked with Minardi on the project. "We combined NEiNastran with our Smart[Browser and Smart[Laminate technologies so that everything could be created within the digital environment—even down to the smallest fiber in the materials."

The chassis design is quite unique. "The chassis has to end up with the smoothest and flattest shape possible within the many engineering constraints that exist," said Paolo Marabini, responsible for the Minardi CAE Group. "These constraints

Circle 282



More than 15 impact tests, including side crash, were analyzed with NEiNastran.

include desired wheelbase, engine interface, fuel capacity, aerodynamic requirements, and even the driver dimensions."

To further complicate matters, the monocoque structure, using high-performance carbon-epoxy composites with either an aluminum or aramidic honeycomb core, also affects the chassis design. The fibers within the materials have to be oriented according to the design, and not bend, while the ply overlapping and necessary cuts are minimized. Getting any of these aspects wrong can affect the performance of the chassis.

Once a design concept is in place, modifications and further evolution continuously interplay with the very stringent safety requirements for the chassis.

"At this point, safety regulations become the main driving force for the chassis design," said Marabini. "We tested the 3-D model in NEiNastran with more than 15 impact tests, including side crash, crash cone push-off tests, and more. The software surpassed our very high expectations."

All of the tests are simulated in the NEiNastran analysis environment. Some can be replicated very closely while the penetration test uses a simplified correlated calculation validated by years of experimental data-fitting within Minardi. The team started using NEiNastran for these tests, checking static analysis, buckling, and surface contact. All calculations are correlated with experimental measurements, thus enabling a continuous refinement of methodologies and material data.

During the testing, and to achieve the required targets, optimization routines are executed involving modifications on material choice, layup sequences, local reinforcements, foams, bulkheads, and inserts.

"At the point of running several optimizations, it is important to us that the FEA software is flexible enough to manage the existing model, able to solve the problems thrown at it, and able to give accurate and detailed post-processing info," said Marabini. "In this way, effective modifications can be easily tested and understood by the engineers."

Minardi worked with SmartCAE thoroughly testing Noran Engineering's analysis and simulation software for six months. In late 2004, the Minardi Team made the change official.



All simulations of the Minardi racecar were validated by testing.

"The SmartCAE/Noran Engineering system has given us an advantage by having our new chassis designed and tested with minimal cost and at high accuracy," said Marabini.

This article was written for *AEI* by **Rachael Dalton-Taggart**.