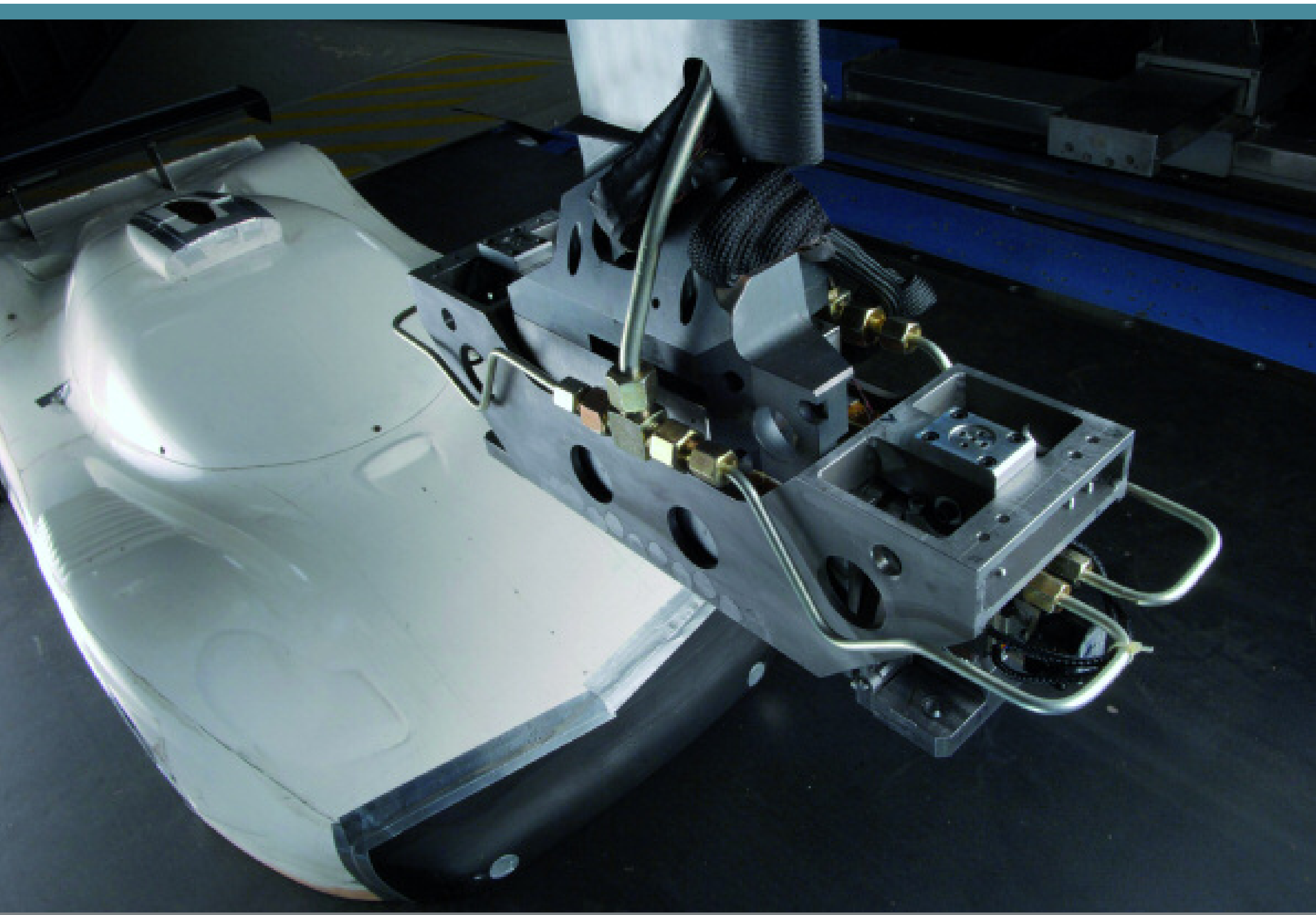
RUAG

Aerospace Defence Technology



Center Aerodynamics – Newsletter 12 – Spring 2006

In this Edition

Dear reader,
I am pleased to present you the 12th edition of our Center Aerodynamics Newsletter.
It is our goal to improve our testing facilities to provide you as a customer with the best possible services.
With this perspective in mind, this Newsletter will focus on the development of a dynamic model shaker in our automotive wind tunnel (AWTE). We have been working for two years on this development and the first results available clearly demonstrate large differences due to the unsteady aerodynamics, meaning that dynamic effects should not be disregarded for the development of a race car. A paper written together with Porsche, who supported this project, will be presented at the SAE World Conference 2006 in Detroit. The paper has already been ranked as ground-breaking research by its reviewers. Please have a look at the following article to learn more about our new dynamic testing technology. Maybe you will consider our new shaker technology to improve your race car performances.
You will see that improvements in our facilities also mean, in the large wind tunnel (LWTE), a new, more user-friendly data format for aircraft testing.
Computational Fluid Dynamics (CFD) is yet another of our core competences, which is illustrated by the icing analysis performed on the Swiss Ranger UAV in cooperation with our partner CFS Engineering.
And our wind tunnels are not only used for aerospace and automotive applications. Last October, members of the Swiss Skeleton team carried out some successful tests in our AWTE with Gregor Stähli winning the bronze medal at the 2006 Olympic Games in Turin. Congratulations from the Center Aerodynamics.

Michel Guillaume
Head Center Aerodynamics

Model Shaker for Dynamic Testing in the Wind Tunnel

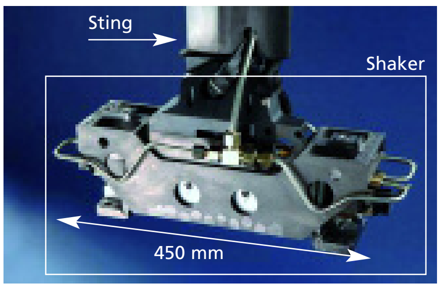
Cars, especially race cars, run in highly dynamic environments where braking, accelerating, uneven road surfaces, cornering and unsteady wind conditions lead to large effects on the aerodynamics. Consequently, static measurements alone can only bring a very limited insight into the aerodynamic behavior of the car. In spite of this, these effects are still mostly neglected in wind tunnel tests, even in the most state-of-the-art facilities. Also in CFD, analyses are all traditionally performed under stationary conditions.

To provide time-resolved aerodynamic forces and pressures for a car being subjected to motions relative to the road surface and be therefore able to investigate these effects, RUAG Aerospace has developed a novel, freely programmable dynamic model manipulator (shaker). This model shaker is now operational in the AWTE for use with 30 to 50% models. Wind tunnel tests with a former Le Mans type race car model have shown that the difference between a steady state and a true dynamic analysis can indeed not be neglected; the dynamic effects were even stronger than anticipated beforehand.

Test setup

The current setup allows fully independent pitch and heave motions in the range of approximately ±3° pitch or ±10mm at frequencies up to 25Hz, thus optimized to cover typical dynamic characteristics found in race cars.

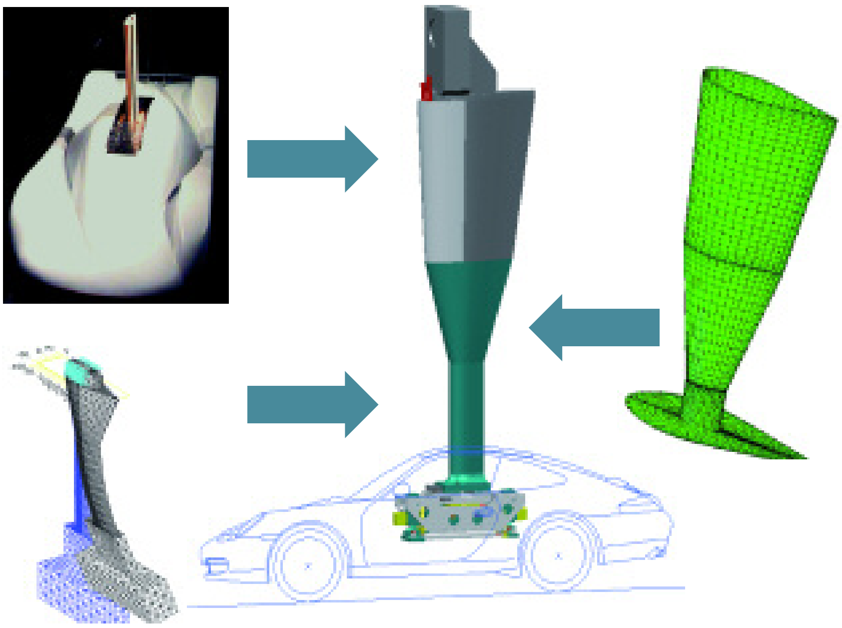
The heart of the shaker consists of an «add-on» model-internal unit completed by a control rack and a PC as the user interface. The internal unit can be divided into a stationary main body, two specifically designed miniature hydraulic cylinders, hydraulic lines and a moving interface part to the model. It also contains the 6-component balance. The main body is responsible for stiffness, allows motions in pitch and heave, and restricts all other motions. The hydraulic power is routed through the model sting over the balance to the static part of the cylinders. The balance crossing system of the oil lines has been designed to get minimal and repeatable interference.



The need for time-resolved measurements and higher precision requirements has also prompted the upgrade of the existing data measurement/acquisition system.

Design of a new shaker sting

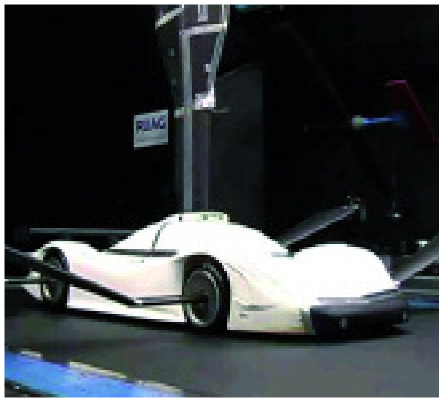
One of the major challenges for the operation of the shaker was that all the mechanical eigenfrequencies should be well above the frequencies of interest (e.g. 25Hz). This is not the case for the sting normally used in the AWTE. Therefore a new sting with increased stiffness, while still providing adequate internal room for the instrumentation cabling and hydraulic power supply, was required. A combination of extensive wind tunnel tests, CFD, as well as computational analysis of the stiffness was used to define the shape and meet the aerodynamic, mechanical, and operational requirements. The new sting is in fabrication and will not only be used for shaker tests but also for static tests with special requirements.

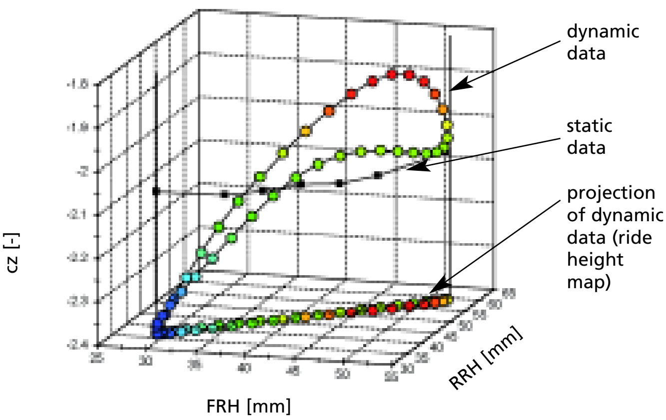


Results that make the difference

The shaker system was tested with a simplified 33% Porsche Le Mans type race car model in our AWTE. During the most recent campaign, static and dynamic tests at 50m/s with periodic movements only were performed. The effects of heave (pure vertical motion) and pitch around the center as well as around the rear axle of the model were studied. In an earlier test, track data had also been used as motion control input.

The main difficulty in the data reduction procedure is to separate the aerodynamic from the inertia loads. The inertia characteristics of the model are determined by using a reference wind-off test; the balance forces are correlated to the measurements of model internal accelerometers. For the wind-on cases, the inertial loads are then calculated from the measured accelerations and subtracted from the total loads.





An example of the results, showing a comparison between static and dynamic lift data with respect to ride height, over one period at 10Hz, for a heave motion of 4mm amplitude, is shown in the figure (FRH: front ride height, RRH: rear ride height, 1:1). The large differences clearly show that the quasi-static values measured by conventional methods can not represent the situation the car actually encounters on the road. The lift coefficients even show a totally different behavior whether the ride height increases or decreases. Other results, not presented here, also indicate that the shape of the curve strongly depends on the frequency.

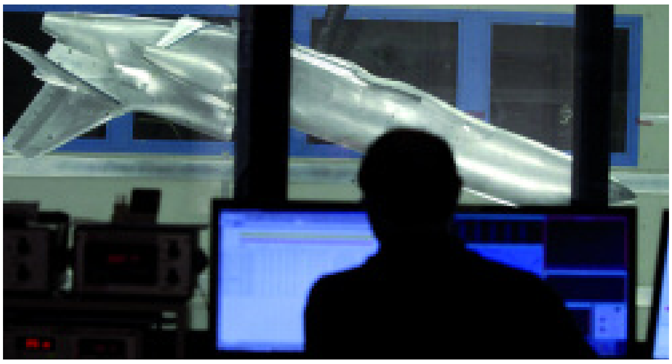
Future perspectives

Aerodynamics is one of the most crucial steps in the design of a successful race car. With its model shaker, RUAG Aerospace becomes one of the pioneers in time-resolved measurements with a moving model, offering to its AWTE customers a new asset to improve realism during the aerodynamic development in the wind tunnel.

Recent Activities

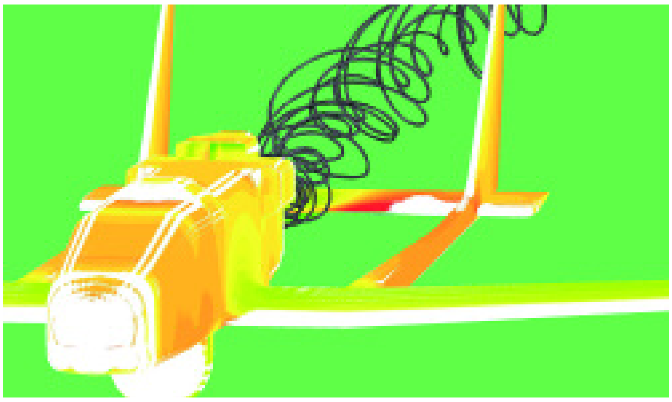
New data format for aircraft testing

The most recent tests with the Dassault F7X model in the LWTE wind tunnel marked the beginning of a new era. For the first time, the data was also presented in the new Wind Tunnel Data Format (WDF). WDF is a data standard created by DNW and ONERA for wind tunnel testing. It is compatible with the latest measurement techniques and the most recent software, and also gives added flexibility compared to the older data formats in use until now. Additionally, a common data format in different wind tunnel facilities considerably simplifies the data handling and reduction for the customer: regardless of their source, all the data can be processed with the same tools.



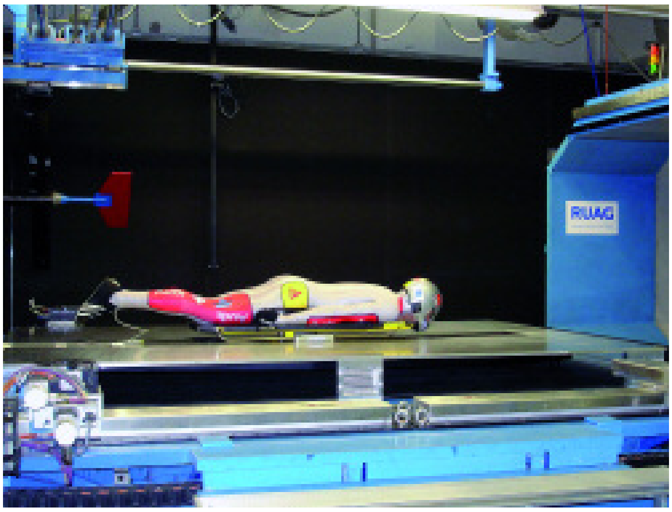
Icing analysis on the Swiss RANGER UAV

The RANGER tactical drone is a catapult-launched UAV developed and produced by RUAG Aerospace with multiple capabilities for military and civil missions. In order to analyze safety issues and further technical improvements on the RANGER operating in icing conditions, the ice accretion during flight in cold and humid air was calculated using FENSAP, NSMB, DROP3D and ICE3D on an unstructured CFD grid. The results provided insight as to the size and the positioning of potential de-icing equipment on the wing and horizontal tail surfaces. In addition, the degradation of flight performance due to the added mass from the ice accumulation and to the altered section shape was also determined.



With 130 km/h headfirst down the ice track

Skeleton, the world's oldest known sliding sport, originates from the village of St. Moritz, Switzerland, where in the late 1880's, men and women descended the icy slopes from St. Moritz to the town of Celerina. The winner received a bottle of Champagne. Since then, Skeleton has largely evolved to become highly technical, a combination of aerodynamics, materials technology, physics, control dynamics and athleticism, all into one. After a long absence of over 50 years, Skeleton was just re-introduced into the Winter Olympics. No wonder that the Swiss Skeleton team came to the Center Aerodynamics. In the wind tunnel, athletes have the unique opportunity to minimize the drag they generate by selecting the best sledge/helmet and perfecting their body posture: when racing down the icy surface at speeds approaching 130km/h, every slight variation can make the difference between winning and losing.



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SECURITY IS OUR GOAL, QUALITY OUR STANDARD

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