RUAG

Aerospace Defence Technology

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In this Edition

Dear reader,
In order to stay current with today's measurement demands, many of our activities are dedicated to continuously improving our facilities and capabilities. The main article discusses the update of the model support systems which allows more flexible and efficient positioning of the models in the Large Wind Tunnel (LWTE). New projects such as the Barracuda technology demonstrator already benefits from this most recent upgrade. Higher safety standards, more efficient testing and increased precision in model positioning are added values which can be directly felt during the aerodynamic testing phase in the wind tunnel.

The second topic takes a look at the continuing efforts to improve wind tunnel interference correction methodologies for both the Large Wind Tunnel (LWTE) with its closed test section and the open test section Automotive Wind Tunnel (AWTE). During this summer the AWTE will see modifications on its support structure and the fixation of the model manipulator. These will remove the current limits on the capabilities of our model shaker system, which has attracted a lot of attention during the past year from race and passenger car manufacturers. A new calibration system allowing on-site calibrations of data acquisition systems has considerably increased the quality of wind tunnel measurements.

The successful operation of the experimental facilities relies on many factors such as flexibility, efficiency, accuracy, and safety. Only by constantly improving these factors the specific and growing needs of our customers can be met. This is the reason why improvements on processes, equipment and facilities are considered a priority item.

Enjoy our first newsletter of 2007! Please, do not hesitate to contact us for further information or discussion of your current needs.

Sincerely,

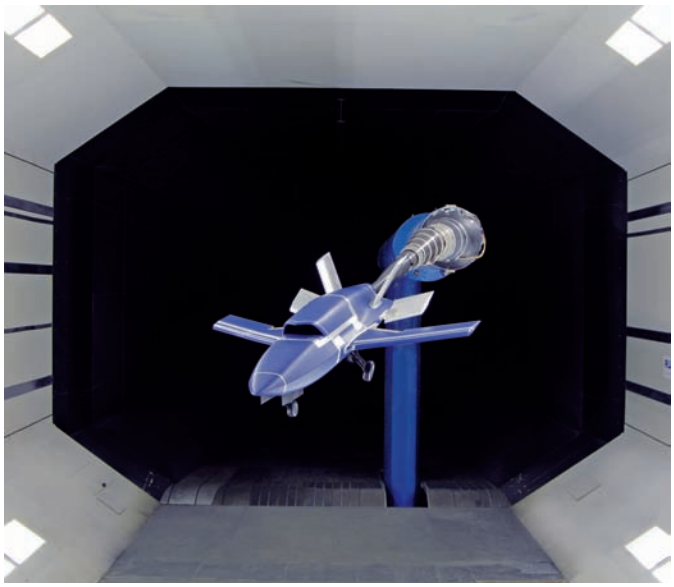
M. Guillaume

Michel Guillaume
Head Center Aerodynamics

COSYS: Update of Model Support Systems in the LWTE

RUAG Aerospaces wind tunnels are constantly updated and improved to better suit our customers' needs. During the last two years we concentrated on the model support systems of the LWTE (Large Wind Tunnel Emmen). Increased demand for our upper and rear model support systems from passenger and transport aircraft development programs as well as UAV and fighter projects has triggered the start for an internal development project to replace the old control systems for these model manipulators. The main improvements can be summarised as follows:

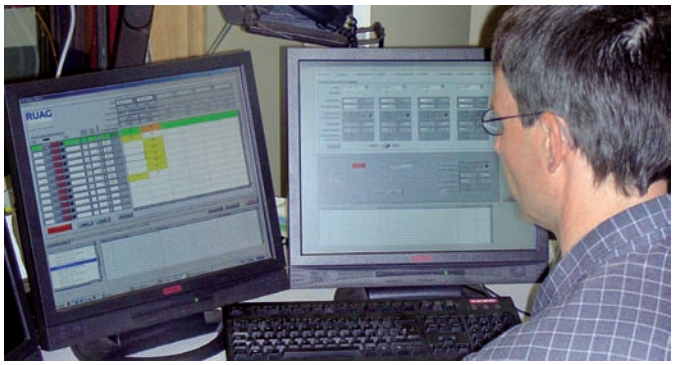
- improved test efficiency due to a flexible and easy to use user interface
- improved position and speed control for linear and non-linear model axes over the full position range
- synchronous control over all integrated manipulators



The system is operated from two PC based user interfaces (MMI and AP-Player) and an interface to the master computer that will allow fully automated runs. A real-time PC runs the control code. The MMI (man machine interface) is mainly used during model installation and removal. It allows to manually control relative and absolute single axis movements on all available axes in both the actuator and the model based coordinate systems. Also the handling of system parameters is performed on this user interface.

With the AP-Player (AP: Ablaufprogramm, position sequence) it is possible to load, store, program and run automatic motion sequences with a number of model axes. Every line defines one motion step for the selected axes, for example "move yaw angle of rear model support from wherever it currently is to 20°, at the same time move the yaw angle of the upper model support to -10° and leave the vertical model position as it is now".

The duration of such a motion step is defined by the selection of the line master axis and the user specification of its speed. The transition from one line (command) to the next can be instantaneous or delayed by a pause. During this changeover the control system accelerates/decelerates all axes in parallel in such a way that the correct speeds are reached within a given time frame, e.g. 1 second. Even though non-linearities and the influence of several actuators might need to be taken into account; accelerations, also in this critical phase, are kept to a minimum to limit the damage potential to the balance and model.



The teach-in feature of the AP-Player is especially useful for ground effect tests with the rear model support. With one mouse-click the current position can be copied into the current position sequence; instead of entering the information numerically the model can be moved manually to the desired position and the automatically measured numerical value at this position is inserted.

While running through a position sequence on the AP-Player, the user can also – additively – influence the motion of the selected axes through the MMI or the interface to the master computer. This feature can be useful when several manipulators are used in parallel and exhibit different deformations due to loads and still must be geometrically synchronized.

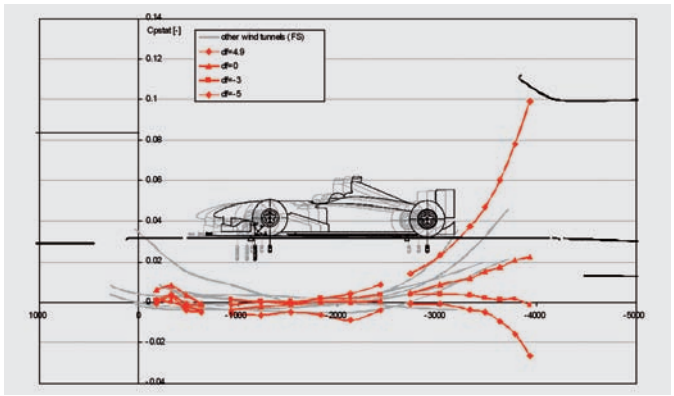
The software is based on National Instruments' LabView real-time programming tool and is designed to allow easy and straightforward inclusion of additional axes and model supports. It is in use for several months now and has received an exceedingly positive feedback, especially with respect to its influence on test efficiency.

Wind Tunnel Corrections

Force and pressure measurements in wind tunnels are affected by interference effects due to the finite size of the test section. This is true for both open and closed test sections. Although the magnitude and for some contributions even the sign of the correction differs, the basic principles remain the same: the tunnel boundaries – the walls for a closed tunnel, the jet boundaries for an open test section – distort the flow field compared to the free stream. This distortion is expressed as an interference velocity at the location of the model from which corrections to the measured coefficients can be determined.

Ongoing research at the Center Aerodynamics aims at improving the correction methodologies in use in its facilities. In the closed test section of the LWTE, a wall pressure signature method (initially proposed by Hackett) has been in use for many years. This method uses pressures measured on the tunnel walls to determine the interference effects. We are currently extending the method to better account for power effects caused by motorized wind tunnel models and to improve the correction accuracy also at higher angles of attack.

While the use of correction methods is standard in the aerospace community, automotive aerodynamic testing often neglects these effects. This could lead to unsatisfactory correlations between the wind tunnel data and the performance of the full-size car. The methods which are well established in the aerospace testing community, often yield disappointing results when applied to automotive applications. This is mostly due to the fact that automobiles are bluff bodies, exhibiting large wakes. The problem is further complicated by the fact that many automotive wind tunnels are of the open test section type. A test campaign in the AWTE (open test section) with a 50% interference contributions and assess the quality of various correction methodologies. It was shown that correction methods are suitable also for race cars and that significant inaccuracies in drag, downforce and pitch moments (balance) must be accepted if no correction is performed.



Recent Activities

AWTE Wind Tunnel Upgrades for Dynamic Testing

In June 2007, the AWTE will be closed to our customers for an upgrade. A stiffening of the model support structure together with a new balance, currently under development, will finally allow access to the full potential of the shaker. Frequencies in excess of 20Hz and ride height amplitudes of several millimetres will then be possible.

In the meantime another shaker wind tunnel test simulating the behaviour of a race car on the track has been performed using improved equipment like a stiffer model sting with integrated hydraulic lines. The acquired data from this test further supports the previously reported large effects generated by model motion. Parts of the test were carried out with the model modified to be more representative of a passenger car. The results indicate that also for this class of cars the model motion will affect the aerodynamics of the flow, although to a somewhat lesser extent. Further investigations must demonstrate whether these effects are relevant for the safe operation of passenger cars.

New Calibration System for MGCplus Data Acquisition

For more than two years now, the Center Aerodynamics has been relying on the accurate MGCplus technology of Hottinger Baldwin Messtechnik (HBM) for data acquisition in the wind tunnels. To comply with ISO-9001 standards periodic calibrations are required for the entire measurement chain. Because wind tunnel testing with many different customers with their specific needs calls for an extraordinary degree of flexibility and availability, it was decided to design and implement a calibration system capable to perform efficient on-site calibrations and ensuring its traceability to national standards (DKD, calibration laboratories in Germany). In addition to calibration, this system is also in use for periodic measurement quality assessments and for data screening purposes during wind tunnel tests when data integrity is in doubt.

The calibration process is controlled by HBM's "SwiftCal" software which allows easy access to the systems features. In accordance to RUAG standards the system was recently certified for calibration of HBM equipment and is also operated as a service for external customers.

Publications

- Aschwanden, P.; Müller J.; Müller R., "The Assessment of the Aerodynamic Load Distribution of a Race Car under the Influence of Model Motion by Use of Non-Static Wind Tunnel Tests"; 6th MIRA International Vehicle Aerodynamics Conference 2006, Warwick, October 25-26 2006.
- Müller, J.; Mercker, E. "Wind Tunnel Interference Corrections"; 6th MIRA International Vehicle Aerodynamics Conference 2006, Warwick, October 25-26 2006.
- Guillaume M., Vos J., Mandanis G., ¨Metal Fatigue on the F/A-18 Vertical Tail due to Buffeting (Unsteady CFD Calculations)¨, 24th ICAF Symposium, Napoli, May 16-18 2007.

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