RUAG

Aerospace Defence Technology

Center Aerodynamics – Newsletter 10 – Spring 2005

Winds of Change in the Center Aerodynamics

During the summer of 2004, Dr. Jürg Wildi, the former Head of the Center Aerodynamics, has been promoted to Head of the RUAG Aerospace Technologies Business Unit and has become a member of the Executive Board of RUAG Aerospace. I, Michel Guillaume, was offered the vacant position at the Center Aerodynamics. Since the RUAG F/A-18 full-scale fatigue test – of which I was the project manager – was slowly winding down, I accepted this new challenge with great pleasure. At the same time, Andreas Hauser, the Center's Engineering Team Leader, was appointed as my deputy.

As the new Head of the Center Aerodynamics, I am thrilled to present to you for the first time our Newsletter, which has already become a traditional way of informing you about our most recent developments. The main focus of this issue is on wind tunnel measurement instrumentation. Our line of well-known high-precision balances is described. They are used as model internal or external balances in our facilities as well as by a large number of customers all over the world. A second topic is the new data acquisition system which has recently been introduced in our wind tunnels. This modern system gives us even more flexibility in fulfilling the wide variety of customer specific testing requirements. The new system has already proved its worth in the complex tests of the motorized A400M model in the LWTE.

Customer satisfaction and excellence in all aspects of wind tunnel testing remain our foremost goals. This is achieved on the one hand by continuous improvement of our testing capabilities and on the other hand by carefully listening to our customers' needs. Customer contact is of utmost importance to me, therefore I will attempt to see you as often as possible, either in Emmen during one of your tests, or on our stand at the Aerospace Testing Expo from April 5th to 7th in Hamburg.

Michel Guillaume

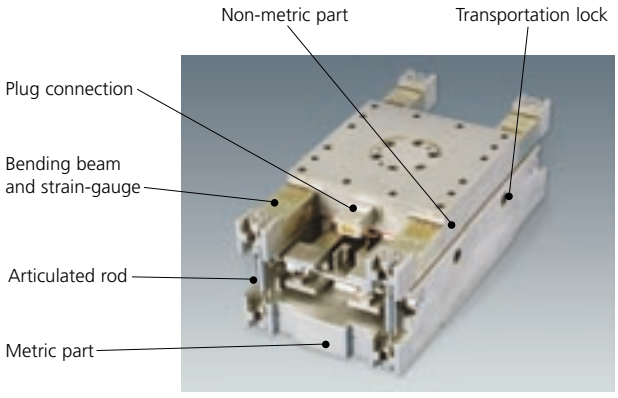
Swiss Precision for Wind Tunnel Measurements

In the field of wind tunnel measurements, the Center Aerodynamics offers a large assortment of equipment and accessories. Besides model supports and model manipulators for automotive and aircraft testing, our core business includes the design and manufacture of highly accurate strain-gauge balances. Our knowledge and expertise, drawn from many years of experience in our own wind tunnels, has undergone an astounding improvement, especially over the last few years. Our high standards are attested to by many customers from the aerospace and automotive industries. This expertise is also applied to systems we deliver to other wind tunnels and facilities all over the world.

Strain-Gauge Balances

Our standard balances rely on the well-known block concept, covering a wide range of applications with a variety of geometries and load requirements. They are characterized by their reliability, high linearity and accuracy, and extreme long-term stability. Due to their compact design, they are mostly mounted internally in the test model with the resulting shorter lever arms ensuring a more precise determination of the moments.

The strain-gauges are installed in a Wheatstone bridge circuit on the bending beams of the wind tunnel balance. Under the action of the aerodynamic loads, the beams deform in the elastic region causing the measuring bridges to emit a voltage signal proportional to the forces/moments applied. In order to convert the output voltage into a load, the balances have to be previously calibrated with precisely known loads. A numerical relationship between the calibration loads and the voltage readings from the balance bridges is obtained.



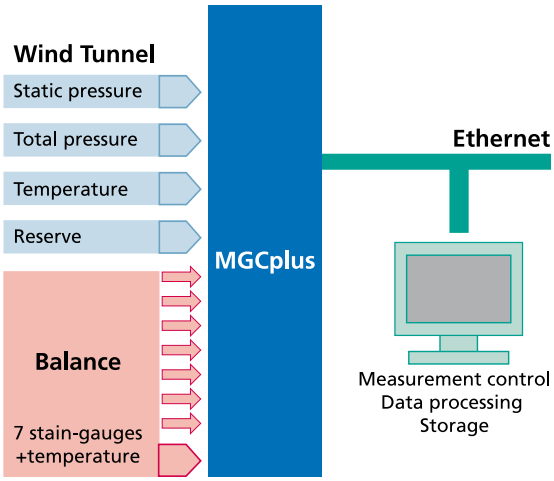
Strain-gauge balance

The calibration of the balances is extremely important as the measured loads can never be more accurate than the accuracy of the calibration. At RUAG Aerospace we have a purpose built calibration laboratory which is equipped with an optimized rig and highly accurate calibration instrumentation.

Besides our standard balances, our product range extends to wheel drag load cells, wing balances and sting balances. Depending on the type, up to 6 load components can be determined with these balances. Due to our experience with the mechanical and sensory design of balances, we regularly deliver custom designed balances for unusual customer requirements.

A new stand-alone Balance Measurement System

Recently, RUAG Aerospace has developed a new stand-alone balance measurement system that can be used on its own in any facility or environment (not necessarily related to aerodynamics). The system is characterized by optimized signal conditioning and data acquisition. The overall accuracy of the entire measurement chain, including balance, is in the order of 0.3% of the design limits of the balance.



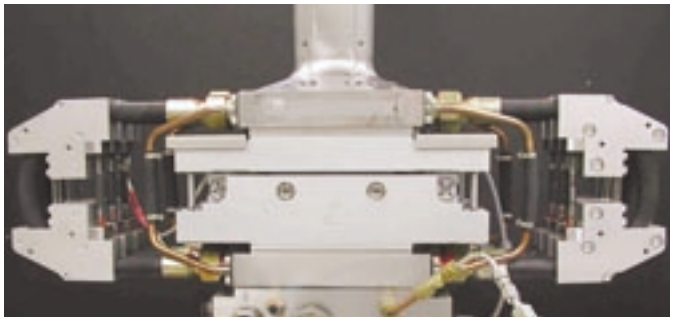
Balance measurement system

The data acquisition part of the system uses MGCplus technology from HBM combining high accuracy, resolution, and repeatability with modular design and simple and efficient operation. The user front end is based on the DIAdem software from National Instruments but could also easily be replaced by LabView software. Data access is provided over a standard Ethernet connection. The software additional features include monitoring of the strain-gauge signals to avoid overloads, statistical evaluation of the measured signals, and a very modular construction. Additional measurement sensors, for monitoring the operating conditions, can be connected and integrated into the measurement process. This system is optimized for static measurements but customers increasingly use our balance measurement system in dynamic environments for time-resolved measurements.

New Perspectives for the Future

During the last few months we have upgraded the data acquisition hard- and software in our LWTE wind tunnel using the same technology as described above. The replacement of the hardware and software in the other wind tunnels will follow soon. With this change, not only is the accuracy substantially improved but also the flexibility and efficiency. For example, time-resolved measurements, as well as static measurements, can easily be performed with the same system.

In our wind tunnels in Emmen we use our balances and measuring systems in a vast range of applications. In the last few years we have developed the technology to allow balance crossings with high-pressure hydraulic lines with only minor loss of precision. This technology is used currently for powered aircraft model tests taking place in our wind tunnels or in the shaker tests mentioned in the Recent Activities section.

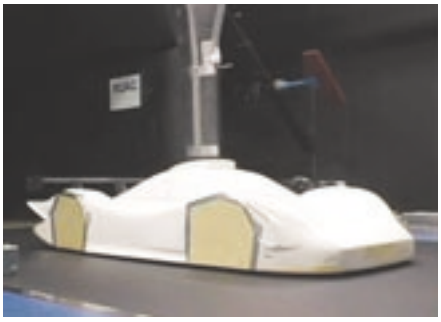


Balance crossing system

Our balance measurement systems are an illustration of the high quality standards you can find in all our wind tunnel equipment and accessories. We are confident that our products will comply with your most challenging requirements either in your or our facilities.

Recent Activities

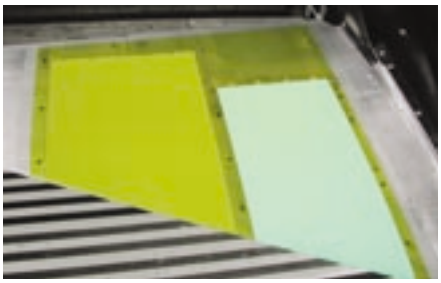
Model Shaker – Balance and Pressure Measurements with a moving Model



After a year of development at RUAG Aerospace, in cooperation with Porsche, a new model shaker was brought into play for the first time in our Automotive Wind Tunnel for a test with a former Le Mans type race car. For the moment, the shaker allows for fully independent control of pitch and heave at up to more than 20Hz. An internal balance and other standard model equipment were used to measure the aerodynamic effects on the moving model. To simplify things for the first test, the wheels were left aside. The results clearly point out that the term "aerodynamics" gets its name from the fact that realistic wind loads cannot be fully assessed in a purely static manner.

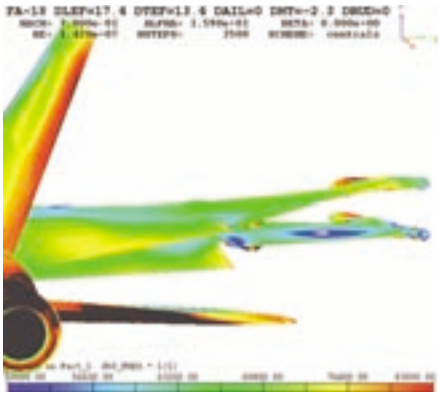
New Developments for the Pressure Sensitive Paint Technique

In comparison with pressure taps, where pressure is only measured at a discrete number of points, pressure sensitive paint (PSP) has the great advantage of providing a complete 3-dimentional pressure distribution on the model surface. Since the first tests in the LWTE in 1996, RUAG Aerospace has been continuously improving its PSP system. The principle of the technique is to excite the PSP layer with an external light source (blue LEDs); the intensity of the resulting luminescence emitted by the paint varies with the local pressure and can be measured by CCD cameras.



One of the recent activities involved the use of an electroluminescent foil as the illumination source, instead of the standard external blue LED illumination. This foil was applied directly on to the model, under the paint layer. The ultimate goal is to combine the illumination and the PSP in one foil, providing an improved system with specific characteristics that could eventually lead to the avoidance of the recurrent problems of the PSP technique (need of a reference image, temperature related effects, etc…). The picture shows a test on the wing of an F/A-18 model with two different foils (the right foil is switched on) and covered with a PSP layer.

F/A-18 Wing Static Deformation due to Aerodynamic Loads



At high angles of attack, aircraft wings deform due to high aerodynamic loads. This is often ignored in Computational Fluid Dynamics (CFD) calculations due to the complexity of transferring the aerodynamic loads into the structure and of translating the deformed structure into a new geometry for the CFD simulation.

However, for fatigue studies, it is important to account for this static deformation of the wing. For this reason, a procedure was developed which linked the in-house Navier Stokes code (NSMB) to the Nastran structural mechanics solver. In an iterative loop, the deformation of the F/A-18 wing due to aerodynamic loads was computed. The figure shows the pressure on the undeformed wing and on the converged position of the deformed wing (top). The results compare well with results from our experimental full-scale fatigue test. The difference in pressure contours on the undeformed and deformed wing show the importance of accounting for the deformation of the wing in the CFD simulations.

RUAG Aerospace
Center Aerodynamics
P.O. Box 301
CH-6032 Emmen
Switzerland

Tel. +41 412 683 801
Fax +41 412 683 897
aerodynamics@ruag.com
www.ruag.com

RUAG
Aerospace Defence Technology