Welcome to the Webinar "Structural Testing in Modern Aircraft Design"

The presentation will begin at 9 am Eastern time / 3 pm Central European time

All attendees' microphones are muted for the entire webinar session. Be sure your speaker is active and join the audio conference.

If you have a question, please send it to the host using the "Q&A" function. Questions will be answered at the end of the presentation.

Organizational Information

◢ All participants' **microphones** are **muted** during the webinar.

◢ Please do not forget to **activate** your PC **speakers** to enable **audio** or connect **headphones** to your PC. You may have to take the step of joining the audio conference to hear sound.

◢ Please type any questions you have into the WebEx Q&A dialog

◢ You can open the Q&A window by selecting the "Q&A" icon in the WebEx toolbar at the top of your screen:

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◢ If you have additional technical questions, feel free to contact our technical support team at support@usa.hbm.com

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Presenter

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- Graduate physicist
- Product manager for MGCplus, CANHEAD, catman Enterprise
- Application manager for Static and Fatigue Testing
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Agenda

1. **Trends**

2. The Seamless Tool Chain
   - Requirements and Benefits

3. Openness

4. Beyond Durability

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Trends in Durability Testing

Turn-key solutions

Collaborative work

Multi-User / Multi-Client
(IT infrastructure, databases, web-based cloud, security)

Reduction of prototypes

High Flexibility in Testing
(universal, distributable)

Bits and bytes

Full Digitalization
(DAS / IT : Ethernet based
Process: Digital Twin, AR/VR,
Multi Simulation Platforms, AI,
Security)

DAS: Data Acquisition System

Maximizing testing time

DAS Service
(on-site calibration, long-term agreement)

Fewer testing engineers

Result Orientation
(online analysis/prediction,
no programming, automation)

Light weight

More variants

Electrification

Autonomous

More in-depth insights

High channel counts
High dynamics

New approaches

Optical Solutions
(fiber measurement,
stereoscopic / cameras)

System integrators

Retrofitting
existing test benches
(new instruments, software)

Image source: IABG

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   - **Requirements and Benefits**

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CAE-based Fatigue Analysis

◢ Before testing even starts, simulation and identification of the critical spots will save a lot of time and effort.

◢ Dedicated tools will help optimize the design and the test:
- Accurate and efficient prediction of fatigue from FEA
- Accelerate your tests without changing the failure mechanisms
- Avoiding of costly redesign and tooling changes
- Decrease of warranty claims by reducing failures
- Reduction of cost and weight

◢ A highly scalable tool makes daily work easier:
- Fast results with parallel processing
- Correlation of CAE data with physical test data using "virtual" strain gages
- Encapsulated processes for the general user
- Highly configurable for the expert user
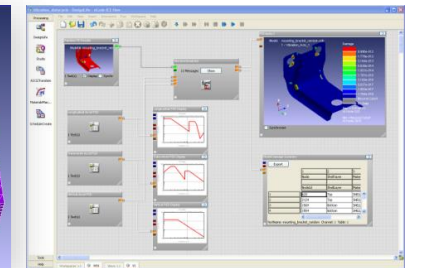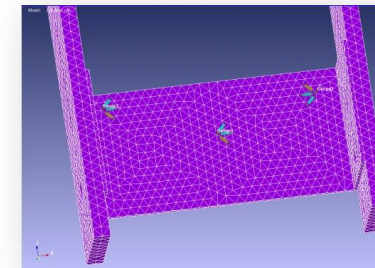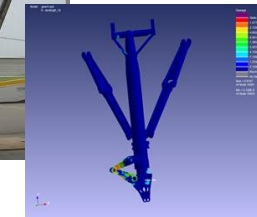
FEA: Finite element analysis
HPC: High-throughput computing

Sensors and Transducers

- ◢ Most important sensor by far is the strain gauge.
- ◢ Key features and needs include:
  - Well-proven technology
  - Cost-effectiveness
  - Short-term availability
  - Easy installation
  - Flexibility
  - Customized solutions

- ◢ However, in many tests also other quantities besides strain/stress need to be measured:
 - Force
  - Displacement
  - Pressure
  - Etc.
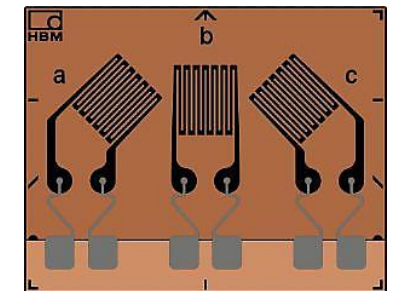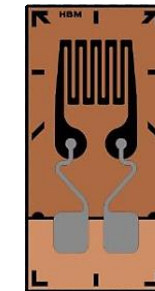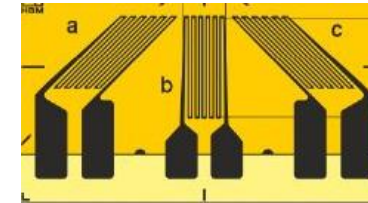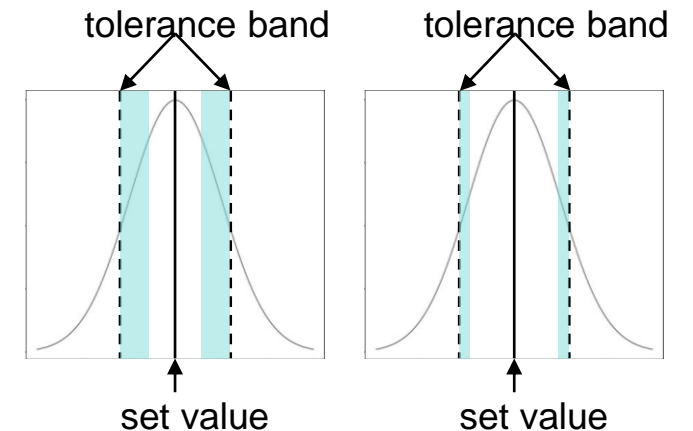
DAQ Hardware

- The choice of hardware heavily depends on the fact that most acquired signals come from strain gauges.

- This brings along several aspects to consider:
  - Available wiring configurations
  - Temperature dependence
  - Completion resistor values
  - Excitation coupling
  - Excitation voltage levels
  - Wiring check

- Of course, besides the ability to measure strain gauges other more generic features are important as well:
  - Scalability of the system
  - Link to the control system
  - Centralized or distributable architecture
  - Synchronization concept
 - Field-proven
  - Long-term stability and support

R_{shunt}

R_{comp}

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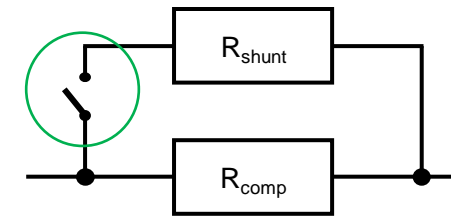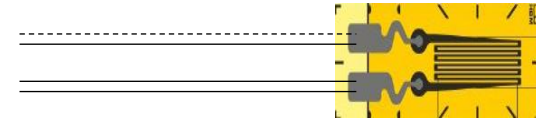
DAQ Software

◢ The DAQ software is what the engineers are working with daily.

◢ Some points are taken as granted, but should be checked for:
- Long-term stability
- No data loss under any circumstances
- Possibility to scale up the channel number
- Extensive logging functionality
- Intuitive usability
- Openness

◢ Clever solutions accelerate the engineers' workflow:
- Intuitive channel structure (logical channel grouping, filter, search, health check)
- Multi-user architecture
- Communication with control system
- Special trigger mechanisms
- Application-specific visualizations
- Enhanced customized functionality

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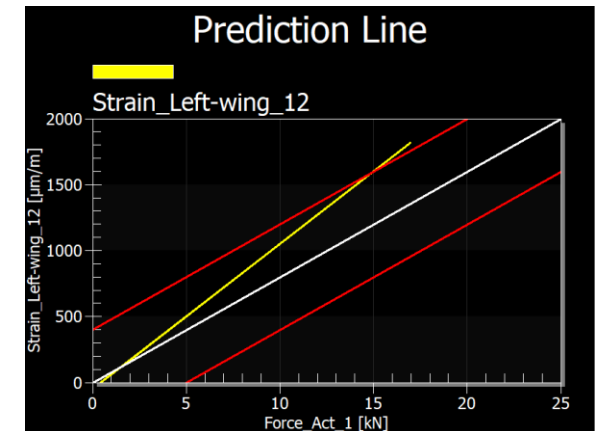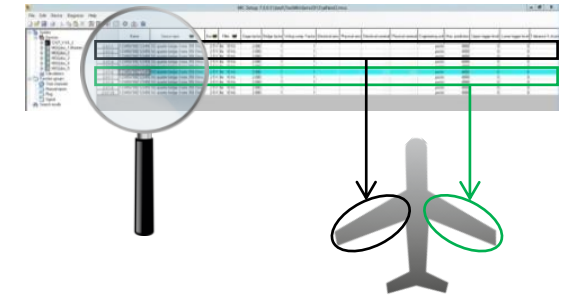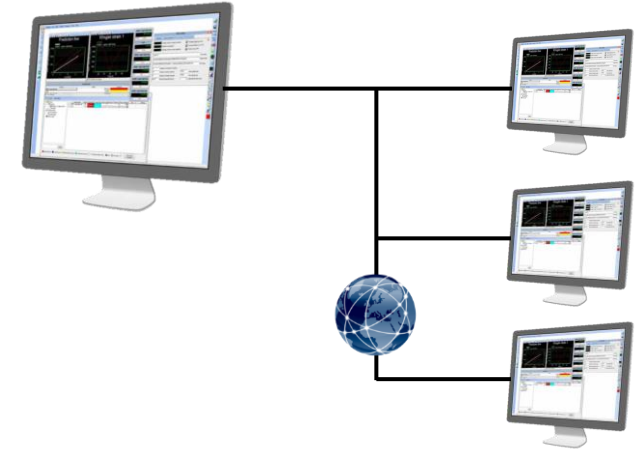
Test Data Evaluation

◢ During and after the test, huge amounts of data need to be evaluated.

◢ Precise results help to get the very most out of the test and the design:

- Clean up raw measured data (digital filters, spike removal, drift removal, etc.)
- Data Reduction of huge amounts of data into metrics, histograms, spectra
- Fatigue Damage and life estimation
  - from the measured strain data
  - comparison with the "virtual" strain and fatigue life estimated from FEA
- Comprehensive analysis for experts but simple to use for occasional users

◢ Store, Secure and Share processes and data online:

- Search for measurement data using metadata
- Use standardized processes via "Apps"
- Improved quality
- Higher productivity

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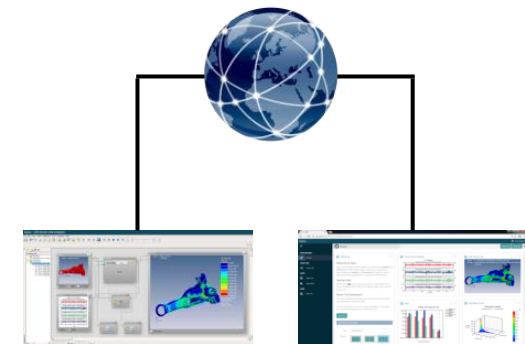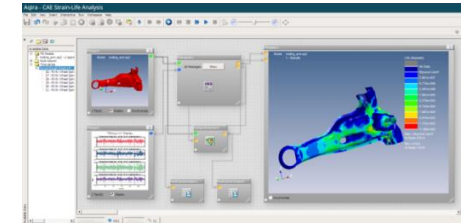
The Seamless Toolchain

Simulation

A one-stop-approach throughout the whole chain offers various benefits:

- ◢ Perfect compatibility
- ◢ Single point of contact
- ◢ High integral level of application expertise
- ◢ Turn-key solutions

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Openness Towards Control Systems

The variety of tasks in Aerospace Testing is evermore increasing. Therefore, concentration on the core competences is mandatory. However, it is important to be open for other tasks and technologies.

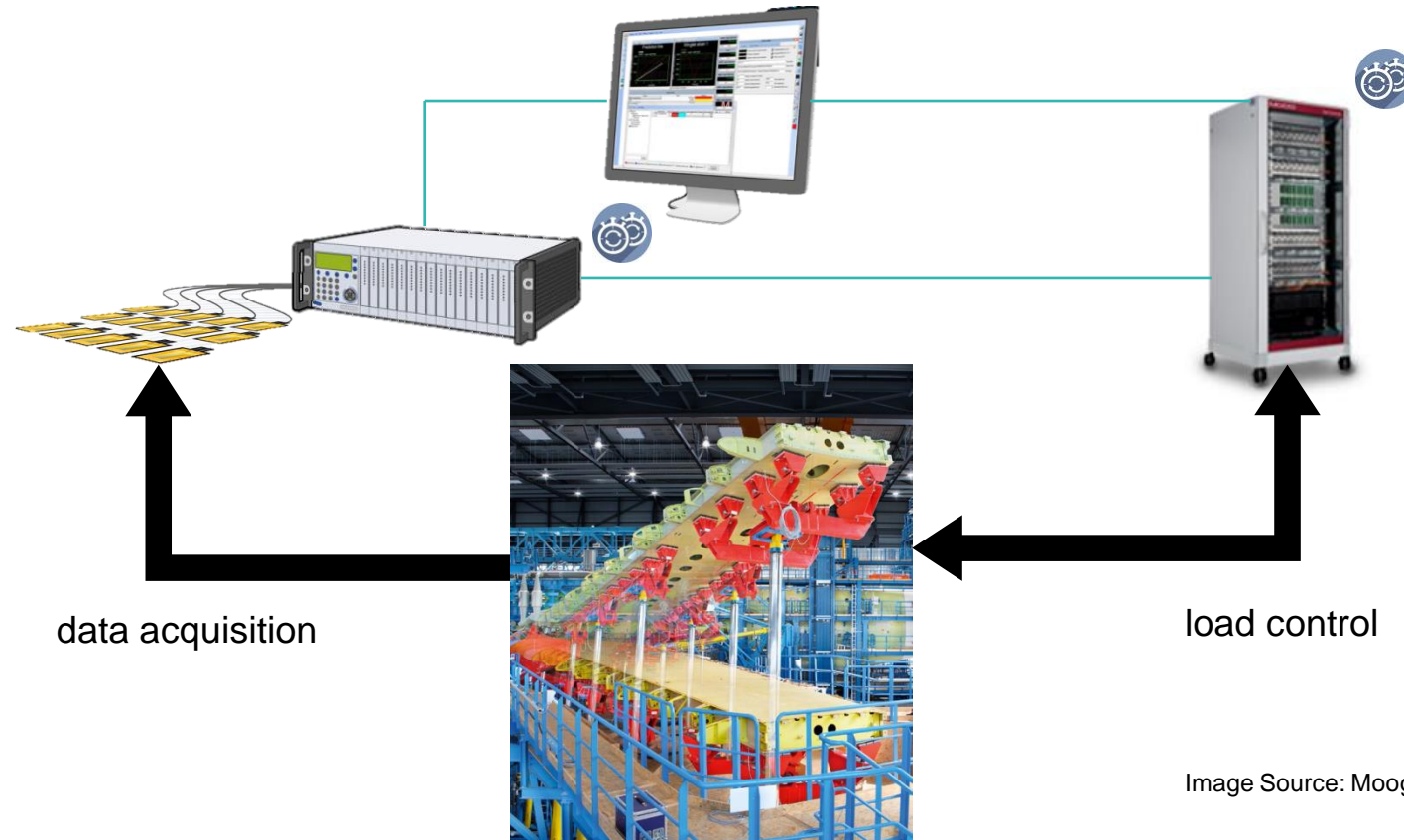Example 1: data acquisition and control as separate disciplines

data acquisition

load control

Image Source: Moog

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Openness Towards Digital Image Correlation

In the last years camera-based measurement technologies have opened new possibilities. However, they are not a replacement, but more a complement to tactile sensors.

Example 2: data acquisition of tactile sensors and digital image correlation in parallel
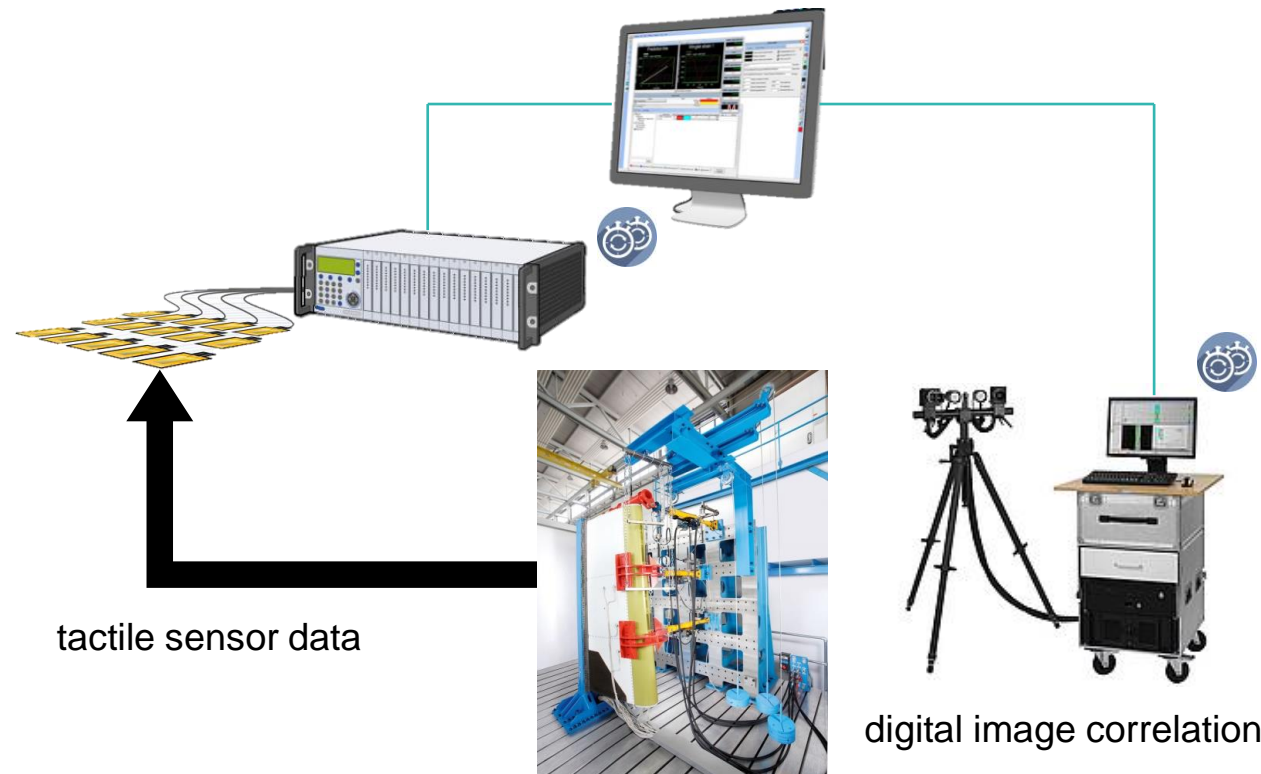

tactile sensor data

digital image correlation

Image Source: gom

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Openness Towards Avionics Buses

Besides acquisition of traditional physical sensors like strain gauges, force transducers, thermocouples, etc., avionics buses like ARINC 429 or MIL-STD-1553 become more and more important in diverse testing disciplines.

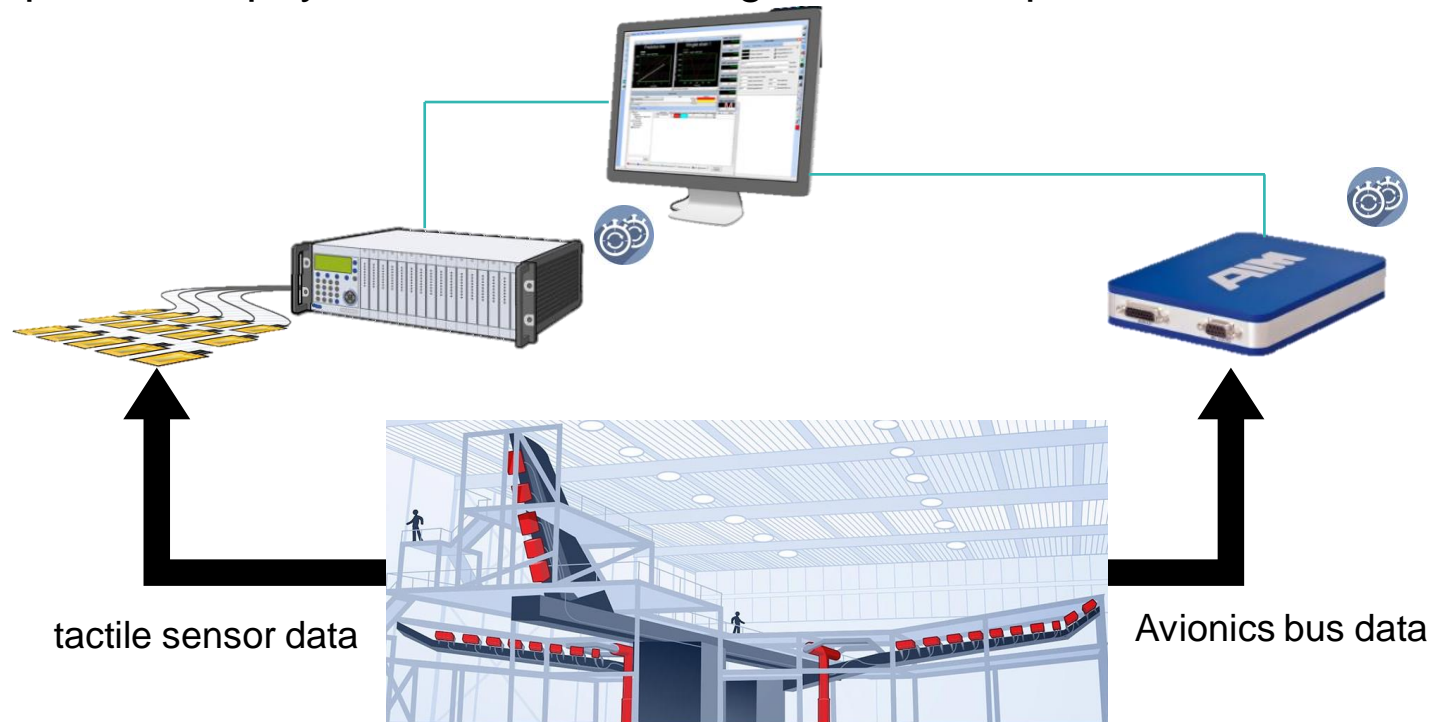Example 3: data acquisition of physical sensors and digital buses in parallel

tactile sensor data

Avionics bus data

Image Source: AIM GmbH

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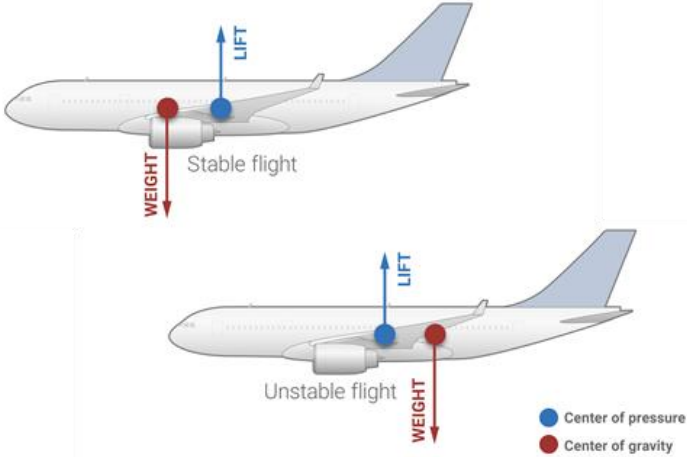HOTTINGER BRÜEL & KJÆR

Other Testing Applications…

Wind tunnel testing

Center of gravity testing

System testing

Drop testing

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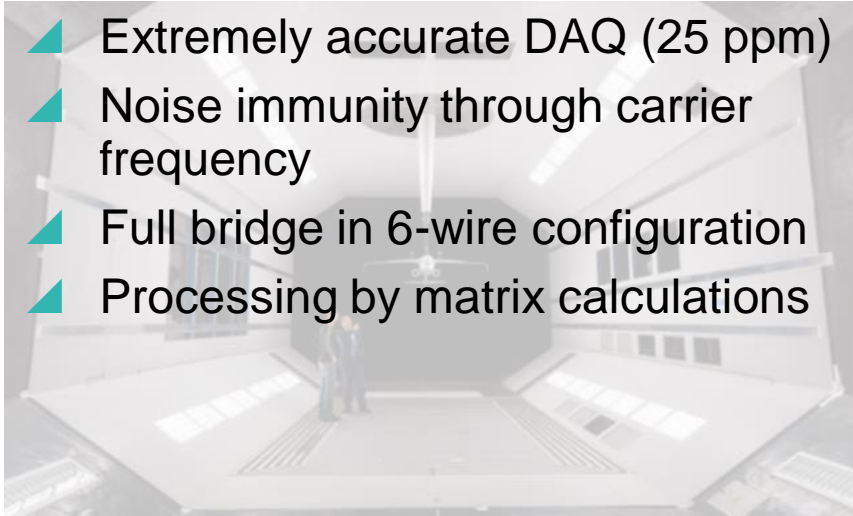
…Served with the Same Platform

Wind tunnel testing

- Extremely accurate DAQ (25 ppm)
- Noise immunity through carrier frequency
- Full bridge in 6-wire configuration
- Processing by matrix calculations

Center of gravity testing

- Highly accurate force or load cells (200 ppm)
- Highly accurate DAQ (100 ppm)
- Noise immunity through carrier frequency
- Full bridge in 6-wire configuration
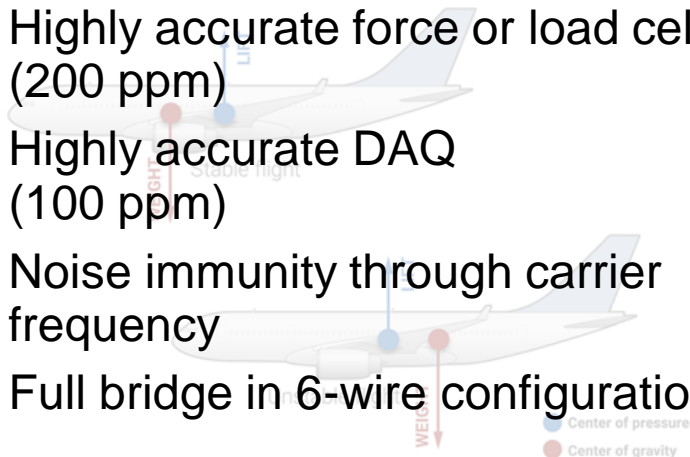
System testing

- Sensor flexibility: pressure, force, displacement, torque
- Distributability of the DAQ system
- Avionics bus integration (ARINC 429, MIL-STD-1553)
- Proven reliability
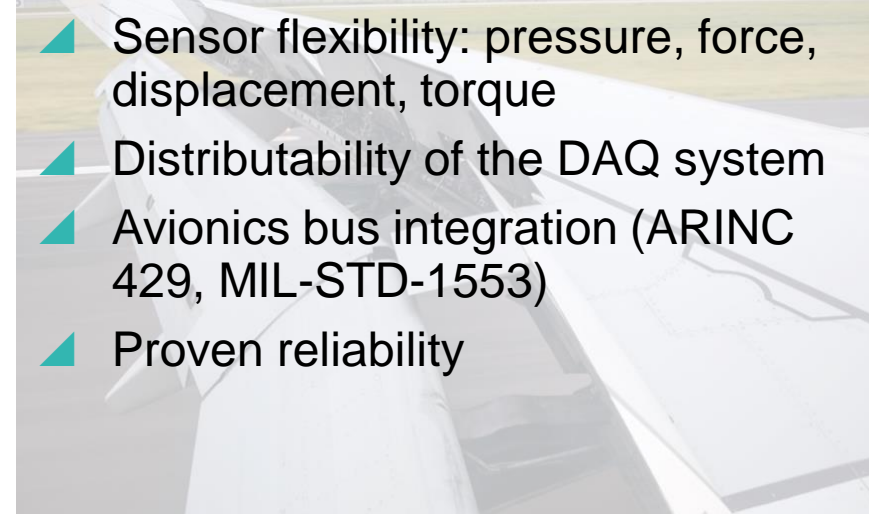
Drop testing

- Sensor flexibility: pressure, force, displacement, acceleration
- Exact synchronization to external devices (IRIG-B, PTPv2)
- High signal bandwidth

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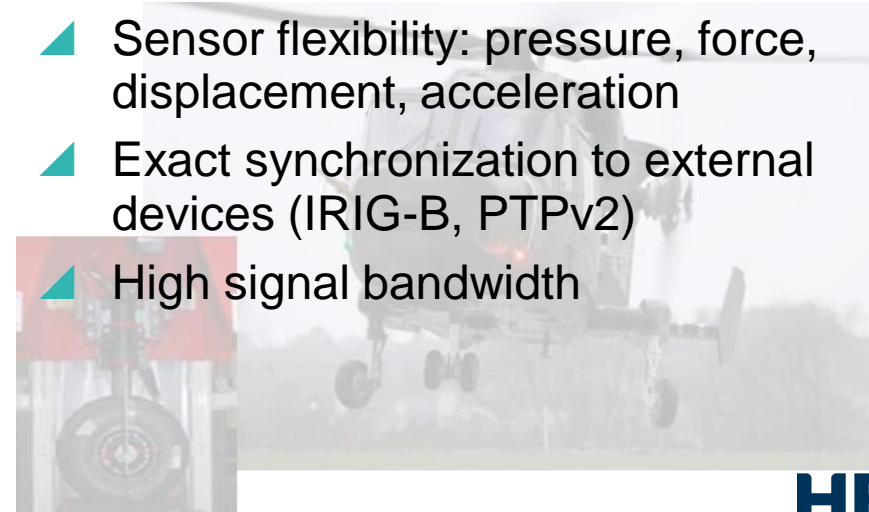
Use Case: Ground Test Instrumentation Division – Sikorsky

Dedicated **Ground Test Instrumentation Division**

Tests covered
- Static and fatigue testing of components, full airframes
- Powertrain dynamic tests
- Material coupon testing
- Other miscellaneous investigative and certification activities

DAQ Station

Entirely based on QuantumX hardware:

- Data recorder and data acquisition PC with catman AP
- Measurement modules can be easily and rapidly installed and removed allowing maximum flexibility.

Additional equipment:

- UPS
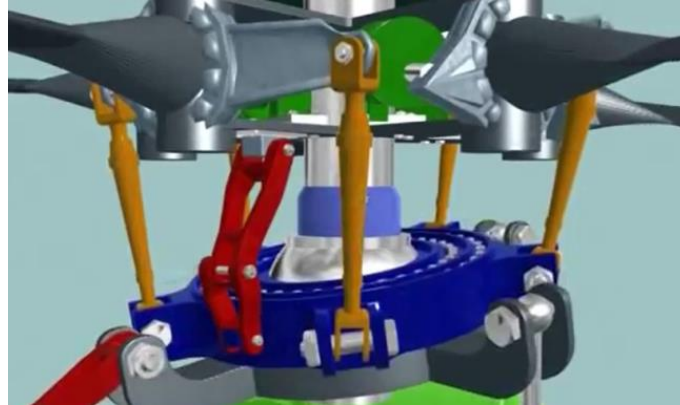- Ethernet switch / USB hub
- HD monitor, keyboard, mouse

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Test Examples – Sikorsky

**CH-53K King Stallion
GTV (Ground Test Vehicle)**

**Helicopter main rotor hub
Fatigue Test**

**CH-53K King Stallion
Fuselage Full Scale Test**

Specific requirements

- Avionics bus recording (ARINC 429, MIL-STD-1553)

- Communication modules, custom calculations
- Integration with test control system

- High input flexibility
- High channel count
- System calibration solution from HBK

Testing purpose

- Testing the Fly-by-Wire Flight Control System (FCS)
- Testing of various components and subsystems of the FCS

- Qualification and certification of components and materials
- Record and analyze data for fatigue calculations

- Helicopter structure certification
- Correlation of FEM models with data from hundreds of SG

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Thank You

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