Welcome to the webinar: “Maximizing Test Time Efficiency in Aircraft Testing”

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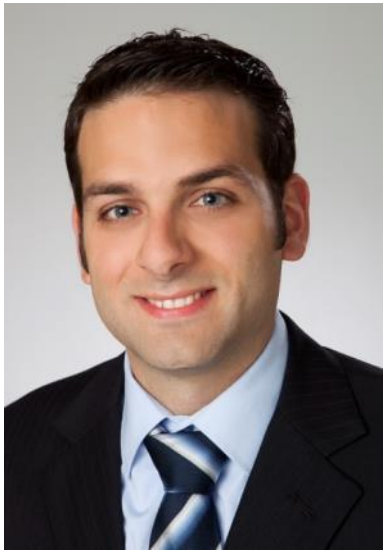

Sandro Di Natale

Agenda

1. **Introduction and Overview**
2. Use Case – Durability Testing
3. Other Test Applications
4. Openness is Key
5. The Sikorsky Story

What Is the Main Driver?

… but results must still be as excellent!

Trends in Aerospace Testing

Turn key solutions

Maximizing testing time

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

Light weight
More variants
Electrification
Autonomous

Collaborative work

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

Reduction of prototypes

High Flexibility in Testing
(universal, distributable)

Bits and bytes

Full Digitalization
Test Specimen: ARINC, MIL-STD
DAS / IT: Ethernet based

Full-scale structural, Iron Bird, Copper Bird, Bird Strike Component, Propulsion, etc.

Fewer Testing Engineers

Result Orientation
(online analysis/results, no programming)

More in-depth insights

High channel counts
High dynamics

New approaches

Optical Solutions
(stereoscopic / fiber measurement, cameras)

System integrators

Retrofitting existing test benches
(new instruments, software)

DAS: Data Acquisition System

Image Source: IABG

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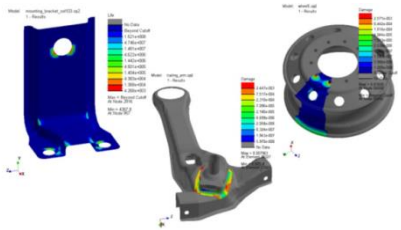
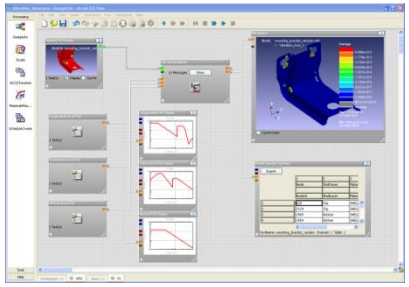
CAE-based Fatigue Analysis

- Before testing even starts, simulation and identification of the critical spots will save a lot of time and effort.
- Good tools will help reducing the test effort without compromise:
  - Accurate and efficient prediction of fatigue from FEA
  - Avoiding of costly design and tooling changes
  - Fast results with parallel processing
  - Decrease of warranty claims by reducing failures
  - Reduction of cost and weight



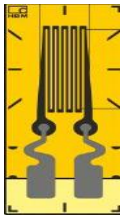
- A highly scalable tool makes daily work easier:
  - Correlation of CAE data with physical test data
  - Encapsulated processes for the general user
  - Highly configurable for the expert user

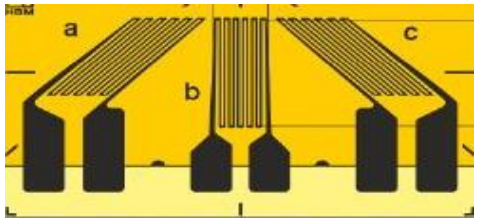


FEA: Finite element analysis
CAE: Computer aided engineering

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

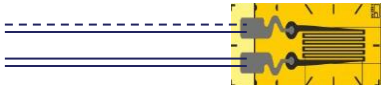


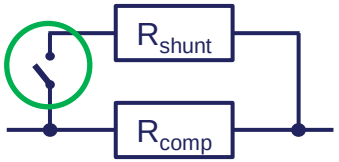


- However, in many tests also other quantities besides strain/stress need to be measured:
  - Force
  - Displacement
  - Pressure
  - Etc.

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 take into account:
  - Completion resistor quality / temperature dependence
  - Completion resistor values
  - Available wiring configurations
  - Excitation coupling
  - Excitation voltage levels
  - Wiring check



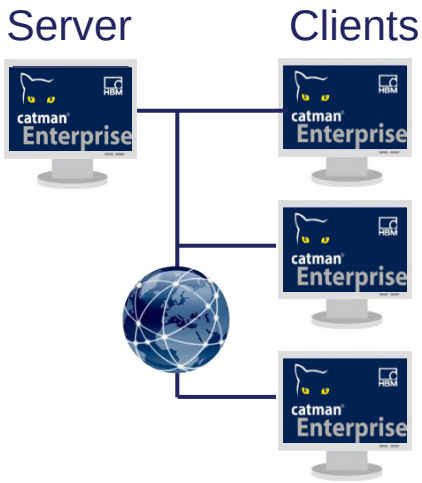


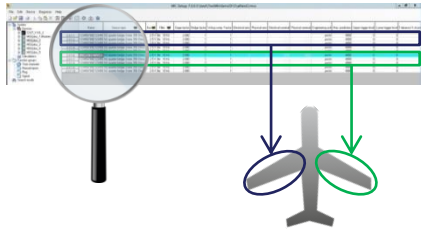
- Of course, besides the ability to measure strain gauges other more generic features are important as well:
  - Scalability of the system
  - Link to the control system
  - Centralized or distributable architecture
  - Synchronization concept
  - Field-proven
  - Long-term stability and support

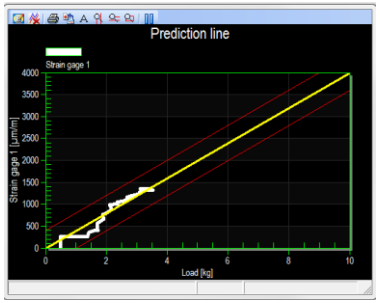
DAQ Software

- The DAQ software is what the engineers are working with on a daily basis.
- 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

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

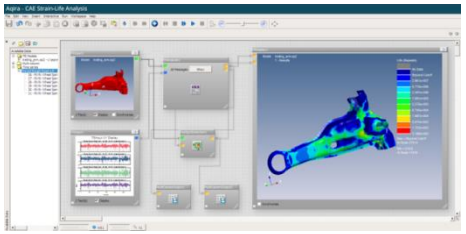




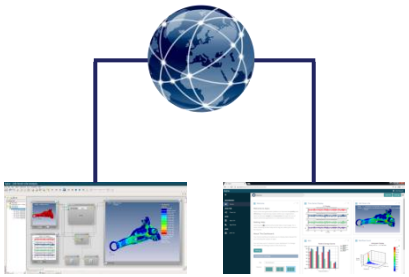


Test Data Evaluation

- During and after the test huge amounts of data need to be evaluated.
- Precise results help getting the very most out of the design:
  - Damage calculation and test profile generation
  - Pre-defined processes
  - Cleaning raw measured data
  - Processing huge amounts of data
  - Comprehensive analysis for experts but simple to use for occasional users



- Sharing processes and data with others online:
  - Improved quality of analysis and standardized processes
  - Effectively managed engineering processes and teams
  - Higher productivity



The Seamless Toolchain from HBM

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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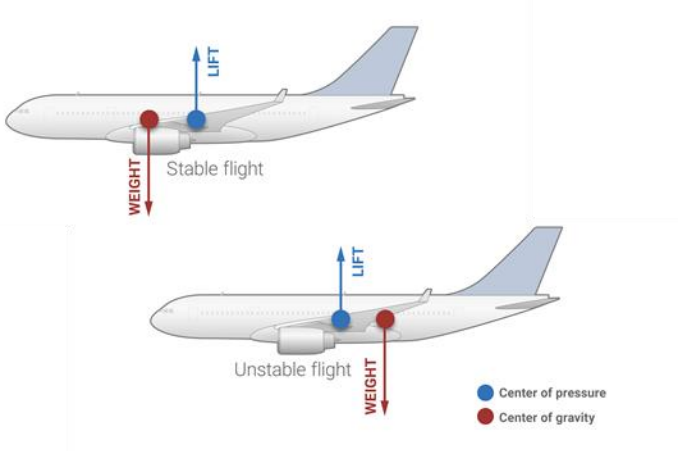
Other Aerospace Testing Applications…

Wind tunnel testing

System testing

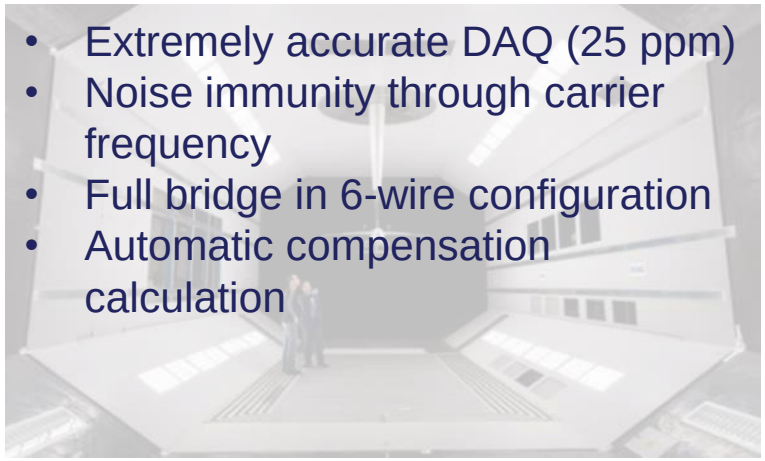
Center of gravity testing



Drop testing

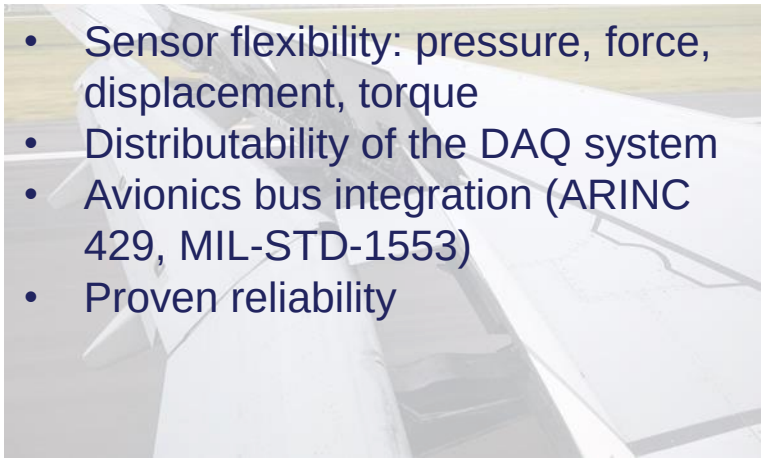
… Served with the Same Platform

Wind tunnel testing



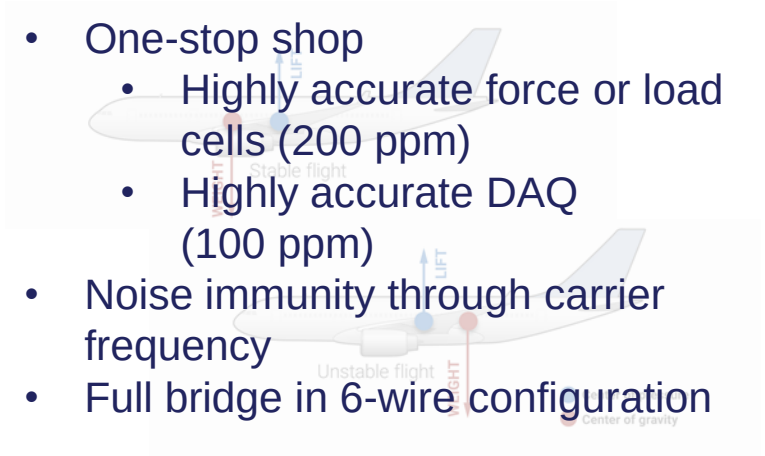
- Extremely accurate DAQ (25 ppm)
- Noise immunity through carrier frequency
- Full bridge in 6-wire configuration
- Automatic compensation calculation

System testing



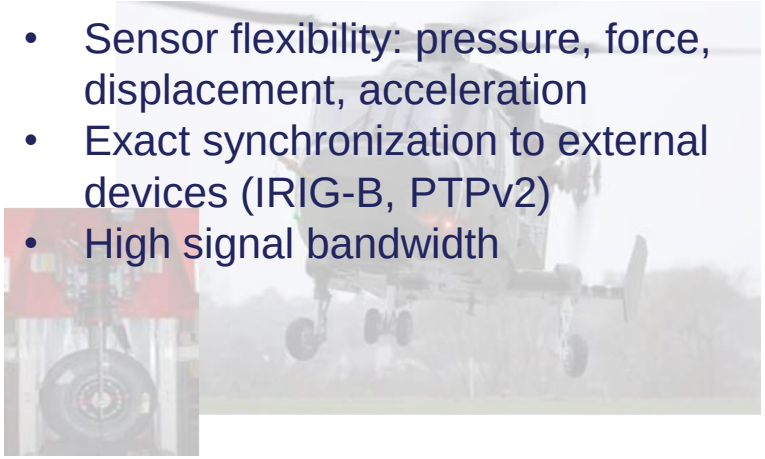
- Sensor flexibility: pressure, force, displacement, torque
- Distributability of the DAQ system
- Avionics bus integration (ARINC 429, MIL-STD-1553)
- Proven reliability

Center of gravity testing



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

Drop testing



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

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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

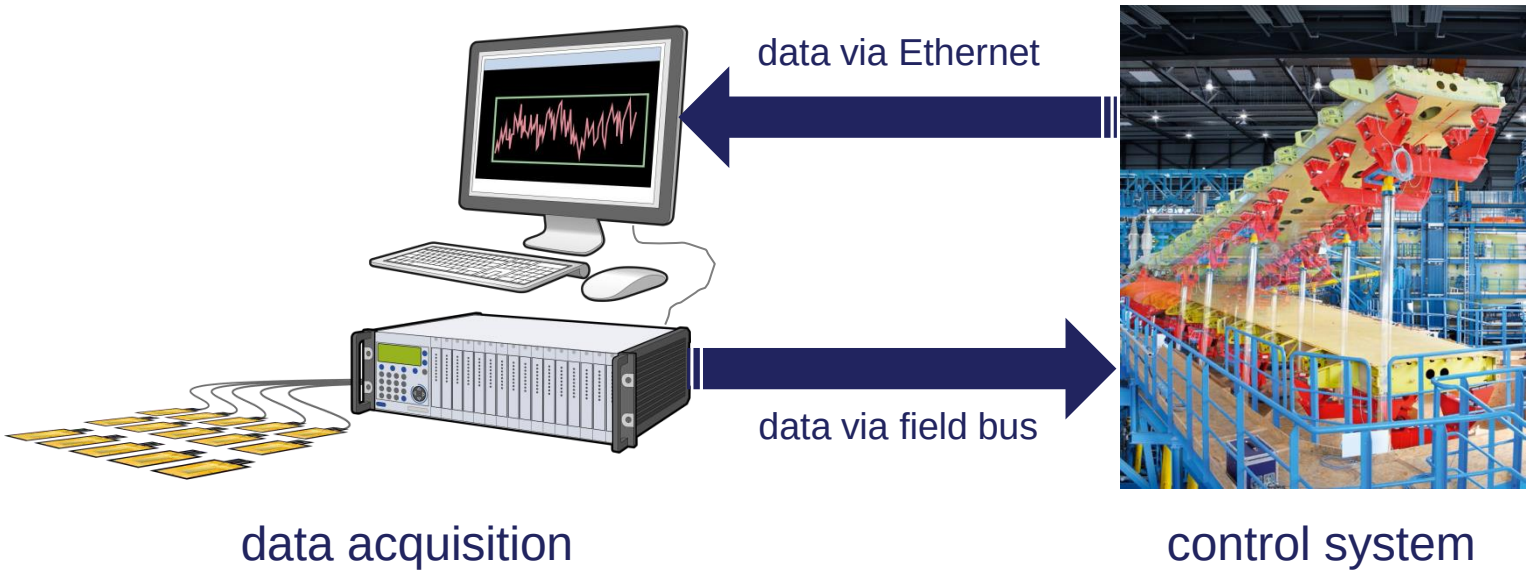
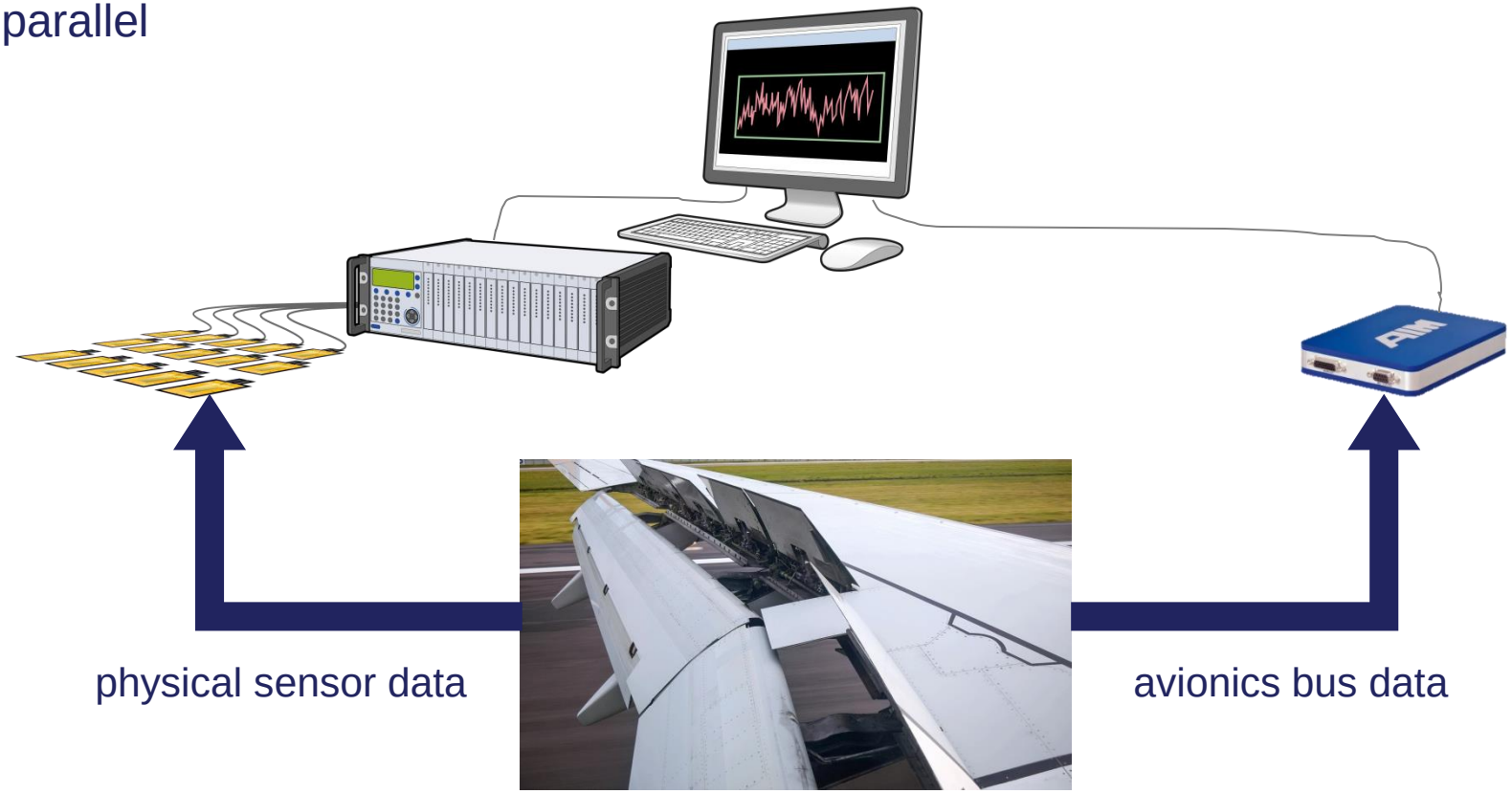


Image Source: IABG

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.

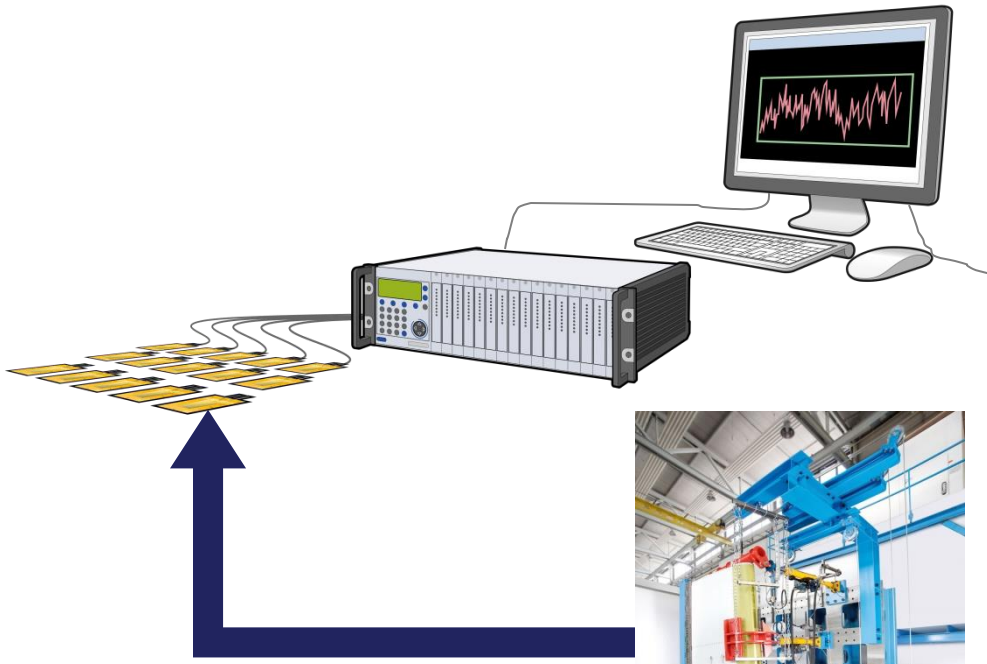
Example 2: data acquisition of physical sensors and digital buses in parallel



Openness Towards Stereoscopic Camera Systems

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

Example 3: data acquisition of tactile sensors and digital image correlation in parallel



tactile sensor data

digital image correlation

Image Source: gom

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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:

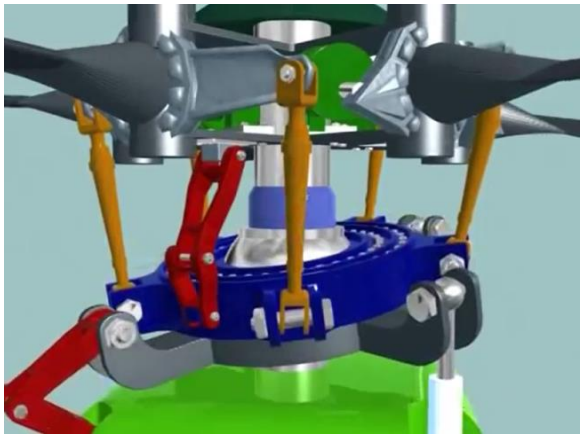
- Data recorder and data acquisition PC with catman®AP
- Measurement modules can be easily and rapidly installed and removed allowing maximum flexibility

Additional equipment:

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

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 HBM

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 SG data
- Acquire and analyze data from hundreds of SG

Additional Information

More information can be found on our website:

- **www.hbm.com/en/5916/aerospace-industry/**

Solutions for Aerospace testing

HBM offers leading measurement technology for structural and functional tests in aerospace as well as aircraft electric system testing.

Any questions?

- If you have any questions, please do not hesitate to contact us: webinar@hbm.com
- Or email the presenter directly: sandro.dinatale@hbm.com

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