Welcome to the “The Challenges of Structural Health Monitoring (SHM)” Webinar

The presentation will begin at 04:00 PM Central European Time | 09:00 AM Central Time | 10:00 AM Eastern Time

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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.
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- 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:

![Q&A icon]

- Today’s presentation will be E-mailed to all attendees. The webinar will also be posted on our website: [http://www.hbm.com/en/3157/webinars/](http://www.hbm.com/en/3157/webinars/)
- If you have additional technical questions, feel free to contact our technical support team at support@usa.hbm.com
Dietmar Maicz

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- Master level degree in Engineering and Economics
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Typical reasons for Structural Health Monitoring (SHM)

Improving standard maintenance and inspection by condition-based maintenance
- Detecting damage in early stage, enabling proactive response
- Optimizing maintenance process
- Extension of major overhaul cycle
  ➢ **Lower costs, higher availability**

Fatigue monitoring, lifetime prediction
- Boost lifetime and safety
- Optimize design and support cost effective solutions
- Continuous observation and data (for new projects)
  ➢ **Better insights, better product development**

Identification of critical situation
- Immediate reaction
  ➢ **Safe lives, avoid breakdown**
Gaining Real Insight into a Structure's Health

![Diagram showing timeline and cost implications of preventive versus reactive measures in structure health management.]

- **Preventive** measures involve early detection of issues, minimizing damage and costs.
- **Emergency systems** and other measures are necessary but less ideal.

**Action in case of damage**:
- Emergency system
- Accompanying measures

**Cost implications**:
- **No monitoring, late detection of damage**: Leads to big damages and long downtimes.
- **Quick detection of damage**: Optimum preventive effect.

[Diagram credit: HBK Hottinger Bühlert & Kuehne]
Challenges

Prerequisites for trustworthy forecasts/decisions
- reliable data
- high signal quality
- long term stability and durability
- data integrity (time synchronized data)
- extraction of the essential information needed for
  - immediate reactions
  - maintenance decisions
  - the prediction of lifetimes

Typical constrains
- Size of the structure, long distances
- Harsh environmental conditions
- remote location, slow data connectivity
- data transfer
- data management and storage (data lake)
Overall solution concept
Ideal solution?

- There is no ideal/standard solution
- Every SHM needs a **case by case analysis**
  ➔ reason for HBK modular approach
Standard approach – useful for most projects

- Logging
- Intelligent triggering
- Preprocessing / Edge computing

Alert via E-Mail

processing

- ftp/sftp
- cloud connect

Reports

HBM push notification

Credits: graphic generic mobile by Matt Jones
Wide sensor range, distributed over distances

- Wide range of physical and digital inputs
- Hybrid fiber optic sensor system
- Ultra-robust (vibration, shock) according to MIL-STD202G
- Extended temperature range: -40...+80 °C, dew-point resistant
- Dust- and water-proof with ingress protection grade IP65 and IP67
- Fire protection rating according to DIN EN 45545-1:2013
- Reliable design offering 10,000 plug cycles
- Distributed system, Time-synchronized data
HBK solution set

- Components (sensors, DAQ – QuantumX, PMX, FS22 software – Catman, nCode, Reliasoft)
- Cabinet equipped with components incl. startup and software (modular set)
- Custom solution incl. cloud, on-site sensor installation and service
Out-of the box: Data logger functionality for Monitoring

- Take long-term measurements over several days, weeks and months
- Easy setup of hybrid systems (electrical and fibre optic sensors mixed)
- Carry out parallel data acquisition jobs using a single data recorder (individual files, triggers)
- Data classification - Rainflow, FromTo, etc - direct in Logger
- Save data locally or automatically transfer data to FTP servers or the cloud
- Implement automated actions and alerts such as smart phone push messages or/and E-Mails triggered by defined events
- Integration of weatherstation signals
- Live data visualization in the Web using Microsoft Power BI
- Event and status logging
Parallel Recording - Define several recorders within one DAQ job

- Recorders are running **in parallel** (max 15)
  - Each recorder can have a individual **subset of channels** with **own sample rate**
  - **Separate** start/stop condition
  - Individual files per recorder
  - By default recorders are repeated endless
Statistic journal for parallel long term measurement

- Statistic journal can be used to do long term DAQ *in parallel to* triggered measurement
  - Use Case: “load events” (crossing train, heavy vehicle, storm) all inputs are acquired with high sample rates (triggered) in parallel to constant time recordings (7 hours / 365 days) for slow moving structure
- Saves Min, Max, Mean in separate bin file
- Works independent from DAQ trigger (optional)
- Wide range of update interval (sample rate): 5s .. 24h
- Configure time interval for file creation
- Available in DAQ job settings

<table>
<thead>
<tr>
<th>Create statistic journal</th>
<th>More Information about statistic journal</th>
<th>Also active during waiting for trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hour</td>
<td>Update interval</td>
<td></td>
</tr>
<tr>
<td>Weekly 24:00</td>
<td>Backup</td>
<td></td>
</tr>
</tbody>
</table>
Enhanced workflow for fibre optical interrogator

- Assign strain and temperature sensors just by Drag&Drop
  ➔ Physical value will directly be displayed on regular channel; No need of extra computation channel
- Fine tune sensor settings via usual Sensor Adaptation dialog (e.g. the reference center wavelength for a FS63)
- FS sensors like FS62 (strain), FS63 (temperature) and FS65 (acceleration) are included in the HBM sensor database
Integration weather stations

- Acquire wind speed, barometric pressure, air temperature, humidity, rainfall and hail
- Tested with model Vaisala WXT520
System diagnostic
Advanced logging capabilities

- Text format for better readability with 3rd party tools
- If log file exceeds 1MB a new file is created
- **All type of events** are logged
  - DAQ job events (trigger, start/stop DAQ)
  - User events if enabled in options (level crossing)
  - System events
  - Accessible over catman GUI (location in user directory)
Integrated FTP/SFTP client for data transfer to a server

- Client configuration: rules for automatic data transfer; server address; user; password, etc.
Push notifications to smart devices as reaction on a detected event/alarm

- Alarms, e.g. overload
- Warnings, e.g. battery low
- Diagnostics, e.g. system alive

Google Play Store  AppleStore
Data streaming to Microsoft Power BI for visualization of data in the web

Live data streaming with a lower sample rate (2 S/s maximum) of selected channels to Power BI dashboards (or generic Endpoint)

• Create Power BI dashboard (visualization) and data endpoints
• Save dashboard and endpoint configuration in text file
• Read text file in catman DAQ project and match catman signals to Power BI variables
• Share dashboard with dedicated users
Emails on status change
System status (custom solution)
Overview measured values
Application example: Railway bridge Austria

- Digital Twin
- Monitoring of temperature influence on the steel construction
- Prove of calculations and assumptions
- 20x Temperature, 6 displacement, 1 pyranometer
Application example: Railway bridge Austria

[Image of Railway Bridge Monitoring diagram with temperature data and graphs showing temperature variations across different sections of the bridge.]
Application example: Zezelj Bridge in Serbia

- Bridge over the Danube River for railway, road traffic and pedestrians
- 2 railway tracks, 2 road traffic lanes, 2 bicycle and pedestrian lanes
- 472 sensors: 328 strain, 80 force, 12 displacement, 32 inclination, temperature
- 24 PMX synchronized over NTP
- Data storage concept: Transfer to data center (FTP) + local storage (USB + internal flash)
HBM support and scope of supply

**Core Functions**

- **Server Software**
  - Data visualization and search
  - Automated analysis
  - Web interface Linux & Windows
  - Server / Cloud
  - Notification / Reports

- **Edge Software**
  - Scalable inputs
  - Distributable / short sensor lines
  - Electrical / optical technology
  - Wide range of physical and digital inputs
  - Time-synchronized data
  - Live visualization
  - Data preprocessing

- **Electronics / DAQ**
  - Strain, displacement, acceleration
  - tilt, own and 3rd party sensors +
  - camera, GNSS

- **Sensors**
  - Bridge, tunnel, railway, wind
  - energy incl. offshore, oil&gas,
  - cranes, building

- **Monitoring Object**
  - Setup and cabinet mounting
  - Turn-key finishing
  - Training setup and Edge recording
  - Network integration

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**HBK Products Offering**

- Setup and scale on-premise or cloud
- IT expertise
- Training analysis

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**HBK Services**

- Expertise selecting the right sensor
- Field service support (on / offshore)
- Training sensor application

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**Domain expertise**: Civil engineering, railway, wind energy experts incl. offshore, oil&gas
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Thank You