Condition Monitoring in the 21\textsuperscript{st} century

Precision meets connectivity
Content

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- Why Condition Monitoring
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- 21\textsuperscript{st} century technology in CM applications
- Real world examples:
  - Condition Monitoring Partner Concept
  - Cloud Solutions
  - Remote monitoring
- 20\textsuperscript{th} + 21\textsuperscript{st} technology = Road to success
Facts and Figures

1972 Founded by Dieter Busch
600 Employees Worldwide

18 Sales & Service Subsidiaries
Belgium/Netherlands, Brazil, Canada, China, France, India, Indonesia, Italy, Japan, Middle East, Poland, Russia, Singapore, Spain, Thailand, Turkey, UK, USA

Distributors in 70 Countries

Made in Germany
Facts and Figures (2)

- **300** Patents Worldwide
- **150** Trademarks Worldwide
- **20%** R&D
- **Sales 2014 90 USD**

Revenue in USD:

- 2009: 0 USD
- 2010: 20 USD
- 2011: 40 USD
- 2012: 60 USD
- 2013: 80 USD
- 2014: 100 USD
We make complex tasks easy to achieve for our customers.

Our Mission

- To be a leading single source provider of premier measurement and monitoring solutions for plant maintenance and quality assurance.

Our Core Activities

- Alignment Systems
- Condition Monitoring
- Nondestructive Testing
Condition Monitoring

Systems and services for vibration analysis and monitoring of machine condition.

Condition Monitoring can reduce operation and maintenance costs by up to 50%.

Why Condition Monitoring?
- Reduced machine lifetime due to excess vibration and loads
- Reduced machine availability due to unplanned shutdowns
- Increased operating costs
- Unavailability of machine health data for CbM or asset reliability

Our solutions
- Portable data collectors and analyzers
- Online Condition Monitoring
- Continuous wear monitoring
- Machine protection
- Monitoring Services
- Certified Monitoring Center

Benefits of Condition Monitoring
- Early detection of machine problems
- Elimination of root cause before failure occurs
- Reduced vibration and wear
- Increased machine availability
- Reduced operating costs
- CM feeds CbM and asset reliability programs
Laser Alignment Systems

Systems and services for laser alignment of rotating machinery.

50% failures in rotating machinery are due to misalignment.

Why alignment?
- Misalignment increases temperature, vibration and loads
- Misalignment increases wear of bearings, couplings, seals and shafts
- Downtime, production losses and mechanical repairs generate high operating and maintenance costs

Our solutions
- Shaft alignment
- Measurement of machine geometry
- Bore alignment
- Monitoring positional changes
- Roll alignment with PARALIGN

Benefits of alignment
- Longer service life
- Increased MTBF and uptime
- Lower power consumption
- Reduced temperature, vibration and mechanical repairs
- Lower operating costs
- Higher product quality
Non Destructive Testing

Systems and services for quality assurance and process control in production of semi-finished metal products.

Why NDT?
- Faults in products lower quality and productivity
- Impacts on competitiveness and performance
- Compliance to quality standards is getting tighter

Our solutions
- Eddy current testing equipment
- Flux leakage testing equipment
- Sensors and accessories
- Turnkey systems from design to commissioning

Benefits of NDT
- Improved product quality
- Optimized production processes
- Reduced scrap
- Improved productivity and performance
Worldwide Machinery Services

- Laser Shaft Alignment
- Turbine Alignment
- Machine Condition Monitoring
- Roll Alignment
- Mobile Measurement
- Geometric Alignment
Customer Support

- Worldwide After-Sales Services
- Calibration and Repair
- Certified Monitoring Center
- Telediagnosis
- Remote Mentoring

**Worldwide Training**

- CAT I-IV vibration training
- Alignment training
- Product training
- Onsite training
Why Condition Monitoring
Why Condition Monitoring

Maintenance strategies

► Break Down Maintenance
  • Run till failure

► Preventive Maintenance
  • Time based

► Predictive – Condition Based Maintenance
  • Maintenance and repair depend on machine condition / health

► Proactive – Maintenance
  • Detect and Improve/Prevent
    • Balancing
    • Alignment
    • Structural changes
Why Condition Monitoring

Condition Based Maintenance

► Purpose of Condition Monitoring
  • Improve Lifetime and prevent Downtime
  • Improve Maintenance Schedule (Goal = no unscheduled stops/failures)
  • Improve Product Quality
  • Reduce Maintenance / Production Costs

► Purpose of the measurements
  • Trend the machine condition
  • Determine which maintenance actions needed when?

► Awareness
  • Support within factory
  • Reliability and commitment
Different measurement techniques

• Thermography (IR)
• Electrical measurements
• Ultrasonic
• Oil analysis
• Precision Alignment
• Vibration Measurements

Every technique provides us with information regarding the condition of the machines, the best suited techniques should be determined for every machine together with correct time interval.
Condition Monitoring Fun Facts

- 15% vibration reduction = 72% increased bearing life

Source: www.ludeca.com
Condition Monitoring Fun Facts

- 15% vibration reduction = 72% increased bearing life
- Why Roller Bearings Do Not Reach Lifetime

Source: Integrated Condition Monitoring Technologies
IRD balancing LLC Dennis H. Shreve
Condition Monitoring Fun Facts

- 15% vibration reduction = 72% increased bearing life
- Why Roller Bearings Do Not Reach Lifetime
- 50% of damage to rotating equipment is MISALIGNMENT
Condition Monitoring Fun Facts

- 15% vibration reduction = 72% increased bearing life
- Why Roller Bearings Do Not Reach Lifetime
- 50% of damage to rotating equipment is MISALIGNMENT
- Imbalance, one of the Most Common Machine Problems

Source: www.ludeca.com
Why this topic?
Introduction – Why this topic?

- In 20th century strong development of measurement systems

1980
- 1 Channel FFT
- Portable?

2015
- 4 Channel FFT
- Triax – Technology
- Touch screen – Wifi – Bluetooth – 3D
Introduction – Why this topic?

- In 20th century strong development of measurement systems
- Tools are available and are better than ever.
  - Still 60% feel it needs to improve

“Q: Rate the performance of your PdM program over the last 12 months?”

- Needs some improvement: 54.1%
- Effective: 21.2%
- Satisfactory: 16.4%
- Not effective: 8.9%
- Very effective: 3.4%
Introduction – Why this topic?

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- Tools are available and are better than ever.
  - Still 60% feel it needs to improve
  - And 80% fail to successfully implement RCM

“Q: Rate the performance of your PdM program over the last 12 months?”

Before You Implement a Reliability Centered Maintenance (RCM) Program...

January 16, 2012
Reliability studies show that up to 80% of RCM efforts fail to produce the desired sustainable outcomes.
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  - And 80% fail to successfully implement RCM
- 21st century technologies make daily life easier
  - All data available whenever and wherever needed
Introduction – Why this topic?

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  - All data available whenever and wherever needed

Combine these tools to improve and facilitate CM programs in the future!
21st Century Technology in CM Applications
21st Century Technology in CM Applications

- Industrial Revolution 4.0
21st Century Technology in CM Applications

- Industrial revolution 4.0

A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities.
21st Century Technology in CM Applications

- Industrial Revolution 4.0
- IoT: Internet of Things (2)

“The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.”

- Smart sensors lead to smart machines lead to …
- Open Communication Protocols !!
  (Modbus, Profibus, …)
21st Century Technology in CM Applications

- Industrial Revolution 4.0
- IoT: Internet of Things (2)
- Smart and Accessible Data Storage
  - Safe (cloud) storage for a huge amount of data
  - Smart data reduction
21st Century Technology in CM Applications

- Industrial Revolution 4.0
- IoT: Internet of Things (2)
- Smart and accessible data storage
- Advanced analysis and analytics software
  - Easily accessible – No local software install
  - Easily understood – Different user levels
  - Automated analytics performs 1st line analysis
  - Not pure CM but Performance Monitoring
Smart Factory – what is it for?

- The goal is the almost complete automation of production and control processes.
- Machines shall communicate with each other.
  - Networking of all components in a System is therefore a key requirement for establishing the so-called Smart Factory.
Smart Products for Smart Factories

- Precondition for automation and the management of equipment is primarily that the machines communicate with each other.
- The vision of Smart Factory assumes that all upstream and downstream production processes are networked.
- Device connectivity is a key issue for their integration in maintenance solutions.
Real World Examples
Real world examples

How do these technologies help CM programs today?

- Cloud Solutions – Fleet of Vessels: World-class CM program across the world
- Remote Monitoring – Worldwide wind turbines
- Smart Laser Alignment System
Cloud Solutions – *Fleet of Vessels*

**World-class CM Program across the world**

**Challenges:**

- Manage a CM program for vessels around the world
World-class CM Program across the world

Challenges:

- Manage a CM program for vessels around the world
  - Combination of online and handheld data collection
- Limited onboard CM knowledge – focus is on vessel operations
- Superintendent travels the world catching up with his fleet
- Analysis is done by service provider
Cloud Solutions – *Fleet of Vessels*

World-class CM Program across the world

Onboard – Initial set-up:
- Predefined measurement locations
- Critical assets – Online monitoring
- Basic training – Collecting data
- No software training – Only web interface
Cloud Solutions – *Fleet of Vessels*

World-class CM Program across the world

**Onboard – Periodical measurements:**
- Work-order automatically created
- Login to cloud server
- Select the measurement route
- See any remarks from analyst
- Drag - Drop to device (like flash drive)
- Measure route
- Add remarks or notes while in route
- Drag – Drop to cloud
Cloud Solutions – *Fleet of Vessels*

World-class CM Program across the world

Data analysis

- Advanced analytics automatically evaluates data
  - First line analysis
  - Different analytic models
  - Find deviations
Cloud Solutions – *Fleet of Vessels*

**World-class CM Program across the world**

**Data analysis**

- Advanced analytics automatically evaluates data
- Analyst only looks at problem assets
  - Analysis center receives a notification
    - Upload route measurements
    - Alarms in online data
- Remarks directly in database
- No separate reports
Cloud Solutions – *Fleet of Vessels*

World-class CM Program across the world

Data interface

- Cloud solution hosts data and software
  - No local software install - only web interface
- All data can be linked to same interface not limited to OEM
- Different user levels All levels of organization
- No lost reports Interactive interface automatically updates
Cloud Solutions – *Fleet of Vessels*

World-class CM Program across the world

21st century technologies

- Visual route set-up (pictures)
- Online monitoring data directly to cloud
- No local software only web interface
- 1st line analysis = Automated
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

Challenges:

- Machines in remote locations
  - Far from any human interaction
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

**Challenges:**
- Machines in remote locations
  - Far from any human interaction
- Massive amount of data (today +1500 turbines)
  - Data reduction – Automated analysis
- Highly dynamic complex assets
  - Multichannel synchronic continuous monitoring
  - Kinematic model for easy analysis
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

**Solutions: Remote locations**

- Communication through local, mobile or satellite network
Remote Monitoring – *Worldwide wind turbines*

**Wind turbine monitoring**

**Solutions: Remote locations**
- Communication through local, mobile or satellite network
- Temporary monitoring
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

Solutions: Remote locations

- Communication through local, mobile or satellite network
- Temporary monitoring
- Easily accessible visualization
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

Solutions: Massive amount of data

- Communication through local, mobile or satellite network
- Temporary monitoring
- Easily accessible visualization
- Smart Analytics
  - Find patterns
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

**Solutions: Massive amount of data**
- Communication through local, mobile or satellite network
- Temporary monitoring
- Easily accessible visualization
- Smart Analytics
  - Find patterns
  - Deviations
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

**Solutions: High dynamic complex assets**
- Communication through local, mobile or satellite network
- Temporary monitoring
- Easily accessible visualization
- Smart Analytics
- Kinematic model
  - Simulate machine to component level
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

**Solutions: High dynamic complex assets**
- Communication through local, mobile or satellite network
- Temporary monitoring
- Easily accessible visualization
- Smart Analytics
- Kinematic model
  - Simulate machine to component
  - 20 Channel continuous synchronic measurements
Remote Monitoring – *Worldwide wind turbines*

Wind turbine monitoring

21st century technologies

- Advanced network setup
- Easily accessible visualization
- Smart Analytics
‘Alignment is not any longer a snap shot it becomes a Condition Monitoring parameter’
ARC 4.0: Laser alignment as a condition monitoring parameter
ROTAALIGN® Touch: the world's first cloud-based Alignment of Industry 4.0
Sending alignment jobs over the cloud

- Alignment jobs can be sent around the world via the cloud with the new ALIGNMENT CENTER RELIABILITY 4.0 software in real time to mobile ROTALIGN® touch devices.
Typical user story: service companies

- For mobile service and maintenance teams cloud networking can become crucial.
- They have to manage alignment tasks at different locations and want jobs to be recalled or measurement protocols to be sent any time.
NFC (Near Field Communication)

- Asset specific jobs in combination with the integrated RFID scanner allow an automatic and error free machinery identification enable
- After correction, the alignment state is comfortably stored back in the tag.

- Build in NFC reader (13.56 MHz)
  - ISO/IEC 14443 Type A and B
  - ISO/IEC 15693
  - ISO/IEC 18092
  - FCC ID / EN 300 328
Built-in Camera

- With the built-in camera, users add pictures to the measurement report, or e.g. review sensor and bracket mounting for specific machineries in advance.
Ease of use

- Centralized assets simplify users’ work:
  - No need to think about machine specification.
  - Just follow the flow

- Up to the perfect alignment
Further highlights

- Speech recognition
  - ROTALIGN® touch can recognize and process voice commands for hand-free operation

- sensALIGN®
  - PRÜFTECHNIK unsurpassed precision and accuracy

- First capacitive glove-enabled touchscreen laser shaft alignment system
20th + 21st technology = Road to success

- We have better hardware than ever
- 21st century technologies widely available
- Together = Industrial revolution 4.0 = NOW
- Tailor-made solutions instead of predefined answers
- Combine the two to your CM-success

Thank you for your attention

Mike Ciocys
Used sources

- Wind turbines: Photographer Christian Steiness