**2016-09-22**

Smart Sensor Technology in Condition Monitoring Low Voltage Motors
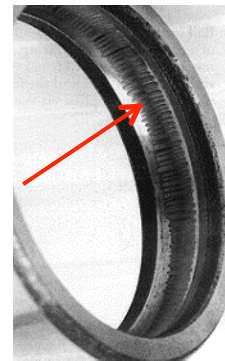
Condition Monitoring

- Purpose of condition monitoring

- Convergence of technologies

- Benefits of condition monitoring

- Smart Sensor example

- Related tools

- Future trends

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Purpose of Condition Monitoring

- Condition Monitoring or CM, is the process of analyzing key parameters of a machine to determine it's condition in order to predict a future fault or failure

- As a result unplanned downtime can be avoided and equipment life extended

- For rotating machinery like low voltage motors the key parameters measured are usually temperature and vibration

Bearing fluting
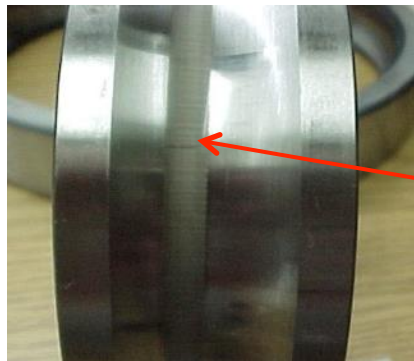
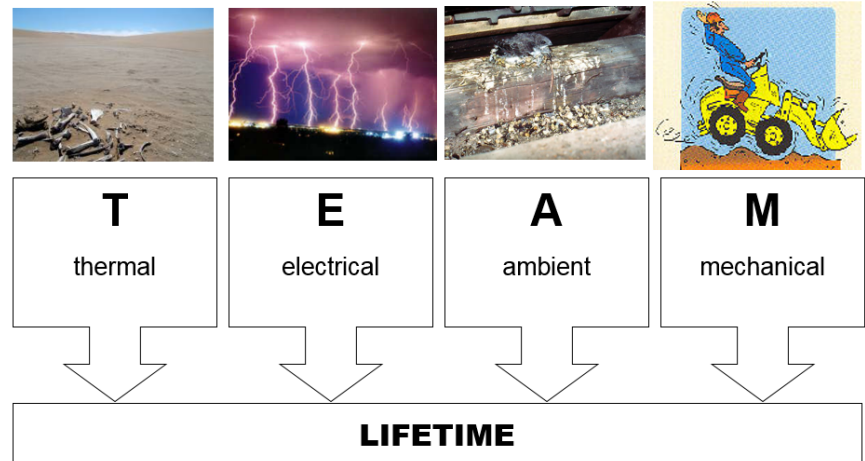Inner bearing race

Outer bearing race

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Condition Monitoring and Maintenance to ...

- Maximize availability
  - Cut downtime cost
- Increase reliability
  - Minimize unplanned stop and related production losses
- Extend lifetime
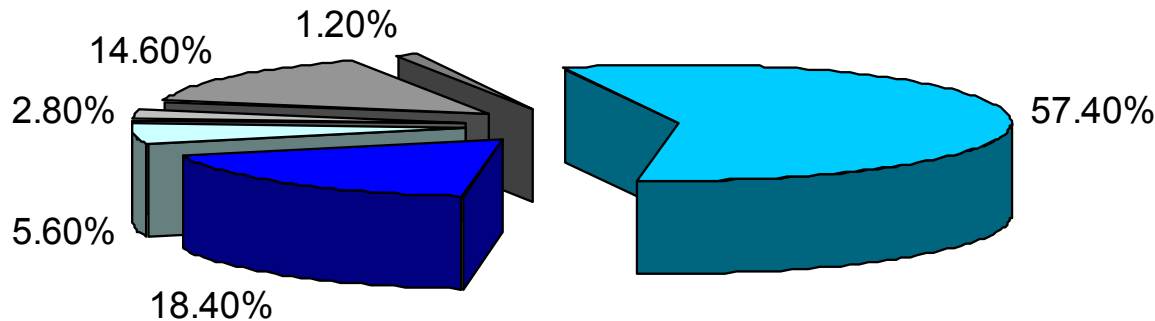- Maintain high safety standard
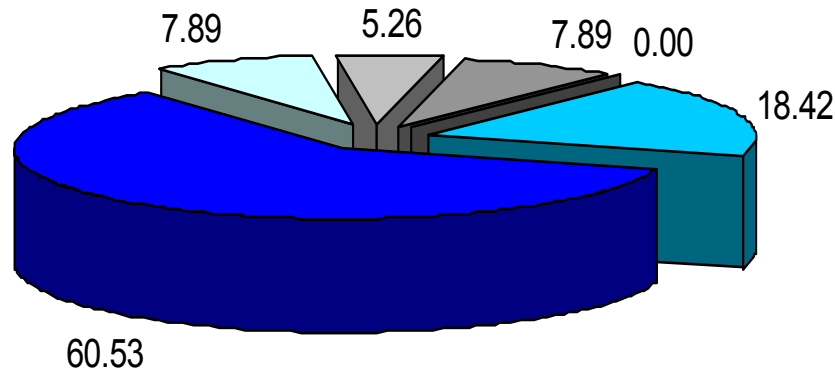- Optimize the investment

Operating Conditions

T	E	A	M
thermal	electrical	ambient	mechanical

LIFETIME

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Failure Statistics
Motors Petrochemical Industry 1999

Motor less than 2 MW

57.40%
1.20%
14.60%
2.80%
5.60%
18.40%

Legend:
- Bearing
- Stator Windings
- Rotor- Bars/rings
- Shaft or coupling
- External device
- Not Specified

Motor more than 2 MW

7.89
5.26
7.89
0.00
18.42
60.53

IEEE transactions on industry applications . vol. 35. no. 4. July/august 1999
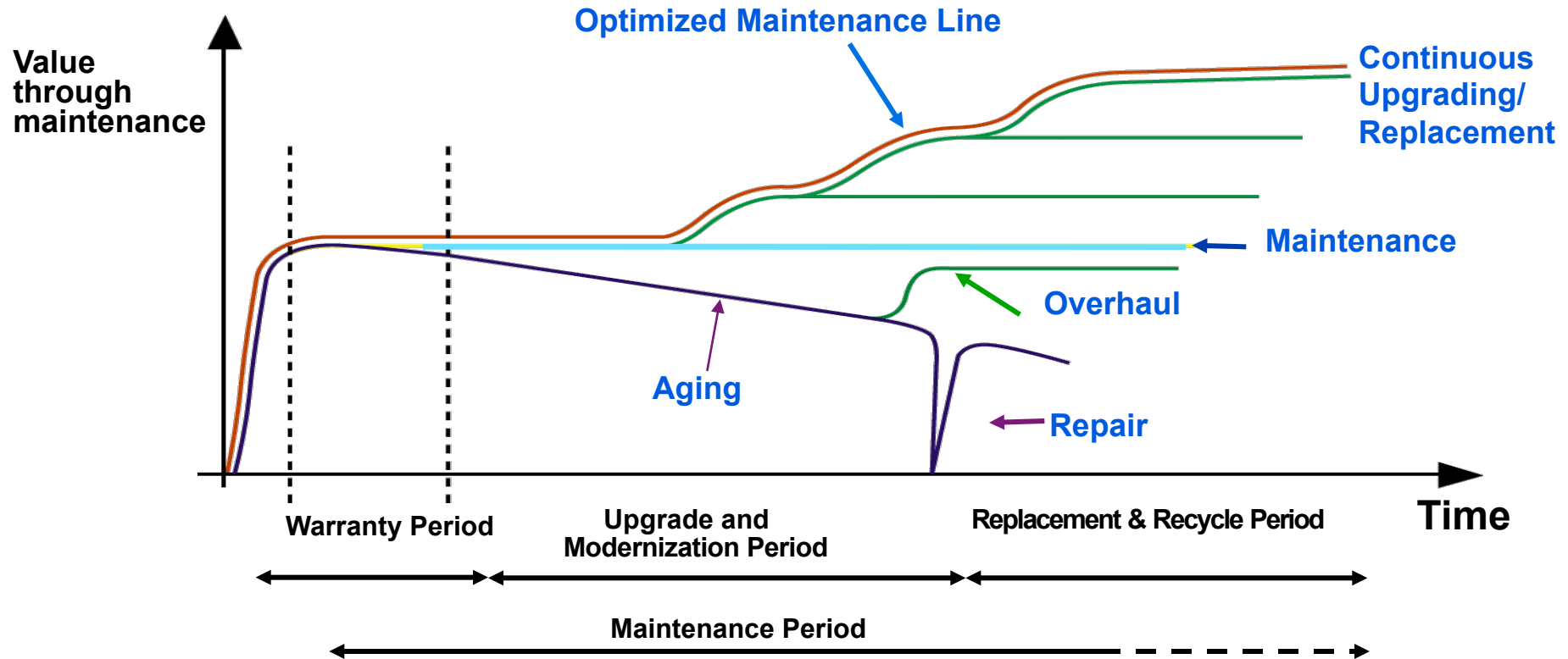
For Machines less than 2000 kW anti-friction bearings are commonly used which are more likely to fail

For Machines above 2000 kW sleeve bearings are often used which are less likely to fail

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Life Cycle Concept
Why condition monitoring?

Value through maintenance

Optimized Maintenance Line

Continuous Upgrading/ Replacement

Maintenance

Overhaul

Aging

Repair

Time

Warranty Period

Upgrade and Modernization Period

Replacement & Recycle Period

Maintenance Period

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Maintenance strategies

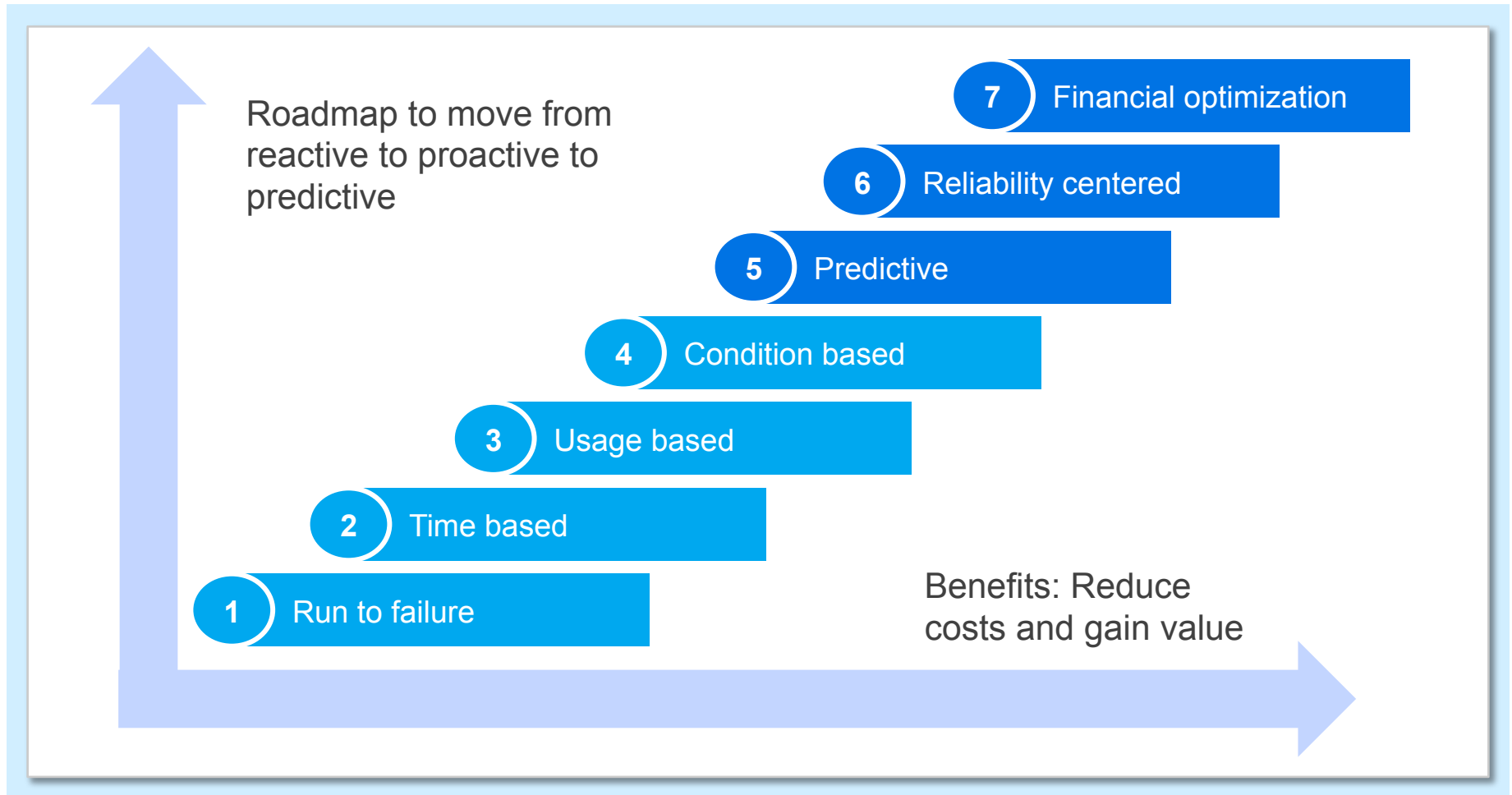| Reactive	**Reactive maintenance** • Corrective actions taken upon **failure** or abnormal operation	Lower maintenance costs Unpredictable stopovers High downtime cost from unplanned stops
Proactive	**Scheduled maintenance (preventive)** • Maintenance actions are **based on a schedule** defined by the supplier **based on experience**	Optimized maintenance costs Planned stopovers Predefined spare parts kits for each maintenance level
	Condition based maintenance (predictive) • Maintenance actions are **defined as consequence of the measurements** activities checking the status of components	Lower maintenance costs Stopover based on findings from condition monitoring Minimized downtime

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Condition Monitoring programs
Vary by company and facility

- Motor's impact on operation and cost determine what motors to put on a CM program.

- Continuous with outfitted with sensors (typically mission critical and high dollar motors)

- Periodic inspection and measurement of key parameters (weekly, monthly, quarterly annually)

- After inspection and measurement trend and analyze the information – often by reliability engineer or appropriate expert.

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Analytics are the driver
Adopting a predictive approach reduces costs and adds value

Roadmap to move from reactive to proactive to predictive

7	Financial optimization
6	Reliability centered
5	Predictive
4	Condition based
3	Usage based
2	Time based
1	Run to failure

Benefits: Reduce costs and gain value

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Convergence of technologies
2016 …

- MEMS or Micro-Electro-Mechanical-Systems are getting smaller and using less and less power.

- Smart Phone and tablet use has become widespread

- Availability of networks such as WiFi, Bluetooth and cellular are widespread

- Cloud computing and big data are here

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Condition monitoring for low voltage motors
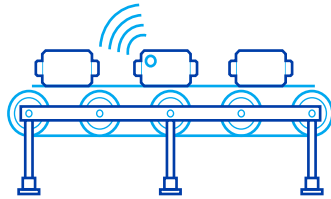# Internet of Things, Services and People (IoTSP)

Industry 1.0 – 1712
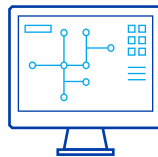Mechanical production with the help of steam
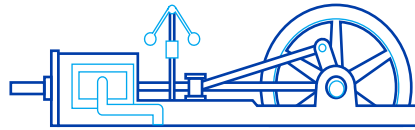
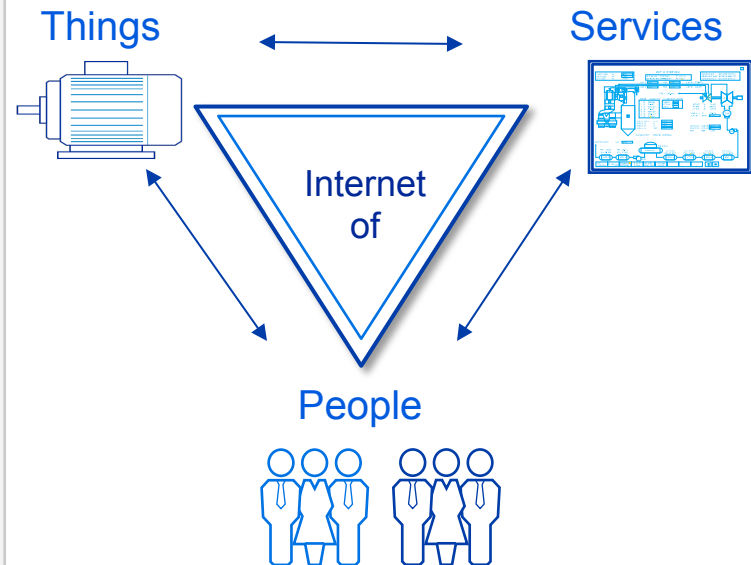### Industry 2.0 – 1870
Assembly lines with the help of electricity

Industry 3.0 – 1969
Further automation with the help of electronics and software-based control

Industry 4.0 – today and tomorrow

Things

Services

Internet of

People

Industry 4.0 – the fourth industrial revolution

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Condition monitoring for low voltage motors
Monitoring and maintenance of LV motors today

Plant owners can boost their results with better monitoring and maintenance for their LV motors

Most LV motors are not monitored, and are only maintained when something goes wrong

In most cases, sophisticated monitoring of LV motors does not make economic sense today

- A significant infrastructure is required, which typically costs more than the motors themselves
- Specialist personnel are needed to install and maintain the monitoring equipment
- Without correctly installed infrastructure, the maintenance team does not have sufficient data to carry out optimizations

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Condition monitoring for low voltage motors
Monitoring and maintenance of LV motors today

Maintenance teams face several limitations

Maintenance is fragmented and unconnected, with a separate team for each site (or at most one team covering a few sites)

The teams do not have the motor manufacturer's know-how and expertise

The teams cannot get contracts to service a significant part of the installed population due to the large number of motors

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Status analysis of LV motors
Will the motor be included in the IoTSP ?

- **If** a large number of motors delivered status information ...

- **If** monitoring equipment were cheap and easy to install ...

- **If** competent data analysis with a large volume of information were readily available ...

  - **... then** service engineers could provide advanced plant optimization at affordable costs

  - **... and** the plant operators could save operating costs and increase productivity.

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Condition monitoring for low voltage motors
How can this solution help me save money?
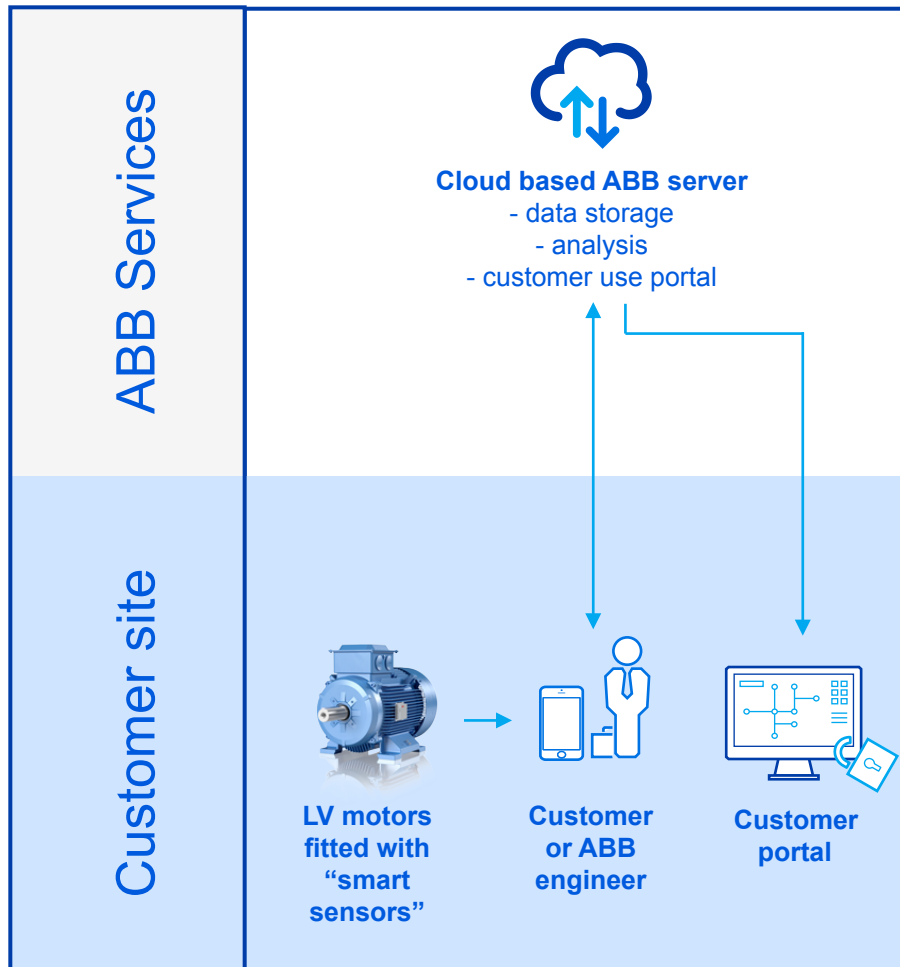

This solution can help you to...

Reduce downtime by as much as 70%

Extend lifetime by up to 30%

Increase energy efficiency by around 10%

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Condition monitoring for low voltage motors
How does it work?

Cloud based ABB server
- data storage
- analysis
- customer use portal

LV motors fitted with "smart sensors"

Customer or ABB engineer

Customer portal

ABB Services

Customer site

Motors are fitted with smart sensors. The sensors can be fitted during manufacturing or afterwards.

The sensors use Bluetooth Low Energy to wirelessly 'talk' to the cloud, via a smartphone.

The cloud-based ABB server uses special software algorithms to analyze the data.

The server sends information on motor condition to smart phone and customer portal.

The data is tracked over time for trend analysis. It is visualized on your PC and can be supplied to other systems at your plant

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Condition monitoring for low voltage motors
What does it monitor?

Regular and accurate monitoring of key condition parameters

Vibration parameters

Overall vibration
Axial vibration
Radial vibration
Tangential vibration

Health parameters

Bearing condition
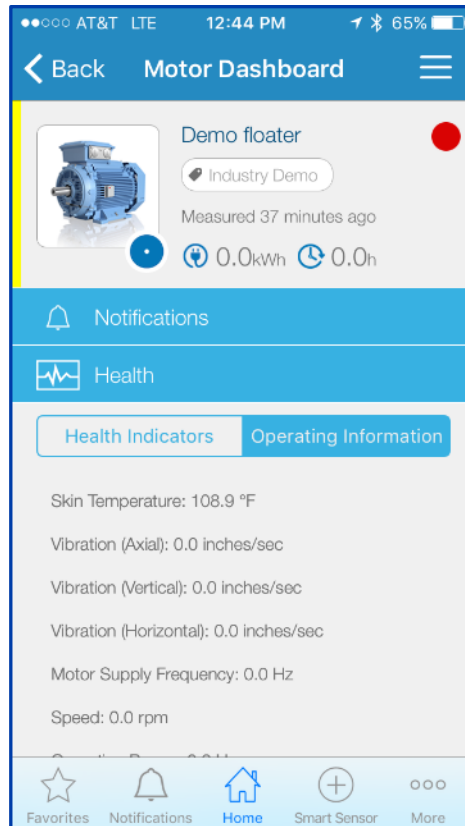Rotor health
Air gap eccentricity
Cooling condition

Operating parameters

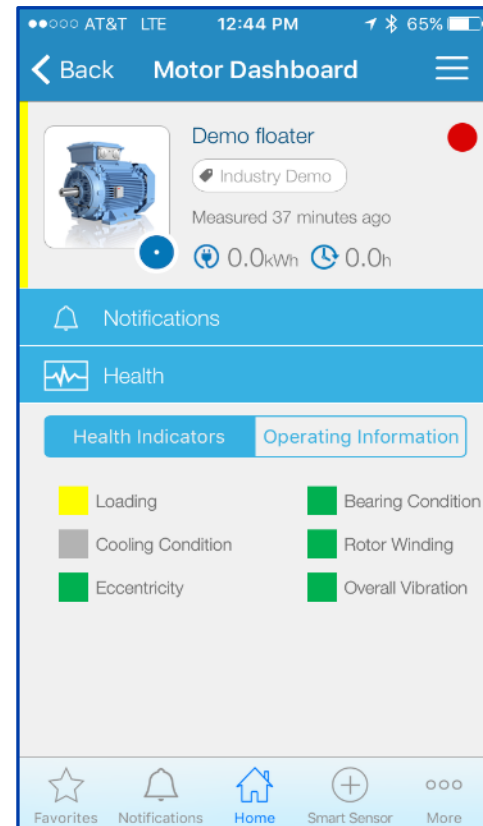Temperature
Energy consumption
Loading (power)
Operating hours

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Condition monitoring for low voltage motors
Intuitive and easy to use app

See the status of your health and operating parameters
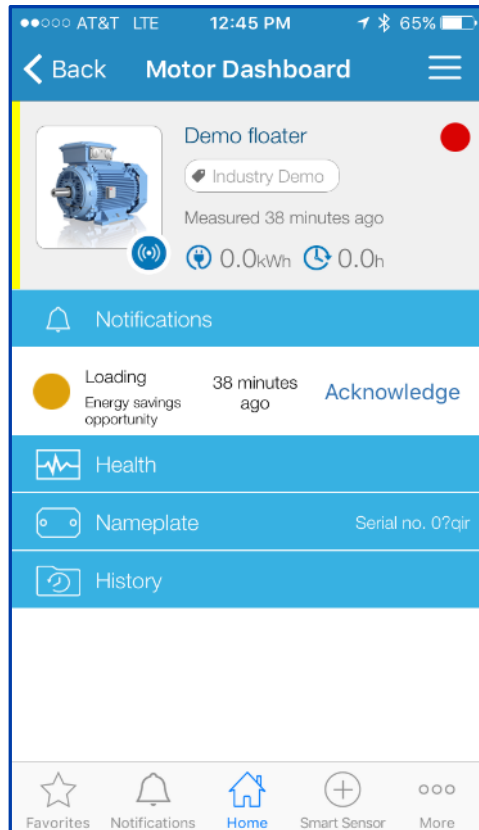

- View the latest operating parameters

- See status of each health parameter

Condition monitoring for low voltage motors
Intuitive and easy to use app

See and act upon
alerts and alarms

■ See and acknowledge your
notifications

Now you can read data from your smart
sensor attached to your motor
periodically with your smart phone

Touchless, just get within Bluetooth
range

Take readings on your priority schedule
(daily, weekly, monthly)

Measurements are taken every hour
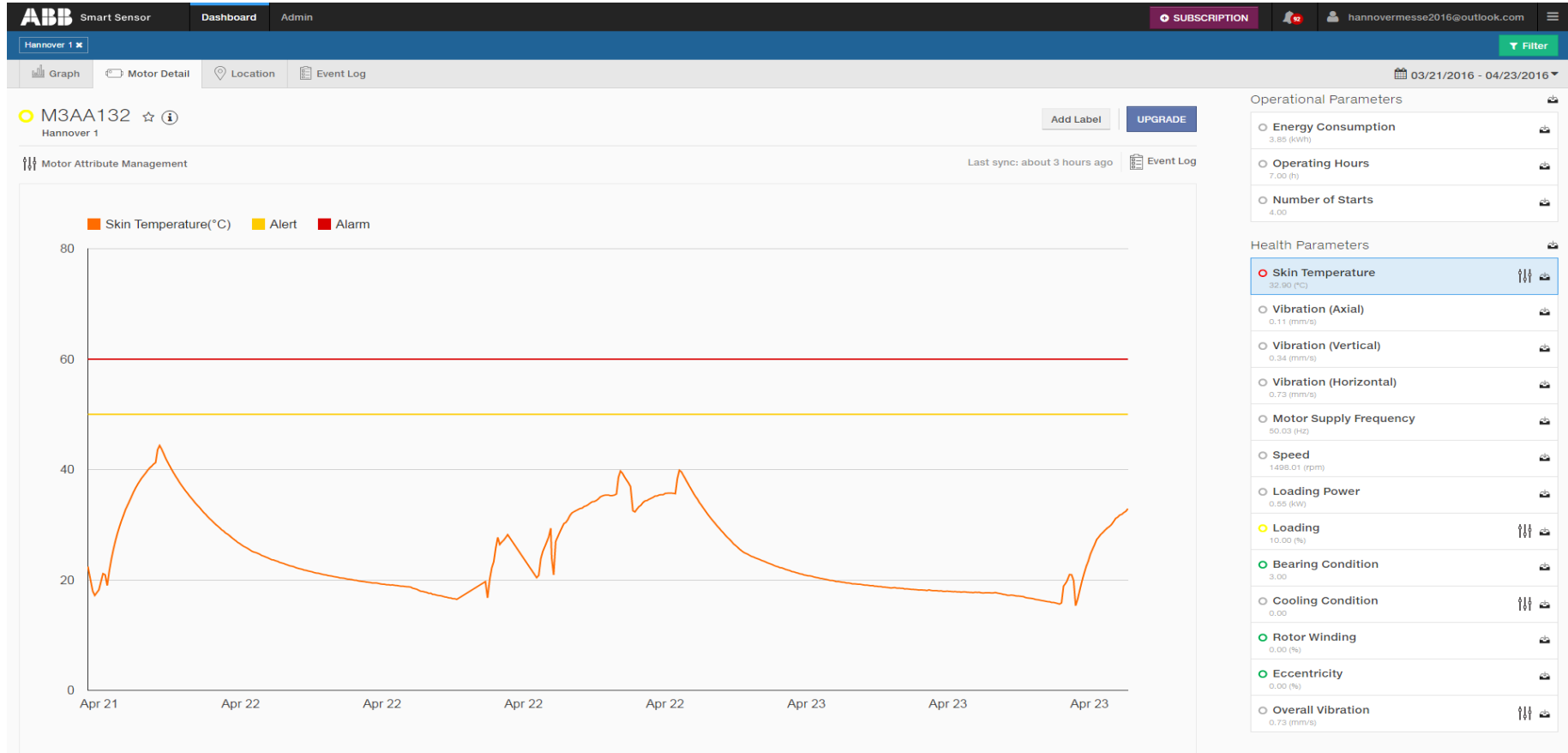
See your operating and health condition
on the app

Manage your motor data

Automatically uploads parameter data to
a portal for more detailed viewing

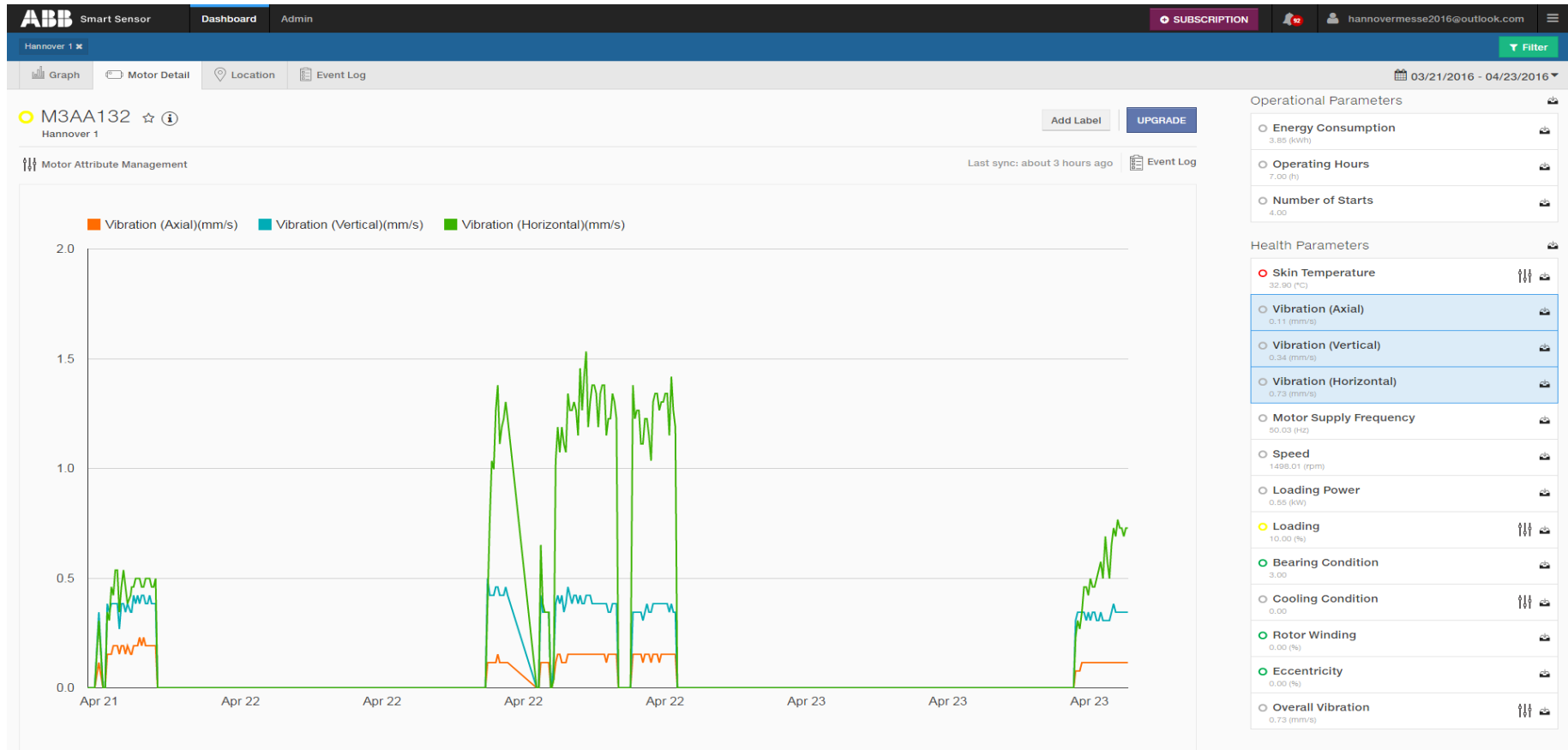ABB

Detailed trending
Single motor temperature

Alert and alarm levels are user settable

Detailed trending
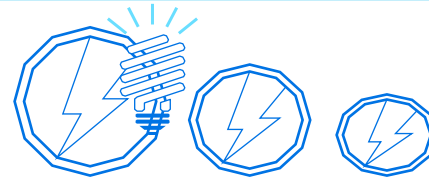## Single motor 3 axis of vibration

All 3 axis of vibration can be viewed on one trend for comparison
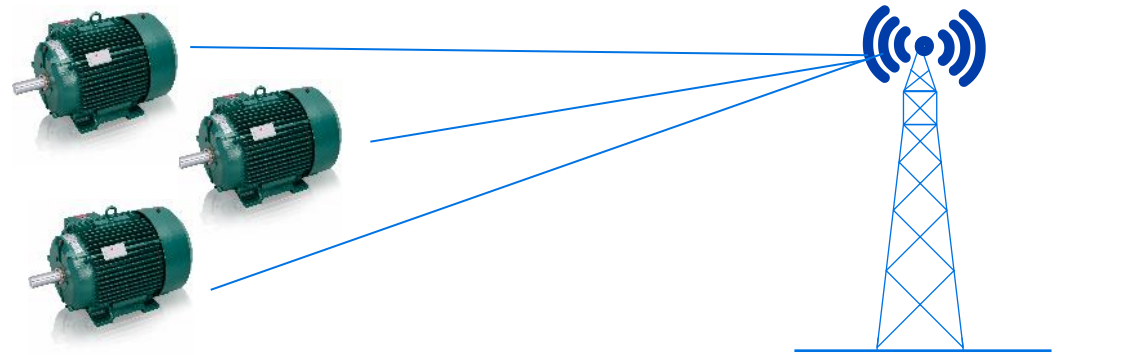
Future Trends

Smaller

Less Power

Longer Network, without Gateways

Connectivity from several miles away

Power and productivity
for a better world™

Questions?