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# Anwendung von (Luft-)Schallanalyse als ein Verfahren der berührungslosen Qualitätssicherung für die vorausschauende Wartung

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Tobias Clauß  
Dortmund, 23.05.2019





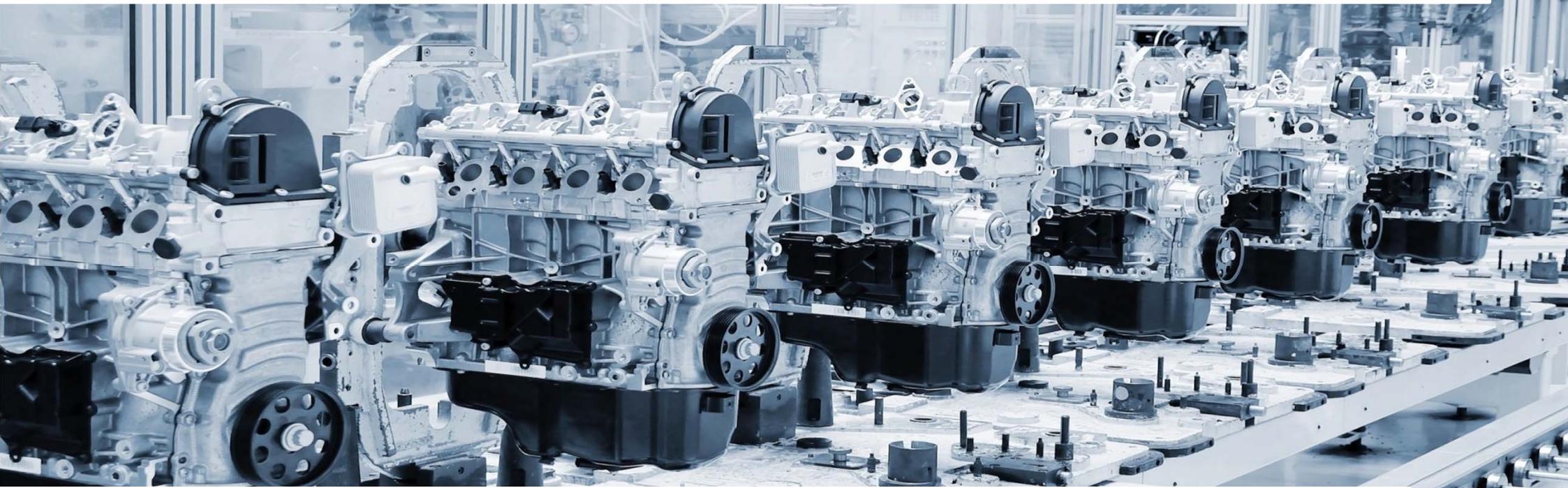
# **Initial Situation:** **Digitization and Automation of Industrial applications**



**Motivation: Increase efficiency, product flexibility**

**Challenges: Complexity, investments, security issues**

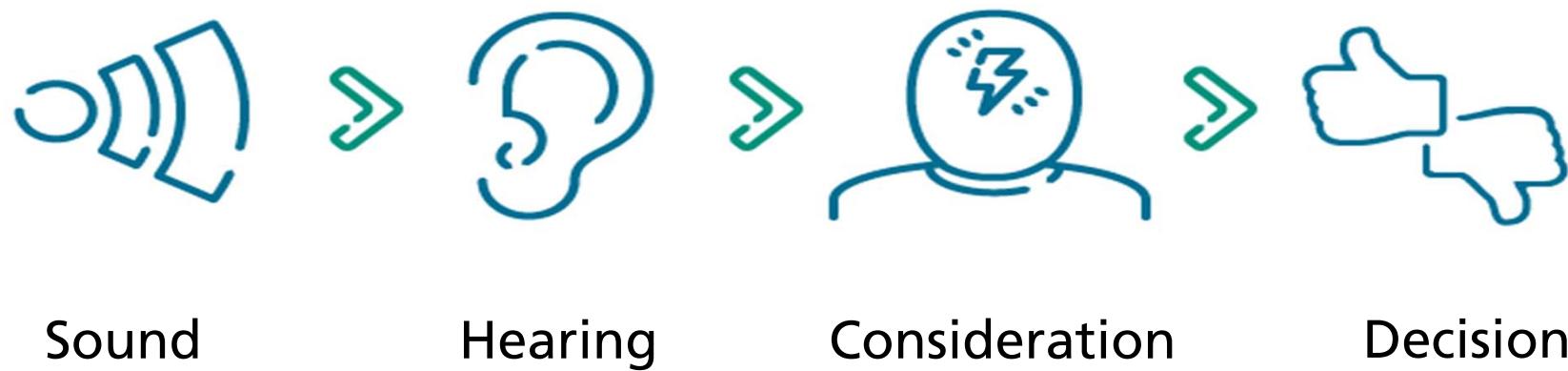
## **Individual solutions: Development of monitoring systems for the customer's requirements**



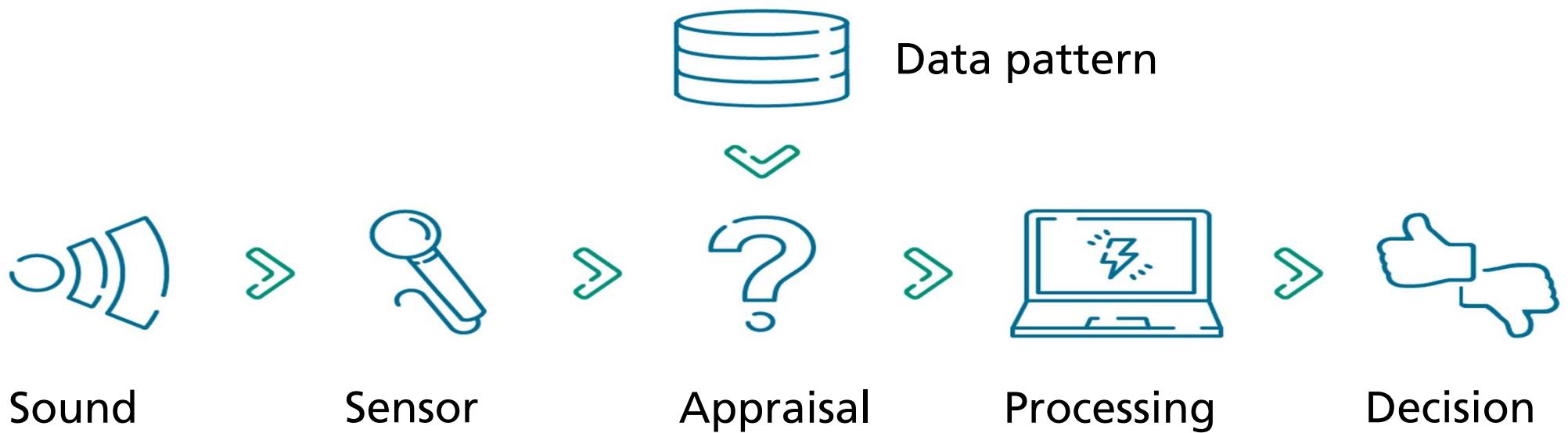
**Quality Assurance: Predictive Maintenance, End-of-Line Testing**

**Acoustic control: non-destructive, contactless, retrofittable**

# Motivation & Goal



# Motivation & Goal



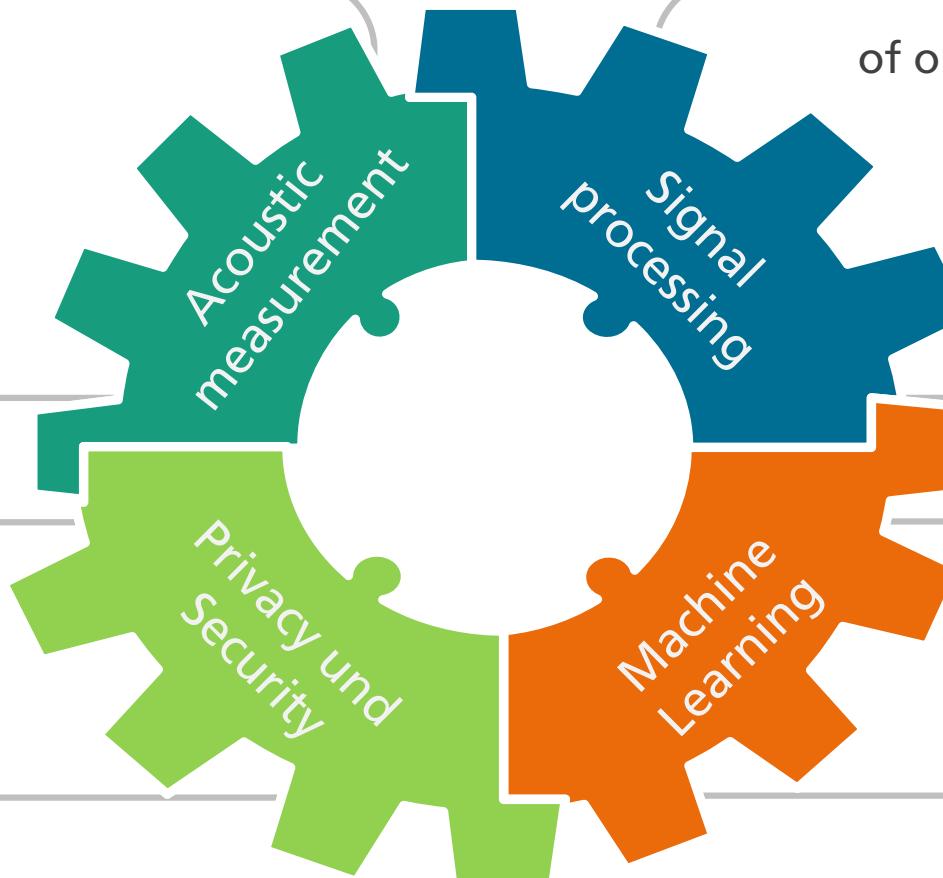
# Elements of acoustic condition monitoring @ FhI IDMT

Measurement of  
- Structure-borne  
- Air-borne  
- Ultrasonic  
sound in noise-free  
and noisy surroundings.

Signal analysis  
of one- or multi-channel signals.  
- Signal processing  
- Embedded  
- In networked  
systems  
- Cloud

- Secure distribution  
- Storage  
- Analysis  
of measurement results.

Scalable methods  
- Supervised  
- Unsupervised  
- Deep learning  
on various sensor data.



# Competencies (1/2)

- Spatial localization of events
  - Microphone array technology (2D/3D)
  - Beamforming microphone technology
- Digital signal processing: auditory scene analysis
  - Source separation algorithms
  - Echo reduction
  - Acoustic fingerprints

# Competencies (2/2)

- Machine Learning
  - Various techniques like Gaussian Mixture Models (GMM), Support Vector Machines (SVM), Deep Neural Networks (DNN), ...
  - Supervised, semi-supervised, unsupervised learning
  - Validation and visualization of classification results
- Secure data acquisition, storage, distribution
  - Techniques for avoidance of data corruption (sensor identification)
  - Decoupling real and pseudonymous identities (pauth)

# Lead Project (1/2)

## Projekt »LidEO«

*Airborne sound analysis in the end-of-line test of the automotive industry  
[German: Luftschallanalyse in dem End-of-Line Test der Fahrzeugindustrie]*

- Quality inspection of electric motors in car seats
- Client: GÖPEL electronic GmbH
- Benefit: Reduction of cycle time in production

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# Lead Project (2/2)

## Projekt »City Noise«

Self-learning system for the detection, prediction and presentation of urban noise

[German: Selbstlernendes System zur Erfassung, Vorhersage und Darstellung von städtischem Lärm]

- Networked sensors
- Detection of noise sources  
(event detection & classification)
- Calculation of noise levels according to TA  
Lärm

[Follow: Website](#)



# Lead project »City Noise«

- Machine learning based system for collection, prediction and visualisation of city noise
- Government-funded (Free state of Thuringia)
- Sensor network with embedded and cloud based analysis
- Beneficial for
  - Urban planning
  - Noise prevention
  - Smart city applications

# Selection of experiences (1/2)



Symbolbild, Quelle: connox.at



## Bearing damage in industrial fans

- Appear after delivery but can be recognized at EOL
- Creeping process
- Air-borne sound



Symbolbild, Quelle: amazon

## Error detection during industrial welding

- Welding robots in the automotive industry
- Detection and differentiation of error images
- Airborne-sound & Ultrasonic

## Malfunction of air conditioners

- Start-Up-Cycle
- Early detection of damage to components
- Structure-bone analysis

# Selection of experiences (2/2)



Symbolbild, Quelle: trend.directindustry.de



Symbolbild, Quelle: silabtec.com

## Crack detection in turned parts

- Hairline cracks
- Automated individual part testing in the line
- Airborne-sound

## Detection of faulty transmission components

- End-of-line testing for the automotive industry
- Noise test before delivery to the customer

## Detection of cavitation in fluids

- Mainly airborne-sound analysis
- Also in the ultra- & structure-borne sound range
- Relevant for e.g. hydraulics, power generation etc.

# Cooperations



## Sensors

- Water & heat resistant
- directional characteristic
- miniaturisation
- sensor fusion

## Automation & Integration

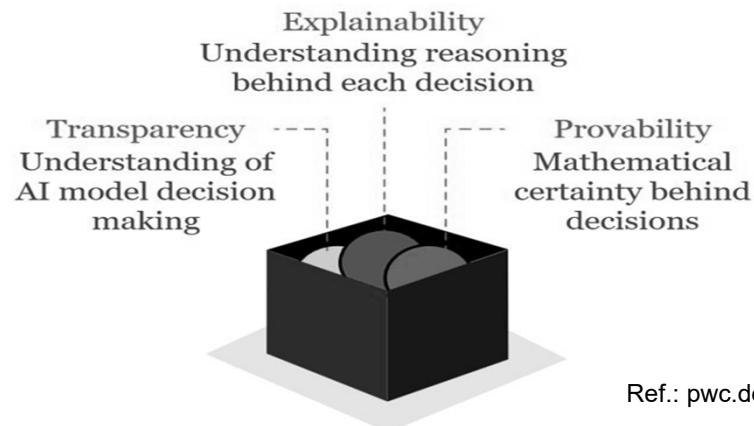
- System design
- Retrofitting
- Control loops

# Overview Committee Work

- Membership at Sensors Industry Group, OPC Foundation
- Collaboration with Bitkom
  - AK Cyber-Physical Systems
  - AK Markt und Strategie
  - AK Interoperabilität
- Collaboration with Fraunhofer Big Data Allianz
- Collaboration with Task Force "Trusted Computing"
  
- Participation in events of "Münchener Kreises"

# Hot topic

## Artificial intelligence as basis for decision-making



## Human machine interface (HMI)



Ref.: pixabay.de

### References:

- Fraunhofer-Gesellschaft e.V. (2017), *Trends für die Künstliche Intelligenz*. In: <http://www.fraunhofer.de>  
Pütter, C. (2018), „*8 Artificial Intelligence Trends*“. In: CIO-IT-Strategie für Manager. München: International Data Group  
Kirschniak, C. (2017), „*Künstliche Intelligenz: Worauf es 2018 ankommt*“. In: PWC Business Analytics. Stuttgart: PricewaterhouseCoopers

# Contact



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The poster features the title "Zweiter Techno-gietag" in large, bold, black letters. Above it, the text "Ausfallzeiten Wissenschaft" and "Predictive Maintenance" is visible. Below the title, there are several keywords and phrases: "Sensorik", "Künstliche Intelligenz", "Innovation", "Mittelstand", "vernetzt", "End-of-Line", "Qualitätsprüfung", "intelligent", "berührungslos", "Luftschallanalyse", "Privacy by Design", "Zukunft", "System", "zerstörungsfrei", "Produktion", "Ultraschall", "Industrie 4.0", "Automation", "sicher", "Neuronale Netze", and "Anomalieerkennung". At the bottom, the dates "30. September – 1. Oktober" and the location "Erfurt" are mentioned. The background of the poster has blue wavy lines on either side.

**CALL FOR CONTRIBUTIONS**

bis zum 31. Mai 2019