UNIVERSITY OF TWENTE.

Specialization
(MEO) MAINTENANCE ENGINEERING & OPERATIONS

Master Mechanical Engineering

MAINTENANCE ENGINEERING & OPERATIONS

Ontwerp en verbetering van onderhoud en logistieke ondersteuning over de gehele levenscyclus van technische installaties.

Kernvakken

- Maintenance Engineering & Management
- Reliability Engineering & Maintenance Management
- Failure Mechanisms & Life prediction
- Structural Health & Condition Monitoring

Werkveld

Multidisciplinair vakgebied: technologie, organisatie en finance
Vraagt: analytische vaardigheden, technische systeemkennis en organisatietalent

CONTENTS

MAINTENANCE ENGINEERING & OPERATIONS (MEO)

INTRODUCTION
BACKGROUND /HISTORY

- **2010-2012**
  - Cooperative research program and Development of Maintenance Master in NL / WCM Summer School
- **2013**
  - Research Center "**T**wente **i**s **M**aintenance **E**xcellence" (TIME)
  - Master specialization in ME
    - ✓ also in Industrial Engineering
    - ✓ later also part-time (executive) Master
  - Master Class Maintenance Engineering for industry
- **2014-2015**
  - PDeng Maintenance program started

RELEVANCE OF MAINTENANCE

Maintenance is an important issue in many industries

- Capital goods are ageing → replace or extend life time ?
  - Chemical plants, infrastructure
- Operational costs must be reduced
  - Trains, aircraft, Defence systems
- New (sensor) technologies and data analysis provide opportunities
  - Semiconductor machines, factories

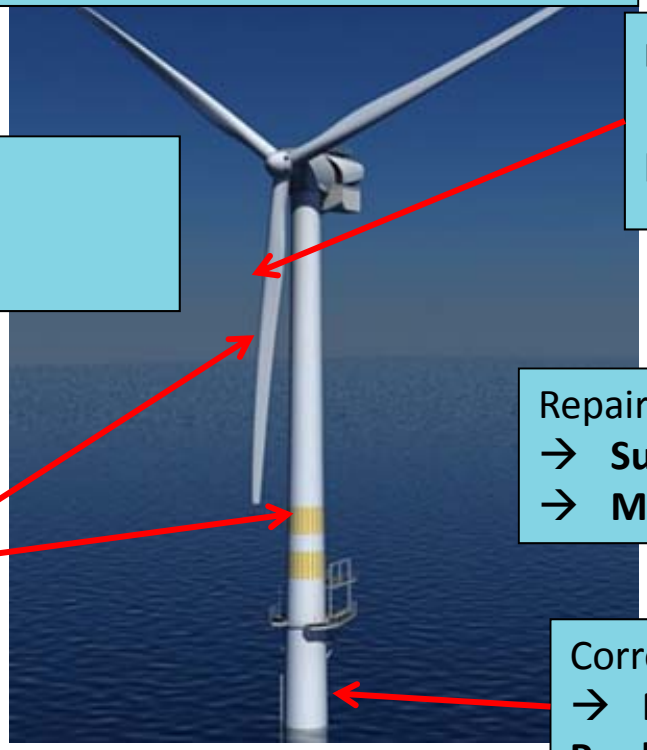
Requires people with specific knowledge / competences

- Analytical skills / data analysis / technical system knowledge
- Multidisciplinary view: technical / costs / logistics / organization

MAINTENANCE → MULTIDISCIPLINARY

OFF-SHORE WIND TURBINE

Design for Maintenance and
Life Cycle Management



Drive-train: bearings + gears
→ **Tribology + Vibration Monitoring**

Maintenance concept
(remote, preventive)
→ **Maintenance Engineering**

Repairs and spare parts
→ **Supply Chain / Logistics**
→ **Maintenance Planning**

Structure + rotor blades
+ dynamic loads
→ **Sensors + Structural Health Monitoring**

Corrosion + fatigue
→ **Mechanisms + Predictive Maintenance**

PROSPECTS MAINTENANCE

- Multi-disciplinary field with many challenges and different areas for specialisation
  - Reliability engineering
  - Structural Integrity assessment
  - After sales service logistics
  - Design for Maintenance
  - Condition Based Maintenance
  - Asset Life Cycle Management

- Companies search for future Maintenance and Reliability engineers

GROUPS & PEOPLE INVOLVED

2 FACULTIES / 4 GROUPS

Engineering Technology (CTW)

- Prof. Leo van Dongen – **Maintenance Engineering**
  - Jan Braaksma / Alberto Martinetti
- Prof. Tiedo Tinga – **Dynamics based Maintenance**
  - Richard Loendersloot
- Prof. Piet Lugt – **Tribology based Maintenance**
  - Rob Bosman

Management and Governance (MB)

- Prof. Henk Zijm – **Production and Supply Chain Management**
  - Matthieu v/d Heijden / Ahmad Al Hanbali

EDUCATIONAL PROGRAM

EDUCATIONAL PROGRAM - MEO SPECIALIZATION

CORE COURSES

- Maintenance Engineering & Management
- Reliability Engineering & Maintenance management
- Failure Mechanisms & Life Prediction
- Structural Health & Condition Monitoring

EDUCATIONAL PROGRAM - MEO SPECIALIZATION

SUGGESTED ELECTIVES

- Reverse logistics
- Product design
- Product Life Cycle Management
- Governing Product Development
- Advanced Dynamics
- Solid Mechanics
- Signal Processing
- Data Mining
- …..

RELATION WITH PROFILES / SPECIALIZATIONS

- **Possible in all three profiles**
  - Design & Construction
  - Research & Development
  - Management & Organisation
- # remaining electives depends on profile chosen

- **Thesis project**
  - supervision from one of participating groups
  - either with industrial partner (external) or PhD students (internal)

WCM SUMMER SCHOOL

NedTrain 2015

Ministerie van Defensie

UNIVERSITEIT TWENTE.

TILBURG UNIVERSITY

TU Delft

Erasmus Universiteit Rotterdam

TU/e Technische Universiteit Eindhoven University of Technology

rijksuniversiteit groningen

4TH WCM SUMMER SCHOOL
on Maintenance Management & Engineering

REGISTRATION
UNTIL JUNE 15TH 2015

www.wcmsummerschool.org

- 8 WORKSHOPS
- LEADERSHIP TRAINING
- CASE STUDY WITH COMPANY VISIT
- €150 EURO FOR SELECTED STUDENTS

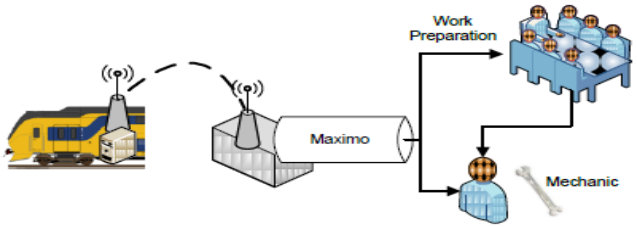
MAINTENANCE ENGINEERING

RESEARCH TOPICS

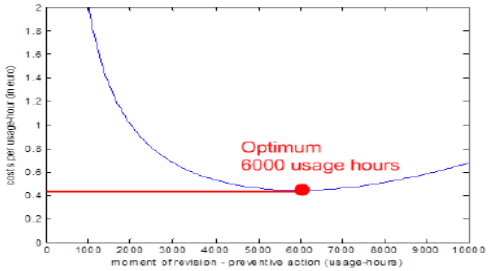
- Design for Maintenance
- Asset (Life Cycle) Management
- Maintenance Decision Making
- Asset Information Management
- Supportability Analysis
- Planning and control of spare parts and maintenance resources (a.o. service engineers, tools)

MONITORING BASED MAINTENANCE

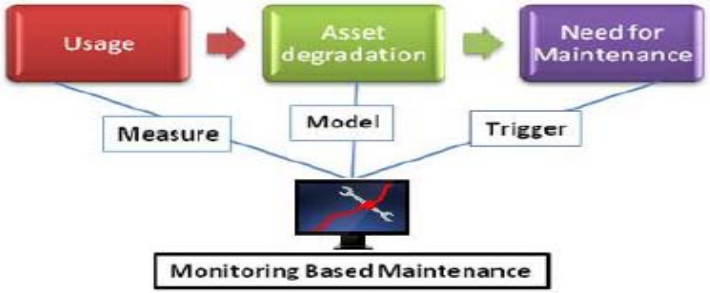
APPLICATION OF USAGE PARAMETERS IN THE MAINTENANCE PROGRAM



Transmission of sensor readings



Model for the maintenance costs



Role of Monitoring Based Maintenance

Preventive overhaul of compressor

CURRENT/PAST MASTER PROJECTS

Life Cycle Costs of ECT – Zhe Chuan Ooi

Life Cycle Management of the electricity grid – Richard Ruitenburg

Sustainable Asset Management - Maurits Korse

Managing supportability data for NedTrain – Joost Ziggers

Design of a classification method for spare parts control – Haico Stegink

Monitoring Based Maintenance – Reinier Moonen

A method supporting Reliability and Maintainability in radar system design – Jack van Dalen

(CBM) planning of naval platform subsystems - Aikaterini Tsoni

Potential Failure Interval Generalization and Assessment – Varun Raman

OPEN MASTER PROJECTS

- A survey study of best practices in Dutch Asset Management (Internship) - SUTO

- Het definiëren van de systeem architectuur van de toekomstige Naval Maintenance Environment Niveau - THALES

- Clustering of maintenance tasks - PRORAIL

- Reducing life cycle cost of railway ballast by optimizing policies of ballast tamping and renewal - PRORAIL

PRODUCTION AND SUPPLY CHAIN MANAGEMENT/ MAINTENANCE PLANNING

CURRENT/PAST MASTER PROJECTS

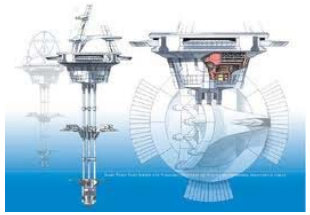
- Spare part inventory management at ASML (Hanneke van der Horst)
- Last time buy decisions for spare parts at IBM (Laura van Silfhout)
- Maintenance planning at “Loodswezen” (piloting of ships, a.o. in Rotterdam harbor) (Simon Prent)
- Service contract fulfillment at Thales (related to spare part supply; Wouter Sleiderink)

TRIBOLOGY BASED MAINTENANCE

RESEARCH TOPICS

- Wear (corrosive, abrasive, (fatigue))

  Life/durability and reliability



- Condition monitoring

  Predictive maintenance

- Re-lubrication intervals

  Aging of lubricants (contamination, oxidation)

- Statistical methods for reliability

  Multi-parameter Weibull, etc.

- Component and system life

  Transients and system reliability (life)

Defensie

Allseas
www.allseas.com

DAF
A PACCAR COMPANY

ProRail

SKF

BOSCH

CURRENT / PAST MASTER PROJECTS

BOSCH: Increasing friction without wear, in a CVT transmission

BOSCH: The influence of wear on the friction in a CVT transmission

SKF: Measuring the dynamic film thickness in grease lubricated roller bearings

ProRail: Redesign of the pantograph with increased reliability

ProRail BOSCH SKF

DYNAMICS BASED MAINTENANCE

RESEARCH TOPICS

- **Dynamic Maintenance**
  - Adapt maintenance intervals to actual usage of systems
    - Failure mechanisms → metals / composites
    - Monitoring of usage / loads / condition

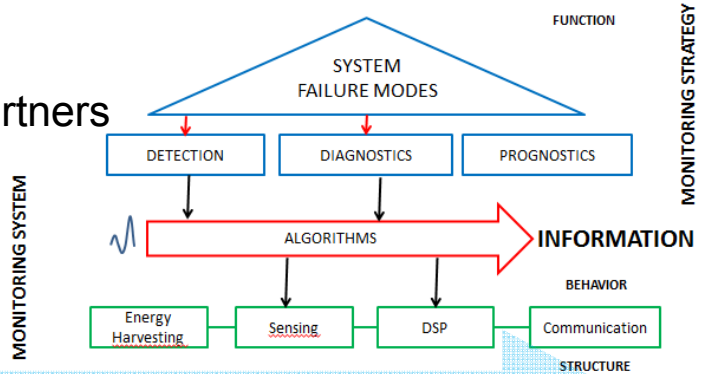
All based on understanding of system behaviour and physical mechanisms !

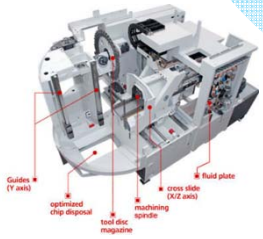
- **Structural Health Monitoring**
  - Dynamic response of systems / structures yields info on damage (location, size)
  - Smart autonomous wireless sensor networks
  - Data analysis, signal processing and interpretation

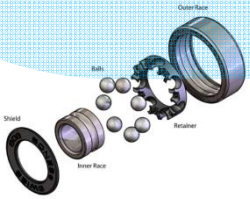
STRUCTURAL HEALTH MONITORING

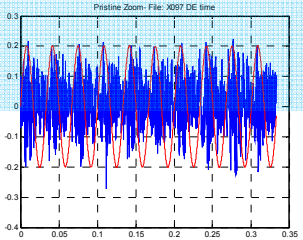
EXAMPLE: RESEARCH OF ANDREA SANCHEZ RAMIREZ

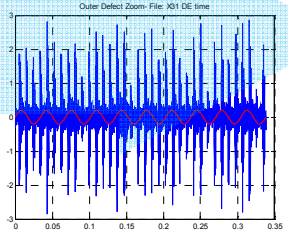
- **Design Framework for Smart Autonomous Wireless Sensor Network**
  - Multidisciplinary (design, signal processing, dynamics, tribology)
  - Various use cases
    - Roller & Journal bearings (trains, machines & gas turbines)
    - Helicopter & wind turbine rotor blades
  - Collaboration in EU project with European partners











/ENTE.

CURRENT / PAST MASTER PROJECTS

Thales: Concept for condition based maintenance on radar subsystems

Sierd Heida – finished December 2013

Imtech Marine: Concept for condition based maintenance for marine systems

Mark ten Dam – finished August 2014

Lloyds: Rail defect identification based on train wheel axle vibrations

Slawik Prosjkin – finished October 2014

WiBRATE: Design of a test set-up for monitoring of rotating blades

Joris Wolters – finished October 2014

WiBRATE: Multibody modelling of rotating flexible blades for SHM

Stefan Oosterik – finished October 2014

CURRENT / PAST MASTER PROJECTS

WiBRATE: SHM based on operational loading – theory and experiments

Ruben Teunis – started December 2014

UNIVERSITY OF TWENTE.

DTP: Energy Harvesting for Autonomous Wireless Sensor Networks

Geert Kottier – started December 2014

MECAL:Monitoring Strategies for Wind Turbines using SCADA and Vibration Data

Dick Breteler – started February 2015

PON Power: Remote Monitoring for Marine Diesel Engines

Bas Aman – starts April 2015

OPEN MASTER PROJECTS

RNN: Developing a condition assessment system for a naval ship

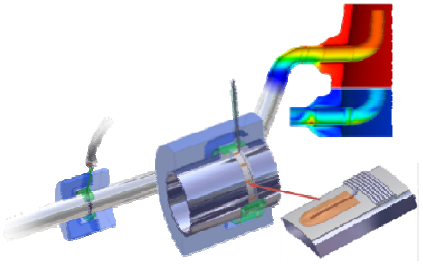
TRIOGEN

Triogen:Rotor Dynamic Analysis for High Speed Turbo Generators

NRG: Fatigue monitoring of nuclear reactors

NLR

NLR, Fokker, Air Force: Effects of 3D printing on Maintenance



NEW MASTER PROJECTS

TNO Rijswijk: Non destructive evaluation of solid state propellant for rocket engines

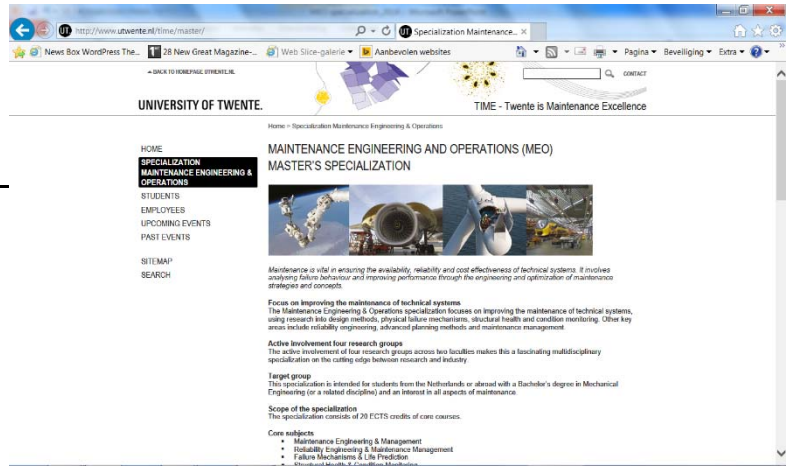
Strukton: Predictive maintenance of rail infrastructure

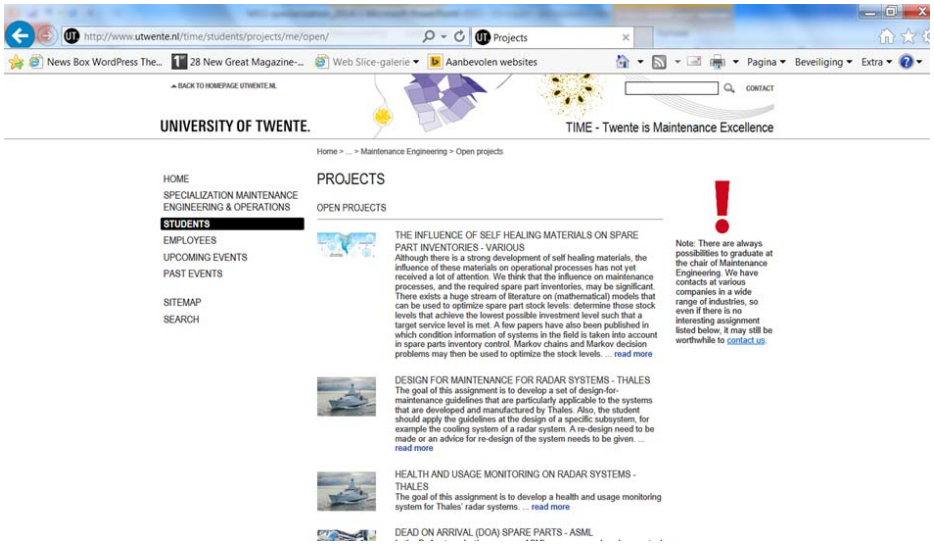
Infrastructures: Structural health monitoring of bridges etc.

Apollo-Vredestein: Smart rubber for car tyres

INTERESTED ?

- **More information**
  - Website: **www.utwente.nl/time/**
  - Contact one of staff members





UNIVERSITY OF TWENTE.

EXPERIENCES WIH MAINTENANCE ENGINEERING AND OPERATIONS

ALICE VAN DER HORST

FIRST YEAR MASTERSTUDENT MEO

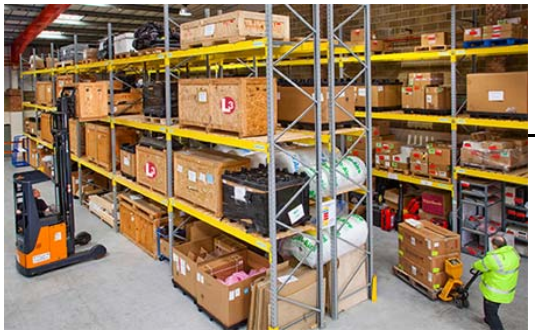
ALICE VAN DER HORST – EXPERIENCES WITH MEO

- Bachelor Industrial Design Engineering
- Pre Master Mechanical Engineering
- Master Mechanical Engineering
  - Maintenance Engineering and Operations

BACHELOR ASSIGNMENT AT NEDTRAIN

NedTrain

UNIVERSITY OF TWENTE.



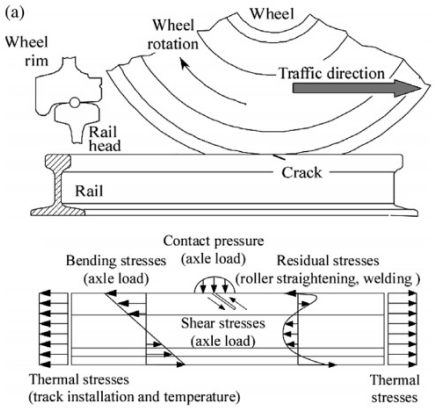
Design for maintenance

Monitoring and data collection for safety and life cycle prediction

Spare parts logistics

Failure mechanisms (corrosion, Fatigue)

Reliability, what is the weakest component? (FMEA and FTA)



When to do maintenance (Preventive or corrective)

If it fails what is the root cause?