UNIVERSITY OF TWENTE.

Specialization
(MEO) MAINTENANCE ENGINEERING & OPERATIONS

Master Mechanical Engineering
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

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Introduction
- Relevance of Maintenance
- Groups / people involved
- Educational program

Research / thesis projects:
- Maintenance Engineering
- Production and Supply Chain Management
  - Maintenance Planning
- Tribology based Maintenance
- Dynamics based Maintenance

Conclusion
INTRODUCTION
BACKGROUND / HISTORY

- **2010-2012**
  - Cooperative research program and Development of Maintenance Master in NL / WCM Summer School

- **2013**
  - Research Center “Twente is Maintenance Excellence” (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

Maintenance concept (remote, preventive) ➔ Maintenance Engineering

Structure + rotor blades + dynamic loads ➔ Sensors + Structural Health Monitoring

Drive-train: bearings + gears ➔ Tribology + Vibration Monitoring

Repairs and spare parts ➔ Supply Chain / Logistics ➔ Maintenance Planning

Corrosion + fatigue ➔ Mechanisms + Predictive Maintenance

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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 Lught – 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
- Advanced Dynamics
- Product design
- Solid Mechanics
- Product Life Cycle Management
- Signal Processing
- Governing Product Development
- 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)
4TH WCM SUMMER SCHOOL on Maintenance Management & Engineering

(DATE CHANGED!)

3RD-7TH OF AUGUST 2015
KASTEEL VAN BREDA · BREDA · THE NETHERLANDS

REGISTRATION UNTIL JUNE 15TH 2015

www.wcmsummerschool.org

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

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 Ruitenbug
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

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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

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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)
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)
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
RESEARCH TOPICS

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

- **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

All based on understanding of system behaviour and physical mechanisms!
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
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

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: Rotor Dynamic Analysis for High Speed Turbo Generators

NRG: Fatigue monitoring of nuclear reactors

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
EXPERIENCES WITH 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

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BACHELOR ASSIGNMENT AT NEDTRAIN

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Design for maintenance

Monitoring and data collection for safety and life cycle prediction

Spare parts logistics

Failure mechanisms (corrosion, Fatigue)

If it fails what is the root cause?

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

When to do maintenance (Preventive or corrective)

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