ASSET MANAGEMENT 4.0

UNIVERSITY OF TORONTO, 10-12 JUNE 2019

Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

C-MORE

Day 1

DAY 1: INTRODUCTION TO ASSET MANAGEMENT IN THE 21ST CENTURY

Day 1 will begin with an overview of asset management (AM) in the 21st century, or what we call Asset Management 4.0. After defining asset management, we will introduce some of the international standards commonly used in AM, such as ISO 55000 standards, GMAM documents, the AM anatomy developed by the Institute of Asset Management, the International Infrastructure Management Manual, and the latest products of the Asset Management Council of Australia. We will explain how they apply to you and your organization. Then we will discuss how to define and set the right policies in asset management, including how to set SMART goals for your organization and for your specific assets and how to mark your progress towards those goals over time to achieve world class performance. Next, we will turn to Industry 4.0 and what has rightly been called the fourth Industrial Revolution, briefly touching on much of the new technology, including augmented reality, autonomous robots, machine simulation, Cloud computing, horizontal and vertical system integration, additive manufacturing, Big Data and machine learning, resiliency vs reliability, cyber security, dependency and interdependency, etc.

What is trending in the field of asset management and what lies ahead in the fourth Industrial Revolution? What new technologies are likely to influence decisions today and tomorrow? What new demographic and social considerations do we need to make? To answer these questions, we will look at a few of the technologies in more detail: artificial intelligence (AI), DEEP learning, Industrial Internet of Things (IIoT), smart contracts, and blockchain. Finally, we turn to questions of leadership and cultural change. How can we manage all this new technology and its potential applications, and what will it mean for our people? We will still need people to perform tasks and managers to define performance requirements. How will this work in our field, as AM advances into an increasingly technological world?

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SPEAKERS ON DAY 1: ALI ZUASHKIANI AND JAMES REYES-PICKNELL

Ali Zuashkiani

Ph.D.

Dr. Zuashkiani, Ph.D., is CEO of PAMCo, a Canadian Consulting Company with projects across the globe. A graduate from Harvard Kennedy School of Policy, Said Business School of Oxford, Wits Business School in South Africa, and INCAE business school in Costa Rica, and PhD from University of Toronto, Ali has been the Director of Educational Programs at C-MORE at the University of Toronto for 13 years. Ali has more than 20 years of practical experience combined with scientific rigour in optimizing asset management decisions in more than 200 plants in +30 countries. His consulting endeavours include numerous Life Cycle Costing management projects for utility and gas distribution companies in North America, RCM implementation projects in power plants, oil and gas companies, and electricity distribution industry, and assignments dealing with asset management practices in 85 plants in the Middle East and South America. His areas of expertise include maintenance performance management, life cycle costing, use of tacit knowledge in asset management, optimization of maintenance tactics, reliability-centred maintenance, root cause analysis, reliability centred design (RCD), planning and scheduling, spare part management, asset management strategy development, implementation of CMMS software packages, and managing change in organizations. He is the author of "Expert Knowledge Based Reliability Models" and a frequent global speaker on a range of pertinent subjects in asset management. Dr. Zuashkiani has been Chair of the International Physical Asset Management Conference for the last 14 years. Dr. Zuashkiani was named by the Asia Society as one of the world's most dynamic young leaders in 2008. He was recognized by the World Economic Forum as a Young Global Leader of 2013. Ali is an RCM2 practitioner working with Aladon Network and is responsible for RCM implementation in the Middle East region.

SPEAKERS ON DAY 1: ALI ZUASHKIANI AND JAMES REYES-PICKNELL

James Reyes-Picknell

James Reyes-Picknell is the author of "Uptime - Strategies for Excellence in Maintenance Management" (2015), “Reliability Centered Maintenance – Reengineered” (2017). He is a Mechanical Engineer (University of Toronto 1977) with over 40 years Reliability, Maintenance and Asset Management. James is widely regarded as a subject matter expert in ensuring the delivery of value from physical assets. His experience spans a wide range of industries, public and private sector, all dependent on physical assets for their success. James career includes naval service (Canada), petro-chemicals, aerospace, shipbuilding, project management, software implementation, management consulting and training delivery. James is a professional engineer (PEng), certified management consultant (CMC), certified maintenance and reliability professional (CMRP), maintenance management professional (MMP), certified asset management assessor (CAMA) and certified blockchain professional (CBP). He was the 2016 recipient of Canada’s prestigious Sergio Guy Award for outstanding contributions to the profession.


FOLLOW ME

Day 1 Sessions

1. Background to asset management (AM)

- International standards, documents, and frameworks, including ISO 55000, GFMAM AM framework, IAM AM anatomy, IIMM, etc.
- What asset management intends to achieve

2. Asset management policy and strategy

- Defining organizational goals
- Defining ways to achieve these goals.

3. Asset management objectives

- Objectives vs goals
- Using the asset management strategy as a basis for long term implementation and sustainment.

4. Asset management plans

- Defining how to manage the various life cycle AM processes
- Applying processes and implementing strategy in each asset class

5. Background to Industry 4.0

- Industry 4.0 and how it relates to the fourth Industrial Revolution
- New technologies: augmented reality, autonomous robots, machine simulation, Cloud computing, horizontal and vertical system integration, additive manufacturing, Big Data and machine learning, resiliency vs reliability, cyber security, dependency and interdependency, etc.

6. Future trends

- Trends in the field of asset management
- New technologies likely to influence future decisions
- Demographic and social considerations

Day 1 Sessions

7. What is Asset Management 4.0?

- Industry 4.0 and Asset Management 4.0
- Trends in automation and data exchange in manufacturing technologies
- Impact of trends on asset management.

8. Artificial intelligence (AI)

- Developments in AI and implications for asset management

9. DEEP learning

- Developments in machine learning and implications for asset management

10. Industrial Internet of Things (IIoT)

- Sensors and data
- Does it make sense to instrument and connect "everything"?
- What can we do with all the data?
- How can we store, transmit and make decisions with so much data?
- "Data distracted"

11. Smart contracts and blockchain

- Definition and applications of blockchain technology
- Definition and applications of smart contracts

12. Leadership and cultural change

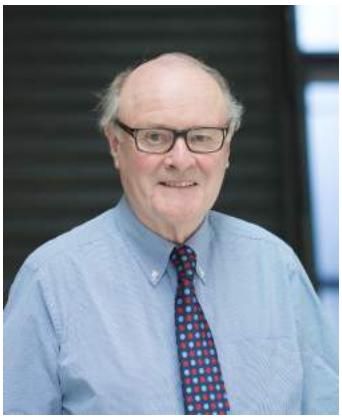
- What technology and its applications mean for the workers in an organization
- How to manage change, including in organizational culture

13. Performance based contracts

- Significance of performance based contracts

Day 2 & Day 3 Morning

SPEAKERS ON DAY 2 AND DAY 3 MORNING: ANDREW K. S. JARDINE, AND JANET LAM



Andrew K. S. Jardine

Ph.D.

Professor Emeritus Andrew Jardine is an internationally recognized expert in engineering asset management whose research and teaching have impacted reliability engineering and industry best practices globally. As Chair of the University of Toronto's Department of Industrial Engineering from 1986-1995, he spearheaded its development into a world leader in academic/industrial collaborations through his creation of the Chair's Advisory Board. He is also Founding Director of the Centre for Maintenance Optimization and Reliability Engineering (C-MORE), where, with the support of a worldwide network of companies, his group produced journal publications, commercialized software packages, and provided postgraduate training to dozens of research students. In his efforts to make academic research accessible to industry practitioners, he has regularly offered training in physical asset management.

Although officially retired, Dr. Jardine continues to teach, consult with industry professionals, and work with C-MORE. His outstanding work represents the perfect marriage of academic rigour and industrial application. Jardine is a Fellow of the Institute of Industrial and Systems Engineers and the Canadian Academy of Engineering. His numerous awards, including the Plant Engineering and Maintenance Association of Canada's Sergio Guy Memorial Award for outstanding contributions to the maintenance profession, indicate the tremendous respect accorded him in his field.

SPEAKERS ON DAY 2 AND DAY 3 MORNING: ANDREW K. S. JARDINE, AND JANET LAM

Janet Lam

Ph.D.

Dr. Janet Lam has a Ph.D. in Industrial Engineering from the University of Toronto and currently serves as the Assistant Director at the Centre for Maintenance Optimization and Reliability Engineering (C-MORE). Her research interests are using maintenance and failure data to develop statistical models that optimize replacement and inspection scheduling decisions.

With over 10 years of experience in maintenance and reliability, Janet's expertise lies in bridging the academic-industry gap, enabling practitioners to benefit from cutting-edge research in academia. As a MITACS accelerate researcher, she worked with Ontario Clean Water Agency (OCWA) from 2010 to 2012 on centrifuge maintenance.

Janet is also a respected instructor with six years of experience teaching undergraduate and professional students. She served as a Teaching Specialist for first year engineering students at Michigan State University from 2016 to 2017 and has given several workshops in teaching and education. In 2017, she was a Fellow of the National Effective Teaching Institute.

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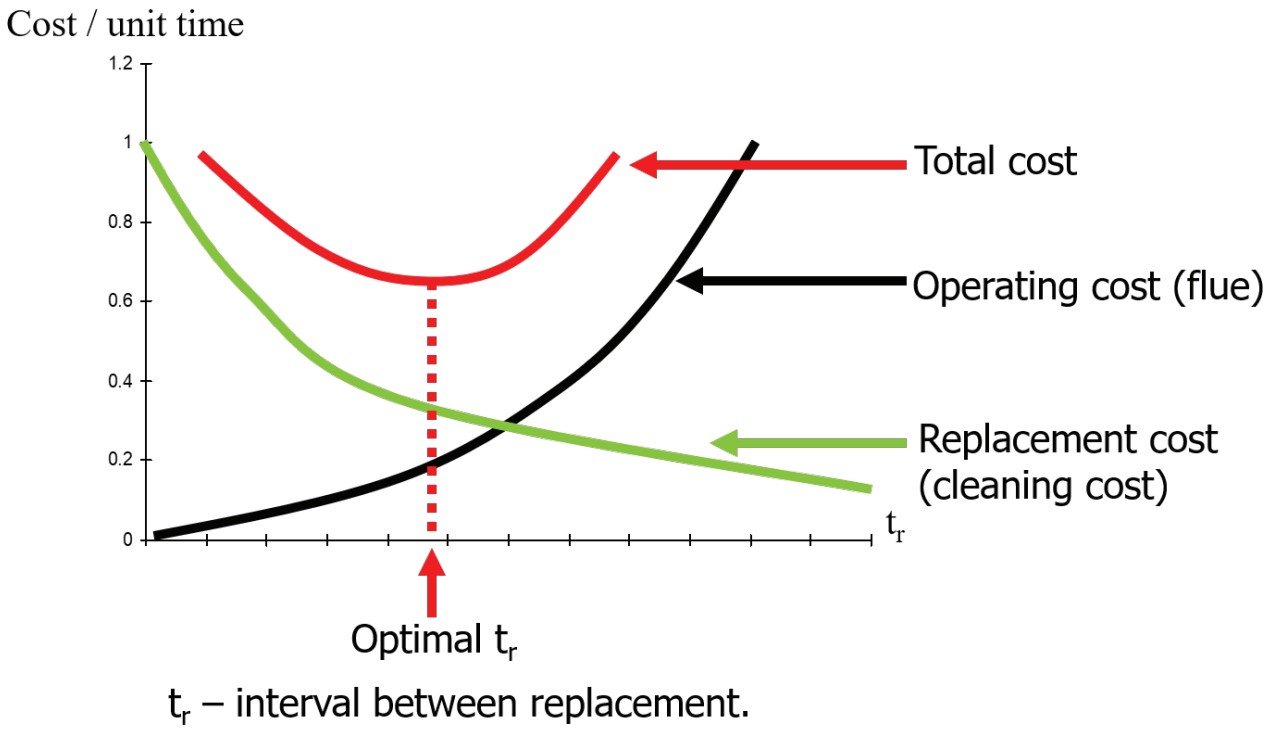
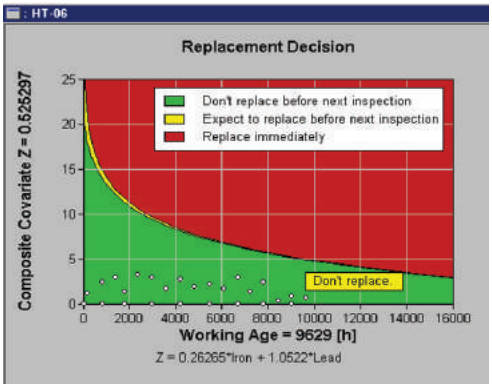
DAY 2 - DAY 3 MORNING: EVIDENCE-BASED ASSET MANAGEMENT (EBAM)

The Evidence-Based Asset Management (EBAM) module offered on Day 2 will introduce the foundational concepts that enable the use of maintenance and condition monitoring data to make optimal asset management decisions, potentially saving companies millions of dollars. We will explain the use of probability distributions, and the Weibull distribution in particular, as powerful tools to describe and predict asset health over time. In order to use and generate these distributions for a firm's particular maintenance requirements, however, a fairly deep analysis is required. Therefore, we will discuss the use of OREST software to engage the Weibull distribution and make optimal replacement decisions. We will also offer some detailed procedures for using limited data to determine the health of the asset. Another dimension of asset management is inspecting the asset or collecting condition monitoring data and using those readings to detect pending expensive failures and make appropriate actions to manage them proactively. For protective devices, it is necessary to periodically inspect them to ensure there are no hidden failures, and they will function in the case of an emergency to prevent costly consequences of multiple failures. With assets equipped with sensors or those with regular condition monitoring measurements, the data can be used to provide information on the health of the asset; this, in turn, is a critical tool for capital replacement planning or fit for service analysis. These and other proven maintenance strategies will be discussed on Days 2 and 3 (morning).



Day 2 - Day 3 (Morning) Sessions:



1. Analysis of component failure data

- PDF, CDF, R(t), h(t)
- Weibull density
- Infant mortality and bathtub curve

2. Exercise in analyzing component failure data using the Weibull distribution

- Estimating the Weibull parameters
- Role of OREST software package

3. Dealing with censored data and the Kolmogorov-Smirnov test

- Censored data
- Checking goodness-of fit

4. Component replacement policies

- Block and age policies
- Case study: finding optimal replacement time for cloth component in a sugar refinery centrifuge when large data sets are available
- Case study: finding optimal replacement time for bearings in a shaker machine in a foundry when only a few observations are available

5. Spare parts provisioning

- Emergency (insurance) spares
- Case study: making the business case for maintaining an expensive insurance spare fume fan shaft in a steel mill
- Case study: determining optimal number of spare repairable components to service a fleet of haul trucks in an open pit mine

6. Reliability improvement through inspection

- Inspection intervals for equipment used in emergency situations
- Optimization of condition-based maintenance procedures
- Case study: detecting reliability growth or degradation for a fleet of haul trucks

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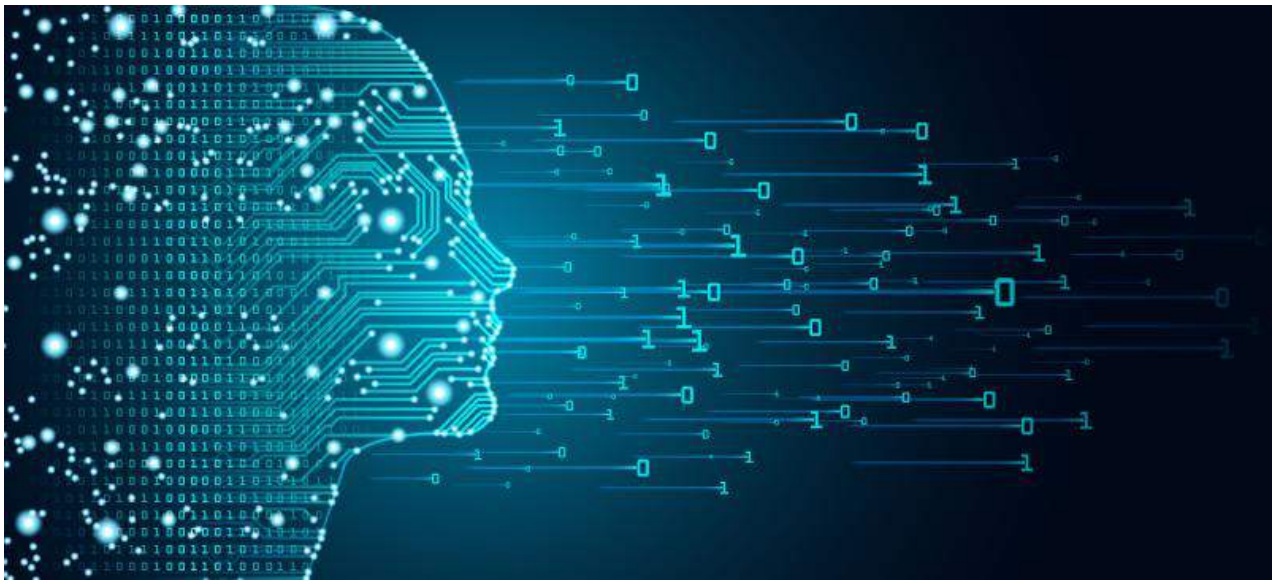
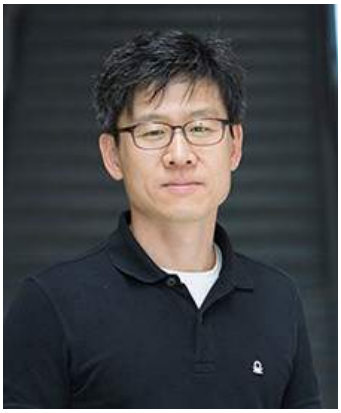
Day 3 Afternoon

DAY 3 (AFTERNOON): MACHINE LEARNING

On the afternoon of day 3, we will discuss machine learning and its implications in more detail. Machine learning is a leading computing technology that aims to enable machines to learn without human involvement. Its popularity has been fuelled significantly by the remarkable success of deep learning, a machine learning method mimicking the way the human brain works. However, the repertoire of machine leaning is not limited to deep learning; the list includes support vector machine, logistic regression, clustering, and reinforcement learning, to name a few. The course will cover some of the most fundamental machine learning methods. C-MORE has actively applied machine learning methods to interesting real-world problems, such as the categorization of power generation units according to reliability characteristics and anomaly detection in linear assets to optimize required maintenance actions. Therefore, in the second part of this module, we will share a few of our case studies to allow students to experience how machine learning methods can be used in MRO (maintenance, reliability and operations). We will conclude the course with a discussion of topics that are not exactly machine learning but are closely related to it. We will also discuss future trends of machine learning and possible applications to MRO.



SPEAKERS ON DAY 3 AFTERNOON: PROFESSOR CHI-GUHN LEE

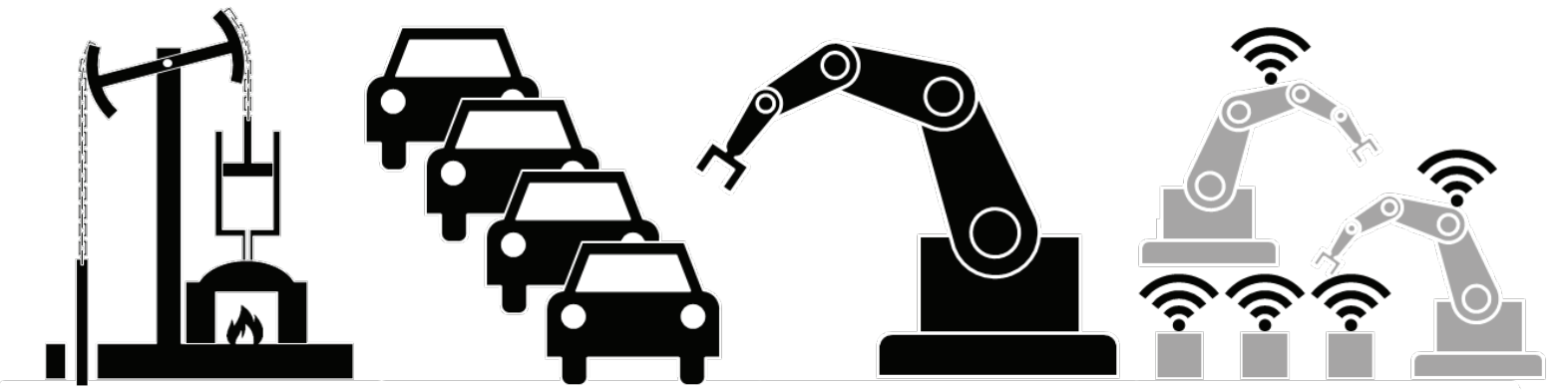


Chi-Guhn Lee

Ph.D.

Dr. Chi-Guhn Lee is a Professor of Industrial Engineering and Director of the Centre for Maintenance Optimization and Reliability Engineering (C-MORE) at the University of Toronto. Dr. Lee received a PhD in Industrial and Operations Engineering at the University of Michigan, Ann Arbor, in 2001. He is active in the areas of dynamic optimization, Markov decision processes, maintenance optimization, supply chain management, and reinforcement learning. He has worked closely with private firms, including IBM, General Motors, Magna International, and State Grid Corp of China, among others.

Dr. Lee has played various roles in the academic community as well. He served as co-chair of the Workshop on Quantitative Finance and Risk Management in 2012, as cluster-chair of Financial Engineering for Canadian Operational Research Society (CORS) Annual Meeting for 2012 and 2013, and president of Association of Korean-Canadian Scientists and Engineering (AKCSE) from 2013 to 2015. He was a member of the Scientific Committee for INFORMS MSOM 2015 conference and a member of the Technical Committee for the 26th International Conference on Flexible Automation and Intelligent Manufacturing in 2016, among others. Dr. Lee has also served as associate editor for two academic journals: Enterprise Information Systems and International Journal of Industrial Engineering: Theory, Applications and Practice.



1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Cyber Physical Systems

Day 3 Afternoon Sessions

1. Introduction of artificial intelligence (AI) and machine learning (ML)
    - Explanation of AI and ML
    - Differences between AI and ML

2. Machine learning algorithms
    - Fundamentals
    - Linear regression
    - Support vector machine (SVM)
    - Logistic regression
    - Deep learning
    - Clustering
    - Reinforcement learning

3. Case studies in asset management
    - Deep learning
    - Clustering

4. Other topics in machine learning and future trends

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GUEST SPEAKERS

GUEST SPEAKER:
David Armstrong

David Armstrong is a Global Business Development Director, Reliability and Integrity Management at Bentley Systems. He serves as Bentley Principal for the Aladon Network and is a certified Aladon RCM2 Practitioner. David has a Master's certification in Enterprise configuration management, along with 20 years' experience in leadership positions in maintenance, reliability and asset management at Hendrickson Canada and ArcelorMittal Tubular. He served as Lean Manufacturing Director for ArcelorMittal Tubular Romania and Maintenance Excellence Transformation Manager at ArcelorMittal Flat Carbon Europe. He is a Senior Change Leader for the Progress Academy and a Six Sigma Blackbelt.

TOPIC: Impact of Digital Twin of brownfield operations.

Technology is moving faster than many businesses can adapt. The goal of this session is to discuss the latest mobile technologies and provide a snapshot of the sliding scale of digital readiness. David will provide examples of the technology behind the creation of the convergence of the virtual and physical, aka the Digital Twin. The Digital Twin can be created quickly and inexpensively through hybrid approaches, using Artificial Intelligence to further classify and quantify asset intelligence. David will go on to explain the latest trends in visual immersive technology that allow the consumption of digital information on demand. Additional discussion points include open source code and the interoperability movement that enables disparate systems to connect to one another without old fashioned integrations. The session will wrap up with a digital assessment focusing on people, process, and technology requirements for best practice and next practice digital organizations.

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GUEST SPEAKER:
Pieter de Klerk

Video Conference

After his study in Aerospace Engineering at the Technical University in Delft, Pieter obtained over more than 20 years of experience as a consultant in Maintenance Management. In 2001, he started working for Mainnovation. Besides the execution of maintenance and asset management related projects, Pieter, as Product Manager VDMXL, is responsible for future developments in the VDM-methodology, like the VDMXL-Control Panel and the application of predictive maintenance techniques. Pieter has broad experience in different branches and industries.

TOPIC: Predictive Maintenance 4.0

The use of big data analytics in predictive maintenance is one of the most talked-about topics in maintenance and asset management. Mainnovation & PWC surveyed 268 companies in Belgium, Germany and the Netherlands to discover where companies currently stand on predictive maintenance, what has changed since the previous survey in 2017, and what plans companies have for the near future. It appears that predictive maintenance with big data analytics (PdM4.0) is not just a fancy topic in an early stage of the 'hype cycle'. Instead, it is proving to be a very powerful new technology that is realising tremendous results and value for companies that have incorporated it into their maintenance operations. This presentation covers the key findings from the survey, including the approach to a successful PdM4.0 implementation

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GUEST SPEAKER:
Markus Krabel

Video Conference

Markus Krabel is Global Director Business Solutions in the SAP Industry Business Unit for Industrial Machinery & Components (IM&C). He is the solution owner of SAP for Heavy Equipment Management and a member of the innovation team for SAP Leonardo Asset Intelligence Network and Asset Strategy and Performance Management. Working in a global role in IM&C, he is the key liaison person for the Asia Pacific region, with a focus on Japan. Since he joined SAP in 1997, he has mainly worked in global positions at SAP business consulting, product development and industry. Markus has enjoyed customer-facing roles in Solution and Business Process Consulting, Project Management, Process Analysis, Application Consulting, Best Practices, Implementation, Solution & Platform Development. Markus' broad experience in software development and solution management across all product life cycle phases comes with solid methodical and business process knowledge. He has a strong commitment to assigned tasks and looks for solutions and sustainable results.

TOPIC: Connect digitally to perfect reality for asset management

In this session, Markus Krabel from SAP will give an oversight of the well-established asset management capabilities the majority of asset management companies rely on. The key focus will be on how SAP has expanded, transformed, and extended these capabilities into five cloud offerings sharing a common central asset data foundation:

- SAP Asset Intelligence Network
- SAP Asset Strategy and Performance Management
- SAP Predictive Maintenance and Service
- SAP Predictive Engineering Insights
- SAP Mobile Asset Management

Together, these enable full digital representation of physical objects, including real-time sensor data for end-to-end visibility and real-time insight across the operating landscape of connected assets.

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