The new industrial revolution is driven by the data collected via new-generation information and sensor technologies. This enables the optimization of a factory or a service-logistics network as a whole, instead of sub-optimizing business units and processes separately.
Scope

The new industrial revolution (Industry 4.0) is driven by new generation information and sensor technologies such as cloud computing, big data and data analytics, robotics and additive manufacturing. These technologies create the internet of things (IoT) in which objects (products, machines, factories, warehouses, customers) are all connected. The increased availability of massive amounts of sensor and manufacturing data that can be shared among the whole supply chain will enable integrated planning in industry to improve manufacturing and maintenance processes and to develop innovative products and services.

Vision

The digitizing industry bears the promise to improve and integrate manufacturing and maintenance planning, thus facilitating the optimization of a factory as a whole, instead of sub-optimizing business units and processes separately. Integrated planning will lead to higher and more flexible production capacity, more efficient maintenance, more reliable production lead times, and lower stock levels. To make this promise come true, the current way of making separate plans for manufacturing and maintenance based on ad-hoc collected data must change.

Research challenges

a) Development of data-collection and data-aggregation techniques to parameterize production, estimation, prediction and maintenance models.
b) Implementation of advanced prediction and estimation techniques (e.g. failures, wear out, demand).
c) Investigate simulation-based optimization techniques.
d) Creation of data-driven integrated prediction and optimization models.
e) Development of a data-driven decision-making framework at operational and tactical level to support integrated production planning and predictive maintenance.
f) Analysis of the value of integrated planning for the whole factory.

Project examples

**Daisy4Offshore, TKI WoZ**
To develop new algorithms for early failure detection to support maintenance of offshore wind turbines.

**Dynamerge, NWO**
Develop new models for emergency service logistics, dynamic planning at operational level, and network design with companies such as Philips, Brandweer Amsterdam, CWI.

**MANTIS, EU ECSEL**
Develop a predictive maintenance platform for smart manufacturing, fleet management, energy production and healthcare.

**Philips Data Science for health flagship**
A joint initiative by Philips and TU/e to create new methods and tools for the smart maintenance of healthcare imaging systems.

**ProSeLo Next, TKI Dinalog**
Creating new predictive maintenance approaches, service business models, and control towers with Marel, Océ, ASML, and Vanderlande.
Exploit the full potential of your data to boost manufacturing and maintenance!

Success stories

**ASML**
A software tool is developed for tactical and operational planning of spare parts that go through engineering changes. The tool uses data from multiple sources within ASML to improve the quality of the planning, which leads to less emergencies, and a reduction of the total workload for the planners.

**Marel Stork**
A sensor system has been developed to continuously monitor the condition of the chain of an overhead conveyor system in a poultry processing plant. This system is capable to accurately monitor and predict the chain length over time, enabling engineers to perform the right maintenance at the right point in time.

**Nexperia**
Advanced optimization algorithms have been developed to automate and improve the weekly scheduling of hundreds of production batches on assembly lines in Nexperia’s semi-conductor plants. Substantial capacity gain is shown to be feasible.

**NXP**
26 gigabytes of production data is translated into valuable information for maintenance managers and engineers. Based on a fluid-flow simulator, a software tool has been developed. Overall equipment efficiency has increased since implementation of the software.

**Philips Data Science for health flagship**
A data-driven approach was developed for the prediction of the useful remaining lifetime of critical components. This approach was implemented into a tool permitting the characterization of the criticality of a predictive alarm and facilitating proactive maintenance.

Scientific staff involved

**Core team**

- **Prof. Geert-Jan van Houtum (RP leader)**
  - Smart maintenance
- **Prof. Ivo Adan**
  - Smart manufacturing
- **Dr. Alp Akçay**
  - Simulation-based optimization
- **Dr. Alessandro Di Bucchianico**
  - Statistical process control, reliability theory, maintenance
- **Dr. Mike Holenderski**
  - Machine learning
- **Dr. Stella Kapodistria**
  - Data-Driven stochastic processes and optimization
- **Dr. Ingrid Vliegen**
  - Project development officer

**Selection of other staff involved**

- **Dr. Rob Basten**
  - Predictive maintenance, spare parts supply
- **Dr. Joos Buijs**
  - Process mining, process modeling, process analysis
- **Dr. Remco Dijkman**
  - Process optimization, data-driven logistics
- **Dr. Rik Eshuis**
  - Data-driven process management
- **Dr. Simme Douwe Flapper**
  - Maintenance, re-manufacturing
- **Dr. Tugce Martagan**
  - Stochastic modeling and optimization, manufacturing systems
- **Prof. Mykola Pechenizkiy**
  - Predictive analytics, evolving data streams, handling concept drift, complex networks
- **Dr. Sasha Pogromski**
  - Manufacturing networks, control systems
- **Dr. Paulo Serra**
  - Bayesian statistics, time series analysis, recursive estimation
- **Dr. Irene Vanderfeesten**
  - Workflow management, business process modelling, human aspects of information systems

**Software**

ProM: An open source and extensible framework for process mining techniques, used to analyze processes and detect deviations. For more information see [www.promtools.org](http://www.promtools.org).
**DSC/e research programs**

The DSC/e consists of over **thirty research groups**, each of which is working on their own topic and/or technique, across **six involved departments**. This wide distribution of research efforts creates many opportunities for new collaborations. By setting up research programs the DSC/e aims to connect these efforts to initiate and align joint research. The research programs are centered around key topics where there is a strong researcher base, with a high impact in research and society.

The program provides a meeting place for researchers and industry to get together and have discussions, workshops or research meetings. The goal is to let novel ideas emerge and collaborations between researchers and external parties to be started or strengthened. It is also important for researchers to be aware of the current industrial challenges, and for industry to be aware of the state of the art of research. Existing external contacts can easily be shared to further increase external collaboration.

**Running research programs**

**Customer Journey** - Prof Mykola Pechenizkiy  
*Informed and responsible analytics to understand and improve the customer journey*

**Health Analytics** - Prof Uzay Kaymak  
*Improving your health through data analytics*

**Internet of Things** - Prof Antonio Liotta  
*Computational intelligence and network science for the Internet of Things*

**Quantified Self** - Prof Aarnout Brombacher  
*Human Vitality & Technology*

**Smart Manufacturing and Maintenance** - Prof Geert-Jan van Houtum  
*Exploit the full potential of your data to boost manufacturing and maintenance!*

More information regarding the research programs can be found on our website: [www.tue.nl/dsce/rp](http://www.tue.nl/dsce/rp)

You can also contact us directly at dsce@tue.nl