



## Project Results

# AVANTI

## Virtual Commissioning test methodology for simulating the behaviour of production systems

### EXECUTIVE SUMMARY

In setting out to increase the efficiency and level of maturity in system development processes through the automated creation of virtual production systems, the AVANTI project took the first step in the right direction. The delivery of a substantial number of convincing results has not only added significant value but has also generated a range of business opportunities in three main domains: automotive, white goods and turbine gearboxes.

### PROJECT ORIGINS

While Europe has a high level of automation and high-quality products, its production systems are still highly complex and need flexible production system design, optimised time to market and extremely high product quality. Against this background the ITEA 2 project AVANTI developed a virtual commissioning test methodology to help leading European OEMs, component and tool providers to gain a competitive edge through two key innovations: (1) virtualisation of the testing process for industrial production lines and (2) the combination of different models and tools for simulating production to create and perform tests for virtual commissioning and industrial application.

### TECHNOLOGY APPLIED

The technology highlights include a co-simulation framework that contains behaviour models and co-simulation, the modelling and simulation of mechatronic components, fast and lightweight FMI-based co-simulation of physical behaviour models, and the integration of co-simulation approaches into existing processes. This performance-based, versatile and scalable simulation approach allows multi-domain simulation based on functional mock-up



AVANTI Application areas

units, the integration of open or black-box component models, protection of Intellectual Property and easy integration into existing Virtual Commissioning tool chains. Another highlight is the Virtual Commissioning Test Generation and Execution Tool for users in the manufacturing sector. This tool automatically generates detailed test cases, performs test cases and provides a detailed overview of the results of test cases performed.

The results of the project are finding their way into the teaching of engineering students (including field knowledge, such as a visit to Daimler to witness virtual commissioning in action). Furthermore, a follow-up ITEA project ENTOC (Engineering Tool Chain for Efficient

and Iterative Development of Smart Factories) due to start in 2016 will use and benefit from the results of AVANTI.

### MAKING THE DIFFERENCE

The technology was demonstrated in the three focal domains, with each participating country taking responsibility for a specific demonstrator. The Finnish partner Moventas targeted a virtual prototyping tool to optimise gearbox efficiency. This cuts both testing time, from 3 to 2 months, and the associated costs, shortens prototype development time and increases the annual energy production (AEP) of a wind turbine. In the white goods domain the Turkish partners wanted to reduce the number of stops of trolleys due to collision

during line commissioning. KaTron is helping to develop the AVANTI Virtual Commissioning Simulator (AViCS) tool to provide a generic co-simulation framework for physics-based industrial simulation for virtual commissioning and automation test processes.

In Germany, responsible for the automotive domain, a demonstrator (Automotive Marriage) for automotive assembly generated automated tests of controller programmes within virtual commissioning and used a highly precise Functional Mock-up Simulation environment for component simulation, system testing, PLC (programmable logic controller) adaptation and physics engine. Furthermore, a demonstrator for factory logistics and material handling focused on physics simulation and 3D modelling along with automated testing of controller programmes in a test environment that could be switched between real and simulated machinery. This will allow Daimler to reduce time for virtual commissioning from 8 to 6 days (+25% efficiency) for a typical automated assembly station.

Standardising automation and functional mock-up interfaces has enabled better

product distribution channels for consortium members and the easy use of standard software, thereby reducing the effort needed to create complex simulation models. Consortium partner TWT has pushed the standards in a new domain (production equipment) while Daimler and others are catching up in terms of production equipment engineering and commissioning. Within five to ten years, within Daimler at least, every new production environment will use the simulation method. To date, Daimler has built its own models for production equipment, taking specs from suppliers to build its own library but now standardised access means better results will be gained through better representation.

All the industrial partners involved will profit from the projects by improving their competence and gain powerful tools in the field of virtual production validation. Service providers and software producers will be able to enhance their software tools and services by investigating new methodologies for the cost- and time-efficient integration of advanced devices in existing and future infrastructures.

## MAJOR PROJECT OUTCOMES

### Dissemination

- More than 10 publication (e.g. Automation 2014 & 2015 & 2016, ETFA 2015 & 2016, IFToMM World Congress 2015, AutomationML-Conference 2014 & 2016)
- Several presentations at conferences/fairs (e.g. Fachkongress Digitale Fabrik 2014 & 2015, ITEA & ARTEMIS Co-summit 2013 & 2015)
- More than 10 Bachelor, Diploma, Master or PhD theses

### Exploitation (Details and contact: <http://www.avanti-project.de/results.html>)

#### New Tools & Services

- Co-Simulation framework
- Process Simulation Tool for gearboxes
- Integrated physics engine and behavior models
- Virtual Commissioning Test Generation & Execution
- Communication Platform for Engineering Data Exchange

#### New Services

- Mechatronic Component Model Description with AutomationML

#### Middleware

- Physics Engine Layer and Corresponding Engine Communication

### Standardisation

Contributions to standard AutomationML:

- Sevrall AutomationML Exporter/Importer
- Pneumatic Plans of Components and Systems within AutomationML

ITEA is a transnational and industry-driven R&D&I programme in the domain of software innovation. ITEA is a EUREKA Cluster programme, enabling a global and knowledgeable community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society.

## AVANTI

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### Partners

#### Finland

Moventas Gears Oy  
Lappeenranta University of Technology

#### Germany

Daimler AG  
EKS InTec GmbH  
Festo AG & Co. KG  
Institut für Automation und  
Kommunikation (IFAK)  
tarakos GmbH  
TWT GmbH Science & Innovation

#### Turkey

Arcelik A.S.  
KaTron Defence AeroSpace and Simulation  
Technologies Inc.

### Project start

November 2013

### Project end

June 2016

### Project leader

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### Project website

<http://www.avanti-project.de/>