ITEA 3

Project Results

ENTOC

The next stage in virtual engineering and commissioning

EXECUTIVE SUMMARY

Production equipment consists of configurations of mechatronic components that are purchased on the market. Through its combination of formalised language concepts and requirements specification and modelling tools, the ITEA project ENTOC proves that their behaviour can be standardised in order to boost the efficiency and adaptability of smart factories.

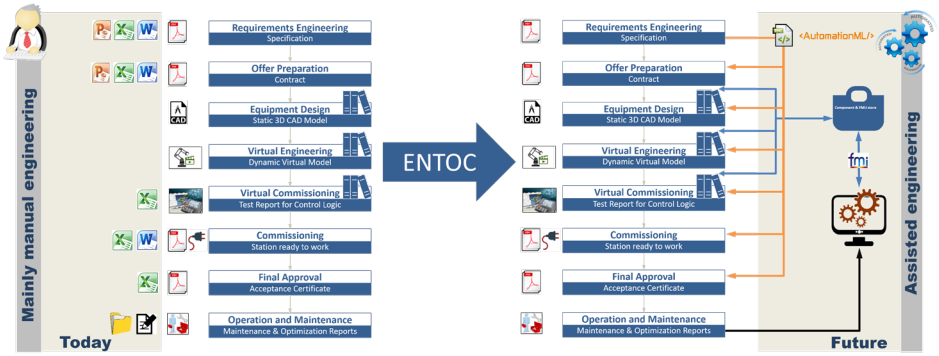
PROJECT ORIGINS

Engineering is the most time-consuming aspect of innovation. Products are also increasing in complexity, yet there has not been a corresponding growth in the number of people involved in production facility planning. Due to the reduction in cycle times needed to remain competitive and the fact that one changed parameter can affect many other areas, problems in the line can have serious time and cost consequences for businesses.

The ITEA project ENTOC (Engineering Tool Chain for Efficient and Iterative Development of Smart Factories) minimises the time and effort involved in engineering without compromising on reliability or integrity. By developing simulation tools, server-based model distribution systems and extensions of existing engineering tools (such as CAD), the consortium generated a formalised specification of requirements that enable the automatic creation of proposals for car/truck manufacturing and machine building. This meant extending missing standards, defining model libraries in an app store-like manner (using bi-directional version management with standardised IDs) and managing intellectual properties. Interoperability across the tool chain was guaranteed through collaboration between OEMs, SMEs and research partners.

TECHNOLOGY APPLIED

Production equipment creation currently begins with the specification of requirements, which engineers bring together manually in a text document for suppliers. One of ENTOC's primary innovations is thus the formalisation of requirements through five language concepts and four tools. These concepts include Unified Modelling Language, RoleClass definition, Natural Language Boilerplates, defining single processes as templates and deriving production equipment structures and production process steps from the product variants.



Optimising the engineering tool chain based on ENTOC results

In terms of tools, two achievements stand out. EDAG's PLCConnect FMU interface integrates FMUs (Functional Mock-up Units) in virtual engineering/commissioning on the basis of the CAD system NX. The easy integration with Siemens' NX MCD allows for the use of FMUs in concept design. EKS's RF:CSPy FMI Co-Simulator, meanwhile, communicates with all tools in their RF::Suite to create a co-simulation environment for several FMUs and acquire real-time data. This is crucial as the behaviour of components must be simulated in a dynamic environment to understand their factory performance.

ENTOC has shown that component behaviour can also be standardised. The resulting standard is currently being incorporated into an external platform for the creation of a digital store in which component models can be purchased from various providers. Whereas simulation models were previously used solely in virtual commissioning, these models can be reused and maintained across different production phases, providing feedback for the requirements definition stage and generating a full digital loop.

MAKING THE DIFFERENCE

ENTOC's success lies in the fact that it opens many doors, changing the face of manufacturing as its innovations are picked up in the wider market. Part of this is adaptability for companies: if the

feedback loop shows that one model is more popular, production can quickly be extended. Efficiency is also key. Whereas the current state-of-the-art is completely manual, ENTOC has achieved a 30% requirements formalisation rate. This should lead to an up to 30% reduction in documenting efforts for OEMs such as Daimler and Volvo. Across all manufacturing domains, engineering process chain duration can thus be reduced by up to 10%, leading to greater competitiveness.

Commercialisation is ongoing for most partners and two tools are already available on the market. As complete software and engineering companies, EDAG and EKS have benefited enormously from PLCConnect and the rfCSPy FMI Co-Simulator. In addition to integrating FMUs, PLCConnect has enabled additional automation interfaces for NX. EDAG has already sold this to ten customers, allowing them to take on at least one additional employee. EKS, meanwhile, has a platform with which new approaches can be realised as prototypes (such as in ongoing ITEA projects like SPEAR, TESTOMAT and XIVT) and virtual commissioning pilot projects can be started via FMUs. They expect a significant increase in simulation results and process time prognosis during virtual commissioning. For all providers, ENTOC also safeguards intellectual property while boosting reputation: formalised descriptions are made for components in the store, providing a quality guarantee for end-users, and a black box set-up prevents the underlying functions from becoming public knowledge.

In order to lay the foundations for future innovations, ENTOC is now pursuing IEC standardisation and disseminating its proof-of-concept at various conferences and workshops. Within the project, OEMs, tool providers and component manufacturers agree that this is the next stage in virtual engineering and commissioning – a crucial aspect of the smart factory market in which the Compound Annual Growth Rate of revenue reached 8.08% between 2013 and 2018. In recognition of this, most ENTOC partners are working on a new ITEA proposal which will combine requirements engineering and Artificial Intelligence in the tool chain to further extend the efficiency, quality and adaptability of manufacturing.

MAJOR PROJECT OUTCOMES

Dissemination

- More than 20 publications, incl. several presentations/demos at conferences/fairs
- Winner of the Best Paper Award at the 22nd IEEE Conference “Emerging Technologies & Factory Automation”

Exploitation (so far)

Development of new products (stand-alone tools) including services:

- Boiler plate requirement specification tool (TWT)
- Tool for project-milestone planning (ifak)
- AutomationML-FMU configurator (EKS InTec)
- Co-Simulation Master (TWT)
- Process for updating the digital twin (Chalmers)

Development of new functionalities (add-ons to already existing tools) including services:

- Product and process requirements Analyz3r (Chalmers)
- 3D modelling tool (tarakos)
- PLC Connect FMU interface (EDAG)
- RF: CS FMI co-simulator (EKS InTec)
- Augmented Reality Model Creator (EKS InTec)
- Collada import to AGX Dynamics (Algoryx)
- FMU export from AGX Dynamics, FMU export from Momentum (Algoryx)
- Automatic cable parameters identification, Cable damage estimation model (Algoryx)

Standardisation

- Extension of the standard “AutomatinML” (e.g. integrating the component description based on the FMU/FMI standard)

Spin-offs

- Foundation of company “in2Sight GmbH” based on results of ENTOC

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.

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Partners

Germany

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EDAG Production Solutions
EKS InTec GmbH
Festo AG
Institute for Automation and Communication (ifak)
tarakos GmbH
TWT GmbH

Sweden

Algoryx Simulation
Schneider Electric Sweden AB
University of Technology Chalmers
Volvo Trucks Corporation

Project start
September 2016

Project end
August 2019

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Project website
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