ITEA 4

Project Results

VMAP analytics

Digital twins and data analysis for the metal industry

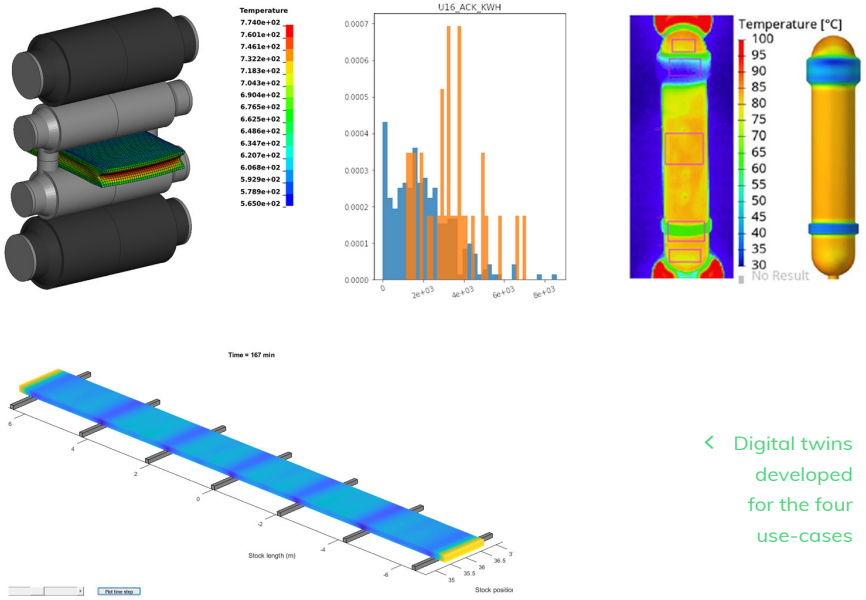
Building on the ITEA project VMAP on interoperable definitions for virtual material models, VMAP analytics (Smart Analytics for Multi-Scale Material and Manufacturing Modelling) enhances digital twins (DT) and data analytics in the metal industry and expands the VMAP standard with multi-scale models, sensor/measurement data and production machine information.

Only a few tools allow producers of advanced materials and complex parts to take a detailed look into ongoing manufacturing processes and changing material properties. Close cooperation is also needed between industry and modellers to obtain relevant data for the validation of models to achieve this. The solution lies in the realisation of smart digital twins and data analytics for materials and manufacturing design tasks.

The vision of VMAP analytics is to bring sensors, measurement data, process modelling and data science tools together in a smart digital twin platform for industrial processes. Through the involvement of use-case providers from the steel industry, real-world processes have been optimised via digital twin development or data collection for analytics that improve control. This enables a deeper understanding of processes, increased process robustness and improved product quality and yield. An association has also been set up to continue VMAP's standardisation efforts, allowing data to be used across multiple software.

Technology applied

When modellers work on use-cases, they typically need specific commercial software to prepare results; this potentially limits their cooperation with industry partners. VMAP analytics therefore developed a smart platform to allow any partner to view results via a graphical user interface. The models remain in the backend while the frontend simplifies the visualisation of results, allowing operators and plant engineers to work with models without dealing with their complexity. For instance, they can vary parameters to see how strip thickness varies with roll diameter, rolling speed or temperature, helping them to understand and optimise profile variation. Such tasks have been demonstrated in four use-cases, each with their own use-case provider and innovations.



Digital twins developed for the four use-cases

For hot rolling (Gränges), a digital twin has been developed that closely mimics the rolling process and uses data analytics to optimise the pass schedule and enable better profile control and more uniform properties. For the walking beam furnace of Prevas, a digital twin can be used to verify the furnace optimisation control system (FOCS) model or simulate different strategies to minimise skid marks. For degassing in the steel melting process (Ovako), data analysis has been employed to allow large amounts of previously unused data to be utilised, resulting in optimised degassing time & top slag mixture and better chemistry control. The sensor data has also been employed for automatic feeding of hot rods to the rolling mill. Finally, blow moulding (Fraunhofer SCAI) has seen a standardisation of ontology and semantics to incorporate measurement data for comparison and validation in a digital twin.

Making the difference

Ultimately, all of VMAP analytics' work is geared to sustainability: by optimising manufacturing process conditions, energy and material use/waste can be reduced while securing a higher yield. Swerim,

for instance, developed a complex finite element model for hot rolling that models 25 passes of a strip versus only 7-10 passes in the literature, enabling far greater optimisation before real rolling takes place. Likewise, the implementation of Prevas' FOCS system on existing furnaces typically leads to 5-10% energy savings, as well as improved temperature control that creates more stable conditions for the hot rolling mill and therefore generates less scrap while increasing yield. Prevas views this as a way to enhance its customer base and remain one of the top furnace optimisation systems on the market.

Less waste without compromising yield translates into cost savings, but VMAP analytics has also helped companies expand their offerings. For example, Gemit was previously active in the water management market but now plans to expand into the metal industry. Through their involvement in the project, they have reduced the data resolution of the software aCurve from minutes to milliseconds and have modified its output to be utilised by other software, such as Python. The software is now ready for exploitation in the steel industry and is partially responsible for their increase from four to ten employees – a significant boost for an SME. Danieli/Morgårdshammar has also demonstrated VMAP analytics' human benefits: their prototype system for handling rods at over 1000°C incorporates sensors to measure diameter, temperature and location, enabling automatic feeding of the rolling mill instead of risky manual work by operators.

Thanks in part to the supportive and collaborative environment fostered by ITEA, the partners will continue to work on standardisation after the project's conclusion. In the VMAP Standards Community, created by the VMAP project, a working group aims to extend the VMAP standard with a global view of data and how this can be used for different processes. VMAP has already been applied in four R&D projects that are separate from VMAP analytics (Pioneer, Restore, Alabama, Hyper Stripes) and their consortia are involved in the VMAP Standardisation Council, bringing the total participants to almost 40. Such commitment beyond the initial scope – in combination with the project's involvement in 11 conferences or industrial forums and four student projects – presents a strong basis for the further exploitation of VMAP analytics' results in the near future.

Major project outcomes

Dissemination

- Several presentations at Swerim's Program Council and a workshop on exploitation of digital twins
- Several presentations at Conferences (eg. ESTAD, NAFEMS world congress, NAFEMS DACH, LS-Dyna users forum, VMAP SC, Jernkontoret Flat Products)
- Three news articles in the ITEA newsletter / ITEA Magazine

Exploitation (so far)

New services:

- Enhancement of capabilities of aCurve for application in metal industry
- Application of digital twins developed in the project for other industries

New systems:

- Automated rod feeding system for higher diameters for the rod rolling mill

Standardisation

- Participation in VMAP standardisation council
- Participation in VMAP user group on sensor data storage

Spin offs

- An efficient tool for exploring plant data for increasing the yield for Ovako based on experience gained in Gränges use case
- A student project correlating increase in rolling loads to skid marks

ITEA is the Eureka R&D&I Cluster on software innovation, enabling a large international 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. ITEA is part of the Eureka Clusters Programme (ECP).

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Partners

Germany

- Fraunhofer

Sweden

- Gemit Solutions AB
- Gränges Sweden AB
- Morgårdshammar AB
- OVAKO AB
- PREVAS
- Swerim AB

Project start

October 2020

Project end

April 2024

Project leader

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