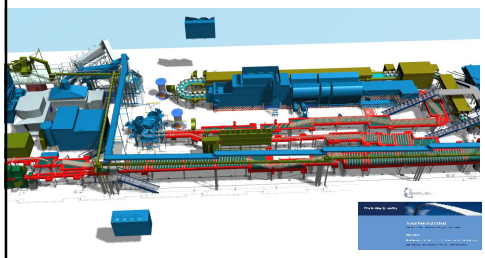
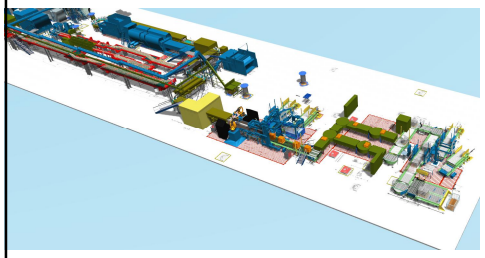
Digital Twin in the Cloud – the results of the EU Research Project “Optimised”



- SimPlan AG
- Dirk Wortmann
- Dirk Wortmann, born in 1967, finished his studies in computer science at the GKS Bad Homburg in 1988. He started his professional career in a Frankfurt engineering office and was involved in the development of simulation software and the implementation of simulation projects in the field of production and logistics. In 1992 he founded the company SimPlan together with his partner Sven Spieckermann. From the founding until 2013 he had been a member of the board. From 2010 to 2018, he set up and developed SimPlan's Chinese subsidiary in Shanghai.



Digital Twin of a building components manufacturing: The EU research project “Optimised” was started in 2015 and finished in 2018. “Optimised” stands for Operational Planning Tool Interfacing Manufacturing Integrated Simulations with Empirical Data. The primary objective was the development and pilot implementation of a manufacturing scheduling optimisation system, which uses smart sensors and big data analytics to monitor, react to and improve manufacturing performance. Three demonstrators of different industries and application focuses were developed:

Demo 1: Alstom’s train fleet management for Virgin´s Westcoast Line in UK

Demo 2: Production order scheduling for a large machining parts production at Goimek in Spain

Demo 3: Planning and Optimisation of a building components manufacturing at Laing O´Rourke (LOR) in UK

The bridge to reality

Digital Twin in the Cloud

Results of the EU Research Project “Optimised”

Dirk Wortmann

Plant Simulation Worldwide User Conference, October 2019, Stuttgart

SIMULATION SOLUTIONS FOR PRODUCTION AND LOGISTICS PROCESSES

Contents

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  - Partners
  - Scope
- Demonstrator 3 – Holistic factory simulation of a building components manufacturing at Laing O`Rourke (UK)
  - System architecture
  - Digital twin in the cloud
  - Energy management in the simulation model
  - Important results and conclusions of the project

About the EU Research Project “Optimised”

Objective, Partners, Scope

EU Research Project “Optimised”

OPTIMISED

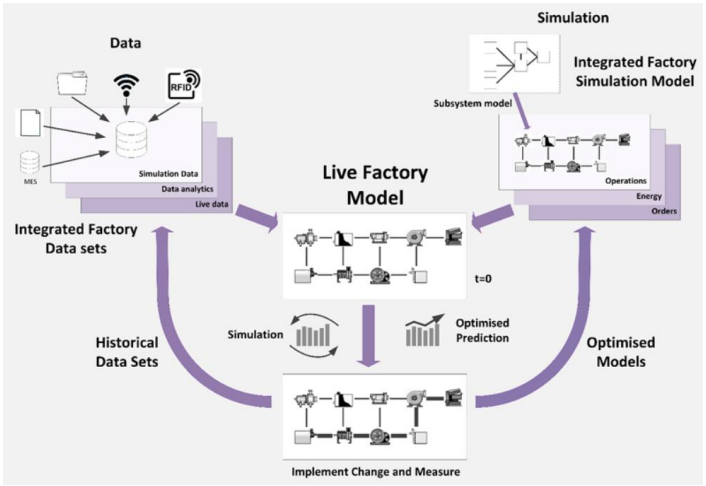
THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION HORIZON 2020

- Operational Planning Tool Interfacing Manufacturing Integrated Simulations with Empirical Data
- Objective:
  - To develop and demonstrate a manufacturing scheduling optimisation system that uses real-time smart sensors and big data analytics to react and improve manufacturing performance. Impact of energy management on factory planning & optimisation is specifically addressed.
- Project Funding:
  - €7m 100% EU-funded (EU Factory of Future call – FoF8, part of Horizon 2020)

EU Research Project “Optimised”

Scope

- Components of the Optimised tool box:
  - Simulation
  - Mathematical Optimisation
  - Live factory data acquisition
  - Integration Platform (MoM = Message oriented Middleware)
  - Dashboard system
- Principle:
  Measure, Simulate, Optimise



EU Research Project “Optimised”

SIMPLAN

Scope

- Demonstrator 1: Alstom’s train fleet management for Virgin´s Westcoast Line in UK

ALSTOM

- Demonstrator 2: Production order scheduling for a large machining parts production at Goimek in Spain

GOIMEK

- Demonstrator 3: Planning and Optimisation of a building components manufacturing at Laing O´Rourke (LOR) in UK

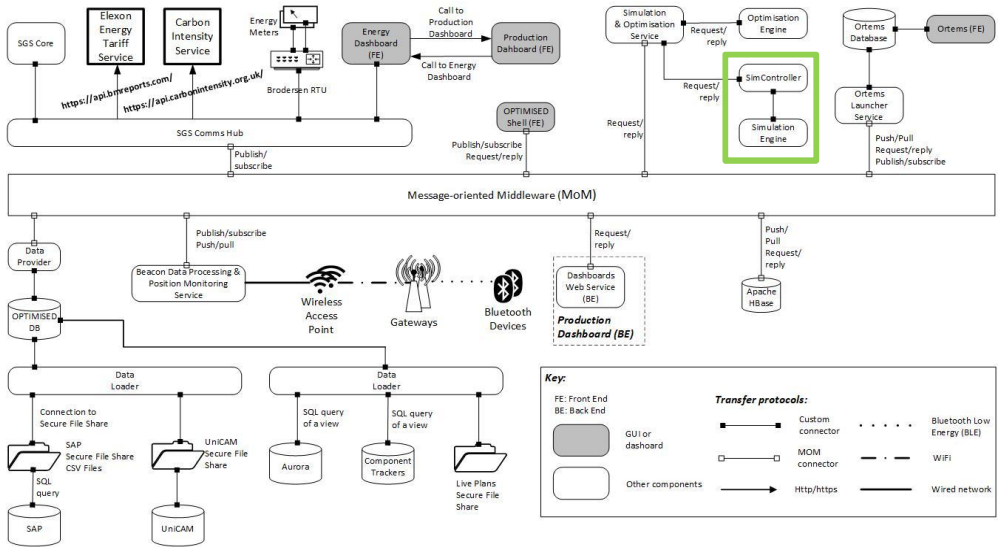
LAING O'ROURKE

SIMPLAN

Demo3 – Holistic factory simulation

Digital twin in the cloud

System Architecture

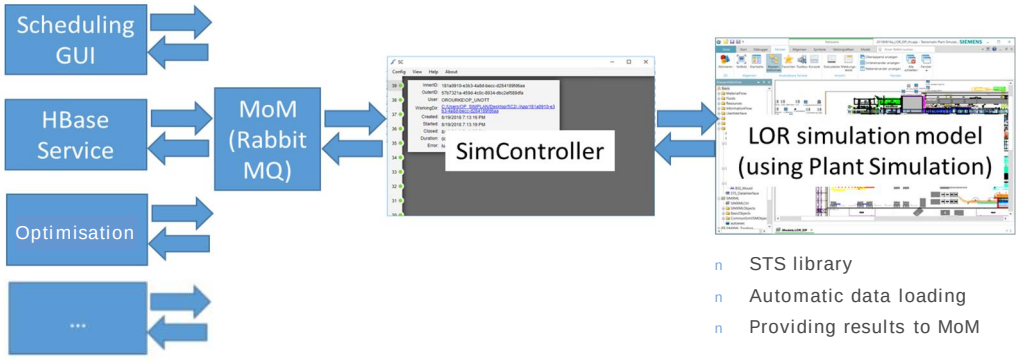


Main objectives:

- evaluation of holistic factory performance in the near future
- evaluation of production schedule, resp. maintenance plan
- Support staff scheduling and production order management

Digital twin in the cloud

- Simulation of the holistic factory model
- Fully integrated in overall system architecture with SimController
- No direct interaction of users with the simulation software

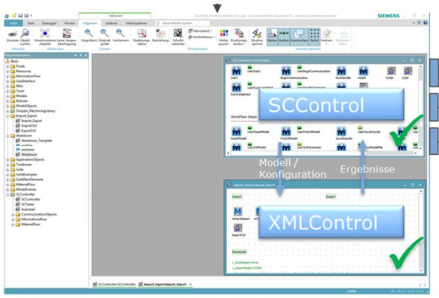


- STS library
- Automatic data loading
- Providing results to MoM

Digital twin in the cloud

SIMPLAN

SimController



SIS
S2C
C2S

„Watcher“ (Startet Simulator)

Internal Communication Layer
Mapping Layer
External Communication Layer
MQ Rabit

Start Services with Parameter-Settings push document to queue “**Simulation.StartRequest**”

{ "Command": "GetOrders"}
{ “Response": SIMXML}
{ "Command": "GetWorkingCenter"}
{ “Response": SIMXML}
{ "Command": "GetWorkplan"}
{ “Response": SIMXML}

ERPDataService

publish State of the Simulation to queue “**Simulation.Result**”

push Result to queue “**Adp.Demo.DataLoader**” in order to store Results to DB

SIS: Connection for socket initialisation
S2C: Connection for requests/reports simulation → client
C2S: Connection for requests client → simulation

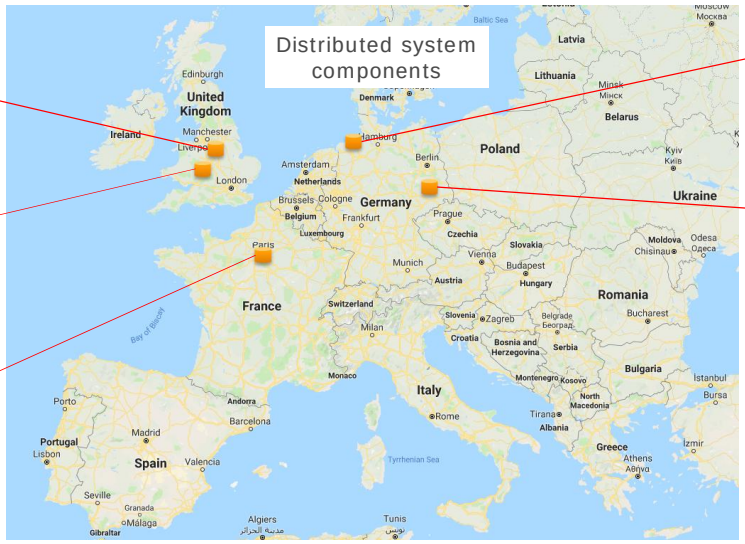
Digital twin in the cloud

SIMPLAN

Factory Data Laing O'Rourke Worksop

Optimisation University of Nottingham

Dashboards Keonys Paris



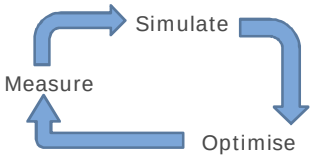
Simulation SimPlan Bremen

MoM, HBase adp Dresden

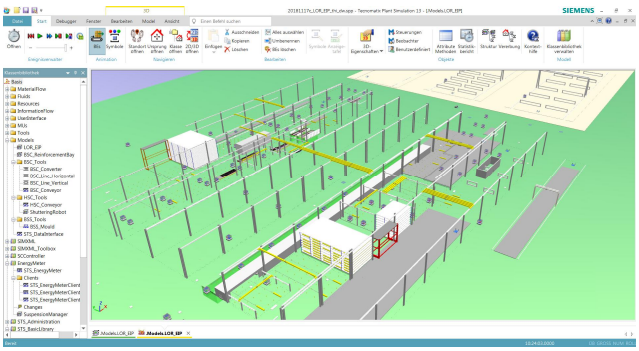
Facts about the simulated process

SIMPLAN

- Complex production process for one-of-a-kind production
  - consider all constraints of the production system such as dimensions and weights of products for processes like crane transports, pallet allocations etc.
  - flexibly allocate space on generate purpose building spaces
  - administrate information flow data such as workplans



- Aspects modelled:
  - space allocation for production line and yard area
  - staff management
  - operations requiring moulds/pallets
  - energy consumption and energy-aware production control

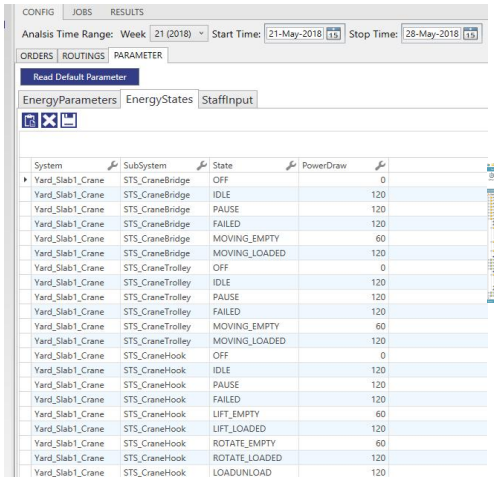


Energy management in the simulation model

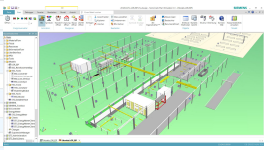
SIMPLAN

- Energy in Simulation
  - Simulate energy consumption of equipment
  - Shop-floor control respecting energy limits
- Purpose: forecast of energy consumption for the near future (analyse week) based on production schedule
- Implementation: simulation library to follow a 2-layer architecture
  - clients in each energy-enabled component to track energy-relevant states of the equipment
  - central component to collect and aggregate values to KPIs
- Integration in Optimised System:
  - Configuration of energy consumption of equipment and parameters (e.g. cost rates) via the optimised shell
  - Results: KPIs of energy consumption, cost and CO2 footprint returned to the MoM

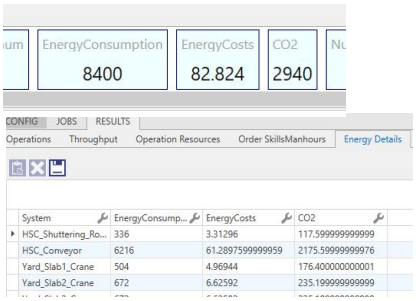
Energy management in the simulation model



Energy configuration of an example system via parameter table



- Configuration of simulation components
- Simulation execution
- Export of Energy KPIs



Energy KPIs after a simulation run (aggregated and detailed)

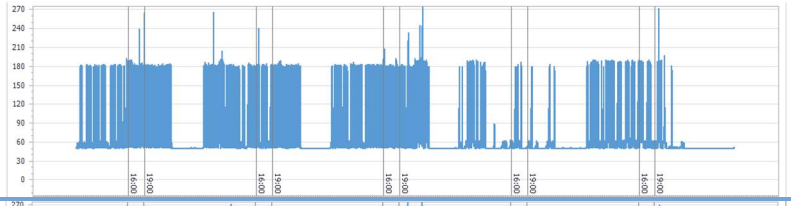
Energy management in the simulation model

- Purpose: enforce an upper energy limit during simulation
- Approach:
  - Energy as a secondary Production Resource
  - Grouping of resources to consumption groups
  - Different budgets for different consumption groups and periods of the day (e.g. low budget during red band period)
  - Energy-enabled components request their required energy from the overall budget
  - Operations potentially have to wait until enough energy is available
- Integration in Optimised System:
  - Energy Limit during red band configurable in the shell
  - Effects implicitly contained in energy KPIs and processing times

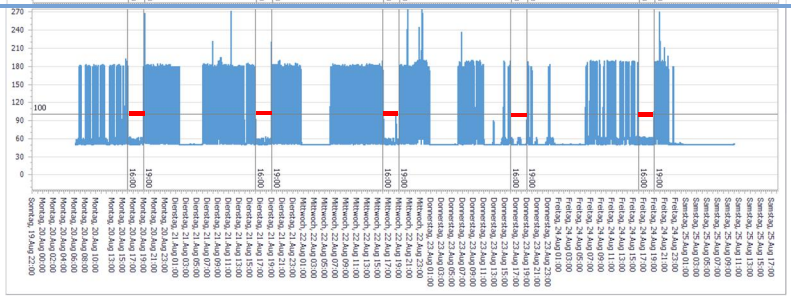
Energy management in the simulation model

- Exemplary Simulated Weekly Energy Consumption (in kW, red-band periods marked)

No limit:



Low limit during red band:



Impact on production process?

- Throughput
- Utilisation
- Adherence to schedule

Important findings and conclusions

- Essential achievements:
  - Functioning pilot of a cloud-based digital twin of a production system driven by live production data
  - Stable and reliable communication between different components of the tool box
  - Detailed forecast of energy consumption and evaluation of the impact of energy management measures
- Biggest challenges:
  - Error-free and consistent data
  - Data errors lead to wrong simulation results which cannot be detected on the first sight
  - Main reason: manual operations
  - Provide all required data automatically
  - Keep the model updated

SERVICE SOLUTIONS SOFTWARE SUPPORT

Thank you for your attention!

Dirk Wortmann

SimPlan AG
Hanau, Braunschweig, Dresden,
Holzgerlingen, München, Regensburg
Sophie-Scholl-Platz 6
63452 Hanau, GERMANY

Phone +49 6181 40296-15
Fax +49 6181 40296-19
Email dirk.wortmann@SimPlan.de
Web www.SimPlan.de