Flexible simulation modelling in the automotive industry

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Content

- Challenges in production simulation
- Flexible simulation modeling
- Case studies (automotive production)
  - Reconfigurable assembly line
  - Modular robotic car-body assembly cell
  - Simulation „tool” for supporting general line design and evaluation
- Conclusions
Fraunhofer PMI and SZTAKI

Institute for Computer Science and Control (MTA SZTAKI)
- Computer science
- Systems- and control theory
- Engineering and business intelligence
- Machine perception and human-computer interaction

Fraunhofer Project Centre
- Modelling and simulation of large production and business systems,
  Digital Factory technologies
- Production planning and optimization
- Real-time, responsive production scheduling and control
- Design and management of co-operative production networks

Budget
13 M €
34% basic funding
30% contract based

Staff
260

Founded in 2010
In cooperation with
FhG IPA Stuttgart
Fraunhofer Austria

Staff
15

Tecnomatix competence

Main references
- Automotive
  - Audi Hungaria
  - Robert Bosch
  - Continental
  - Knorr-Bremse
- Electronics
  - GF Lighting
  - Robert Bosch
  - Hitachi
- Energy
  - GE Energy
  - Hitachi
  - Gamesa

Siemens Plant Simulation
- More than 15 years experience
- Started in 1994 with SIMPLE++ and being HUNGARIAN distributor of it with Aesop Gmbh. in 1996
- Numerous industrial projects in the last 5 years
- + Research and educational purposes
- From April 2014 Fraunhofer PMI is the Tecnomatix competence Centre of Enterprise Group in Hungary
Challenges in production

- Challenges in planning, reconfiguration and operation of a production / material handling system
  - How to evaluate the effect of changes/modification in the system?
  - How to help the ramp-up of the modified system?
  - How to recognize changes, react to deviations?
- Apply material flow simulation (e.g. DES) for decision support,
  - for the validation, ramp-up, anticipatory recognition of production disturbances and estimation of their influences
- but...
  - how to collect data, formalize model, interact with the user for large scale, complex production and material handling systems?
- R&D goals
  - Automatic simulation model generation
  - Model reconstruction methods (from available information)
  - Reuse model components
  - Standardized model input data
DES in production – Current needs of industry

- Case: typical vs. large-scale system to be modeled
- Speed up modeling process
  - Reduction of the most time-consuming and expensive tasks of a simulation project (input data preparation and model building)
  - Automated data gathering and processing (connection to ERP, MES, SCADA)
- Keep simulation models up-to-date
  - Problem of "throw away" or "stand-alone" models
  - Apply simulation models on a daily/weekly basis → "on-demand"
  - Automated model building and parameterizing procedure
- User friendly interpretation of settings and results
  - Use DES models as a black-box on the user side
  - Web-based graphical user interface for reporting and experimentation
- Application domains: e.g., automotive, semiconductor, electronics, component manufacturing

Support data gathering and model building

- **Data gathering** and model building: cover approx. 50% of a simulation project
- Components of the manufacturing automation and control systems (PLC, MES, CNC, NC)
  - Data gathering can be supported by the coupling of simulation with the control systems
  - Model building can be supported by the information stored in the components
- Selected papers on automated model building for manufacturing systems
  - Fowler & Rose (2004), Grand Challenges in Modeling and Simulation of Complex Manufacturing Systems
  - Son & Wysk (2001), Automatic simulation model generation for simulation-based, real-time shop floor control
  - Bagchi et al. (2008), A full-factory sim. as a daily decision-support tool for 300mm wafer fabrication productivity
  - Wya et al. (2011), A data-driven generic simulation model for logistics-embedded assembly manufacturing lines

*Handbook of simulation, Principles, Methodology, Advances, Application and Practice, Jerry Banks, 1998
Self-building simulation

- **Definition**
  - Simulation model is built up by means of the combination of the MES/SCADA data as well as the knowledge extracted from the MES/SCADA data (e.g., resource and execution model)

- **Capability**
  - Plant-level active disturbance handling by using different operation modes of a simulation
  - On-line simulation mode
    - Proactive
    - Reactive
  - (Off-line simulation mode)

Pfeiffer, Monostori, 2007
Flexible simulation modeling

- Reuse model component/models
- Unified data structure
  - Mapping model description and production data (e.g., Excel, DB)
  - Self-building methods
  - Automatic configuration generation

- Rapid model building vs. Flexibility

Case study #1

- Electro-mechanic component production for the automotive industry
- Main goal of the simulation analysis
  - Estimate required (operator) capacity of different line configurations
  - Fine tune line specification parameters
- Results of the simulation based analysis
  - Feedback for the design in form of reports
- Methodology
- Siemens Tecnomatix Plant Simulation software

VIDEO+ detailed description
Case study #2

- Reconfigurable car-body assembly line
- Detailed modular cell model
  - Processes, detailed material flow, assembly operations etc.
  - Automated model building based on predefined data
- Features
  - Simulation of reconfigurations /changeovers
  - Inventory management
  - Shift calendar
  - Calculation of costs
  - Backlog calculation
  - Operators
  - Stochastic events

Case study #3

- Analysis of assembly process-orders, automotive component manufacturing
- Problem description
  - Create a tool for supporting general line design and evaluation
  - Line balancing during design phase
  - Increase utilization of the assembly line(s)
- Challenges
  - Several processes on each workstation, dedicated operators
  - Capable of assigning operators to workstations on a dynamic manner during analysis
  - Handle flexible process-orders
- Solution, results
  - Predefined excel input is applied, containing every assignment, times, failures (MTM level data)
  - Simulation is created by using the self-building methodology

Siemens Industry Software
Thank you for your attention!

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