The Use of Simulation for Manufacturing Applications

SIMMaApp – Special track

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- studied Industrial Engineering at the Technische Universität Dresden, Germany
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- Studied Business Administration and Engineering at Karlsruhe University of Applied Sciences as well as Business Administration and Economics at FernUniversität Hagen.
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- studied computer science at the RWTH Aachen University, Germany.
- at the Fraunhofer Institute IITB in Karlsruhe, Germany: worked primarily on algorithms for production control and received in this field a PhD.
- at SAP AG: several positions (Germany, Japan and USA), at the last as director.
- as a Professor for Production Logistics at the University of Applied Sciences in Regensburg, Germany: work mainly on planning algorithms, optimisation and simulation for operative production planning and control at companies.

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- **Academic:** Mechanical Engineering, spec. Production and Logistics (2007-2014)
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"Interoperable Scheduling of Online Large-scale Self-driving Vehicle Systems for Pickup and Delivery with stochastic Transportation Requests"

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- Studied Informatics and Information Systems at the University of Koblenz-Landau, Germany.
- Applied process thinking to automation technology in the chemical industry for his PhD-Thesis.
- Considered electronic negotiations from a process perspective for his state doctorate.
- Between 2007 and 2015 Professor for Information Systems at the Provadis School of Technology and Management Frankfurt/Main.
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- She completed an apprenticeship as a management assistant in freight forwarding and logistics services.
- Studied International Logistics Management (B.A.) at the Hochschule Worms.
- In her lectures, she came in touch with the learning laboratory and the box game. Interest in process design and Petri nets led her to writing her Bachelor‘s thesis cross faculty on the topic „Visualization and Simulation of a Box Factory“.

The Use of Simulation for Manufacturing Applications

- Modelling of process problems in manufacturing
- Solutions of planning problems in manufacturing
- Simulation of processes in manufacturing

Summary

- Solving Stochastic Resource-Constrained Multi-Project Scheduling Problems (SRCMPSP) is an upcoming topic in industrial practice:
  - A large number of variants, smaller batch sizes and shorter product life cycles lead to more uncertainty.
  - Schedules are often invalid due to high uncertainty and disturbances.
- Ad-hoc scheduling with so-called composite dispatching rules
  - Simulation-based generation of CDR.
  - Using evolutionary algorithm to handle search space.
- Optimizing different objectives with statistical parameters (mean, standard deviation, range…)
  - realization of project-specific objectives with the pareto-dominance concept.

Future Investigation

- Development of a Benchmark-Library for SRCPSP

Summary

- Dilemma of workforce requirement planning in a decentrally controlled production system
- Developing a simulation-based forecasting method to schedule workforce deployment (short- to medium-term horizon)
- Integrating the “worker” as “first level resource”

⇨ Ensure efficient resource planning in decentrally controlled production systems: Including workforce, orders and machines

Future investigations

- Creation of benchmark problem / library
- selection of a suitable metaheuristic and studies on improvement possibilities using ML-techniques

Provision of Model Parameters for Capacity Planning of Aircraft Maintenance Projects – Fabig

Summary:

- In aircraft maintenance projects approx. 40% of workload is corrective and becomes known after project start.
- Order operations of completed projects can be utilized for workload estimation and provision of consistent model parameters.
  - Classifications of maintenance event types, skills, aircraft locations, and project workflow in ERP system.
  - Integrated data wrangling and assignment method has been implemented. Adequate level of detail and can be defined by ‘rules’.
  - In case examples, the resulting workload distribution could be validated using expert surveys. Interface from ERP system to a simulation-based capacity planning software has been created.

Future investigations

- Solving the underlying Multi-Mode Resource-Constrained Project Scheduling Problem (MRCMPSP) through discrete-event simulation.

Scheduling of a real world filter production with lot-size 1 – Herrmann

Summary:

- Real world flow shop scheduling problem have more and more often specific restrictions, not covered by restrictions in standard classification.
- In this case: Simulated processing times should be used in rules. Then, RR and RM local deliver the best mean tardiness.
  - RR is beneficial with low and RM local with (very) high time pressure.
  - RR rule delivers the best standard deviation of the tardiness (for all time pressures).

Future investigations

- Scheduling of workers.
- Limited resources - number of coils or assembly ground plates.
- Efficient improvement procedure – based on behaviour of priority rules.

OTH REGENSBURG

Summary

- Work-in-progress Paper:
  Development of a charging strategy for a large-scale AGV system
- Objective: high fleet availability & reduced traffic density
- Methodology: Modelling and evaluation by a simulation study

Future investigations

- A simulation study will validate and compare the developed methods
- Positioning of Charging & Parking Station will be investigated in detail
- Different batteries varied in their capacity and their loading curve curve will be compared

Summary

- This paper is about a new modeling and simulation technique for Petri nets to observe the raising and discharging of stocks of a production process in order to identify bottlenecks and compare production strategies such as push and pull.
- For this, a novel, web-based Petri net modeling and simulation environment called **Process-Simulation.Center (P-S.C)** has been developed to overcome limitations of existing tools.
- A logistics laboratory for students has been chosen as a sample objective. The simulation now helps the students to scale up their personal observations with respect to time, amount and value.
- The paper explains the situation in the laboratory, the novel features of P-S.C, and the finding of the models themselves.
- The results found are compared with a so-called event triggered approach, that is shortly considered in contrast.

Future work

- The comparison of clock-pulse and event triggered simulation raised the question on how to visualize the simulation results. Especially for high-level Petri nets this is not sufficiently worked out. For the paper, the authors had to export the simulation results and used external tools for the visualization. Instead of this explorative approach a more structured one should be developed for the future.

- A prominent application of Petri nets is process mining. Obviously, there exists a certain duality between process mining which is retrospective and simulation which is forward-looking. It seems to be worthwhile considering this duality and probably to integrate process mining techniques in the P-S.C.

Future challenges in SIMMaApp

- Finding a compromise between generation time for Composite Dispatching Rules and objective fulfillment.
- Integration of the optimization object worker in decentrally controlled systems as a “first level resource”.
- Need for scheduling algorithms taken advantage of highly restrictive technological constraints.
- More effective use of historical data for decision-making processes and for the automated parameterization of simulation models.
- Visualization of Simulation Results for the Optimization of Business and Production Processes.