Challenges of Stochastic Project Scheduling in Manual Manufacturing: A Hybrid Simulation-Based Scheduling Approach

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• Work: Research Assistant (since 2014)
• Interests: (decentral) Production Planning and Control, Machine Learning in Production, Modelling Uncertainty, Simulation-Based Optimization, Evolutionary Algorithms, Lean Production
Agenda

Problem Statement and Motivation „Customized Assembly of Large Products“

State of the Art „Project Scheduling Without Baseline Schedules“

Adressed Goals and Challenges „Benchmarking SRCMPSP, Robust Solutions, ...“

Next Steps „Future Challenges“
Problem Statement and Motivation: Domain Project Manufacturing

Assembly of Large Scale Products with Project Character

Considered Special Problem: Stochastic Resource-Constrained Multi-Project Scheduling Problem (SRCMPSP)

Multi-Project-Character

Network-Character

E.g. Printing Machines

Stochastic Character

Multi-Objective Character
State of The Art: Solutions for Stochastic Influences

- Complete Uncertainty
- Random Variables
- Range of Values
- No Uncertainty

Stochastic Influences

- Online Scheduling
- Robust Scheduling (pro- and reactive)
- Deterministic Scheduling

Stochastic Scheduling

- Manufacturing-Execution-System (MES)
- Without Baseline Schedule + Priority Rules
- Master Production Scheduling (MPS) + Priority Rules
- Advanced Planning and Scheduling (APS)

Static Approach Dynamic Approach

- Solution Approach: Generating Priority Rules with Hyper-Heuristics for Scheduling
  (First proposal by Chand (2019): Evolving Heuristics for Resource Constrained Project Scheduling)

Reference (left): Bianchi 2009: A survey on metaheuristics for stochastic combinatorial optimization
State of The Art: Hyper-Heuristic with Composite Dispatching Rules (CDR)

Hyper-Heuristic-Generation and Representation of Sequencing Heuristic*

Parameter-based representation with fixed length: weighted sum*

\[ CDR(ji) = \sum_{e=1}^{E} p_{we} \cdot PR_e(ji) \]

- Calculated priority index
- Weight
- Job attribute

\( \text{...job}\ i...\text{project} \)

* Branke et al. (2016): Automated Design of Production Scheduling Heuristics: A Review

→ Widely used in Job-Shop-Scheduling, not in Project Scheduling → Scope of the Project Hybrid PPC
General Approach Project Hybrid PPC
Adressed Goals and Challenges (Extraction)

Goals:

• Best possible compensation of disturbance variables and stochastically influenced process parameters
• Multi-objective optimization: Differentiated optimization of project-specific and production system objectives
• Use of practical and easy to collect information in the production system as data basis for CDRs

Challenges:

• Benchmarking SRCMPSP
• Heuristic and solution robustness: Defining evaluation strategies
  • Optimizing conflicting objectives: mean and standard deviation
• Investigation and application of computational fast algorithms for generating CDRs
Adressed Challenge Benchmarking SRCMPSP

Model extension process:

Benchmark Challenge: How to provide a suitable input to other participants solving a given problem instance?

→ information about stochastic distribution or concrete values for a finite number of stochastic scenarios?
Adressed Challenge Optimization of Mean and Standard Deviation

Multi Objectives:

- Project Objectives
  - Project 1
    - Deviation Cycle Time
    - Mean Cycle Time
    - Deviation Cycle Time
  - Project 2
    - Mean Tardiness
    - Mean Cycle Time
  - Project 3
    - ...
- Shop Floor Objectives
  - Mean Resource Utilization
  - Max WIP

Possible Solution: Pareto-Optimization

Challenge stochastic optimization: Which statistical parameters are suitable for optimization?
Next Steps:

- Completion of Modelling
- Development of the Representation of the CDR
- Selection and Development of Fast Computing Algorithms
- Ideas for Initialization: Reuse Simulation Data → Analyzing with Machine Learning Algorithms
Thank you for your interest!

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