ASSISTANT SE Case Study

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Constraint Based Production Scheduling

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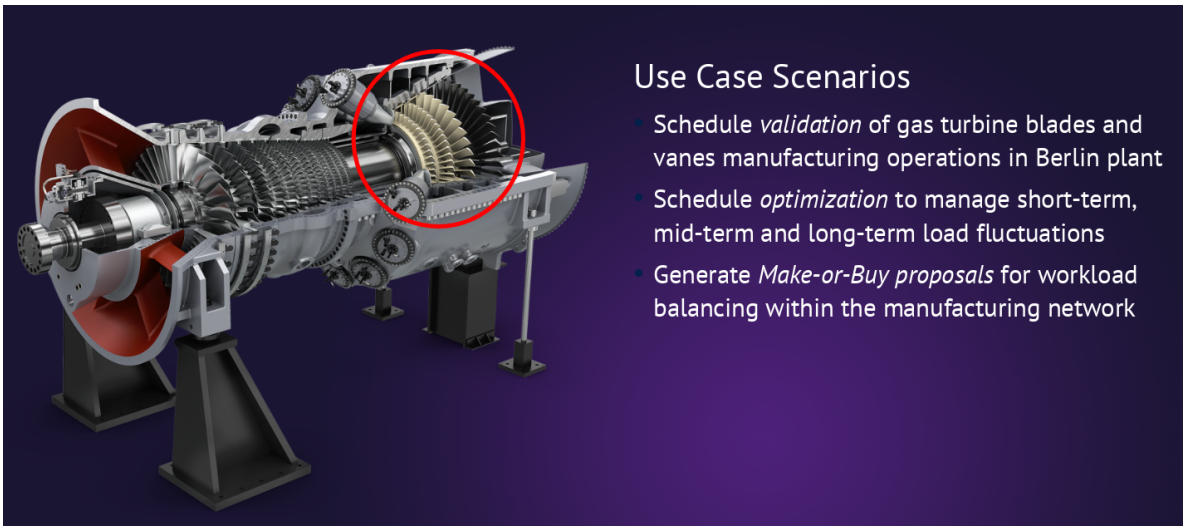
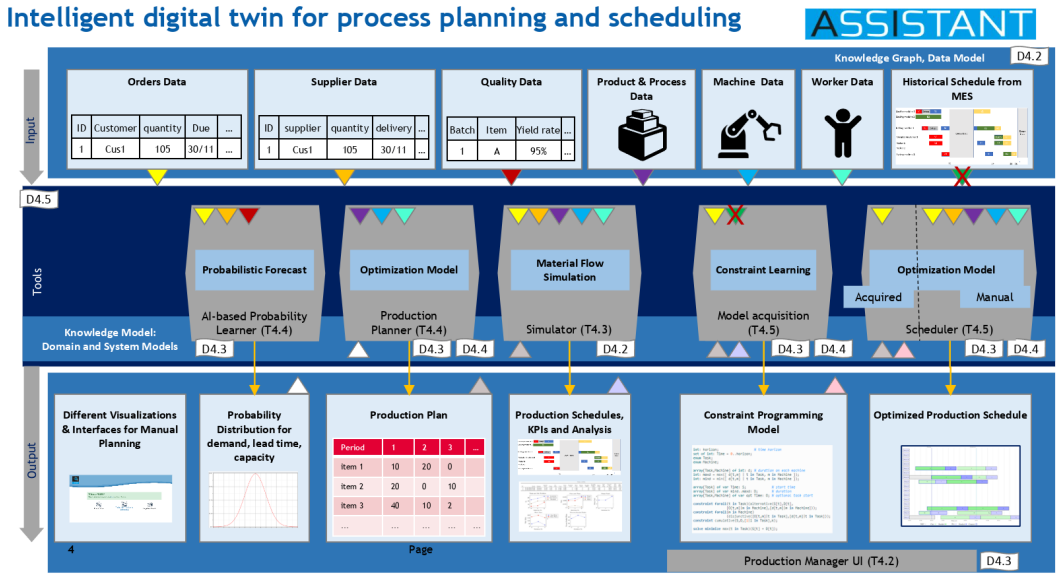
Key Points

- Scheduling/Planning tool for manufacturing industry
- Developed as part of European ASSISTANT project
- Focused on key make-or-buy decisions
- Complex manufacturing process with alternative process paths
- Outperforms both current in-house tool and commercial simulator
- Key Technology: Optimization and Constraint Programming

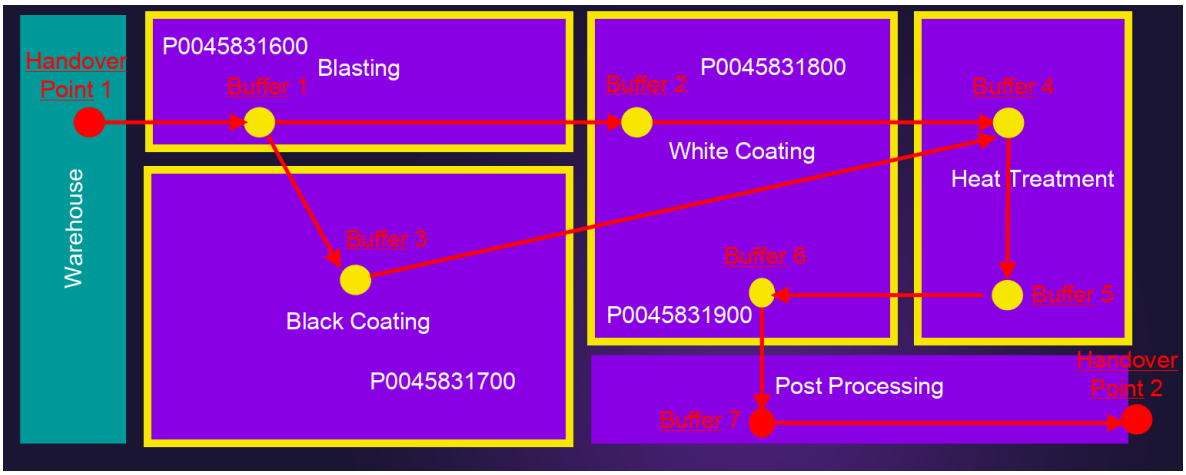
Assistant Siemens Energy Use Case



ASSISTANT Project Overview



SE Product Routing



Test Datasets

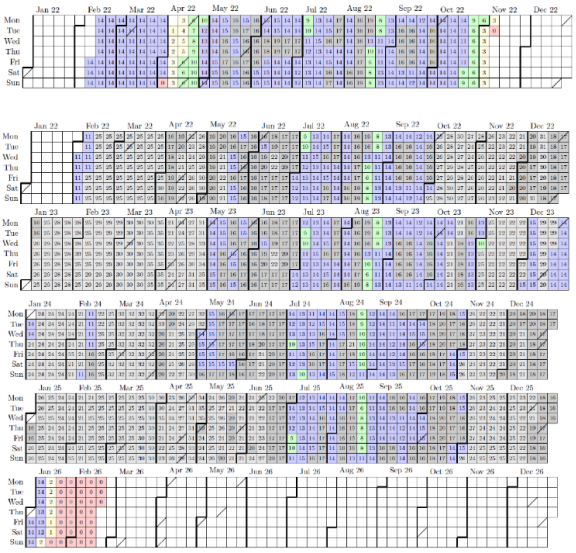
Full Scale Datasets

Berlin06: 96 orders, 9 months horizon, previous review

Berlin07: 450 orders, 4 years horizon

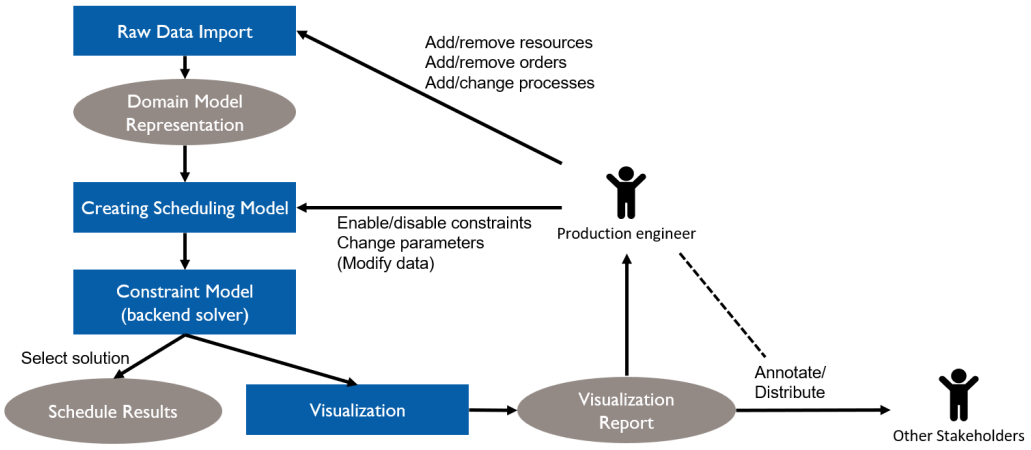
Berlin08: 559 orders, Christmas gap added

Berlin08a: 670 orders, filling gaps



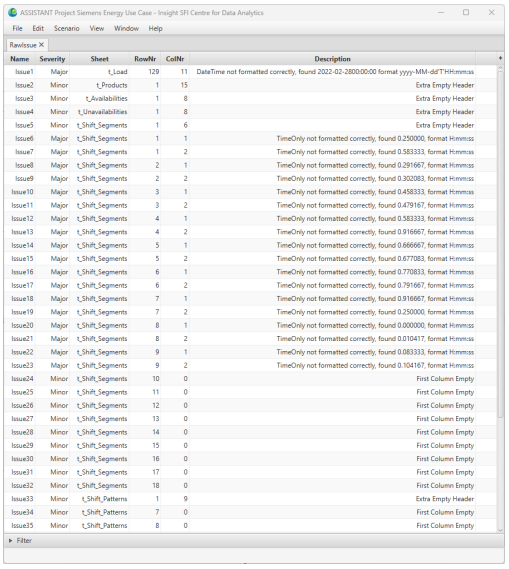
Value in cell indicates active orders
Yellow and red colors indicate low order volume

Optimizer High Level Structure

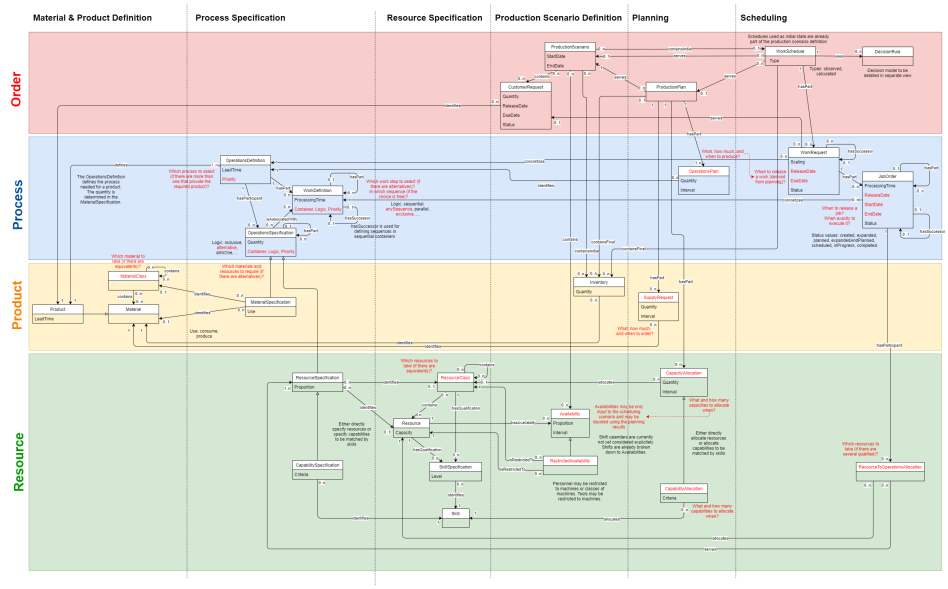


Raw Data - Manual Data Entry Causes Problems

- Raw data come from spreadsheet
  - 20 tabs
- Excel is a particularly bad input data format
- Realistic, not real data
- Created by hand/automatically from existing test scenarios
- Series of files Berlin01 - Berlin05 were too inconsistent to run
- Berlin06 still contains some errors
- Optimizer explains all issues that it finds



Domain Model - Knowledge Graph



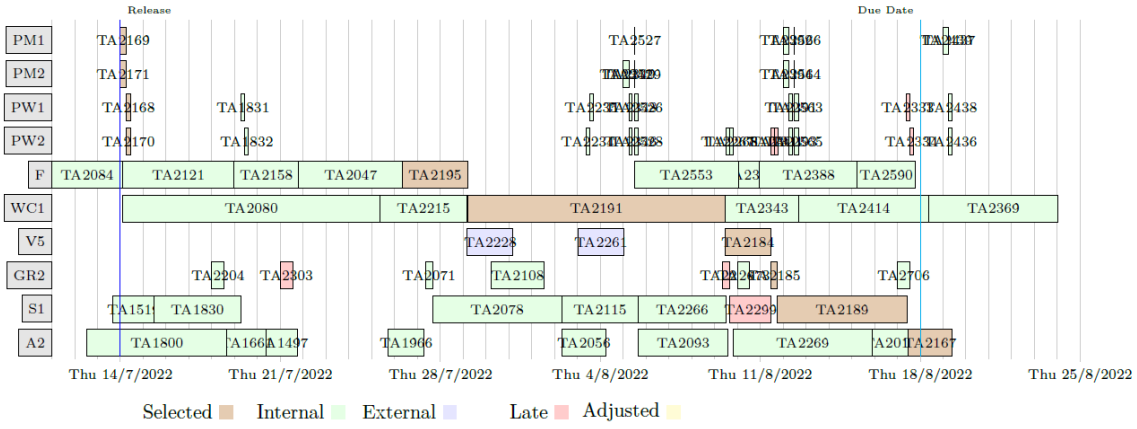
Solution for Berlin 08a - Shows Only 20% of Tasks in Model

Implementation

- Requirement capture done inside project
- Data checking/cleaning most time consuming aspect
- Some specified functionality was rejected by Betriebsrat
- Built in Java
- Uses IBM's CPOptimizer back-end
- 120k LoC, 110k generated, 3k solver
- Outperforms both
  - Current in-house tool
  - Simulation based tool based on commercial simulator
- System installed at SE site, but not in daily use

Explaining Late Delivery

- Explain why some orders are delivered late
- Find root-cause, show schedule in context



Evaluation - KPIs

KPI	Baseline	Optimizer
OTD	> 80 %	92 %
Bottleneck machine utilization	99.5 %	100 %
Manufacturing defects	10-15 %	< 10 %
Scenarios in 8 hours	15-20	> 100,000

Conclusion by Siemens Energy

*"Within less than eight hours the **ASSISTANT** tools provided us thousands of manufacturing scenarios including different make-or-buy recommendations for making deliberate decisions on the way to proceed for strategic planning."*

from ASSISTANT final project review: Siemens Energy assessment

Summary

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