Quantum Technology in Flexible Job Shop Scheduling? A Field Report Using Digital Annealer

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Sören Wilmsmeier, Head of Production Planning and Control, Institute of Production Engineering and Machine Tools, Leibniz Universität Hannover
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Quantum Algorithms: Between the Poles of

Rudimentary ↔ Too Complex
A „Taste“ of Quantum
Real World Example: Flexible Job Shop Scheduling

Machine 0

Machine 1

Machine 2

Time

0 1 2 3 4
> 10^{100}
Map to Quantum

Production Plan  Fingerprint  Qubits
Quantum Annealer

- Energy
- Solution
- Qubit states
A “Taste” of Quantum: Digital Annealer

quantum intuition → massively parallel
10,000 x faster

60 s vs 166 h
Tape Dispenser Production

- Individual configurations
- Automatic production planning
- Lot size 1 production
Tape Dispenser Production

- 40 jobs
- 4 operations
- 6 machines
- 2 scheduling decisions
- $> 10^{287}$ schedules
Evolution of scheduling

Quantum Computing

Digital Annealer

ML & AI

MES

Rules

Optimal

Adaptive

Dynamic

Rigid

[Bild: Gert Altmann, Pixaby.com]
Results

<table>
<thead>
<tr>
<th>MES with scheduling rules</th>
<th>MES with genetic algorithm</th>
<th>Digital Annealer</th>
</tr>
</thead>
<tbody>
<tr>
<td>338 h</td>
<td>276 h</td>
<td>201 h</td>
</tr>
</tbody>
</table>

Production time

-40 %

-18 %
Digital Annealer vs. Other Classical Methods

Faster

Better Results

Higher Scalability

Higher Flexibility
Business Value: Higher Flexibility

Throughput

Delivery Reliability

Last Minute Orders

Production Outages
Near optimum sufficient – Digital Annealer
Combinatorial problems

Absolute optimum – Quantum Annealer
Decryption
Digital Annealer ...

Moves the boundary of Quantum Advantage

Proven relevance for Job Shop Scheduling

Wets the appetite for Quantum Advantage