REACTIVE SCHEDULING OF MULTI-STAGE, MULTI-PRODUCT FOOD INDUSTRIAL PLANTS

Motivation & Scope of the Study

- Scheduling-related decisions are mainly derived by managers and operators.
- Overall plant performance is subject to their experience.
- Very few real-life applications of optimization-based scheduling.
- Main objective is to optimize the production schedule for a real-life multi-product multi-stage food processing facility.

The examined production scheduling problem

<table>
<thead>
<tr>
<th>Given</th>
<th>Determine</th>
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<tbody>
<tr>
<td>Operational data, e.g. available equipment, processing rates, changeovers</td>
<td>Batching/lot-sizing of product orders</td>
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<td>A weekly demand</td>
<td>Assignment of batches/lots to units</td>
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<td>Full demand satisfaction</td>
<td>Timing and sequencing of batches/lots</td>
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Minimize production makespan
Reduce idle times and changeovers

Modelling Framework

The proposed solution strategy consists of:

- A decision making process
  - Batching and lot-sizing decisions are optimized using a batching algorithm.
  - Optimal utilization of the sterilization chambers (batch process)
  - A novel continuous general-precedence-based mixed-integer linear programming model is employed for the unit allocation, timing and sequencing decisions.
  - Plant-specific constraints (e.g. foodstuff quality) cleverly integrated

Case Study

<table>
<thead>
<tr>
<th>Product order</th>
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<tr>
<td>b0 b1 b2 b3 b4</td>
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- A bi-level decomposition strategy utilizing a relax-and-fix forward heuristic
  - Breaks initial problem into tractable subproblems
  - As a result reasonable computational time is required

Real-life Use Case

- FRINSA del Noroeste: One of the largest canned fish industries in Europe
- Main plant characteristics:
  - Four processing stages with multiple parallel units
  - Mixed-batch and continuous processes
  - More than 400 product codes
  - Large production with high granularity
  - High production flexibility
  - Order-driven demand
  - Not clear production bottlenecks
  - Efficient tailored-made models required to get nearly optimal solutions

Scheduling Results – Weekly Demand

Conclusions & Future Work

Key points

- Optimisation-based scheduling of a real-life food processing industrial plant of significant complexity. A problem of this size has never been successfully studied before.
- Acceptable total computational time: 68.6 mins
- Optimized schedule leads to significant reduction in overtime production.
- The proposed strategy can be the core for a computer-aided scheduling tool.

Future Work

- Cost objective minimization
- Rescheduling actions (order cancellations/modifications)

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