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

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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

Given
- Operational data, e.g. available equipment, processing rates, changeovers
- A weekly demand

Considering
- Full demand satisfaction
- Tight operating and design constraints

MILP-based solution strategy

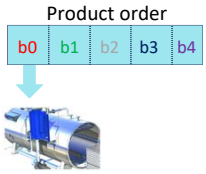
Determine
- Batching/lot-sizing of product orders
- Assignment of batches/lots to units
- Timing and sequencing of batches/lots

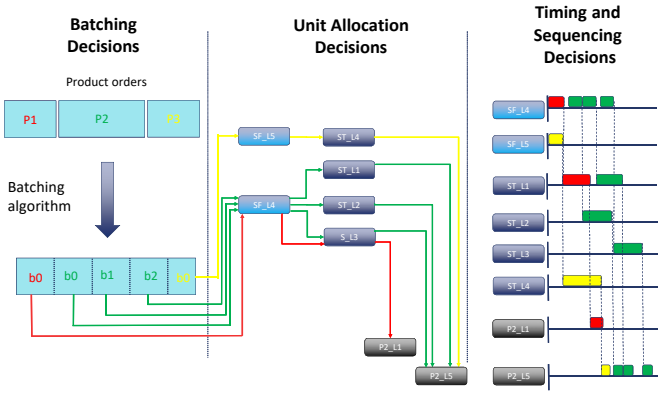
Minimize production makespan
Reduce idle times and changeovers

Modelling Framework

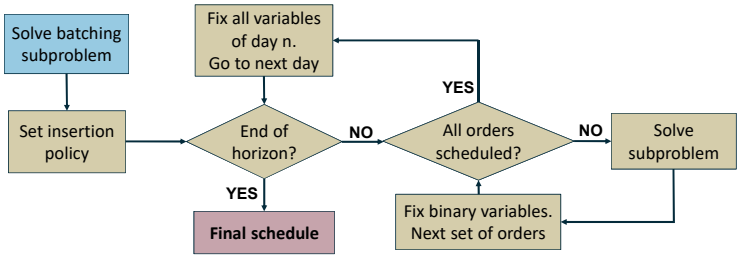
The proposed solution strategy consists of:

- 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



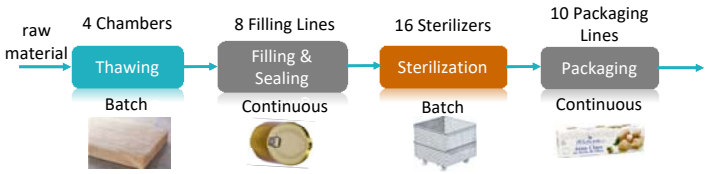


- A bi-level decomposition strategy utilizing a **relax-and-fix forward heuristic**
  - Breaks initial problem into tractable subproblems
  - As a result reasonable computational time is required



Real-life Use Case

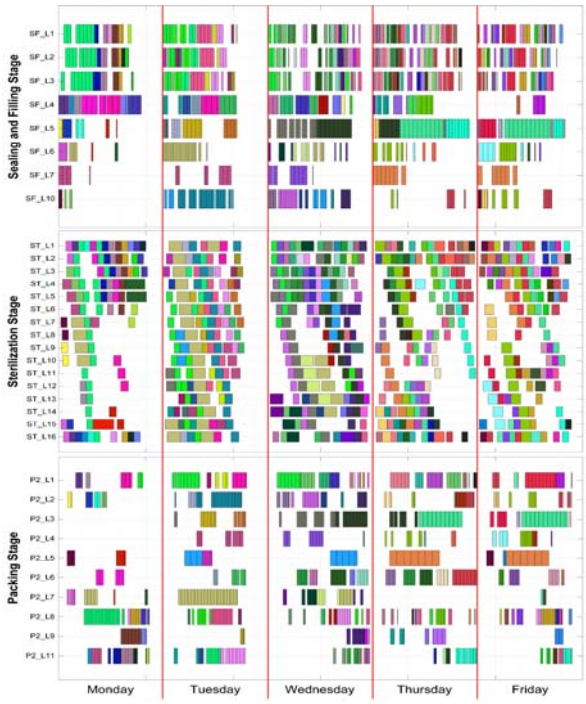
- **FRINSA del Noroeste:** One of the largest canned fish industries in Europe
- Main plant characteristics:
  - Four processing stages with multiple parallel units
  - Mixed-batch and continuous processes
  - More than 400 product codes
  - Large production with high granularity
  - High production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



Scheduling Results – Weekly Demand

Case Study

- Proposed mathematical framework employed on a **real weekly demand**
- Thawing stage is overdesigned, not included in the optimization process
- Solution strategy implemented in GAMS utilizing the CPLEX 12.0 solver



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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