The objective is to decrease downtime caused by change-overs by optimizing the production schedule. More than 300 different product variants are scheduled and produced on the same production lines. Many change-overs take place due to many different liquid formulations and package types, which cause large production down times, waste and unnecessary energy consumption / use of resources.

Optimising Production Scheduling - Modelling Framework
- Multi-product continuous process
- Tight operating constraints
- Products due dates
- Real problem instances provided by P&G.
- Full weekly demand satisfaction
- Production stage constraints are integrated to eliminate infeasible schedules
- A continuous general precedence based Mixed-Integer Linear model
- Unit allocation, timing and sequencing decisions are optimally taken
- Maintenance restrictions are also taken into account
- An efficient decomposition-based approach has been investigated

Results - Discussion
- Various case studies have been considered and detailed nearly optimal production schedules have been generated for over 130 products scheduled weekly.
- The proposed model can assist decision makers towards rigorous scheduling plans in a dynamic production environment under realistic uncertainty.

Conclusions
- Efficient MILP based decomposition approach for the solution of problems with arbitrary number of products
- Efficient computational times (~2 CPU minutes)
- Production/formulation stage as well as the maintenance constraints are considered to guarantee feasible schedules in the production stage

Decomposition Algorithm
- Insert product orders 5-by-5 (or 1-by-1) and solve the MILP model
- Allocation and global sequencing binary variables are fixed
- Unit specific immediate precedence binary variables remain free
- When all orders have been inserted the schedule is constructed

Agile Layout
- Decoupling of the formulation and packing stages
- Increase in formulation throughput by decoupling from the packing line
- Minimisation of changeovers by efficient utilisation of the available capacity

Modelling Framework
- Discrete-time based MILP model with tracking of the available buffer capacity
- Material balances for the intermediate buffer
- Efficient order and temporal decomposition
- Unit allocation, timing and sequencing decisions are optimized
- Due dates are accounted for in a rolling horizon fashion

Exemplary Buffer Profile for a small test case

Layout 1: Nearly Optimum Weekly Schedule for 130 Products

Layout 2: Nearly Optimum Weekly Schedule for 130 Products

Optimisation of production scheduling

P&G Case Study

Layout 1: Nearly Optimum Weekly Schedule for 130 Products

Layout 2: Nearly Optimum Weekly Schedule for 130 Products

Ongoing – Future work
- Testing of the model on real-life data and demands provided by P&G
- Validation studies to assess the derived schedules (by P&G)
- Comparison of optimal schedules of the agile layout with current production schedules
- Comparison of optimal schedules for the current and the potential future layout
- Investigation of various storage policies and buffer capacities
- Assessment of the benefits of the agile layout

Exemplary Buffer Profile for a small test case

Total Stored Amount

Buffer Amount of different Orders

Positions in Buffer

Time

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