The work concerns the production of fast moving consumer goods. The process consists of two stages, filling of pouches and packing. We consider a layout where the two stages are decoupled by a buffer. This makes a better use of the capacities of the two stages possible because the bottleneck can be either stage, depending on the product. The goal is to maximise the overall throughput by minimising idle times and changeover times.

## Use Case

### Problem characteristics
- Sequence-dependent changeover times
- Product families of intermediate products on the formulation lines
- Approx. 300 final products on the parallel packing lines
- Processing rates do not depend on the assignment to the lines.

### Decisions
- Allocation to the lines
- Sequencing
- Timing

### Objectives
- Maximisation of plant capacity utilisation
- Assessment of different layouts

## Results

### Planning and scheduling of make-and-pack processes

The models
- Precedence-based MILP model
  - Decide product sequence on the packing lines
  - Changeover times are minimised
  - Optimised packing line allocation and sequencing
- Discrete-time MILP model
  - Decide when to start an operation on which line
  - Determine the timing of the packing lines
  - Decide on the allocation and timing on the formulation lines
  - Satisfy buffer capacity constraints

### The Algorithm

1. Pre-sorting of the list of product orders w.r.t
   - Deadlines
   - Product flexibility
   - Take subset of orders
   - Solve precedence-based model for the packing lines
2. Obtain optimal allocation and sequences on the packing lines
   - Determine the timing of packing operations
   - Fix previous decisions and shift the time horizon
3. Sorting of the list of product orders w.r.t completion time of packing line products
   - Take subset of orders
   - Solve discrete-time model for the packing lines
   - Obtain optimal
     - Formulation line allocation and timing
     - Buffer profile
     - Packing line timing
4. Fix previous decisions and shift the time horizon

### The Workflow

#### Production data pre-processing
- Read product demands and product properties
- Calculate case specific parameters

#### Solution algorithm
1. Pre-sorting of the orders
2. Pre-optimisation with precedence-based model
3. Heuristic resorting
4. Final optimization using a discrete-time model

#### Results
- Optimal schedule for short-term operation
- Evaluation of the benefit of the buffer
- Decision support

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This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 723575