Development of optimal production plan for the Nestlé pro-biotic factory in Konolfingen

1 Motivation for simulation

• The food industry is confronted to high dynamism and complex processes with special setups (cleaning and sterilization).
• Quality and best-before requirements are tight and raw materials less controllable because of rapidly changing quality approvals and the growing number of interacting suppliers.
• The products are perishable and have, due to conditioning reasons, very high inventory holding costs.

2 Industrial challenge & Objectives

• Food products of the same category often have to share the same production line due to profitability reasons.
• Only one product and batch can be produced at a time (discrete lot-sizing and scheduling problem, DLSP).
  → The best sequence and the optimal lot-sizes have to be determined by considering a tradeoff between production and inventory holding costs.

3 Context based Analysis

This structural decomposition shows the location of the decoupling point, separating the planning-driven activities from the customer-driven activities. This differentiation is important as the internal planning organisation changes. Planning-driven orders are produced-to-stock and the customer-driven activities are assembled-to-order.

The planning software developed during this master thesis delivers production plan for this specific location:

- Raw materials
- Wet process & Spray drying
- IBC
- Pre-blend mix & packaging
- Customer-driven activities
- Planning-driven activities

Decoupling point

Planning-driven activities

Customer-driven activities

4 Optimization Strategy and Technique

• The planning software includes within the simulation engine Arena two modules, namely the factory and the search and optimization module.
  → The production plans get optimized by a genetic algorithm and are evaluated by the factory module.

5 Scheduling Analysis

• Planning is done in week zero for week three to six, with a floating horizon.
  → The first two weeks are frozen due to operator availability.
  → Further demand forecasts are not reliable.

6 Planning Software Interface

• A user interface was programmed to allow the planner to navigate easily within the Excel file containing all the model input and output data.
• This interface is able to pilot the simulation and therefore Arena does not have to be mastered at all to use the advantages of this planning software.
• Next to presenting the proposed production plan in details and summarized in charts, this planning software also allows the user to quickly evaluate manual modifications.

7 Results Comparison

• The inventory profile in the left chart corresponds to the production plan obtained/simulated by the planning software considering six products.
• There are no stock outs and the upper inventory limit is not violated. The total inventory holding costs are low and the evaluation fulfills the constraints.

• The inventory profile in the right chart is the original production plan of the factory during the same period.
• The quantities produced are above the FreshBiies requirements for two products and one product went out of stock from day 48 on (see BL.999).

8 Performances and Conclusions

• The Planning Software is optimal and robust for 42 day horizons (6 weeks) and can also be used for 84 day predictions (12 weeks) as proven previously.
  → It is also a powerful “what-if” evaluation tool to forecast production plans including additional working days per week, more shifts per day or new recipes and products.
• The result comparison shows that the genetic algorithm delivers great results for this complex problems and is capable to handle all constraints.
  → Arena simulation showed to be a valid tool for planning and scheduling as well and together with the programmed interface it became operational.
• The proposed planning software can be of significant help to support the production operations as it is easy to define, run and analyze new scenarios and the average simulation time is between 10 and 15 minutes.