

# Production scheduling for the food industry: an integrated approach

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## Abstract

An integrated approach to scheduling in a real world food processing environment is presented, while considering the scheduling of multiple orders and respecting multiple routing and time constraints. It is a very complex scheduling problem. The approach applies a graph matching method for handling the routing constraints. Further on, a translation to a general project scheduling problem is used to handle most of the constraints. The approach has been integrated into a MES software package and has shown to be capable of scheduling the production orders in a test setup at a real world food company.

**Keywords:** resource-constrained project scheduling, food industry

Scheduling the orders in a food processing environment can be a very complex task. The plant layout induces some routing constraints, i.e. connections between work centers, buffers and storage zones. The time constraints include, but are not limited to; time lags, finish-start relations, processing times, setup times, release dates, and due dates. Additional difficulties include the possibility to group or split orders.

We developed an integrated approach [2] to refine the scheduling kernel inside the products of MESware<sup>1</sup>. Customers of MESware are faced with the challenge to cope with an increasing demand for flexible, customized and faster production. At the same time, MESware also aims at serving larger customers with the scheduling system.

In the remainder of this abstract we present a high level overview of our approach. The scheduling task is decomposed into several steps. We can distinguish: a preprocessing step, a decision step, a translation step, a schedule generation step, and finally an optimization step.

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<sup>1</sup>MESware nv is a software company that offers generic MES solutions.  
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The *preprocessing step* checks the correctness of the incoming orders and makes some preparations. It calculates, for example, all the possible assignments of process steps to work centers for manufacturing the demanded products. This leads to the following routing problem. Consider a plant layout containing all the connections between work-centers, buffers and storage zones. The connections contain information about process relations and possible time lags between them. The product structure, which is the recipe of the product (defined by the order), is also given. This product structure contains a number of process steps and the order relation between them. In fact, the problem is to find one or all mappings from process steps to workcenters, with the restriction that the workcenters can perform the required processes. A graph matching approach, similar to a well known method for solving the (sub)graph isomorphism problem was developed for this routing problem. Selecting an actual route is left for the decision step. The *decision step* assigns values to the decision variables. These in their turn include the possible routes and the order sequence. The *translation step* uses the background information, the incoming orders, and the decision variables for formulating a scheduling problem. We use the resource-constrained project scheduling problem with generalized precedence relations (RCPSP/GPR). It encompasses all the resource and time constraints. Each order is translated into one project scheduling problem. Multiple orders compose a multi-project scheduling problem. The *schedule generation step* solves the scheduling problem formulated in the previous step, which is a multi-project RCPSP/GPR [1]. The multiple scheduling problems are solved one by one by the given sequence of orders (chosen in the decision step). The individual scheduling problems can be solved by any applicable method from the literature. For the RCPSP/GPR, we use a scheduling method based on priority rules, together with a serial schedule generation scheme with an unscheduling step [1]. The schedule generation step provides some feedback on the quality of the solution that was generated. This information is fed back to the optimization step, so that better local decisions can be made and better solutions (schedules) can be found iteratively. Finally, the *optimization step* searches for good quality solutions in a guided way. Many optimization methods can serve as guiding mechanism. For example, steepest descent, simulated annealing, tabu search and variable neighborhood search are appropriate. This step also holds the termination condition and the set of objectives (e.g. makespan, weighted tardiness, ...).

In all the steps we assume the presence of *background knowledge*. It holds static and dynamic information about the plant layout, process relations, product structure, processing times, setup times, machine breakdown or maintenance, personnel, working hours and equipment. Experimental results obtained for real life test cases will be presented at the conference.

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## References

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