Product Scheduling - Sealed Air Corporation

Background

Sealed Air is a US-based multi-national manufacturer of packaging and package equipment. Its most well-known brand names are Bubble Wrap (hence the name Sealed Air) and Cryovac food packaging. Sealed Air has a manufacturing plant in Fawkner, Victoria where it produces Cryovac shrink bags, padded mail bags, etc.

Sealed Air has been working with Opturion since 2015 and Opturion has provided it with optimisation software for reducing setup times in parts of their production process, as well as for maximising its labour force utilisation.

In 2016, Opturion started a proof of concept with Sealed Air on end-to-end supply chain optimisation. We have focused on the manufacturing of Cryovac shrink bags, which are used by the meat industry to avoid spoilage. The manufacturing process for these bags consists of three steps: extrusion, printing, and converting.

The extrusion process involves the manufacturing of a 7-layer tubing. The Sealed Air Fawkner plant has two machines that produce the tubing. The extrusion step is relatively straightforward as only a few SKUs get produced in any given week. Also, less than 10% of the available machine run time is spent on changeover setup between jobs. This means that there is relatively little opportunity for optimisation in the extrusion step.

In the printing step, customer branding and decoration is printed on the tubing. There are currently around 1,700 SKUs and in a typical week, about 80 of those are printed. The Fawkner plant has four printing presses with varying capabilities. The largest press can print jobs with up to 10 different colours. In the printing step, some 40 to 50% of available machine hours are spent on changeover setup, which include changing print plates and changing the colour in up to 10 ink stations. As such, there is a considerable opportunity to reduce setup time through optimisation of the production schedule.

The final step, conversion, consists of producing bags from the tubing by sealing one end and cutting them to the appropriate size.

This then becomes the final product. The Fawkner plant produces more than 2,800 SKUs using 18 machines with different capabilities (in terms of supported width and length, seal type, bundling type, etc.). Setup times in conversion account for about 15% of the available time. However, certain types of setup require specific labour skills and are only performed during the day shift. Also, most machines will generally have spare capacity and as such labour utilisation becomes a major concern.

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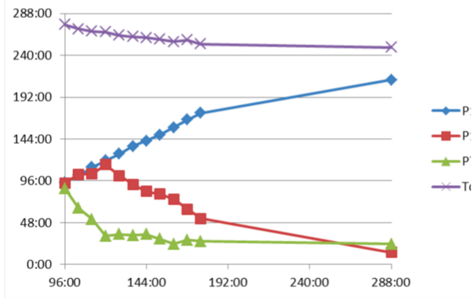
Summary

For the end-to-end supply chain optimisation, we have modelled the entire process from raw materials to order delivery at the customer. Sealed Air works with a two week lead time where printing is done in week 1 and converting in week 2. However, frequently, so-called move-ups require deviating from this schedule. In any case, the schedule is to be driven by the order delivery due date and we'd be aiming for delivery in-full on-time. Working our way backwards, we'd have to ensure enough time for transport, converting, printing and finally extrusion. There are only 62 SKUs of tubing, and they'd be mostly made to stock, so we focus on printing, converting and transport. Transport is performed by a 3PL, and we will not concern ourselves with creating a transport delivery schedule, but we can make use of the fact that there are different delivery methods with varying cost and varying durations, i.e. transport by road, rail or air freight. This imposes alternative due dates for the finished product (post conversion), with each of them having a different cost (which increases the closer we get to the delivery date).

Working back further, we have to schedule the printing and conversion, as well as ensure optimal labour utilisation. The outcome of each of these may influence each of the others.

For instance, an optimal print schedule may put a job late in the schedule, limiting the options for when to convert. An optimal conversion schedule (from the perspective of minimising setup time), may lead to poor staff utilisation. At the same time, there's a point where having more flexibility to schedule one activity, does not much further improve the cost.



For example, the graph below shows the effect of changing the maximum number of hours available to each press (and as such the latest due date for each job), on the total run time as well as the run time per press. In this case, we need at least about 96 hours per press to complete the work. As we extend our time line, the total cost goes down somewhat, but almost flattens out at around the 160 hours mark, but the imbalance of workloads between the presses becomes massive (due to press 13 being faster and capable of doing more jobs in this case).

The solution requires modelling both labour costs and minimising setup (or rather maximising machine productivity). It also requires modelling the interaction between different steps of the supply chain.

The Solution

The complete solution starts from the orders and their delivery due dates. We modelled a three step supply chain of printing, followed by conversion, followed by transport.

Each of the steps only interact through due dates: they do not share equipment or staff and as such are mostly independent. Furthermore, for the transport step we have pricing set by a 3PL with different options at different prices, but irrespective of any other orders. That is, for each order, we can create a set of increasing due dates at increasing cost, ranking from cheapest to most expensive transport option.

The remaining focus then is to optimise the combined printing and conversion, both staff and machine schedule. None of these can be done in complete isolation. For instance, with the conversion process, there are machines that can share an operator in case they are running simultaneously, but will need a dedicated operator otherwise. From a setup minimisation perspective, it may be totally sensible to have 18 machines up and running at the start of the week, and only one or two at the end, but from a staffing perspective that does not work out.

The solution ultimately would do one optimisation in which it incorporates all of the above aspects. The problem becomes increasingly complex though: by itself the task of scheduling jobs on the printing presses for a typical week of 80 jobs, requires considering up to 72·10117 different permutations of these jobs.

It requires the best of algorithms to tackle that size of problem. If we then add to that the equally complex task of scheduling the conversion, and the task of scheduling the labour force, it quickly becomes an impossible task.

Luckily, we can get far by optimising different aspects independently, within some reasonable bounds (e.g. we would not allow printing to finish the minute before transport is required), and then resolve any remaining conflicts as they occur. A typical conflict would be that a conversion job starts before the printing is finished. In such a case, we can constrain the printing to finish earlier, the conversion to start later, or some middle ground in between.

The Result

As part of this proof of concept, we improved our printing, conversion and labour force optimisers, so that they can work together seamlessly, providing true end- to-end supply chain optimisation. This included improving support for due dates and job availability dates at all levels, improving useability and user acceptance. The traditional setup of print in week 1, convert in week 2, is no longer a necessity, although it can be a good starting point from which we only need to deviate in case of urgent jobs.

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Some of the benefits from the tool chain are the following:

- Substantial reduction in setup times has become achievable.
- Discussions between planners and staff on the shop floor on what the best plan is, have become much less of a problem, and can now be substantiated by considering the real cost of each alternative option.
- Compliance and customer service become controllable. The effect throughout the supply chain of move-ups can now be measured, which makes the decision to accept or reject a move-up more objective.

Potential

This form of end-to-end optimisation has further potential benefits that may well be explored in a follow on project, or series of projects:

- Transport planning is easily achievable, and can be used to negotiate better terms when using a 3PL.
- There's a potential for taking inventory management into account.
- Longer term modelling can highlight skillsets for which there is a regular staff shortage, and can be used to create a staff training plan.

These are only now possible because we can link containers information directly to customer orders.

Acknowledgments

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- Sealed Air for providing the opportunity, facilities and data to address this problem.

Customer Perspective

"Opturion built us a solution for printing and converting, but now we also have a scheduling tool that allows us to do what-if analysis on labour planning and move-up requests. This will definitely benefit our operation."

Further Information

Please contact Opturion for a demonstration, or give us some data that we can use to identify potential benefits.

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