Proceedings of the 1996 Winter Simulation Conference
ed. J. M. Charnes, D. J. Morrice, D. T. Brunner, and J. J. Swain

SCHEDULING WITH SIMULATION IN THE FOOD & DRINKS INDUSTRY

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ABSTRACT

The ever increasing pressures from the market place has caused companies to re-assess how the production planning function is carried out and to look for tools that will support the decision making process and generate achievable schedules in a timely manner. This paper describes the use of capacity planning and scheduling decision support tools that combine a simulation model generated with ARENA, with PREACTOR, a PC based finite scheduler. The use of this combination is illustrated by their use in food processing plant in the UK and then discusses how these may influence the way that variable costs are measured.

KEY WORDS

Manufacturing Applications
Scheduling
Food & Drinks Sector

INTRODUCTION

This paper describes the increasing use of decision support tools such as simulation to help in understanding problems in the production environment and to generate achievable schedules on a day-to-day basis. The text firstly covers the term ‘finite capacity planning’ and explains how this compares to traditional planning systems. This is followed by a case study of the installation of a simulation based process line scheduler installed in a food processing plant in the UK . Finally the benefits of using finite capacity scheduling and how this is translated into savings in variable costs is discussed.

CURRENT STATUS

Production planning and scheduling have always been an important element in maximizing the efficiency of plant. Inefficient planning and unclear objectives can lead to significant increases in variable costs. However the emphasis in terms of the way that schedules are produced, is changing. Currently, production planners see their goal as making best use of resources since standard methods of costing invariably makes ‘maximum utilization of plant’ the key cost driver. The pressure in the market place is now shifting to providing 100% service levels at shorter and shorter notice. This has shifted the production planner’s emphasis from ‘maximum resource utilization’ to the elimination of stock-outs by making the right products at the right time. This may require a re-evaluation of traditional techniques such as batch consolidation, sequencing for minimum set-up times etc.. Now producers will be forced to examine the impact of running smaller and smaller production batches in order to react to variable demand. Attention is thus turning to decision support tools that can help production planners make decisions on a daily, if not hourly, basis.

The food and drinks industry, particularly the small to medium business, has undergone significant changes over the last 10 years. Many of these were controlled by the original owners of the business who had an intimate knowledge of the products and processes. As they retired or their businesses were acquired by larger organizations, they were replaced by managers with a more financial background, and in trying to deal with the day-to-day control of production, they tried the tools with which they were most familiar, invariably spreadsheets.

These managers then realized that a spreadsheet could not deal with the complexities of their business and deal adequately with such issues as capacity planning driven by forecast distributions that are used for setting stock control levels, shelf-life expiry of products in storage, and then provide a total vision of current stock at SKU (stock keeping unit) and total pallet level, detailed production work-to-lists, and dispatch waiting times.

Other systems on the market have proved to be expensive, require extensive consulting activity to install and maintain, and often do not provide an interactive interface that the planner can use to make fast changes in the event of unexpected changes in demand or plant performance.

FINITE CAPACITY PLANNING/SCHEDULING?

Finite capacity planning and scheduling is a process whereby a production plan consisting of a sequence of operations to fulfill orders is generated based on the *real* capacity of resources. Resources can be machines, tanks, piping, labor, storage areas, fork-lift trucks, delivery lorries, tooling or anything that could constrain production processes.

Most planning systems assume sufficient resources are available to produce batches when required, that is, resources have infinite capacity. Traditional planning systems take the orders, break them down into component parts or ingredients and then calculate when to launch the batch based on the individual lead times (perhaps adding adjustments for waiting time etc.) and when raw materials are required taking into account current stocks. No account is taken of the real capacity of resources to produce batches in a timely manner so that it does not matter if resources have a high utilization or not, the same lead time is used to calculate the launch time for any batch.

At the same time that the launch time for batches are calculated, the materials required are also ordered to arrive in time for work to start. If there is a delay in production upstream of a particular operation then the material will be ordered too early. With no concept of bottlenecks available to the planning system, resources become overloaded, queues of work get longer and work in progress increases. Because now, batches must join queues for resources at each process step, orders take longer to make progress through the process route, expected lead times are too optimistic and deliveries are late.

Using finite capacity scheduling, operations are only planned when resources are available. Materials are ordered only when they are needed for the operation to be carried out. Case studies have shown that inventory levels fall dramatically, key resources are better utilized and flow of work more controlled. Work in progress remains at a relatively constant level, lead times are more predictable and delivery dates more reliable. In this way production management spends less time progress chasing and fire fighting and can concentrate on the every day job of balancing, often variable demand, with the capacity available.

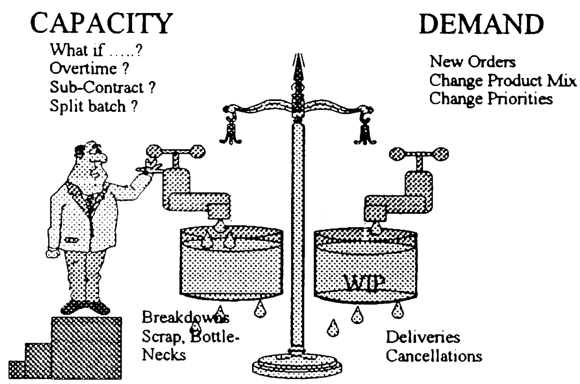

Figure 1 A question of balance

This is the art of the production controller. He/she must constantly try to maintain the balance between demand and capacity. On the demand side the 'flow' of work can vary due to new orders arriving, changes in priority, and stock orders launched against forward forecasts of demand. 'Leakages' take place as deliveries are made, forecasts are translated into real demand and orders canceled. The options available to the scheduler to increase capacity might include overtime, subcontracting, splitting batches, and avoiding bottlenecks, while leakages in capacity will occur due to machine breakdowns, operator absence, scrap, re-work and excessive changeover times. Any decision support tool must be able to support this balancing task.

CASE STUDY: PROCESS LINE SCHEDULER

This is an example of how Preactor, in combination with a discrete event simulation model, is used in a food processing plant in the UK. St. Ivel is a major food processing company. Management had recognized a problem with the scheduling of work at a plant making low fat spreads, particularly in the packaging and storage facilities. After processing, the product is passed to one of a number of filling lines. The packaged product is then passed to a quality assurance then held in a chill store. The product is removed from the chill store as orders are received.

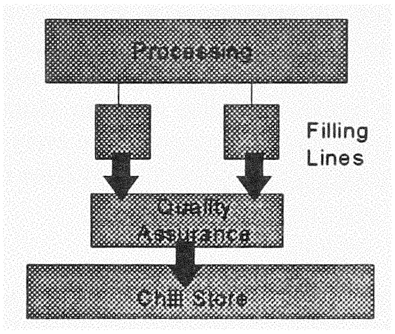

Figure 2. Process Schematic

The planner's primary task was to ensure that the utilization of the machines was high over a 66 hour cycle since this was the main constraint to production. Unfortunately the decisions taken took little account of current stock levels of the various product lines nor the capacity of the chill store. Sometimes the wrong products were being made at the wrong time. This resulted in unacceptable levels of stock out and/or overloading of storage space. The use of spreadsheets had been attempted but this could not take into account the complexities of the system. The requirements of the scheduler was to:-

- plan pallet storage
- control stock at case or part pallet level
- control stock replacement either by dynamic or fixed demand
- schedule changeover times between products
- plan manpower requirements

The solution was a combination of Preactor linked to an Arena** simulation model. The Preactor database holds information on the forecast orders, real orders and opening stock for each product. This information was held on another database and downloaded to Preactor over a PC network. An example of the initial stock view/edit screen is shown in Figure 3. This shows the number of SKUs at each stage of the Quality Control process and in the cold store.

The database also holds information on how to control the stock for each product. In this system three options were available:-

- fixed quantity replacement (FQR)
- dynamic replacement using minimum economic batch quantity (MEQ)
- Just-in-time replacement (JIT)

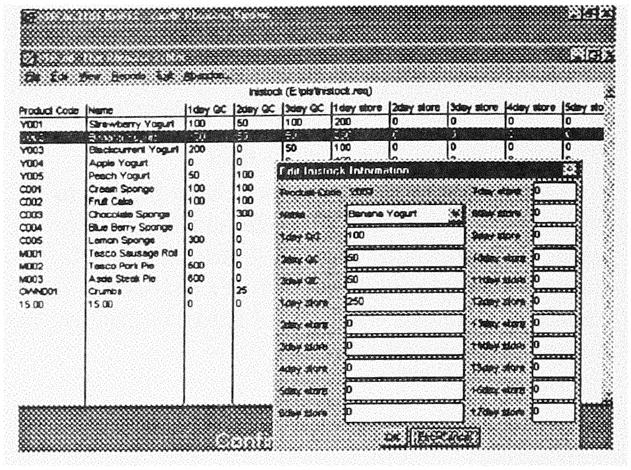

Figure 3. Stock Initialization View/Edit Screen

The FQR control rule is a conventional stock replacement rule where a threshold trigger level is defined and a fixed replacement quantity, MEQ, set. When stock is below this threshold, a demand equal to the replacement quantity is added to the manufacturing requirement.

The dynamic MEQ control again uses a threshold trigger and replacement MEQ value, but here it is calculated as multiples of MEQ (nearest to the order requirements) and in addition will use a forward forecast period, set by the user, to estimate the total manufacturing requirement over the period and generate demand accordingly.

The JIT control is used for controlling the processing of product through a Kanban system. Typically the Kanban level would be set at much lower thresholds than the MEQ used in the other two methods of control. As orders arrive which use up the products then this will trigger the Kanban quantity replacement in the manufacturing requirement that is generated.

Having set the current stocks, orders and forecast demand in the database, as well as the period to schedule in advance, the user runs the ARENA model to decide which batches should be scheduled using the rules described. These requirements are then used by Preactor to load them onto the production lines. The appearance of the scheduling screen is shown in figure 4.

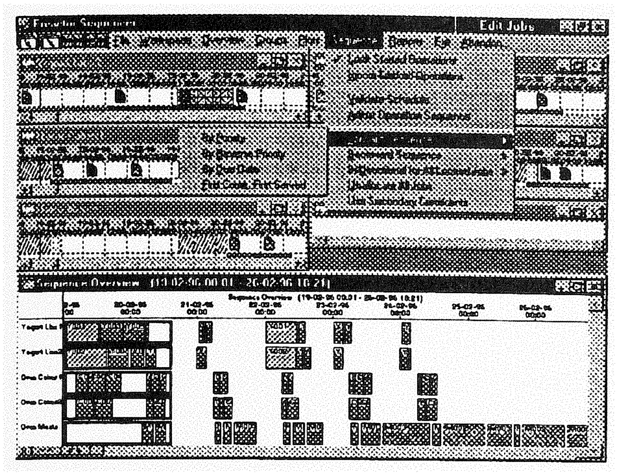

Figure 4. Scheduling Screen

The user has a range of batch sequencing options e.g. by priority, by due date etc. and it is here that various 'what if ...?' scenarios can be tried out, alternatives tried, alterations made by picking up batches with the mouse and moving them, before the decision is made.

Reports are available to the user on required manning, any problems of shelf-life, material requirements to meet the schedule, late dispatch and so on. A product demand report is shown in figure 5. This shows the total volume required by product base and the time span over which it is required.

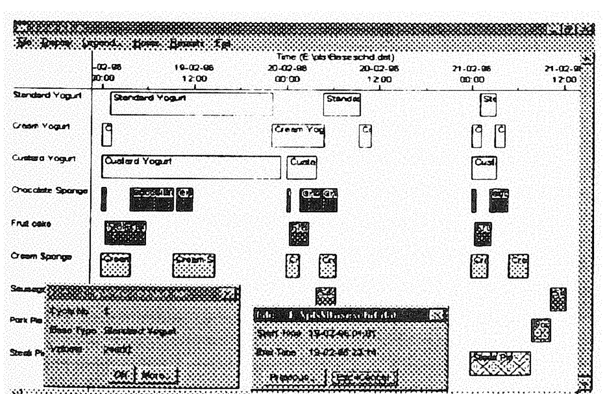

Figure 5. Product Demand Report

The user could also use the scheduler on a long term forecast basis typically a year ahead to assess the implications on production and to take decisions early to correct an imbalance between demand and capacity and in particular how they could maintain a high service level to customers.

COST v VALUE

The case studies are good examples of how management is having to re-assess traditional ways of doing things and introduce new methods that may be quite radical for the production planner but increasingly required in the ever more competitive world. No longer is the goal one of maximum utilization of machines. Now the key is giving customers a 100% service level which requires making the right products at the right time even if utilization of packaging machinery is lower than in the past. Using simulation and finite capacity scheduling has provided a vast improvement in decision making and enabled service levels to be improved dramatically.

Control of variable costs is obviously important in meeting the need to maintain good profit margins in any company. The cost of holding inventory is an important contributory element to variable costs and case studies have shown a major reduction in inventory when production is planned using finite resource constraints. This is an obvious tangible benefit.

However how can we measure the advantage of on-time deliveries ?

We have seen that pressures in the market place are changing and how some companies are reacting to this. The challenge now, perhaps, is how do you put a value on service. The old cliché that accountants '*know the cost of everything but the value of nothing*' springs to mind. What is the value of service ? Lost business, perhaps, or the ability to differentiate in the market place, not on price, but on ability to react to your client's changing demand. Some advantages of changing the approach to planning and scheduling of production may well be tangible while others, of equal importance, may be intangible. There will be pressure on managers to put a value on these intangible benefits as well as quantifying the cost of providing an increased quality of delivery.

* Preactor is a registered trademark of The CIMulation Centre Ltd
**ARENA is a registered trademark of Systems Modeling Corporation
WINDOWS is a trademark of Microsoft Corporation

AUTHOR BIOGRAPHIES

MICHAEL D. NOVELS is Chairman and Managing Director of The CIMulation Centre Ltd., a company based in the UK that provides software, support, training and consultancy in simulation and scheduling applications throughout Europe in a wide range of industrial and commercial sectors. He has an Honours degree in Engineering from the University of Bath, and has led a number of European and National initiatives in the use of simulation for finite scheduling applications in manufacturing and process industries.

STAN JONIK is an independent consultant who specializes in decision support tools for the food industry such as simulation, stock control and finite scheduling. Stan started his career in the engineering industry including a period with Hawker Siddeley where he took part in design studies for the implementation of manufacturing control systems such as MRP and Kanban. His experiences required extensive use of discrete event simulation for system design and extended into bespoke applications of simulation models used as a day-to-day operational tool. This led to the development of the PLS (Process Line Scheduler), a stock control and scheduling tool for food and drinks processing company sector.