Scheduling is an Art Form and Our Problems are Unique

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No it isn't. No they aren't. Scheduling can be a complex problem and some parts of the scheduling process can be specific to individual firms and industry groups. But large parts of the scheduling process can be carried out using rationally constructed models that greatly reduce the burden on plant production schedulers. Our purpose here is to briefly describe such a system recently developed at Welch's A more detailed description will be presented at the June Process Industries Symposium in Cincinnati and is available from the authors.

Welch's is a make to stock food manufacturer and faces an environment of steeply escalating customer service requirements. This imposes the need to maintain safety stocks which reflect dynamic demand, forecast errors and bias. The current scheduling system, called the Inventory Planning Model (IPM), determines reorder points using demand during manufacturing lead time plus dynamic safety stocks and computes a lot size based on anticipated reorder point after lead time. It successfully accounts for the dynamic and uncertain nature of the demand forecast as well as bias. However, it does not recognize production capacity limits, and lot sizing does not incorporate set-up and holding costs considerations. As capacity utilization increases, it is important that we explicitly account for finite capacity and ensure that set-ups do not absorb excessive amounts of scarce productive capacity.

The manufacturing process at Welch's utilizes dedicated, high speed manufacturing lines and centralized batching areas. Each line runs several product families, each family containing products with similar set-up costs and production rates. Family set-up times and costs dominate those of individual products.

The new system is hierarchical in nature, as suggested by Arnoldo C. Hax and Harlan C. Meal (see reference). At the highest level, the aggregated families are allocated production time over the next 6 months using the Family Planning Model or FPM. This part of the system smoothes peak demands over the planning horizon so that production capacity is not exceeded and inventory buffers supplied by IPM are maintained. The system simultaneously allocates near-term (4 weeks) requirements by week in a way that balances the major family set-up costs and holding costs. This part of the system requires safety stocks and these are supplied by the existing IPM described earlier. The Family Planning Model operates in a spreadsheet environment but requires an add-in capability for solving linear programs containing binary variables (to account for set-ups).

The family production requirements by week for the next 4 weeks are then passed to the Disaggregation Planning Model (DPM). The purpose of this subsystem is to provide weekly production requirements for each individual end item within a given family. In doing so, it makes sure that the total family production requirement is met as

closely as possible, that end-item buffers are preserved, and that a balance is achieved between the costs of holding and set-up for individual products. The resulting weekly lot sizes may be obtained in continuous form or as integer values, i.e. number of 1/4 shifts of production.

For the integer lot size disaggregation process, it turns out that it is not necessary to require binary and integer values for the linear programming solution. The structure of the problem is such that a "relaxed" standard LP solution is naturally integer valued and computer run times are very short. We estimate that the total computer run times for the new system will not add more than 2.0 minutes of 486 (33mhz) run time per week per production line to the present time of 10 minutes.

In summary we have developed a practical method for weekly scheduling under conditions of finite capacity, dynamic uncertain demand and make-to-stock that is compatible with a decentralized desktop computer environment using spreadsheets. This can easily be adapted for use in any manufacturing situation with multiple products produced on dedicated production lines and natural family product groupings.

Reference: Hax, Arnoldo C. and Harlan C. Meal. "Hierarchical Integration of Production Planning and Scheduling." Studies in the Management Sciences, vol. 1. Elsevier/North Holland Publishing Co., 1975.

March 11, 1993
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