

Constraint-based planning and scheduling

by John Slater, Ph.D.

Food and beverage manufacturers must adopt a planning process that combines long-term visibility of future demands and manufacturing constraints with near-term production scheduling and execution, says Dr John Slater of Logility. Here he offers tips to select the right supply chain planning solution.

Is your company a food or beverage manufacturer? Do your ingredients come from seasonally available crops? Have limited shelf life? Vary in quality throughout the season? If you answered “yes” to one or more of these questions, planning your operations presents an interesting set of challenges for demand and supply management.

The complexity is expanded when manufacturing constraints are considered. Food preparation and packaging equipment is often shared among a number of different products and product families. In addition to managing the time-constrained supply of the key ingredients, manufacturers must also consider production capacity as part of the overall plan. In both the preparation and packaging processes, manufacturing capacities may be limited by a variety of constraints, including allergens, packaging configurations and kosher versus non-kosher ingredients.

The time-limited nature of a short harvest season makes proper planning essential. Once the harvest is past, the opportunity to take corrective action is limited until the following season. Capital investment in processing equipment and storage capacity is significant. Fresh-pack manufacturing and off-season processing need to be planned carefully to ensure that the capacity is used for the proper products at the proper time. Sufficient capacity must be allocated to pre-processing of ingredients during the harvest to meet the material requirements for off-season manufacturing. To do this effectively, it is necessary to have long term visibility of future demand and constraints including ingredient supply and production resources. Both the ability to plan for the long term and to react flexibly to near-term change are the key ingredients for managing a bountiful harvest.

What’s the key to managing these complex challenges facing food and beverage manufacturers? The right supply chain planning process. When evaluating supply chain solutions to help manage constraint-based planning and scheduling, consider the following:

- 1. Modelling flexibility.** Perhaps the single most important characteristic is the ability to model a wide variety of constraints and configurations. Every plant has its own distinct characteristics and operating requirements. For true success, the planning solution must quickly adapt to the characteristics of the plant and not the other way around.
- 2. Extended planning horizon.** To provide visibility into long-term demands and plan to meet them, the manufacturing planning logic must support projections for 12 to 18 months into the future.
- 3. Demand forecasting.** A finished goods demand forecast extending at least 18 months is necessary to project the future requirements from season to season. The typical wavelength, or time between production windows, is close to a year for products with a single harvest season. The off-season products are produced out of phase with fresh-pack products. The combination of these two types of product makes the extended visibility of an 18 to 24 month forecast essential.
- 4. Constrained pre-building logic.** Bridging the supply gaps introduced by seasonal availability of key ingredients makes it a requirement for manufacturing planning logic to support pre-building. Infinite capacity ERP logic is of little use for planning manufacturing in this type of environment because it is not capable of recognizing the need to produce only during the season.

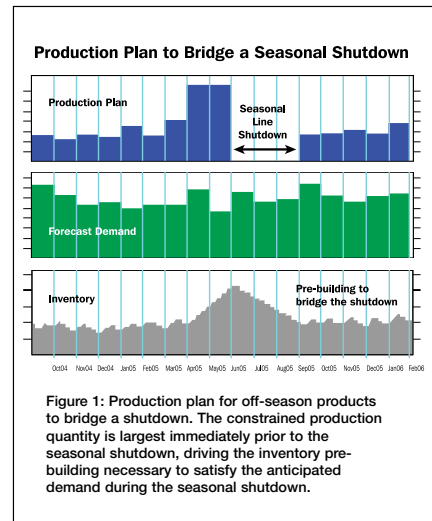
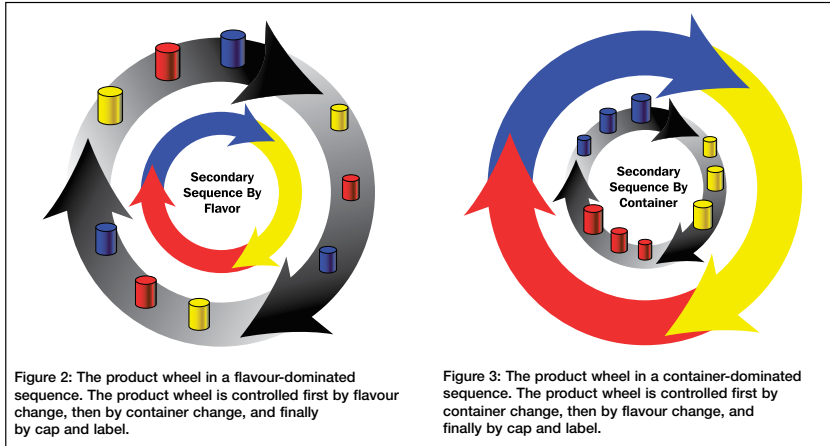


Figure 1: Production plan for off-season products to bridge a shutdown. The constrained production quantity is largest immediately prior to the seasonal shutdown, driving the inventory pre-building necessary to satisfy the anticipated demand during the seasonal shutdown.

- 5. Recipe or bill-of-materials.** In order to transform the independent finished goods demand forecast into the dependent raw material requirements for manufacturing, it is essential to derive the ingredient requirements from the manufacturing plan and not the demand plan. In a pre-building environment, the production plan and demand plan differ significantly. Planning the conversion of fresh ingredients into the frozen or paste format required to supply future off-season production means that both types of production process must be represented in the plan. The bill-of-materials explosion from a constrained long-term production plan is also necessary to determine the requirements for long lead-time components such as labels and glass.
- 6. Changeover representation.** When multiple package configurations are important, or when multiple ingredients are processed sequentially, the ability to represent changeovers easily, and to optimize the production sequence based on those changeovers, is essential for efficient capacity utilization. Pre-defined product wheels and dynamically optimized production sequences are important methods for achieving this objective.
- 7. Shelf life constraints.** Managing shipments of fresh ingredients with limited shelf life makes it necessary to project the expiration of on-hand material prior to processing in order to minimize ingredient loss and the corresponding increased cost.
- 8. Block operation constraints for manufacturing.** Planning manufacturing to →



meet the annual demands in a constrained time window makes it necessary to predict and control when different groups of products are to be produced. Since raw material supply is generally not known with precision when the initial plan is developed, material constraints alone will not be sufficient to control the time window. A line calendar or block operation constraint is necessary. Material availability may vary from day-to-day once the season starts.

9. Product prioritization. To allocate capacity effectively to different product families with overlapping seasons, it is necessary to prioritize by family. For example, if product family A has a two-week season and product family B has a six-week season that overlaps the season for product family A, it is essential to prioritize the production of family A over the production of family B. The products with the longer season can be pre- and post-built to bridge the gap necessary for production of products with the shorter season. If family B were otherwise a more valuable product group, such as a product with a higher profit margin or a product sold to a key customer, it might consume the capacity during the shorter season for family A and leave unused capacity available earlier or later. This unused capacity would be feasible to use for family B but not for family A.

10. Safety stock calculation. The need to bridge the gap across a harvest season makes it necessary to assess demand variability. Uncertainty in the start of the subsequent harvest season adds further value to properly calculated safety stock or minimum inventory. Days of supply calculations for some items, especially the fresh-pack products, may be sufficient. Service level calculations for off-season products can provide greater reliability, as these products are more subject to demand

uncertainty while there is still a possibility to react in manufacturing.

11. ABC classification. The ABC classification of finished goods is a useful mechanism for determining the relative importance of different products within a family. The ABC classification can be used to determine which products not to build when there is a supply constraint on a key ingredient, and can provide guidance as to which products to produce when a harvest is early or exceeds the expected quantity. Multiple classification methods can help manage different objectives, such as maximizing supply by volume, revenue, cost, consumption demand, profit or forecast accuracy.

12. Shared resources. If processing equipment for preparation, cooking, filling, or labelling is shared and interconnected by flexible feed lines, planners must model the shared resources to avoid double booking of a resource for two or more processing lines at the same time.

13. Calendar flexibility. To stay competitive, a plant must react quickly to the dynamic nature of ingredient receipts during harvest. Such flexibility includes easily manipulating the production calendar and dynamically re-sequencing production operations to react to day-to-day changes in supply during the season.

14. Communication of the plan. Good reporting capabilities, together with data integration capabilities, are an important part of an overall supply chain management solution. Long-term requirements for materials and finished goods supply drive successful sales and operations planning (S&OP), while short-term scheduling allows the plant to execute efficiently.

In summary

Food and beverage manufacturers must adopt a planning process that combines long-term visibility of future demands and manufacturing constraints with near-term production scheduling and execution. Seasonal harvests impose a significant constraint on manufacturing, especially with short shelf life ingredients, because a full year's supply for an entire product family may need to be produced in a few short weeks during the harvest season. To effectively determine the proper mix and quantities of products to be produced, a long-term demand forecast is required.

Efficient utilization of capital equipment may require that the same processing lines be scheduled to produce multiple product families with different seasonality. A constraint-based production planning and scheduling solution is necessary to predict and minimize the impacts of equipment and material constraints and changeovers to maximize existing manufacturing capacity. Plant consolidation, coupled with product portfolio expansion to meet new consumer demands for low carbohydrate foods, makes these challenges more complex. While these challenges may seem paramount, the right supply chain planning process can address these planning and scheduling issues and help food and beverage companies operate efficiently and profitably. ●



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