White Paper

A Food Manufacturing Plan for All Seasons

Constraint-based planning and scheduling for food manufacturers

Executive Summary

Seasonal harvests impose a significant constraint on manufacturing because a full year's supply for an entire product family must be produced in a few short weeks during the harvest season. The planning process must combine long-term visibility of future demand and manufacturing constraints with near-term production scheduling and execution.

Efficient utilization of capital equipment may require that the same processing lines be scheduled to produce multiple product families. A constraint-based production planning and scheduling solution must predict and minimize the impacts of equipment and material constraints and changeovers.

This paper describes some of the key planning challenges facing food manufacturers and how a powerful supply chain planning solution can help to address them.

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Long-term requirements for materials and finished goods drive **successful sales and operations planning [S&OP],** while short-term scheduling allows the plant to execute efficiently.

A Demanding Season

In a business based on time-limited seasonal harvests, proper planning is essential. A full year's supply for an entire fresh-packed product family must be produced in a few short weeks. Companies often process bulk ingredients into a form that has a longer shelf-life [freezing is a common method], thereby allowing year-round processing to take place. During the off-season, the frozen ingredients are used to make a different set of products.

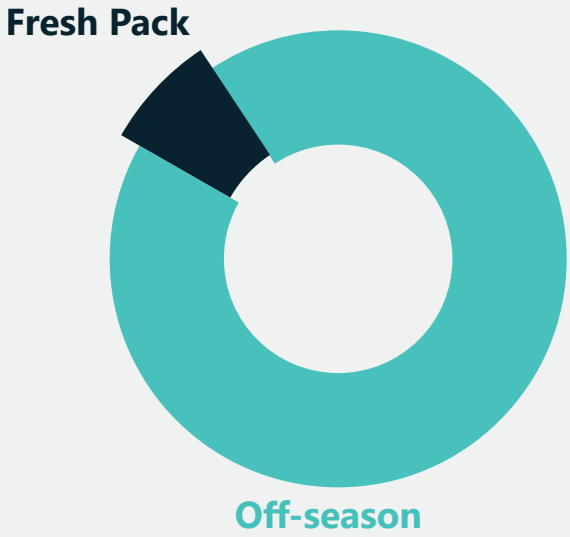
Success requires both an accurate long-term demand forecast [to determine the proper mix and quantities of products to be produced] and a constraint-based production planning and scheduling solution [to minimize the impact of constraints and changeovers when processing lines produce multiple product families with different seasonality]. Long-term requirements for materials and finished goods drive successful sales and operations planning [S&OP], while short-term scheduling allows the plant to execute efficiently.

Fresh-pack manufacturing and off-season processing must 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.

Every plant has its own distinct characteristics and operating requirements, so your planning solution must quickly adapt to the characteristics of the plant and not the other way around.

Processing capacity used for ingredient preparation during the fresh-pack season must meet two sets of demands: the current demand for fresh-pack products, and the future demand for make-from-frozen products. Deriving the production plans for make-from-frozen products and fresh-pack products at the same time can provide a constrained bill of materials explosion to calculate the dependent demand for the frozen ingredients. The bill-of-materials explosion from off-season production plus fresh-pack production determines the total demand for the fresh ingredients.

Fresh vs. off-season manufacturing windows



Takeaway: The ability to plan for the long term 18-24 month forecast, yet react flexibly to near term changes is essential [e.g. re-sequencing production operations to react to day-to-day changes in supply during the season]. The single most important factor is having the ability to model a wide variety of constraints and configurations.

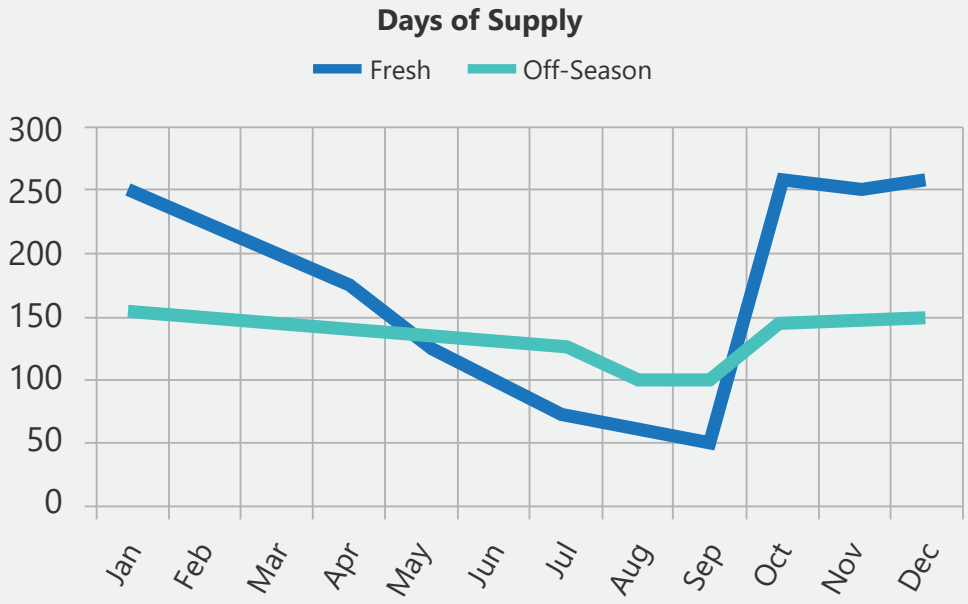
Fresh-pack and Off-season Coexistence

When preparation, cooking and packaging lines are shared by fresh-pack and off-season products, dedicating equipment to fresh-pack during harvest times creates a supply gap period for off-season products that must be bridged. The peak inventory position just prior to the start of the harvest season must be sufficient to cover the supply gap during the season plus safety stock requirements and demand uncertainty prior to the resumption of production.

A good demand forecast can reduce unnecessary pre-processing of ingredients during the harvest season.

The manufacturing plan must pre-build sufficient inventory to bridge supply gaps for both fresh-pack [as much as 250-300 days of supply] and off-season products [usually equal to the length of the harvest season].

Processing capacity used for ingredient preparation during the fresh-pack season must meet two sets of demands.



Takeaway: It is essential to derive the ingredient requirements from the manufacturing plan and not the demand plan. Planning the conversion of fresh ingredients into frozen or extended formats for off-season production means both types of production processes must be represented in the plan.

Harvesting Uncertainty

The actual start date of a fresh-pack season is variable. A rainy spring may delay the arrival of some crops but hasten the arrival of others. Safety stock calculations [to determine the appropriate value for days of forward cover] must take into account harvest timing uncertainty as well as forecast uncertainty in order to maintain sufficient inventory to meet unexpected demand during the off-season when no production is possible. Uncertainty regarding the start date of the subsequent harvest season adds another compelling reason why safety stock buffers must be calculated properly.

An earlier-than-planned crop may require production of off-season products to be stopped earlier than planned, resulting in a short supply for the off-season products. Packaging components for fresh-pack products may not be available due to the unanticipated early start. By contrast, a delayed harvest may make it necessary to commence off-season production earlier than desired to make use of available manufacturing capacity, while orders may be shipped late or are filled by a competitor.

An earlier-than-planned crop may require production of off-season products to be stopped earlier than planned.

Takeaway: Time-phased supply of ingredients and components must be managed simultaneously with manufacturing constraints and the time-phased demand for finished goods. Service level calculations for off-season products may be more reliable than for fresh-pack products, since there is a longer manufacturing window in which to react to their demand signal.

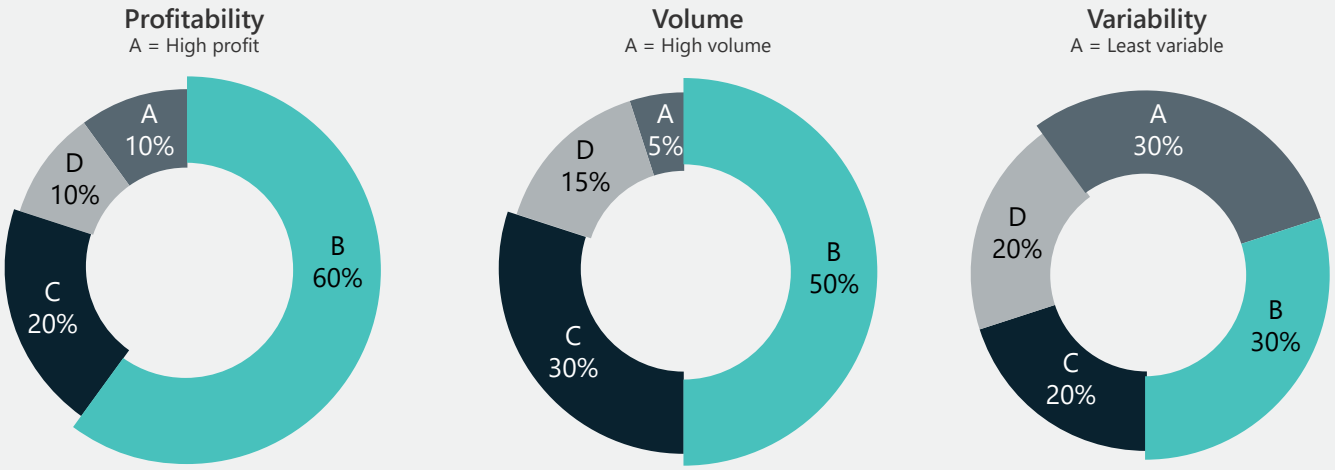
Handling Yield Variation

Insufficient yield creates the need to optimally allocate a constrained supply to a set of products [decide "what not to make"]. The optimal allocation depends on factors including the concentration of each ingredient [raw material] in the final product [finished goods], as well as the profitability of the product.

A given ingredient with constrained supply may make up only a small portion of an important finished product, or may be a small contributor to its total cost, but without the ingredient the very important finished good is under-produced and crucial service levels can be missed.

If a company contracts for the yield of a fixed acreage, whenever harvest yield exceeds expectations it may not be possible to back off the processing of ingredients. Projecting such situations in advance allows marketing and sales to generate sufficient future demand to consume the product before the next harvest season arrives. On the other hand, excess supply may be converted into a saleable finished product, or into an intermediate product with long shelf-life for future processing. Demand forecasts must justify these processing decisions.

ABC classifications



Takeaway: Establish a method for determining the relative importance and value of different finished goods, and use an ABC classification scheme to drive planning and production decisions.

Prioritizing Sequencing and Changeovers

To accommodate allergen cleanings, packaging configurations and kosher processing requirements while achieving maximum manufacturing utility, it is necessary to optimize the processing sequence on production lines and minimize equipment changeovers. If a packaging line produces several different product flavors, in several different containers, with different caps or labels, the number of possible production sequences can quickly become hard to manage.

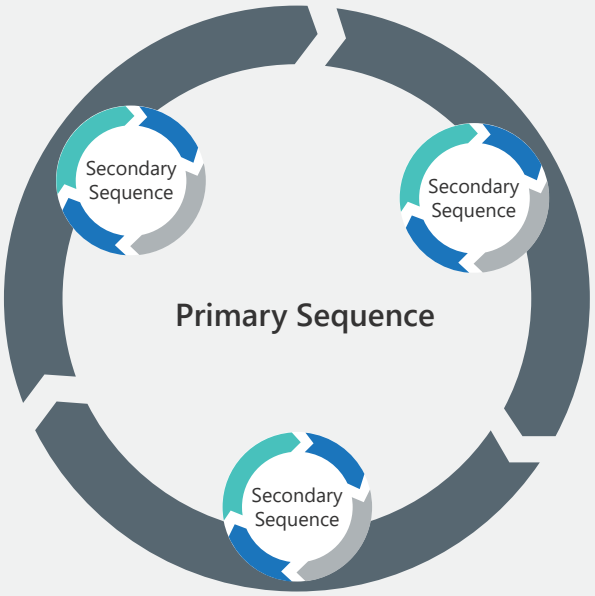
Some types of changes [e.g. a cap or label change] may only take 5-10 minutes to accomplish, while container changes and flavor changes are more time-consuming and may be sequence-dependent. Situations vary widely, but a typical packaging line experiencing 40 product changes per week at 30 minutes per change, loses almost 25% of the total available capacity. Optimizing the manufacturing sequence is a key tool for minimizing downtime.

Example: For a line of 50 products comprising five flavors, two container sizes, two caps and ten labels, the total number of changeover components totals 134 [5 x 5 flavor changes plus 2 x 2 container changes plus 2 x 2 cap changes plus 10 x 10 label changes].

A well-defined product wheel approach organizes production for efficiency. Product wheels are sorted by changeover characteristics so that, for instance, flavor changes [mild to spicy] may be given precedence to minimize the number of allergen cleans required, then color [light to dark], then container [small to large].

When a simple product wheel approach lacks enough sophistication, sequence optimization logic can be employed to determine the best product sequence. For instance, when the set of products includes flavors in different allergen groups, the allergen changeovers will dominate. If the flavors contain no allergens, the flavor or container changes will dominate. The sequence optimization logic may also vary depending on the need to pre-build for future demand [pre-building typically operates on larger lots and requires fewer changeovers].

Product wheel sequencing



Takeaway: Scheduling efficient manufacturing sequences that respond to changing conditions requires a flexible and powerful optimization platform that can represent changeovers easily, and optimize the production sequence based on those changeovers.

Balancing Supply Push with Demand Pull

For bulk processed foods, such as frozen French fries, pretzels and cereals, a single high-volume processing line may feed multiple packaging lines, which run concurrently. Usually the bulk product must be packaged immediately after the make step, rather than treated as work-in-process [WIP] inventory. Common reasons include potential loss due to breakage [pretzels], limited shelf-life [cereal], shrinkage during excess dwell time [cured products] or in-package freezing [French fries].

Even if the processing rates of a single making line could be aligned to one packaging line, the need for packaging in different sizes, brands, container types, etc. necessitates multiple lines.

When the making line runs at a fixed rate, packaging rates may need to be adjusted to avoid out-pacing production [supply constrained] or, conversely, package demand may be pulled forward so that the packaging lines absorb the output of the making line [pre-build]. Pre-build must take into account any shelf-life constraints for the finished product.

Manufacturing planning must synchronize the make supply of bulk products with the packaging demand across various compatible finished goods.

In any case, the planning and scheduling system must be able to synchronize the timing of demand-driven packaging operations with the timing of the supply-driven make operation.

Takeaway: Supply push [what the production line is producing] and demand pull [the finished packaged goods that need to be made] must be synchronized so that full-scale processing matches the full opportunity presented by the market. Multiple packaging resources must be managed to absorb the output capacity of the production line, deliver the appropriate assortment of finished goods, and provide the ability to pull forward demand when necessary.

Conclusion

Successful production planning in a seasonally constrained business requires a powerful planning and optimization system that possesses these key capabilities:

- **Modeling flexibility.** The planning solution must quickly adapt to the characteristics of the plant and not the other way around.
- **Extended horizon.** The manufacturing planning logic must support projections for 12 to 18 months into the future.
- **Demand forecasting.** Support for a finished goods demand forecast covering short-term and long-term needs extending 18 to 24 months is essential.
- **Constrained pre-building logic.** The manufacturing planning system must support pre-building. [Infinite capacity ERP logic does not.]
- **Recipe or bill-of-materials.** The system must derive ingredient requirements from the manufacturing plan, not the demand plan. In a pre-building environment, both fresh and frozen ingredient production processes must be represented in the plan.
- **Changeover representation.** The planning solution must represent changeovers easily and optimize the production sequence based on those changeovers for efficient capacity utilization.
- **Shelf-life constraints.** Project the expiration of on-hand material prior to processing in order to minimize ingredient loss and the corresponding increased cost.
- **Product prioritization.** The planning system must prioritize and allocate capacity effectively across different product families with overlapping seasons.
- **Safety stock calculation.** Assess demand variability [uncertainty] to bridge the supply gap across a harvest season and properly calculate safety stock buffers.
- **ABC classification.** The system must provide guidance as to which products to produce when a harvest is early or exceeds the expected quantity, as well as which products not to build when there is a supply constraint on a key ingredient. Should support multiple methods of classification to manage different objectives.
- **Shared resources.** If processing equipment for preparation, cooking, filling or labeling is shared and interconnected by flexible feed lines, the planning system should prevent double booking a resource for two or more processing lines at the same time.
- **Communication.** Like forward-looking views through a windshield, Key Performance Indicators [KPIs] allow planners to see the impacts of alternative strategies from the standpoint of cost, service and capacity. Equally important are Plan vs. Actuals comparisons that, like a view through the rear window, allow planners to assess performance against the plan and adjust accordingly. Good supply chain management must be built on excellent reporting and data integration capabilities.

Successful production planning in a seasonally constrained business requires a powerful planning and optimization system.

About Logility

Accelerating the sustainable digital supply chain, Logility helps companies seize new opportunities, sense and respond to changing market dynamics and more profitably manage their complex global businesses. The Logility® Digital Supply Chain Platform leverages an innovative blend of artificial intelligence [AI] and advanced analytics to automate planning, accelerate cycle times, increase precision, improve operating performance, break down business silos and deliver greater visibility. Logility is a wholly owned subsidiary of American Software, Inc. [NASDAQ: AMSWA].

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