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Using PlanetTogether for Effective Scheduling in the Food Process Industry

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Introduction

In many ways Food Process production is similar to other industries: products must be produced on time to meet demand, production capacity is limited, raw material purchasing and intermediate production must be coordinated, and there are constraints limiting which products can be made on which equipment. In addition, Food Process manufacturing poses a number of unique production scheduling challenges. For example there are spoilage concerns, cross contamination must be avoided, cleanouts can be lengthy, intermediate storage is limited and conveyance equipment constrains material flow paths.

The benefits of effective scheduling in the Food Process industry are also unique and substantial. Good schedules mean more time producing and less time performing cleanouts - resulting in increased output and higher revenues. Also, risks associated with spoilage and cross contamination are reduced as are the costs of storing products that are produced too early or shipped late. Even transport costs can be reduced by tightly integrating shipment schedules with production.

This document describes these and other special Food Process scheduling considerations as well as provides an overview of how these issues are managed when scheduling a facility using PlanetTogether production scheduling software.

Defining Production Capacity, Production Rates and Expected Yields

Production equipment in Food Processing is extremely expensive and therefore limited. A facility's maximum production output is constrained by "Physical Constraints" such as:

- the number of machines available
- the rates at which products are produced on each machine
- the time lost to yield problems, changeovers, and equipment downtime

In addition, capacity is lost due to "Timing Constraints" - where raw materials or intermediates are not available at the right time or when

equipment is not staffed and offline according to hours of operation. In these situations equipment is idle by choice or at least according to "plan".

Some of the Physical capacity constraints are relatively static and are input directly into the ERP system, such as:

- Work centers with specific defined machines.
- Expected yield rates by product.
- Standard production rates by product, by work center, indicating for example x gallons of output per hour in work center w for product p.

Often times, the output rate and expected yield for a single product can vary depending upon the specific piece of equipment used. For example, one mixer may produce 250 gallons per batch while another produces 1,000 gallons per batch so the time to product x gallons varies based on the mixer chosen. This is handled by creating a lookup table that specifies the capacity, production rate and expected yield of each product on each machine. In this case, PlanetTogether will dynamically schedule using the appropriate specifications for the given product on a given machine. If you "drag-and-drop" the production run onto another machine the time will be updated automatically and it will also be updated if the production run is reassigned during the Optimization process. To specify operating hour constraints, the planner can specify exact operating hours that can be shared across the facility or vary by machine. In times of high demand the planner can perform "What-If analysis" to see the production impact of changing operating hours.

Product Specific Resource Assignment

In any manufacturing process there are limitations on which machines are capable of producing which products: machine A may be able to product products x and y while machine B can produce products y and z. Assuming machines A and B are in the same work center this can be handled by simply specifying the required work center in the product formula/routing for each production step. In the Food Process industry this method of work assignment can be much more complex as more flexible logic is needed.

Physical Properties

In addition to work center constraints, there are often “physical property” constraints that limit which machines can schedule which products. Take for example a situation with three meat grinders: A, B, and C. Pork can only be ground on A and B while Beef can only be ground on B and C. Clearly the “work center” assignment alone is insufficient since B’s capability spans what might be setup as the “pork grind” and “beef grind” work centers. PlanetTogether handles this with capability-based scheduling. In addition to treating the work center as a required Capability, additional physical property Capabilities can be defined for the product. PlanetTogether will only schedule a product on a machine if it has all of the Capabilities required. Thus, in our example, a product may be a beef product and so only machines B and C would be considered eligible since they are grinders that can grind beef. These physical property Capabilities can also be used to avoid allergen problems where only specific machine are defined as capable of handling products that contain the allergen. (See the Cross Contamination section below for options on handling allergens in situations where the same machine runs both allergen and non-allergen products.).

Quantity, Quality, or Other Assignment Limitations

There are situations where the eligible machines cannot be specified by physical properties of the product alone. For example, some machines may only handle orders of certain quantities due to size limitations. Two orders for the same product could therefore have differing eligible machines. Orders of less than 500 pounds may be made in the small mixer while larger orders are handled in the large mixer. Alternatively, orders may be assigned based on the customer for whom the order is being manufactured. In these situations PlanetTogether can have sophisticated custom rules easy programmed in any Microsoft.NET language making the options nearly limitless.

Inventory Constraints

Food production often requires a wide variety of ingredients - both raw materials and intermediates. Ensuring that the requisite materials are available at the right time is a critical and difficult task. PlanetTogether makes this much easier by automatically creating schedules that are based on current on-hand inventories and projected receipts.

PlanetTogether creates schedules that are always material feasible - a production batch is only scheduled at a time when the necessary inventory is expected to be available. The source of supply can be: from on-hand stock, from a scheduled purchase order, from a scheduled intermediate batch, or based on the standard purchase lead time if no other supply is available.
Since the schedule can be constrained by materials, there is clear visibility to material bottlenecks. For example, if material is late due to a delayed vendor delivery. The production batch is highlighted in red on the Gantt making it obvious that there is a material bottleneck coming. Simply pointing to the batch on the screen warns the planner which material is the problem so that the material can be expedited or produced in time. This is a far better alternative to unexpected material shortfalls discovered at the last minute.

Material Handling Equipment Constraints

The movement of intermediate food product between operations is often done with the use of direct feed material handling equipment with no manual intervention. For example, molded cheese might fall directly from a molder into a transport canal where it cools while being transported to the packing workstation. This creates a scheduling constraint because the selection of machines for molding and packaging are interdependent. The cheese can only be packaged on a pack line that is setup to service the particular transport canal. There may be other pack lines available but if they are not connected to the mold machine then they are not eligible to do the packing.

This type of constraint can be handled by PlanetTogether in a few ways. First, “Cells” can be defined and each machine can be linked to a cell. In our cheese example, we might create “cell 1” and link mold line 1 and pack lines 2 and 3 to cell 1. Then PlanetTogether would only schedule the pack operation on a pack line in the same cell as the mold line. Moving a production run to a different mold machine would automatically cause the associated pack operation to be moved to an eligible pack line, ensuring feasibility.

If more sophisticated logic is required, there is also the option of defining a custom constraint. For example, if the material handling equipment can be moved between machines, then limiting a pack line to a particular cell may

not be flexible enough. A custom material handling constraint rule can be easily created to solve the problem.

Scheduling Cleanouts

Equipment cleanouts are required to maintain hygienic conditions and prevent cross-contamination between products. Cleanouts are often scheduled during non-productive hours (weekends for example) when day laborers are not present except for the personnel who perform the cleanouts. In this situation, PlanetTogether can be setup to always schedule cleanouts on weekends or during other specific time frames. If there are “minor cleanouts” that can be performed during the week for example and “major cleanouts” that should only occur on weekends then this can also be handled automatically.

In the event that cleanouts can be scheduled during productive times, Lookup Tables are defined to specify cleanout times required when switching between products with different attributes. For example, a cleanout when switching from beef to chicken may be longer than if switching between two different beef grades. The system will automatically schedule the appropriate amount of cleanout time, even when a drag-and-drop reschedule is performed to change the sequence. Additionally, the Optimization algorithm can be set to avoid excessive changeovers and thus maximize production output automatically and preventing cross contamination/ allergens.

A common goal in Food Process scheduling is to avoid certain products from running in sequence on the same equipment thus preventing allergens from cross-contaminating other products. For example, a mixture containing peanuts followed by another mixture that does not contain peanuts could lead to traces of peanuts in the second mixture. There are several strategies for avoiding this problem.

- Machine assignment: The system can be configured to only allow certain products to run on certain machines. So in our example, products containing peanuts might only be assigned to machine A while non-peanut products only run on machine B.

- Avoid bad sequences: If products with different allergens must run on the same machine, then the system can be configured to disallow

certain sequences. For example, products with no peanuts could be prevented from directly following products with peanuts (unless a major cleanout were scheduled between the runs). So all peanut-free products might run at the beginning of the week, saving peanut containing products for the end of the week. In the event that a "bad sequence" was absolutely necessary, the system can display a visual Flag (a diamond shaped block) plus schedule adequate time for a major cleanout to take place.

- Cross-machine contamination: In situations where airborne particles can result in cross-contamination between machines, it's necessary to prevent non-compatible products from running together on machines in the same vicinity. This can be accomplished by using PlanetTogether's Compatibility Coding. Products of different Compatibility Codes can automatically be prevented from running at the same time on machines in the same room for example.

Avoiding Spoilage

Food spoilage typically results from either product cross-contamination or from products being excessively delayed in the production process or in storage. PlanetTogether can reduce the risk of spoilage due to production delays using the "Maximum Delay" value in the routing. A maximum duration can be specified between any two operations and if this delay is violated during scheduling, a visual Flag is shown on the Gantt to warn the planner. Pointing to the Flag shows a popup with details explaining that the product is being delayed beyond its Max Delay value. In addition, preferences can be given to material that has been waiting for longer periods of time thus reducing the chance of this Max Delay being violated at all.

Spoilage can also be reduced by producing finished goods and intermediates as close to their need date as possible. This reduces the amount of time the product will sit in inventory, hence shortening its remaining shelf life. Production orders can have limits placed on them to prevent them from scheduling to start before a Release Date. In addition, each production resource can have a Maximum Head Start duration set to prevent it from running any products more than x days/hours before necessary. Lastly, production can be allowed to schedule early and simply

have a warning “early” color displayed to alert the planner to the condition for manual control.

Batch Processes

Batch processes such as blending or mixing have some special requirements in terms of scheduling:

- They are uninterruptible: Once a batch is started, it can’t be “paused” at the end of the shift or for the weekend. PlanetTogether can handle this automatically to make sure the operation only schedules at a time when it can finish completely without interruption.

- Their time varies by equipment: If 300 gallons of soup are needed and a single 300 gallon batch is scheduled on a 300 gallon blender, then the time may be 1 hour. However, rescheduling the batch to a 100 gallon blender means three batches of 100 gallons at say, 45 minutes per batch or two hours and fifteen minutes total. PlanetTogether can be setup to dynamically calculate these times as operations are scheduled on various pieces of equipment. The calculation can be very flexible, programmed based on certain logic or pulled from lookup tables in Excel. This makes it very easy to adjust schedules since the planner simply drags the production run to an alternate machine and PlanetTogether does the rest.

Continuous Material Flow Between Stages

In a multi-stage production, it’s often the case that material flows out of one piece of equipment directly into another with no storage in between. For example, a hot dog manufacturer may grind beef in the grinder while the ground beef is fed directly into a stuff line. If each grinder has a one-to-one fixed connection to one stuff line then the process can simply be modeled as a single operation. However if each grinder makes products that can feed multiple varying stuff lines then this presents a scheduling challenge.

As material is made by one operation, it is creating intermediate material at a particular rate. This material is then consumed at a particular (perhaps varying) rate. In our example, a grinder may be making beef that is consumed by multiple stuff lines simultaneously (which perhaps start at different times and run at different rates). This is handled by PlanetTogether by automatically examining the cumulative production and

consumption rates of the material over time and ensuring that the resulting schedule is feasible that enough beef is being ground to feed the pack lines as scheduled.

Shared Input Constraints

In multi-stage food production there are situations where an intermediate is produced by a machine which directly feeds multiple other machines. The flow of material is direct (food transport may even be automatic between the equipment) and so the second stage machines are limited to producing output from the same intermediate at all points in time. For example, cookie dough might be blended in a blender which directly feeds two mold lines. Therefore when chocolate chip dough is finished blending and fed to the mold lines, it's not possible to mold chocolate chip cookies and sugar cookies simultaneously - the mold lines only have the chocolate chip dough to work with. PlanetTogether can handle this constraint using the Compatible scheduling feature. PlanetTogether would only allow the molders to schedule products simultaneously across the molders if they are Compatible - in this case, if they use the same intermediate dough.

Limited Storage

When intermediates or finished goods are produced they need to be stored until consumed. In Food Process plants there are often limits on this storage space, particularly for intermediates which are stored temporarily between production stages. For example, a coffee roaster may roast coffee beans, grind them, and then need to store them prior to packaging. The floor space and storage bins may be limited so exceeding the total amount of available material space is not possible. PlanetTogether can produce custom reports that look at inventory projections across products to warn of any such situations. Also, by favoring products that have been in queue longer, these situations can be minimized automatically.

Integrating Shipping and Production Schedules

Once the production schedule is known, further economies can be realized by generating schedule-driven shipping schedules. This will save on costs associated with trucks waiting for the product to be completed and makes it easier to provide accurate shipping plans.

If the necessary destination information is supplied to PlanetTogether, then custom shipping schedule reports can be created based on the actual

production schedule plus current on-hand inventories. Using the product dimensions and truck sizes, PlanetTogether can indicate when full truck loads will be ready for shipment and the products and quantities to be shipped in each truck.

Conclusion

While this document is in no way an exhaustive description of the scheduling challenges faced by Food Process companies, it serves to highlight how complex and difficult this type of scheduling can be without a system that can model the various constraints.

Because PlanetTogether is a modern Microsoft.NET based application, it is very easy to add constraints for specific production environments. This, combined with the rich pre-defined tools related to Food Process scheduling, result in a system that is rapid to implement,
easy to learn, and highly profitable to use.

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