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# Corporate Management of Formula Development and Batching Using TechWizard™ and Production Wizard™

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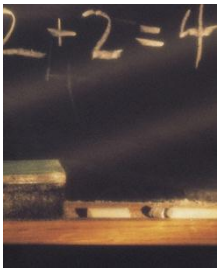
## Summary

Antiquated calculation techniques such as Pearson's Square, the Serum Point Formula, the Milk and Cream Formula, or algebraically solving for a few unknowns are not robust enough for today's formulation requirements. Manufacturers need to be able to handle a variety of formulation contingencies efficiently on a daily basis. These contingencies include making the same formula at various locations, reclaiming salvage, switching tanks during a batching operation, or formula restandardization. Owl Software's TechWizard™ and Production Wizard™ act as a central clearing house for formula information and provide for overall formulation management from product inception, through nutrition facts creation and finally to manufacturing product at one plant or many. The reasonable pricing of these software packages provides a quick return on investment and makes it possible for companies to use these programs in complicated mix formulation situations or in situations where they are simply standardizing for a single component.

## Introduction

Formulating and batching dairy formulations such as ice cream or cultured dairy products can be a challenge. This is because the dairy ingredients that make up the recipe contribute multiple components such as milkfat, MSNF, total solids, etc. This in conjunction with the fact that different shipments of dairy ingredients vary in milkfat, MSNF, and total solids forces those striving to describe and configure the formula for batching to do so based on composition instead of simply listing a recipe of ingredients (the number of recipe combinations would make listing all possible combinations impractical). For instance, an ice cream formula may require a predetermined amount of total solids, milkfat, MSNF, whey solids, sucrose solids, stabilizer solids, etc. This being stated, the amount of milk, cream, condensed skim, skim milk powder, condensed whey, etc. may vary substantially in the recipe depending on the source ingredients on hand, the age of the source ingredients (the plant may be trying to use up certain sources), and of particular interest because the amount of total solids, milkfat, MSNF, whey solids, etc. varies from one shipment to the next.




## The Past - Early Calculation Techniques

A variety of simplified techniques referred to in Figure 1 as *Classical Methods* were adapted by the dairy industry in the late 1800's and early 1900's to help address formulation issues. These simple methods included Pearson's square (a technique for balancing ingredient amounts for one component such as total solids or total fat), the "Serum Point" formula (used to estimate the amount of concentrated skim milk solids ingredient needed), and the "Milk and Cream" formula (used to estimate the amount of concentrated milkfat ingredients needed). These formulas have been used for decades to balance simple ice cream mixes for total solids, total fat, and MSNF.

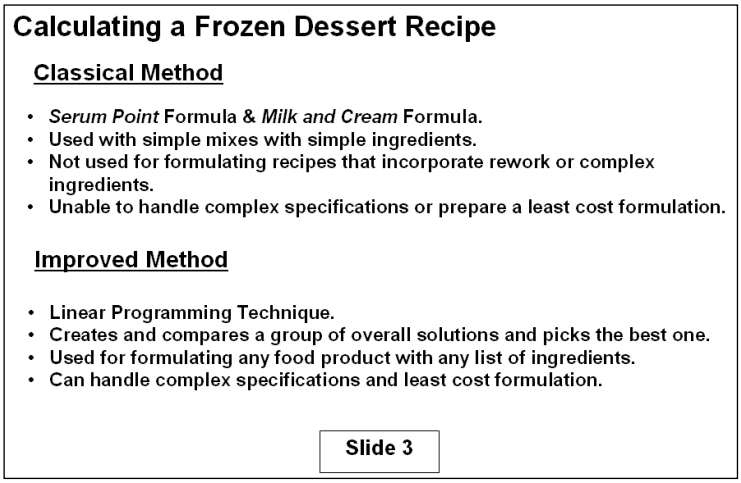



**Figure 1. Comparison of calculation techniques. The following is a slide from a presentation used by Owl Software at the Cal. Poly Frozen Dairy Desserts Manufacturing Short Course, the Penn. State Ice Cream Short Course and the Penn. State Cultured Dairy Products Short Course.**

These techniques are still taught at short courses such as Penn. State's *Ice Cream Short Course*. As the people in charge of this short course will readily point out, the *Classical Methods* are still used because they fall within the abilities of what the attendees can handle mathematically but are not endorsed as state-of-the-art. The *Classical Methods* have many limitations including (Figure 1):

1. Unable to handle rework or complex ingredients composed of non-dairy water,
2. Unable to handle complex specifications (such as excluding rework if it contains allergens),
3. Unable to handle day-to-day plant floor batching such as shifting from one source of milkfat and MSNF to another,
4. Unable to restandardize formulas, and
5. Unable to prepare a least cost formulation.

## Improved Formulation Techniques

With the advent of affordable computers, better methods are now available. Owl Software utilizes more sophisticated techniques in its computer programs that are capable of formulating for any food product in spite of its complexity. Owl Software makes use of the *Improved Method* described in the second half of Figure 1. This method uses a Linear Programming technique, which means it creates and compares a group of overall solutions and picks the best one. This *Improved Method* can be used to formulate recipes using any list of ingredients and any list of specifications. Owl Software is committed to providing state-of-the-art software solutions to the dairy industry and takes part every year in teaching the computer assisted formulation portion of the short courses mentioned in Figure 1. Owl Software has been teaching the computer assisted formulation section of the Penn. State Ice Cream short course since 1997.

Let's consider the Owl Software formulation techniques. The user provides a desired composition and a list of candidate ingredients. The software considers many different combinations until it finds one that meets all compositional requirements. This is done while at the same time minimizing cost. Other constraints can also be set, for instance, a formula can be configured to use a particular amount or range of an ingredient. Examples of this would be to limit the maximum corn syrup usage to 4% or to limit skim powder usage to only those times when condensed skim milk cannot supply the necessary MSNF. Our software products are segregated to deal with the task at hand. TechWizard™ is a research and development tool whereas Production Wizard™ is a robust batching tool to be used on the plant floor.

## TechWizard™ A Research and Development Tool

TechWizard™ offers product development, nutrition labeling, food formulation (least cost), and some batching capability in one affordable software package. A list of features is provided below.

**Figure 2. TechWizard™ features**

**Least Cost Formulation** TechWizard™ can evaluate all ingredients in a food product and quickly come up with re-formulations that reduce cost and meet quality specifications in a matter of seconds.

**Nutrition Labeling** TechWizard™ makes it easy to prepare a nutrition datasheet, nutrition facts label (including trans fat) and ingredient declaration for any food product. The typical nutrition labeling program can only produce a nutrition label.

**Reverse Engineering** TechWizard™ has the capability to use product analyses results or a product's nutrition label and the product ingredient list to develop an equivalent formulation.

**Goal Oriented Formulation** TechWizard™ determines how much of each ingredient to use to meet compositional, quality, and flavor goals. For instance, the user could retrieve an ice cream formula and quickly reformulate it to reduce fat or switch to another sweetener source without adversely influencing mouthfeel and dipping characteristics.

**Recipe Entry & Conversion** Starting from a recipe in a cookbook or a formula for a large batch of product, TechWizard™ makes it easy to enter information regardless of the source or the units.

**Formula Archiving** Formulas can be transferred from one archive file to another or shared with other TechWizard™ users. The user can have an unlimited number of formula archive files.

**Ingredient Database** Nutrition and composition information is easily edited and fully under the user's control. Ingredients can also be transferred from one database file to another or shared with other TechWizard™ users. The entire USDA Food Composition database (5976 items) is also provided. TechWizard™ and Production Wizard™ can share the same ingredient file.

ProductionWizard™

## Efficient Formula Batching

Production Wizard™ brings order to what can be chaos at certain times – the plant floor. Production Wizard™ simplifies the process of day-to-day batching and batch sheet creation. The mixer is provided a simple user interface where he or she answers a few questions such as which tanks of cream and milk should be used first? Next, a batch sheet, formatted to your needs is produced. Many batching programs solve for only a few properties, for example, milk fat and milk solids non-fat in dairy products. Production Wizard™ allows you to formulate for up to 40 different properties. What does this mean? You provide Production Wizard™ with a list of ingredients to choose from and a list of characteristics you want the formula to have, (e.g., the amount of corn syrup solids, protein, fat, milk solids non-fat, milk fat, total fat, cocoa solids, egg yolk solids, total solids, allergens, etc.). Production Wizard™ will consider the various ingredient combinations to meet all these requirements while minimizing cost. Production Wizard™ is a very powerful tool for formulation, reformulation, and effectively using up salvage and rework. A list of features is provided below.

**Figure 3. Production Wizard™ features**

- Day-to-Day reformulation and batching.
- A user interface that is easy to use with flexibility to handle any situation.
- Composition-based formulation with least-cost formulation.
- Real time ingredient updates and tank selection.
- Specialized calculations for a particular situation.
- Control of product loss/rework.
- Dispensing error determination / "smart" batching.
- Control of unwanted ingredient contamination / allergenicity issues.

Today's manufacturers are dealing with customers that are demanding tighter composition constraints with no unintentional ingredients in their products especially allergens. They expect each formula to have a composition that matches the product's contract or nutrition facts and to contain only what is stated in the ingredient listing. Production Wizard™ provides a means of implementing these formulation needs such that a mixer is prohibited from making a batch if any pre-set critical requirements are not met.

At many companies there is a lack of interaction between those responsible for creating nutrition facts and those responsible for making product. This is an outcome of companies using one software program to create nutrition labeling information and an entirely separate program to make the product. Owl Software brings transparency to the process. An administrator can retrieve any formula destined to be used to make a mix or enter information from a batch sheet and with the click of a button review its nutrition facts and ingredient listing. With Production Wizard™, the formula for making product is the standard formula used to make the nutrition facts.

## Using TechWizard™ for Formula Development

How can one use TechWizard™ and Production Wizard™ to control the process of developing or improving a product then making it at any processing facility? Let's start at the product development level and use an example to demonstrate how we would proceed.

A customer would like you to produce a 3.5% vanilla soft serve formula. Before making the product, the customer would like a review of the existing formula and determine what would happen if high fructose corn syrup is replaced with corn syrup solids (36 DE). This can easily be done using TechWizard™. The desired composition is entered in TechWizard™ and the candidate ingredients selected (Table 1 and 2).

**Table 1. Desired composition of a 3.5% fat soft serve ice cream.**

| Property | Desired Composition |
|---|---|
| Milkfat (%) | 3.50 |
| MSNF (%) | 10.00 |
| Sucrose Solids (%) | 10.00 |
| Stabilizer Solids (%) | 0.10 |
| Total Solids (%) | 25.5 - 26.5 |
| Whey Solids (%) | 2.00 |

**Table 2. Ingredients used to make 3.5% fat soft serve ice cream.**

| Ingredients | |
|---|---|
| Cream | Liquid Sugar |
| Milk | Stabilizer |
| Skim Milk | Sweet Whey powder |
| Cond. Skim Milk | |
| High Fructose Corn Syrup or Corn Syrup (36 DE)? | |

TechWizard™ quickly determines the necessary amount of each ingredient to make the formulas. TechWizard™ calculated that a ½ cup serving of the soft serve ice cream at 50% overrun would weigh 85 grams. This information is used to generate the nutrition facts for each formula is shown in Figure 4. Comparisons of sweetness and freezing characteristics are shown in Table 3, Table 4, and Figure 5.

**Figure 4. Nutrition Facts comparison for 3.5% fat soft serve ice cream made with 2% HFCS solids or 2% corn syrup solids.**

| Soft Serve Formula 3.5% Fat with 2% HFCS Solids | Soft Serve Formula 3.5% Fat with 2% Corn Syrup Solids |
|---|---|

**Nutrition Facts**
Serving Size 1/2 cup (85 g)
Servings Per Container 1

| Amount Per Serving | |
|---|---|
| **Calories** 100 | Calories from Fat 25 |
| | **% Daily Value*** |
| **Total Fat** 3g | **5%** |
| Saturated Fat 2g | **10%** |
| *Trans* Fat 0g | |
| **Cholesterol** 15mg | **5%** |
| **Sodium** 60mg | **3%** |
| **Total Carbohydrate** 15g | **5%** |
| Dietary Fiber 0g | **0%** |
| Sugars 15g | |
| **Protein** 3g | |
| Vitamin A 2% ? | Vitamin C 0% |
| Calcium 10% ? | Iron 0% |

*Percent Daily Values are based on a 2,000 calorie diet.

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| Dietary Fiber 0g | **0%** |
| Sugars 14g | |
| **Protein** 3g | |
| Vitamin A 2% ? | Vitamin C 0% |
| Calcium 10% ? | Iron 0% |

*Percent Daily Values are based on a 2,000 calorie diet.

*Nutrition Facts created using TechWizard™.*

**Table 3. Sweetness comparison for 3.5% fat soft serve ice cream made with 2% HFCS solids or 2% corn syrup solids.**

| Formula | Sweetness (g /100 g) |
|---|---|
| Soft Serve Formula 3.5% Fat with 2% HFCS Solids | 13.6 |
| Soft Serve Formula 3.5% Fat with 2% Corn Syrup Solids | 11.8 |

*Sweetness information calculated using TechWizard™. Values represent the sweetness as compared to a sucrose solution at that concentration.*

**Table 4. Ice Content comparison for 3.5% fat soft serve ice cream made with 2% HFCS solids or 2% corn syrup solids at 20° F.**

| Formula | Calculated Ice Content (g /100 g) |
|---|---|
| Soft Serve Formula 3.5% Fat with 2% HFCS Solids | 49.6 |
| Soft Serve Formula 3.5% Fat with 2% Corn Syrup Solids | 53.4 |

*Ice content calculated using TechWizard™.*

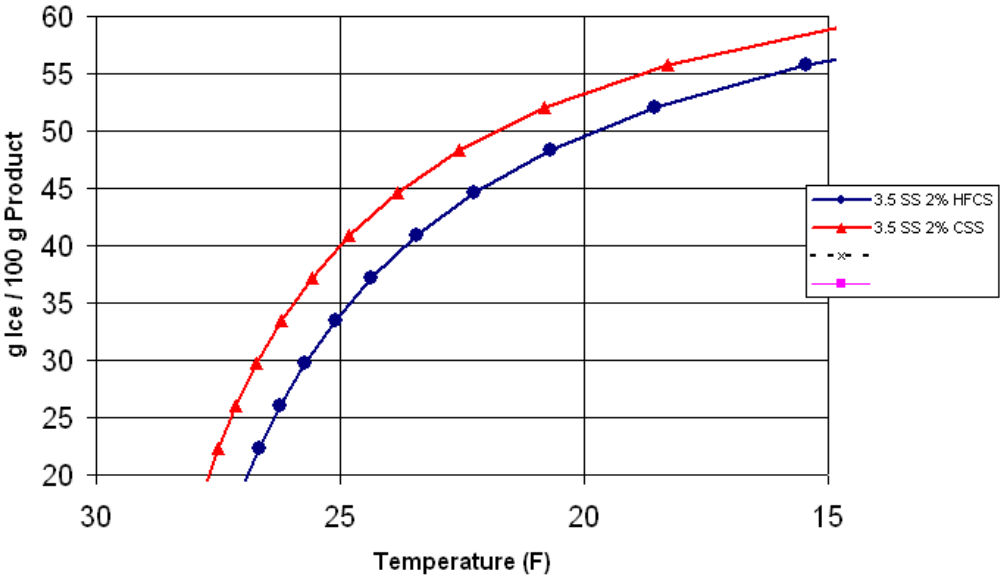



**Figure 5. Freezing curve comparison for 3.5% fat soft serve ice cream made with 2% HFCS solids or 2% corn syrup solids.**

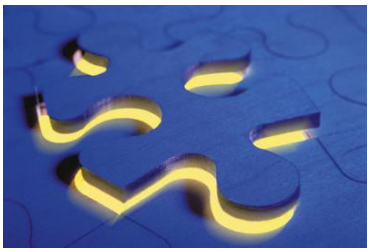
*Freezing curve created using TechWizard™.*

We find that there are no differences in the nutritional values (Figure 4). The formula containing corn syrup instead of high fructose corn syrup is less sweet and has more ice in it at a draw temperature of 20°F (Table 3, Figure 5, and Table 4). Most likely these differences would be noticeable. All analyses were immediately available in TechWizard™ once the formulas are generated. It is decided that the original formula containing 2% HFCS solids will be used. Before we start making the product in the plant, we need a run down on raw material cost to make 40,000 gal. This again is quickly accomplished using TechWizard™. The results are shown in Table 5 below.

**Table 5. Information compiled from TechWizard™ to prepare 40,000 gal of 3.5% fat soft serve ice cream made with 2% HFCS solids.**

**Amount:** 40,000 gal 361,933.6 lbs
**Calculated Density:** 9.048 lb/gal
**Raw Material Costs:**
Price per 40,000 gal: $106,155.67
Price per lb: $0.293
Price per gal: $2.654

| Estimated Ingredient Amounts to Make 40,000 gal | |
|---|---|
| **Ingredient** | **Amount** |
| Cream | 1,337 gal |
| Milk | 29,480 gal |
| Cond. Skim Milk | 2,556 gal |
| Liquid Sugar | 5,080 gal |
| Stabilizer | 15 bag (50 lb) |
| Sweet Whey Powder | 150 bag (50 lb) |
| High Fructose Corn Syrup | 915 gal |
| Vanilla Flavor | 5 gal |
| | |



## Using Production Wizard™ to Manage Batching

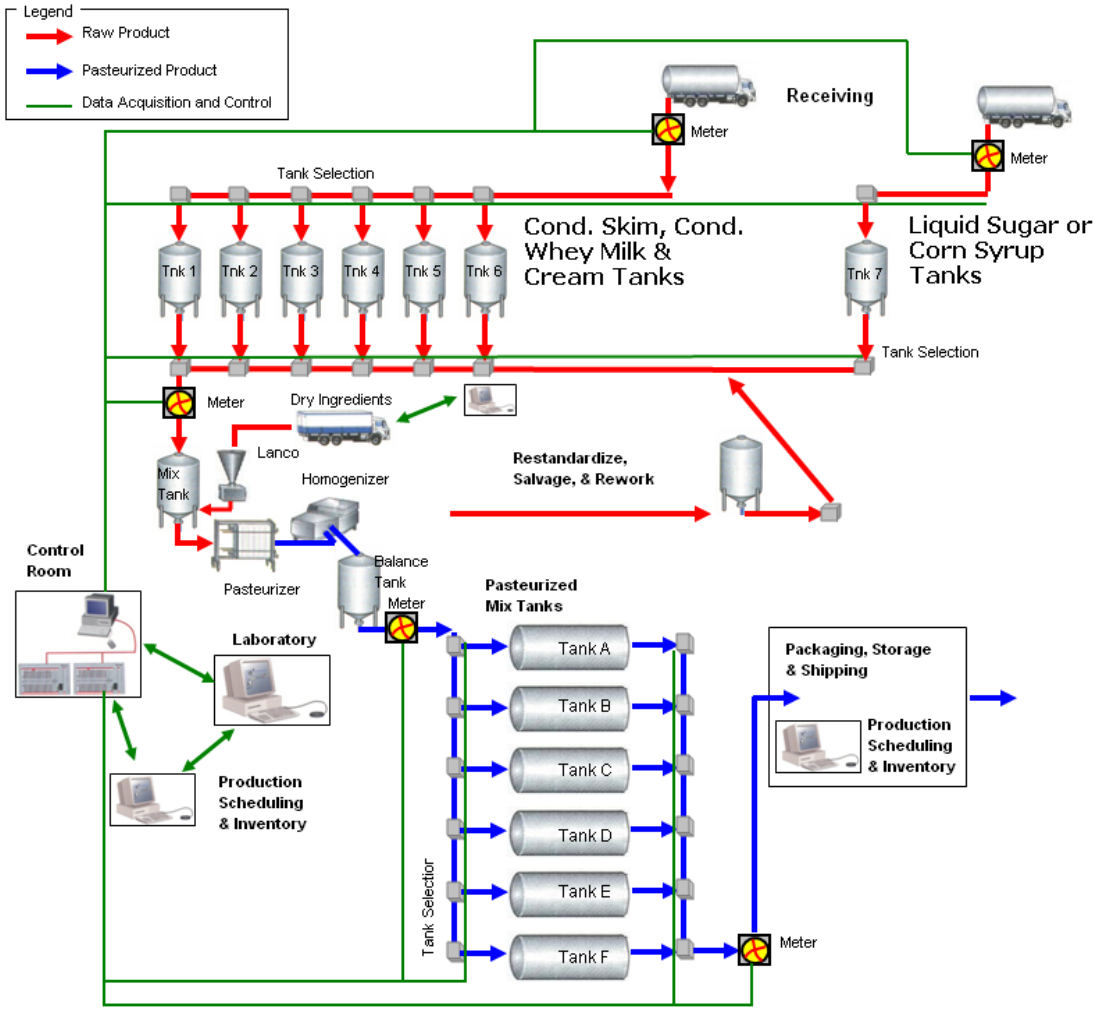
We are now ready to start manufacturing our product. In our case, we will be making the same product at 3 different locations. Before we discuss how that works in detail, let's look at some general operating components of Production Wizard™. Figure 6 describes a simplified processing plant. Liquid ingredients are delivered and placed in tanks. This information is updated in Production Wizard™ which will be tracking the amount in each tank, how long the product has been in the tank, and its composition. The appropriate personnel use the tank contents editor and the ingredient update tool to designate what is in each tank and to update the composition of the contents.

Mixers use the batch creation tool to retrieve formulas. Once the formula is retrieved, the mixer is provided with necessary tank information including which tanks are available, tank contents, tank fill date, and tank status diagnostics (e.g. tank expired?, composition data recent enough?). Mixers use this information to select the source tanks to use. If a tank is almost empty and they are not sure if it will provide them enough of that ingredient, they can select an alternative tank. Production Wizard™ uses this information and the ingredient composition data to

formulate a recipe and prepare a batch sheet. If this information needs to be sent to a report file to be read by accounting software or sent to controllers that is initiated at this time.

If tank contents have been in the tank too long or the composition of the contents has not been updated, the administrator can configure the formulas to stop the batch recipe from being created. Additionally, if the formula does not meet all specifications it can be stopped too. A good example of this would be if the mixer tries to use rework or salvage containing an ingredient that is not allowed in the formula (e.g. rework containing egg yolk or cocoa powder).

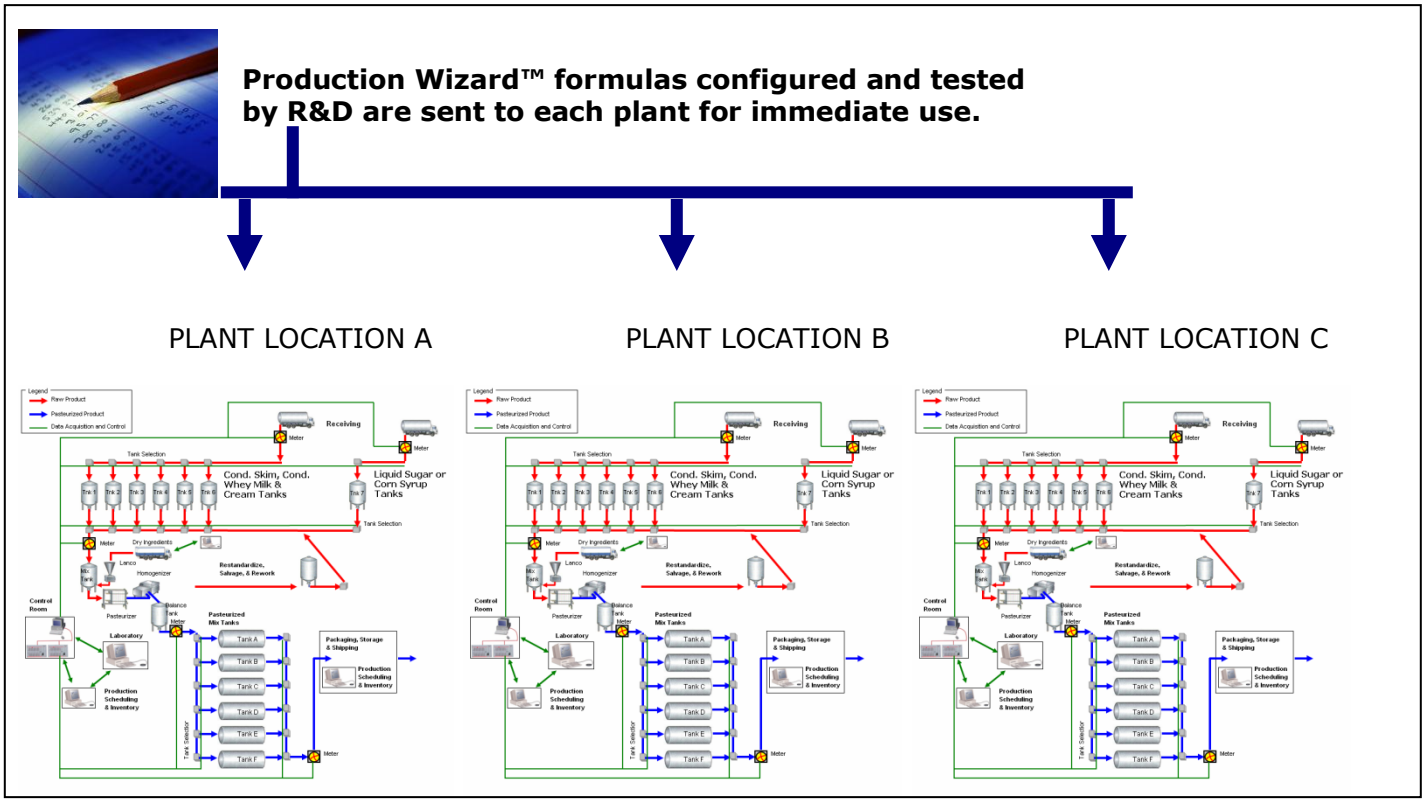
**Figure 6. Simplified Processing Plant.**




### What has to happen to make the 3.5% soft serve formula at the 3 different plants?

The TechWizard formula is converted to a Production Wizard™ formula. Some additional configuration data is added to the formula such as how much to make and which batch sheet report to use. A restandardization formula is also created in case a dispensing error is made. The mixer can use the restandardization formula to determine what needs to be added back to the original formula to fix it.

**Figure 7. Making the same 3.5% fat soft serve formula at 3 different locations.**




Once these formulas are configured, the administrator can use an enterprise version of Production Wizard™ to do simulations on his or her computer. The simulations duplicate the procedures followed in Production Wizard™ for making the formula at the various plants using that plant's tank data. If any problems arise the administrator will know before actual product manufacture occurs. The administrator can also make ingredient substitutions if necessary. If a particular plant uses condensed whey instead of whey powder or may need to chose one or the other this is a simply reconfiguration task with Production Wizard™. Once the administrator is satisfied that the formulas are ready, he or she simply supplies them to the various plants.

Owl Software's TechWizard™ and Production Wizard™ act as a central clearing house for formula information and provide for overall formulation management from product inception, through nutrition facts creation, and finally to manufacturing product at one plant or many. The reasonable pricing of these software packages provides a quick return on investment and makes it possible for companies to use these programs in complicated mix formulation situations or in situations where they are simply standardizing for a single component.