Food & Beverage White Paper

Content Created for Junction Solutions, Microsoft Dynamics AX Gold Partner

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A Delicate Dance of Supply & Demand, Part 2

Processing Complexity & the Case for Industry-Specific Business Applications

ABSTRACT

As dairy producers and processors continue to look for means to reduce costs to boost the bottom line, it is clear that cost-cutting measures alone will be insufficient to afford them long-term success. Responding to these pressures, both camps are positioning themselves to take increasing advantage of business technologies that automate and streamline a variety of processes that enable them to "do more with less."

In a landscape characterized by mounting competitive pressures, shrinking margins, overwhelming complexity, and myriad factors beyond their control, dairy companies at the forefront of their industry are blazing new frontiers in their use of powerful business applications to reduce production lead times, improve customer retention, reduce labor and material costs, and ultimately ensure future profit and long-term success.

INTRODUCTION

The dairy industry is unquestionably one of the most unforgiving in today's marketplace, a status easily supported by its combination of grueling and unending day-to-day labor, coupled with government intervention that has altered traditional cycles of supply and demand. With ever-narrowing margins and continued pressures from forces outside their direct control, the dairy industry poses formidable challenges for those within it seeking to increase efficiencies to raise profits. (Because the complexities around historic and current-day government involvement in the dairy industry are so vast, this background is separated out as Part 1 of this white paper, entitled, "A Primer on Dairy Industry Complexity.")

Part 2 of this white paper series focuses on challenges to dairy operations and how leaders in this space are harnessing software applications designed to address the unique requirements of the industry. The discussion begins with a high-level introduction to the players in the dairy supply chain, followed by a review of the weighty and complex issues they face, including:

- Competitive pressures, both domestic and global
- Inputs and margins as components of profit
- Regulatory, customer, and consumer demands
- Production and processing complexity

For areas in which these challenges may be able to be effectively addressed with technology solutions, the paper then highlights the increasing role industry-specific business applications are playing for

leading dairy companies, as well as how these forward-thinking producers and processors are using these tools to automate and streamline their operations.

DAIRY INDUSTRY SUPPLY CHAIN

At the most basic level, the dairy supply chain begins with the farmers and agricultural suppliers who produce raw milk and ends with the processors, institutions, and consumers who utilize products that were created in the production chain, with raw milk, processed milk, and by-products serving as ingredients in other processing chains.

The supply chain for unprocessed milk may include cooperatives and other supplier organizations that receive milk from the original producers, and/or buyers, wholesalers, or other intermediary operators who sell product either to the small unprocessed milk consumer base or, far more frequently, to milk processors who may then sell their product directly to consumers, or to distributors, retailers, further processors, or dairy product factories, all of whom will ultimately sell their finished goods to the end consumer.

While dairy farms often focus exclusively on the production and processing of a single product—raw milk—that milk is often then sold into secondary stages of the production chain to fulfill requirements around a range of dairy products that are so broad, diverse, and growing as to be almost limitless, each of which brings with it unique requirements for milk solids, proteins, and volume as well as its own distinct recipe for processing.

Because of the interdependent and overlapping environments in which producers and processors must operate, both will be discussed in this paper.

DOMESTIC & GLOBAL COMPETITION

As a baseline from which to explore the challenges faced by dairy producers and processors, it is useful to examine a recent snapshot of the competitive landscape within which players in the industry must operate, including domestic production and sales figures, global export conditions, and overall competitive trends.

Domestic Production & Sales

While down from year-over-year production increases of 4.3 percent and 4.2 percent, respectively, in February and March of 2012, the U.S. Department of Agriculture (USDA) estimated year-over-year milk production increases for April 2012 of 3.3 percent for the 23 states that report data to the agency and 3.2 percent for the U.S. as a whole, marking the 27th straight month U.S. milk production has increased (year over year). These increases correlate with higher quarterly production levels for a number of associated dairy products: Q1 2012 year-over-year dairy product production levels rose sharply, with notable production increases seen over the same months in 2011 for butter (6.4 percent increase), cheese (3.7 percent increase), and nonfat dry milk (49.9 percent increase). The number of U.S. dairy cows also increased slightly in Q1 2012 (1 percent over 2011 levels or 94,00 head in the top 23 dairy-producing states), as did the average amount of milk produced per cow, per year (2.2 percent, or 40 pounds). [1, 2, 3]

While the U.S. government purchased no dairy products in 2011 under federal price support programs, 2012 fluid milk sales within the U.S. flagged, running below 2011 levels, and sending most of the increases in milk production back into domestically manufactured dairy products.[4] Consequently, in 2012 the government was expected to make payments to many dairy producers under the provisions of the Milk Income Loss Contract (MILC), a program begun in 2003 to assist dairy farmers when the price of milk falls too low. [5]

Global Export Sales

As of June 2012, more than 13 percent of all domestically produced milk in the U.S. was being exported.[6] Despite widespread challenges associated with increases in production around the globe, import demand by other regions was considered to be strong and resilient—with Southeast Asia, the Middle East, and North Africa making up for decreased purchases by the historic leading importers China, Russia, and Algeria. Overall year-over-year export volume for dairy was higher in Q1 of 2012 than during the same time period in 2011; however, closer examination revealed a mixed bag with regard to relative sales of specific products. Especially strong export sales were returned during this period for cheese (7 percent higher than in 2011), whey protein isolates (16 percent higher), lactose (9 percent higher), and nonfat dry milk/skim milk powder (5 percent higher), while decreased sales were seen over the same time segment for dry whey (8 percent lower) and butterfat (34 percent lower). [7, 8]

Competitive Trends

While global industry analysts anticipated improvements in near-term market conditions as supply imbalances correct themselves, June 2012 found global dairy prices nearly 30 percent off their spring 2011 high point, and as a whole still reeling from the last few years' disastrous combination of recession, rising fuel and feed costs, and sharp price declines. At that time, the global dairy industry continued to exhibit "soft" pricing, with burgeoning production worldwide mirroring that within the U.S. and transforming previous supply deficits into both surpluses and rising inventories that have fed overall downward pressure on milk prices. [9, 10]

U.S. Dairy Export Council President Tom Suber called these conditions "a painful re-affirmation that market cycles will continue, even as demand, over time, strips supply." Says dairy industry analyst Tim Hunt from Rabobank Group, "International demand has proved insufficient to soak up all the increased surplus generated in export regions. More milk is being channeled into storable commodities as a result, and there are some early signs of stock accumulation ... in the E.U. and the United States."[11]

It is also worth noting that recent and ongoing discussions around the 2012 Farm Bill's Dairy Security Act have brought to the forefront concerns by some over the proposed Market Stabilization Program component of the plan, which would limit milk supply under certain conditions at the same time that there are regions within the U.S. and the world that lack sufficient milk supply to meet demand. Considerable debate has taken

place over the potential for dairy producers in other nations to enter or grow their presence in the marketplace under these conditions and effectively "own" market share that might have been available to U.S. producers.[12]

INPUTS & MARGINS

Adding to the business challenges associated with trying to ensure profitability amidst weighty competitive pressures and the complexity of external milk pricing systems, the dairy industry is also struggling to operate profitably with almost nonexistent margins. These producers and processors of quick-turnaround, highly-perishable products fight to balance the reality of higher production costs for items outside their control with increasing demands made of fickle consumers, while also meeting strict expectations of large retail customers. The recent past has brought to dairy producers and processors higher commodity prices for feed and grain; higher fuel and energy costs; and higher packaging materials costs for paper, plastic, and metal.

This discussion of suffocating margins begins with a review of how margins are being affected by feed costs, energy requirements, and the size/capacity of dairy operations. A startling statistic puts into perspective the severity of the margin loss threatening producers in the dairy industry: U.S. dairy farmers currently receive $15 to $17 per 100 pounds of milk, for which they have incurred a production cost of between $16 and $18.[13] Between 2007 and 2009, these same producers saw a decline in their net worth of more than $20 billion, with thousands leaving the industry entirely after soaring feed prices destroyed any margin they might otherwise have had.[14]

Feed Costs and the "Ethanol Effect"

A large proportion of dairy farmers' production costs are related to feed, the primary sources of which are corn and alfalfa hay, with soybeans making up a smaller component. Over the past several years drastic changes have taken place in the price of corn, much of which is linked to the status of ethanol, whose use has been federally mandated and (until 2012) production subsidized for more than 30 years. Up from 5 to 6 percent six years ago, 40 percent of today's domestic corn production in the U.S. goes to ethanol, with this increasing demand more than doubling its price over the same period.[15]

Energy Requirements

While the production and subsidization of ethanol has had a dramatic effect on dairy producers with regard to rocketing feed prices, the industry also incurs substantial energy costs in a more traditional manner. While energy demands and associated costs vary within the range of processes undertaken by dairy producers and processors, virtually all require significant amounts of electrical energy (for refrigerators, drives, and motors); thermal energy, primarily in the forms of natural gas, fuel oil, or propane (for product water and space heating as well as transportation); and water (for cows, cooling water, and steam generation).

According to the World Bank Group, thermal requirements account for about 80 percent of the energy required to process milk, specifically for use in hot water and steam generation for process applications that include pasteurization, evaporation, and milk drying. Electricity accounts for the remaining 20 percent, used to drive process machinery,

refrigeration, ventilation, and lighting.[16] For most dairy processors, energy costs per facility have increased steadily over the past 20 years, and represent a significant cost component pushing margins lower and lower.[17]

Production Capacity & Economies of Scale

Struggling to overcome the challenges of higher production costs and resulting shrinking margins, a snapshot of the last decade shows U.S. dairy farms consolidating (and diversifying) and "going big" to survive and remain competitive and profitable, maximizing economies of scale in their operations. While the number of U.S. dairy cows has not changed substantially over the past decade, the number of dairy farms in the U.S. has fallen dramatically, but in a telling way. While the number of small farms (defined as having 100-199 cows) decreased precipitously, the number of large farms (defined as having more than 1000 head of dairy cows) has increased.[18, 19] According to the USDA, "Since 2001, the overall trend in the United States dairy industry has been toward more large operations (places with 500 or more head of milk cows) that have a greater share of total milk cow inventory and a greater share of total milk production."[20]

REGULATORY, CUSTOMER & CONSUMER DEMAND

In addition to concerns over evaporating margins, dairy producers and processors are also faced with substantial requirements from regulators, customers, and consumers. Understandably, milk and associated dairy products are expected to meet quality control requirements indicating they are safe for consumption by consumers. To this end, the FDA publishes the "Grade A" or Pasteurized Milk Ordinance (PMO), which sets sanitation standards for milk production in most states and for all interstate milk shippers. The composition of milk and milk products is specified in Agricultural Handbook 52 published by USDA, which lists both federal and state standards. Testing of milk products includes tests for fat content, total solids, pasteurization efficiency, presence of antibiotics used to control cow disease, and many other factors.[21]

In addition, the dairy industry will have to comply with applicable requirements in FDA's recent Food Safety Modernization Act (FSMA), considered to be the most sweeping reform of U.S. food safety laws in more than 70 years, signed into law January 4, 2011. The act aims to ensure the U.S. food supply is safe by shifting the focus from responding to contamination to preventing it. One of the FSMA components likely to have the greatest impact on the dairy industry is a mandate for all food companies to develop and follow a hazards analysis and critical control points (HACCP) plan. While HACCP adoption had been voluntary for dairy companies to this point, many (especially larger processors) had already embraced the requirements based on pressure from their grocery store or foodservice retailer customers.[22]

This scenario in which customer demands effectively intensify or speed the adoption of regulatory requirements is not new to the food and beverage industry as a whole, or to the dairy industry specifically, which has had to respond to increasing customer pressure to provide options such as allergen labeling, private labeling, and seasonal production, as well as fortified, organic, and locally farmed options. Such options are of

course the result of increasing consumer demands as the end user base increasingly seeks out foods that provide more than basic nutrition and looks to cultured and fortified dairy products as some of the healthiest, nutrient-dense foods available, including dairy products enhanced with micronutrients/probiotics.[23]

To meet all of these requirements, dairy processors must carefully balance raw material availability against growing and broadening customer and consumer demands.[24] At the same time, they are coming under increasing pressure to provide this array of safe and complex products with shorter and shorter lead times, in spite of challenges such as stock-outs and last minute/rush ordering.

Shrinking this period between when a dairy order is placed and the final delivery of product to the customer is becoming increasingly critical to the survival and success of dairy processors, with lead times often meaning the difference between making the sale and watching a competitor sign the contract. Processors able to deliver products on time, every time—preferably days or weeks ahead of the competition—stand a markedly better chance of receiving future customer orders and experiencing long-term success.

PRODUCTION & PROCESSING COMPLEXITY

While milk and dairy products share characteristics of other micro-verticals within the food and beverage industry, milk is substantially unique in its designation as a "flow commodity," which places additional requirements on aspects of its production and processing.[25] This section begins with a high-level discussion around categories of milk and the precise and detailed steps typical in a standard milk processing environment, as well as the almost limitless complexity of the production and scheduling processes around a broader range of dairy products.

Milk, cultured products, and cheeses all share a requirement for fluid milk to be stored in tanks, as well as routed to and processed into other tanks or silos. This continuous process, in which the commodity flows between "stages" through networks of sterile pipes, is substantially more complex than manufacturing processes for discrete products, wherein a complete item or component of an item is moved from place to place (i.e., stage to stage) in its entirety as a separate entity.

The inherent complexities of dairy processing require producers to track and plan production through flow meters and tanks that are full, half full, or in cleaning stages, and to monitor temperature and quality throughout all of these stages. Scheduling yogurt production, for example, can require that material be both pumped into a batch from several different holding tanks as well as have other ingredients added to it manually. This complexity increases exponentially when factoring in the quality (i.e., percentages of butterfat, solids, and proteins) of the milk being used to produce the yogurt. Accounting for these diverse requirements through manual calculations for an ever-growing mix of products can quickly become overwhelmingly time consuming and complex.

To address these challenges, dairy producers are continuously searching for tools that enable them to plan and track what is moving through tanks (at what quality and into what finished products) more efficiently. For

example, automation that ensures production orders are scheduled in the correct sequence can eliminate unnecessary cleanouts, changeovers, and potentially production shifts as well, resulting in considerable cost savings, regardless of dairy size.

Milk Production 101

Milk is generally separated into two grades based on quality standards that measure somatic cell and bacterial counts as well as farm conditions such as those in the milking parlor, storage tanks, and water wells. Grade A is the higher standard and indicates that milk can be processed and sold as a fluid milk product as well as for any other ancillary dairy products. Grade B indicates a slightly lower quality milk that is appropriate only as a component of manufactured dairy products.[26] Outlining typical initial processing stages required for fluid-grade milk begins to highlight the complexity of the process:

- Weighing & Pumping. Milk arriving from producers is weighed and pumped into refrigerated tanks.
- Separating & Clarifying. Cold raw milk is spun through a series of conical disks with clarifiers that remove debris, certain bacteria, and sediment. Separators perform a similar function but also separate heavy fat from lighter milk to produce creams and skim milk. Standardizer-clarifiers may also be used, which remove only excess fat, which then may be processed into cream or butter.
- Fortifying. Processors may add vitamins (frequently A and D) to the flow of milk via peristaltic pump.
- Pasteurizing. While several process options exist for pasteurization, one of the most common heats the milk to 161 degrees Fahrenheit (72 degrees Celsius) for 15 seconds as it flows continuously through the pasteurization device.
- Homogenizing. Most milk is homogenized by pressurization to decrease the size of fat particles and keep them from separating and coming to the surface. To achieve this outcome and evenly distribute the fat within the milk, it is pressurized to between 2,500 to 3,000 pounds per square inch (psi) via a pump that forces it though a very small opening to achieve the desired pressurization. The milk is then rapidly cooled to 40 degrees Fahrenheit (4.4 degrees Celsius) to keep its taste intact.
- Packaging. Homogenized milk is pumped into bottles or paper cartons with a “sell by” date printed on each.
- Cleaning. Processing and piping equipment is cleaned at least once daily to ensure sanitation requirements are met.[27]

For milk destined to become a component of one of the endless list of dairy products, the complexities around processing are magnified to an even greater degree.

FLUID MILK AND BEYOND: A CASE STUDY IN PROCESSING COMPLEXITY

Broadly speaking, milk processing can be separated into a number of categories, including those for fluid milk, cultured products, cheese, butter, ice cream and other frozen products, and evaporated/dried products, all of which have unique and complex processing as well as quality control requirements.[28]

Against this backdrop of extraordinary production and scheduling complexity, many dairy processors are further handicapped by attempts to address the complicated and interwoven workflows and contingencies of their business with manual processes (typically whiteboards and spreadsheets) that severely limit their production flexibility and their ability to optimize efficiencies.

As a whole, these processors also face a critical business need to adapt to production variability. Four variables that play major roles in milk processing operations include:

- Quality. Milk received varies from day to day in terms of quality (e.g., percentages of butterfat, solids, and proteins), which affects the outputs that can be produced from a set quantity of raw milk received.
- Quantity. Dairy processors receiving milk directly from farms are required to adjust production to accommodate the milk that is actually received each day (including quality factors mentioned above).
- Timing & Expiration Dates. Consumer demand drives seasonal processing for certain dairy products throughout the year (e.g., sour cream during holiday periods or ice cream in the summer) and must be balanced with requirements around shelf life of the raw milk used to make them.
- Cost. Production costs can vary by month as determined by federal milk marketing orders that determine cost for Class 1, 2 and 3 milk. Production decisions are required to determine the best use of milk, a consideration that must also be balanced with sales demand and capacity to process the milk before its expiration date prevents downstream sales.

Adding to the complexity of such scenarios are the potential for interruptions in the supply chain, shortages of required raw materials, and delays in delivery, alongside possible production interruptions in the form of disturbances such as equipment failures and labor issues.

Historically, interruptions in production due to raw material shortages, equipment failures, or other unplanned contingencies have been addressed through exhaustive, time consuming, and costly manual exercises that usually involve manufacturing and production personnel scheming alternate production plans while attempting to manually account for almost endless scenarios and outcomes, all while margins sour quicker than the milk being produced.

WHAT CAN BE DONE & WHERE? THE CASE FOR INDUSTRY-SPECIFIC BUSINESS APPLICATIONS

The dairy industry is likely unique in its extreme levels of complexity and uncertainty, coupled with the range of business factors that fall almost entirely outside the control of any individual industry player. Of the myriad challenges they face, only some can be effectively and directly addressed by dairy processors and producers themselves; however, of these factors, nearly all can be positively and substantively impacted by the introduction of industry-specific business applications.

While dairy producers and processors continue to look for means to reduce costs to boost the bottom line, it is clear that cost-cutting alone will not afford them a long-term strategy for success. This has led forward-thinking dairy producers and processors to explore the benefits of

business applications that enable sustainable growth through increased productivity and consistent delivery of value to customers and consumers. In a landscape characterized by mounting competitive pressures, shrinking margins, overwhelming complexity, and myriad factors beyond their control, these dairy industry leaders are dispelling the notion that determining ROI for industry-specific business applications is too complicated; rather, they are embracing these technologies as a necessary bridge between their operations and sustainable future profit.

With unparalleled ability to access and centralize relevant data from disparate sources, make intricate and immediate calculations based on this information, and allow for optimal analysis and execution on the part of the processors, dairy-specific business applications are transforming quickly into a strategic asset that enables cost cutting alongside improvements in customer service, increased productivity, streamlined operations, and consistent delivery of the right product at the right time, each time that product is required. While the potential business applications dairy processors could effectively employ are varied and numerous, the discussion that follows will focus on two of the most critical—Enterprise Resource Planning (ERP) and Advanced Production Scheduling solutions.

The Foundation: Enterprise Resource Planning

To address the challenges outlined in this paper that fall at least partially within their control, leaders in the dairy industry are increasingly looking to foundational technologies like ERP systems as their operational system of record. These systems must be able to both accommodate complex track and trace reporting for compliance as well as quality control, recall management, shelf life tracking, market-based pricing, formulation and recipe management, ingredient substitution, milk producer payroll/milk contracts, and scalable batching. As they are in many micro-verticals within the food and beverage umbrella, these software systems are proving invaluable to the dairy industry in providing access to accurate, real-time inventory status of butterfat, solids non-fat and protein, as well as streamlining of operations across all functional areas within a company, from finance, accounting, and customer service to purchasing, warehousing, shipping, and receiving.

While these systems offer extraordinary value to dairy processors and automate many important tasks, not all inherently include the full functionality required to support intensive traceability requirements in mock or real recall scenarios, or the robust scheduling capabilities required of this user base, making it critical for dairy processors to seek solutions specifically designed for the unique requirements of their industry. Otherwise, these capability gaps around traceability and scheduling would leave many dairy industry processors to rely on manual spreadsheets, whiteboards, and static workflows to augment missing scheduling functionality in methods that are both time consuming and error prone.

Advanced Production Scheduling

The reality for dairy processors is that production environments that involve tanks typically experience greater than average challenges around scheduling, especially related to requirements around short lead times and order changes.

This has led industry leaders to embrace advanced production scheduling—a technology solution designed specifically to address these challenges while bringing with it the increased efficiencies and productivity that add tangible benefits to the bottom line and support strategies around long-term sustainable gain.

The most powerful tools on the market in this space are providing dairy processors with a single, comprehensive published schedule that synchronizes the activities of all aspects of production using algorithms that optimize all specified components of a particular production environment.

Bringing with them the flexibility and adaptability required of dairy processors, some solutions offer ease of integration with virtually any ERP solution, effectively reducing or eliminating manual data entry, improving data integrity, and providing real-time visibility to the same information by all relevant parties.

Advances in software development have also made some of these dairy-specific scheduling tools simple to use, as compared to commercialized versions of engineering or mathematical optimization tools. In all cases, the best scheduling applications bring speed—discernible reductions in the time required to generate plans, allowing for a greater amount of high-value "what if" analysis. As a whole, these processors experience benefits including:

- Reductions in excess inventory and fewer instances of shortages
- Increased throughput capacity and shorter run times
- Improvements in on-time delivery and production completion
- Reductions in planner workload, freeing up capacity of high value staff to work on critical projects
- Consistent planning methodology, used across the organization
- Fewer time-consuming meetings required to review or adjust scheduling
- Less scrap/waste due to inefficient changeover planning
- On a more granular level, processors who use these industry-specific advanced scheduling technologies are rapidly gaining the ability to:
- Account for all critical production resource and scheduling constraints including tanks, fillers, maintenance schedules, allergens, flow rates, light to dark, etc., to produce an optimal schedule
- Solve scheduling dilemmas nearly instantaneously, even for complex, multi-line BOM-constrained problems and tank-restricted high speed filling operations
- Easily schedule multiple products across multiple lines
- Quickly adapt and respond to unplanned scheduling changes because the application is reactive to "time of day"—allowing thorough rescheduling in a matter of minutes

Using advanced algorithms, some advanced planning software offers dynamic calculation of optimal workflow scenarios in minutes by taking the strongest "elements" from a population of potential scenarios and leveraging them to deliver the best available production scheduling options. From these options, the dairy production planner can add his/her own unique preferences into the equation, resulting in an optimal scheduling solution that is accurate, precise, and almost instantaneous.

THE BOTTOM LINE

While the uniqueness of the dairy industry in terms of complexity and uncertainty is unlikely to change, industry leaders are increasingly leveraging industry-specific business applications to achieve the tangible business benefits they require to boost the bottom line and ensure long-term success.

At a foundational level, industry-specific ERP systems are enabling dairy leaders to centralize and gain immediate visibility to all data throughout the enterprise while automating critical tasks and complying with regulatory requirements. From a margin and cost containment standpoint, advanced production scheduling tools are allowing them to efficiently manage within their specific operational constraints and incorporate changes with minimal impact on downstream functions, saving critical time and enabling cost savings.

In terms of customer and consumer satisfaction, the technology enables increased production completion and on-time deliveries, quicker reaction to last-minute and rush orders, and fewer stock-out scenarios. At the same time, advanced scheduling offers tangible benefits around product quality and safety, ensuring that production takes place within appropriate quality management constraints.

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