# Blueprint for building more profitable dairy & juice production

**A Practical Guide to Meeting Key Challenges of Today and Tomorrow**

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## Abstract

*This document describes the key challenges facing dairy and juice producers today. It provides insights into each one's market context and offers practical guidance toward effective solutions. It cites many case study references from around the world as examples of how other dairy production facilities have handled similar issues. Where relevant it suggests ways to build a business case for implementation.*


## Welcome

*"Rocket science" is a term used to describe anything complex and is one that applies to the dairy and juice processing business.*

*I know that few other industries have the kinds of process and market variables, interdependencies and public health regulations that ours does, all in spite of unforgiving profit margins.*

*When we set out to develop this information to share with you, we wanted to offer our insights into the key challenges that we believe our industry faces today and in the future. Our views reflect conversations not only with U.S. producers but also with others from around the world.*

*Of course, as a supplier of processing automation solutions, we have a vested interest in selling these solutions. But our approach to any application of technology is fundamentally pragmatic. We aim to first understand the business context of the specific opportunity or challenge, then the process or processes that can support a successful outcome. Only at that point will our engineering teams begin to develop a solution with the right combination of technology and services.*

*We hope you find this content insightful and useful. We have designed it in such a way that lets you to read it as quickly or as thoroughly as your limited time allows. I invite you to contact me directly for further information or a no-obligation consultation.*

*Thank you.*

## About Siemens

Siemens has served the worldwide food and beverage industry for over 25 years. In this time, we have developed a wealth of best-practice knowledge and applied expertise, plus an engineering staff with hundreds of years of combined experience. We also offer a portfolio of proven, advanced solutions to optimize your dairy plant operations so you can maximize your company's profitability and market share. With a deep understanding of the dynamic and highly competitive markets dairy producers address, Siemens stands ready to help you achieve your highest production goals and increase the value of your enterprise for all of your stakeholders.  www.usa.siemens.com

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## Dairy & Juice Producers Challenge #1

# Market Position and Image

With 45,000 SKUs in the average size supermarket, consumers today are accustomed to a wider variety of With With 45,000 SKUs in the average size supermarket[1] , consumers today are accustomed to a wider variety choices when they shop there than ever before. Dairy products, almost 10 percent of grocery sales[2] , are no exception. The same applies to juice products, which account for as much as a quarter of many dairy food plants' output.

Certainly the dairy and juice industries have kept pace with other food producers over the years to meet these market expectations. From fresh milk variations to flavored yogurts, artisan cheeses and chilled treats, the numbers and kinds of dairy and juice products have exploded. That doesn't count demand from other channels outside the dairy and juice aisles for semi-finished products like powdered milk and whey or for finished cheeses and other dairy and juice products as inputs to processed foods.

**Changing tastes.** More and more, consumers are conscious of health and safety, too. Media bombard them with warnings about fat and sugar consumption, cholesterol, lipids and the like. All this heightens their awareness about the effects foods and beverages can have on their health, for better or worse. Ultimately this knowledge can change their eating habits as they seek healthier choices. Still they will continue savoring the richer flavors and textures of more traditional fare, challenging dairy producers to deliver rich-tasting but low and no-fat alternatives. They also look for juices and juice blends with little or no added sugars.

To meet evolving consumer tastes, dairy and juice producers need ways to be more responsive to shifting market demands, spurring such questions as:

- How can research and development cycles be accelerated?
- How can the risk of shortened product life cycles be man aged better?
- Which production methods best meet the demands of dynamic consumption trends?

At any one time, thousands of SKUs in the average supermarket are new products vying for consumer attention and sales to keep their shelf position and sustain their existence. The ultimate question: How do you ensure your new dairy and juice products prevail against the competition – and improve their odds for success?

Health consciousness becomes even more acute when reports surface of foods gone bad causing sickness even death. Perishable dairy products can become suspect, undermining the valuable brands of dairy producers. And liability protection costs can soar.

Of course, keeping unsafe foods out of distribution in the first place is preferred. But if existing controls slip, then executing a fast recall -- thanks to detailed tracking and tracing -- can help contain the safety dangers as well as liability and brand damages.

Today's large-scale dairy production facilities can process hundreds of thousands of gallons of milk each day through miles of plumbing, thousands of sensors and hundreds of valves and vessels, turning out a wide range of packaged and bulk dairy products. Juice production can share these facilities or have similarly complex ones. Such systems have almost infinite operating variables and innumerable points of contamination or failure. Standard operating procedures are needed to contain all this potential variability. The more these procedures are automated, the less chance for human error to undermine predictable and consistent outputs. In the face of such complexity, Totally Integrated Automation (TIA) can help optimize the overall performance of dairy and juice production facilities while ensuring uniform yields from each production stage. TIA is a comprehensive process control system (PCS) that includes not only the necessary process line controller (PLC) and human-machine interface (HMI) but also much more: an extensive library of pre-built and pre-configured generic and dairy/juice-specific functions. These come in the form of discrete software modules based on best practices from around the world, from across automated industries and from within the dairy and juice production industries – the best of the best, if you will.

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### Meeting Challenge #1

### ▪ Speed with Confidence

Today's large-scale dairy production facilities can process hundreds of thousands of gallons of milk each day through miles of plumbing, thousands of sensors and hundreds of valves and vessels, turning out a wide range of packaged and bulk dairy products. Juice production can share these facilities or have similarly complex ones. Such systems have almost infinite operating variables and innumerable points of contamination or failure.

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[1] Food Management Institute, http://www.fmi.org/facts_figs/?fuseaction=superfact
[2] Ibid

These come in the form of discrete software modules based on best practices from around the world, from across automated industries and from within the dairy and juice production industries – the best of the best, if you will. TIA can provide precise, centralized control and operation of all plant processes, including receiving, storage, pasteurization, homogenization, filling, batching and clean-in-place (CIP) procedures. It can minimize the risk of process, component and sub-system failures by monitoring each one's performance for anomalies presaging such events.

**Dynamic flexibility.** Not only does TIA offer much greater operating efficiencies (see Challenge #2) but also tremendous flexibility to try new recipes and re-plan production batches, small or large. Doing so is easy and quick without taking down a production line and incurring costly, time-consuming conversions. Control recipes can be modified in-process so operators can fine-tune a recipe dynamically.

Because TIA's process and automation systems use similar data sets, a recipe change instantly adjusts the entire automation environment. This helps dairy and juice producers reproduce recipes consistently without guesswork.

These capabilities give producers the means to tailor production recipes and capacities to the needs of channel customers like private labels or other food processors. It also lets them process shorter runs for targeted market trials, which can help minimize the risk of larger, more costly production runs.

Complementing TIA for production is a **Manufacturing Execution System** (MES) that links dairy and juice plant processes with Enterprise Resource Planning (ERP) systems like SAP, Oracle and others.

Building the Business Case

## ROI of a Manufacturing Execution System (MES)

AMR Research interviewed more than 20 companies that had implemented MES. It found that companies saw three tiers of benefits from their projects:

- **Cost reductions**
  *(1x savings in the first year)*
  Inventory, people and cycle time
- **Process improvements**
  *(3x savings in the second year)*
  Faster New Product Introduction (NPI), new customer compliance, and data services from better tracking and genealogy
- **Market improvements**
  *(10x savings in the third year)*
  Tuning the manufacturing operation to be extremely responsive to actual demand allows companies to capture market share without increasing costs.

*AMR Research Alert – Bill Swanton, Alison Smith*
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Bridging the gap between plant automation and production with precisely timed packaging runs will reduce work in progress inventory and boost machine utilization.

An MES captures hundreds of data points every minute and displays key indicators in full-color graphs, charts and dashboards. In its role as an interface between real-world automation systems and upper level planning and financial systems, the MES layer provides production monitoring and modeling, It also can provide a view into Overall Equipment Effectiveness (OEE) as well as downtime monitoring and inventory control

With both historical and real-time data available, complete product lifecycle support is possible. Combined with built-in statistical functions, strategic decisions can be made faster, to respond to new and emerging market trends before the competition.

If dairy and juice production facilities are located in different geographies with ingredient variations, an MES can provide "brand specification management." That is, the MES can enable central recipe management and help determine the precise adjustments needed to ensure a consistent taste and overall product result across the dairy producer's market footprint, regardless of geography.

**Packaging on demand.** Effective packaging can make a huge difference in how well dairy and juice products sell, but the real effect of packaging begins long before they reach the shelf. The longer a production output sits before packaging, the greater the chance variations in the plant environment will affect product quality, even leading to contamination or spoilage.
Bridging the gap between plant automation and production with precisely timed packaging runs will reduce work-in-progress inventory and boost machine utilization. The "Optimized Packaging Plant" (OPP) combines an Optimized Packaging Line (OPL) with a plant's TIA and MES as well as its ERP systems to facilitate these packaging runs, while providing real-time views across the dairy and juice corporate enterprise. With that comes flexibility to adapt packaging for new and existing products alike as well as for any private label channel customers you may have. Products get to market faster, helping retailers avoid out-of-stocks, and dairy and juice producers can turn inventories into cash much more quickly.

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Today's large-scale dairy and juice producers must balance dynamic market demands that require speed, responsiveness and agility with perennial business demands of efficiency, profitability and growth as well as regulatory compliance for cleanliness, quality and traceability. Synergies gained via integrated MES, primary process control and automated packaging lines can lay the needed foundation for meeting the marketing challenges that dairy and juice producers face.

## Dairy & Juice Producers Challenge #2

# Production Efficiency & Flexibility

Profitability in the dairy foods and juice industries depends on a host of variables: the cost of milk and juice inputs as well as the costs of production, packaging, distribution, marketing and overhead, especially labor. Some costs, like milk, juice and energy, are at the market's mercy, while the others need tight controls to keep them within predictable limits. In all, they're enough to keep plant operators awake at night and to give them fits by day. Dairy and juice food profits – typically slim – can leak from any one of hundreds of operational points across large, complex dairy plants capable of processing thousands of gallons of milk or juice a day:

- **Milk and juice loss** at any point from receiving, during vessel transfers, CIP cycles and on its way to packaging
- **Wasted power** in the 100-plus motors that typically drive production through large dairy and juice plants
- **Excessive energy** use at various production stages – evaporator, dryer, boiler, refrigeration and pasteurization – as well as in the facility itself
- **Unused capacity** that still must be depreciated, maintained and kept in repair
- **Downtime** due to recipe changeovers, cleaning operations and other maintenance and repairs
- **Latency between finished output and packaging,** time that can also increase chances of spoilage
- **Costly errors** due to time-consuming, manual recordkeeping
- **Excessive water consumption** during clean-in-place (CIP) operations
- **Unnecessary wastewater treatment** or municipal fines due to untreated or under treated biological oxygen demand (BOD) releases

Often what can further compound the downstream effects of operating goblins like these is a lack of real-time information about them. Hours, days and weeks can pass before one is discovered, if it's discovered at all. Some of these unaddressed issues can also undermine quality, leading to contamination, wiping out valuable inventory or triggering a shockingly expensive recall.

Dairy and juice plants also need operating flexibility to adapt global recipes for local markets, using local ingredients and making precise adjustments to meet customer expectations of consistent flavors, textures and quality.
Market responsiveness also requires production line agility – to conduct trial runs of new products, to shift capacity as demand dictates or to change the plant's overall product mix to maximize plant margins.
Conventional wisdom might suggest that tradeoffs must be made between efficiency and flexibility, sacrificing a bit of one to gain in the other. But in these demanding times, conventional wisdom deserves to be reconsidered.

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Meeting Challenge #2

## ▪ The "Intelligent Plant" for Dairy and Juice Production

Of course, the easy answer for dairy and juice plant optimization is the same as it is for most industries: technology. But for what? Technology is a means to an end. The more difficult answer is understanding what ends are to be achieved, not just at one point in a process but across its entirety.
That understanding requires systemic plant knowledge and experience to drive relevant insights. Also helpful are proven process improvement methodologies like Lean, Six Sigma and other techniques or a recently introduced integrated approach that uses the best of their features.[3]
In general, these methods break processes down into discrete measurable parts, analyze them for potential improvements, determine key metrics, make the needed changes, gauge results and fine-tune changes. They also can help address issues of cost accounting, variation, waste and what key performance indicators. With an understanding of the ends plus clear insights into measurable process improvements, technology can then help dairy and juice plant operators realize significant efficiency gains, better controls and new-found flexibility.
Milk or juice loss, for example, can be a big cost for dairy and juice plants. Most losses are small amounts that add up and can occur during loading or changeovers. Other causes can be human errors, carelessness or poor operating procedures. Plant accounting can inadvertently mask these losses without the right data to reveal where, when, why and how they occur.

[3]The Ultimate Improvement Cycle: Maximizing Profits through the Integration of Lean, Six Sigma, and the Theory of Constraints, by Bob Sproull, 2009

With easily deployed functionality from a comprehensive library of software modules, Totally Integrated Automation (TIA) can help plant operators cut annual milk and juice losses up to 50 percent or more.

Benefiting from a comprehensive library of software modules, Totally Integrated Automation (TIA) systems can schedule, coordinate, control and monitor all milk flows across the plant including vessel transfers and output packaging. This capability can help plant operators cut annual milk and juice losses by as much as 50 percent or more. Large dairy and juice plants can realize savings of hundreds of thousands if not millions of dollars a year.
Round-the-clock vigilance. In addition, TIA systems can continuously evaluate temperatures, pH levels, volumes and capacity utilization in real-time, providing alerts according to presets and also genealogy for tracking and tracing purposes. When products are ready to package, TIA systems can communicate with packaging facilities to schedule precisely timed packaging runs that reduce work-in-progress inventory and increase machine utilization.

TIA systems can continuously evaluate temperatures, pH levels, volumes and capacity utilization in real-time, providing alerts according to presets and also genealogy for tracking and tracing purposes.

TIA coupled with a **Manufacturing Execution System** (MES) can automatically collect and transfer all production data to higher-level plant systems including all major Enterprise Resource Planning (ERP) systems such as Oracle and SAP as well as warehouse and inventory management systems. This can save the time and cost associated with error-prone manual recordkeeping. It can also help operators determine optimal production line utilization and product mix, then have the flexibility to quickly execute changes to production lines with little or no latencies or downtime.

Importantly, operators gain real-time and historical visibility into every plant process that provides the needed intelligence for process optimization and alarms to respond faster and more effectively to almost any situation. They also can remotely access this intelligence 24x7 through the web and mobile devices. Multiple plant sites can also be networked to provide enterprise wide visibility and oversight virtually worldwide.

**Making the most of energy.** The "intelligent plant" for dairy and juice production can also conserve valuable energy and water resources, further driving cost out of production. In doing so, the plant's environmental footprint is reduced, which can support a company commitment to sustainability and help build the dairy brand image.

Advanced drive technologies, for example, can reduce the power consumption of motors by as much as 20 percent or more. Given the average dairy plant's 100 motors, that can add up to significant energy cost savings each year.

Unless motors need to run at 90 percent capacity or more for more than 90 percent of the time, variable frequency drives make economic sense. They can power-match a motor's speed to its load demand instead of the binary all-on-or-all-off operation that otherwise occurs. This can significantly cut energy costs and increase motor life.

Power monitoring and control can conserve even more energy. With insights into the plant's kilowatt demands moment-to-moment, machine-by-machine, process-by-process, it's possible to schedule power-hungry tasks during off-peak hours when energy costs less. Historical energy usage data can also help negotiate better rates and possible rebates from local utilities.

[4] "Creating the Lean Dairy Plant" by Thomas R. Cutler, Quality Digest, Feb. 19, 2007

**Conserving "blue gold."** That dairy and juice plants use lots of water is no secret – much of it for clean-in-place (CIP) systems that push 100 to 200 gallons per minute across processing surfaces. What is a secret, or often unknown, is just how much of that water is wasted as well as the cost of that waste.

An automated CIP program can help a plant save $20,000 or more each month in water charges. It can also help recover valuable production time by eliminating unnecessary wash cycles. One study showed a 6.25 percent increase in equipment availability without any increase in fixed costs.[4]

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The "Intelligent Plant" for dairy and juice production is a technology-enabled business model that can provide management and operators with real-time and historical operational visibility to maximize efficiency, gain flexibility and conserve limited resources. Annual cost savings in raw inputs, energy and water for an average size plant alone can add up to more than a million dollars – hard dollars that can directly boost the plant's bottom line.

## Case Study Snapshot – U.S.

*When Golden Cheese Company of California, the world's largest cheese maker, needed higher yields of Grade A cheddar and Monterey Jack cheeses, it chose to integrate more than 2,500 machines that were operating independently. After extensive planning, it combined a SIMATIC PCS7 and advance process technology software, to achieve the following:*

- Increased annual throughput by 10 million pounds
- Boosted Grade A production efficiency to 97 percent or higher
- Minimized spills
- Gained the flexibility to continuously fine-tune production processes
- Reduced equipment maintenance and repairs
- Extended equipment life
- Reduced wastewater treatment requirements \ and costs

*All for a modest $1.5 million investment.*

## Dairy & Juice Producers Challenge #3
# Traceability and Genealogy

According to the latest estimates of the Centers for Disease Control and Prevention, more than 200 known food borne diseases cause approximately 76 million illnesses in the U.S. each year, resulting in 325,000 hospitalizations and 5,000 deaths.[5] Tracing food's genealogy is the basis for discovering the cause of these outbreaks.

In a tribute to the sanitary practices of the U.S. dairy industry, dairy products are estimated to cause less than one percent of food borne illness outbreaks, even though the industry processes over 185 billion pounds of milk each year.[6]

And given that juice production engages as much as a quarter of all capacity at many dairy food plants, that can logically apply to their portion of the nation's juice output, as well.

**One illness is too many.** Still, even one illness caused by a dairy or juice product is too many. That's why the dairy and juice industries continue to take the initiative to work closely with regulators to help formulate and enforce strict food safety regulations that can help boost consumer confidence and avoid tragic outbreaks.

Examples are the modernization of Good Manufacturing Practices (GMP), progress in the development and rollout of the National Conference on Interstate Milk Shipments (NCIMS) voluntary Hazard Analysis and Critical Control Points (HACCP) programs for both dairy and juice products. The industry also actively supports supply chain and consumer education on issues such as allergen labeling and raw milk legislation.[7] All this complements or replaces long-standing Pasteurized Milk Ordinance (PMO) regulation.

> Food genealogy and track-and-trace capabilities are vital for the sake of both the public's health as well as that of the food industry.

**Farm-to-fork traceability.** Of course, despite this active regulatory engagement, illness outbreaks in other parts of our food supply can shake consumer confidence across all parts of the food supply. Outbreaks can also provoke calls by the public and politicians alike for even stricter regulations that may or may not be necessary with today's already high levels of industry compliance – but that would still add compliance costs all the same.

When outbreaks occur, both authorities and food producers typically scramble to identify the culprit. But doing so quickly and effectively has its challenges. Given the complexity of our food supply chain, days can pass and confusion can mount about the source or sources of contamination.

Meanwhile people can continue getting sick and the health of an entire food category can suffer, sometimes unjustified as was the case in 2008's salmonella-tomato scare. The source was found to be jalapeno peppers, but before that discovery, U.S. tomato growers took it on the chin: supermarkets drastically cut space for tomatoes and average prices fell about 50 percent. Total cost to the tomato industry? About $100 million.[8]

Point is, food genealogy and track-and-trace capabilities are vital for the sake of both the public's health as well as that of the food industry. While implementing such a system in a way that tightly integrates quality and production is the answer, it can also seem dauntingly complex and costly. But with lives, jobs and business viability at stake, can a dairy food or juice producer afford not to do so?

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[5] "Food Related Illness and Death in the United States" by Paul S. Mead et al., Centers for Disease Control and Prevention, 1999.

[6] "2007 Fluid Milk and Dairy Product Overview," International Dairy Foods Association, 2008

[7] "Keeping Up with Dairy's Grade A Food Safety Initiatives," interview with former IDFA president Allen R. Sayler, Food Safety magazine, July, 2007

[8] "Fresh Tomato Industry Shaken by FDA Salmonella Link, Seeks Answers," by Cary Blake, Western Farm Press, Aug. 21, 2008

Meeting Challenge #3

## ▪ Integrated Quality Management

Meeting the challenge of tracking and tracing food genealogy, especially in complicated, high-volume dairy and juice production plants, is not easy.

First obstacle is the fact that the majority of HACCP programs were implemented more than a decade ago as paper-based, records management systems. Not only does this make getting appropriate data into such legacy systems time-consuming, costly and error-prone, it makes getting data out time-consuming, costly and error-prone.

Another issue is the lack of standards in data collection across food industries. Add to that the growing complexity of farm-to-fork food supply chains as well as the diversity of how food items are used whether as ingredients, sold wholesale to restaurants and institutions or sold to consumers through supermarkets.

For example, the salmonella-tainted peanuts sold by a small Georgia plant found their way into nearly 4,000 different products. These products were recalled at an estimated cost of $1 billion, the largest recall in U.S. history. [9] That the peanuts were tracked through to so many products at all is remarkable on its own, but it also begs the question of what products containing those peanuts escaped recall and were consumed.

**Ditch the clipboard.** To their great credit, dairy and juice producers are increasingly making regulatory compliance part of their normal course of business. Even then, however, they must determine the right business and operational strategies to reconcile quality and regulatory compliance requirements with their needs for efficiency and flexibility to meet profitability and market expectations.

Helping producers make this determination in a precise, data-driven way is one of the most profound benefits of a **Totally Integrated Automation** (TIA) system and a **Manufacturing Execution System** (MES). These systems can help dairy and juice producers (a) bridge the gap between business systems and the control layer; and (b) synchronize operations along the entire production life cycle and provide enterprise visibility of the supply and manufacturing chain.

From sensors placed at critical control points (CCPs) wherever specified by the quality management design of a production process, a TIA system coupled with an MES can gather and log production process data in real-time. Electronic data collection eliminates the labor costs and latency associated with doing so manually and eliminates the inevitable errors that will occur.

Because data are collected in real-time, alarms can be triggered as soon as a CCP value is violated. Automatic responses can occur based on preset rules. Or, depending on the kind and magnitude of the violation, human intervention can be required and an alarm sent to the person with the right expertise to deal with the issue.

[9] "Has Eating Become More Dangerous?" by Andrew Martin and Gardiner Harris, The New York Times, May 10, 2009, p. A1

## Case Study Snapshot - CHINA

The Mengniu Dairy in Inner Mongolia is the world's largest producer of UHT milk and China's largest maker of liquid milk, ice cream and yogurt. It turns out over 200 different products and variations from 21 production sites in 15 Chinese provinces.

Time-consuming and error-prone paper and spreadsheet-based information systems could not meet the dairy's increasing quality control demands – especially across all the plants, with 15 various production, quality control and R&D laboratories. The solution? A SIMATIC IT Unilab system, a fully integrated Laboratory Information Management System (LIMS).

From pilot to full implementation in just six months, the Mengniu Dairy's LIMS now provides greater work efficiency, standardized lab workflows and optimized data analysis. Throughput is 1.5 million samples a year.

Personnel were able to configure the system with little programming thanks to the extensive SIMATIC IT library object-oriented functionality including sample types, info cards, parameters, methods, test frequencies, sample lifecycles and more. Key benefits include:

- Shared quality-management platform across the company's facilities
- Greater data accuracy and safety
- Dramatic reduction in paper-based activities
- Reduced operating costs
- Improved quality and productivity

**Sooner known, the better.** Of course, the sooner a CCP violation is known, the sooner it can be corrected and the less production is wasted, not to mention the vastly reduced chances of any contaminated output making its way into the food supply. Even better, to avoid CCP violations altogether, statistical process control (SPC) calculations can be used to issue advisory alarms when a process starts to destabilize but before a CCP spec is violated.

For the sake of continuous process improvements, data associated with these alarms can be logged for corrective action. This can be used to document a plant's response to process failures and help drive continuous improvement efforts.

When CCP specs are violated or destabilize, data analytics can help producers gain operational insights of processes and quickly determine and eliminate the problem's root causes. In a paper-based system, this could take days or weeks, while an automated approach can take from a few minutes to a few hours.

The TIA and MES systems can then generate HACCP reports needed to comply with regulatory, customer and internal audit requirements. These reports – and the data that generated them – can be stored in the underlying plant database for quick retrieval at any time. This also eliminates the cost and trouble of storing paper-based records as well as the time that would be required to access the records and reconstruct historical production episodes.
In addition, the quality parameters of raw material, Work in Process (WIP or final output of any product can be automatically test-sampled by connecting the MES with a laboratory information management system (LIMS) module. This additional capability can ensure that samples conform to specification. It can also seamlessly integrate the laboratory management system into both the plant's production and quality management systems.

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The need to integrate quality controls, reporting and production is vital to public health and that of the food industry. After all, information – not data – is the key to proper decision support. The big question for dairy and juice producers is how to realize this integration via TIA and MES systems. They can accomplish this transformation by taking a systematic approach to this goal and then, with the participation of all key stakeholders, use classic project management techniques, to arrive there on time and on budget.

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## Case Study Snapshot - EUROPE

Spain-based Grupo Leche Pascual is one of the European Union's top dairy and juice producers and one of its most innovative. Among its firsts: first to use uperisation for longer-life milk, packaged in cartons; first to produce fresh-squeezed juice with just one pasteurization; and first to enrich the calcium content of milk.

In an effort to improve production efficiencies as well as quality, traceability and genealogy, Grupo Leche Pascual deployed the standard SIMATIC IT Manufacturing Execution System (MES). The MES originally was deployed to provide the company's ERP system with real-time data capture,monitoring and traceability. Since then, it has evolved to control all aspects of maintenance including preventive, corrective and predictive asset management, plus energy management.
Key benefits include:

- Greater production efficiency and flexibility
- Real-time data visibility
- Continuous process improvements
- Backward and forward genealogy

With its MES in place, Grupo Leche Pascual can now provide a service for customers, who can request a status check of everything that has occurred during a production run, just by giving the batch number. It can now deliver that information in a minute or less – a process that before required more than a day to compile by hand from manual records.

## Dairy & Juice Producers Challenge #4
# Supply Chain Responsiveness & Transparency

Most dairy and juice products need cold storage on their way to market but the game played along the way is more like hot potato the clock is ticking and no one wants to be left holding perishable inventory when time's up. The real goal, of course, is for dairy and juice producers to get their goods into the hands of consumers, restaurants and food processors while still fresh and stay profitable at the same time.
Fortunately many advancements in filling, packaging and supply chain processes, technologies and integration over the years have helped both to improve the timeliness of dairy and juice deliveries and, despite ever-compressed margins, to maintain profits. In some respects, however, these advances have also driven many countervailing developments:

- **Super-sized supermarkets** can now fill miles of aisles with thousands of SKUs that may not have existed a decade ago without supply chain advances.
- **New competition** from outside the region that may have stayed put in years past now can extend their market reach to new customers.
- **Demand-driven ordering practices** have collapsed order-to-delivery cycle times to less than 150 hours, with expectations often under 100 hours.[10]

Communication disconnects between the production floor and the packaging room can also be disruptive – and expensive. Output may sit in temporary containers waiting to be packaged longer than necessary. As it sits, variations in the plant environment can begin to affect the overall product quality. But even if not, one-day of finished goods inventory sitting unnecessarily can cost a company an average of $7 million a year. [11]
All these factors demand a better alignment of production with demand along with improved product visibility. But many producers lack the real-time information to quickly adjust production to demand and to account for product inventories on-site much less enroute. Manual warehouse management systems require considerable administrative overhead. Paper logs for receiving, put-aways, stock moves and picking not only need to be kept accurate and timely, they also at some point need to be keyed into ERP systems so customer invoices can be generated based on actual quantities shipped. Any delays or errors along the way can slow deliveries as well as cash flow, not to mention introducing corrective cycles and upsetting distributors and customers.

[10] Siemens research.

[11] Ibid.

> The goal is to identify all existing process interfaces, whether machine-to-machine, machine-to-human or human-to-human.

### Meeting Challenge #4
### ▪ The Synchronized Supply Chain

The ultimate goal of a fully synchronized supply chain is twofold: first, to be flexible enough to finely tune production to demand signals; and, two, to have sufficient visibility along both production and supply chains to keep inventories at just the right levels. Easier said than done, right?

At first, aligning the supply chain into and out of an operation as complex as a dairy or juice production facility might seem akin to changing engines on a jet plane while in mid-flight. Whenever production stops, so does cash flow and profits.

But a step-wise approach to implementing **Totally Integrated Automation** (TIA) and a **Manufacturing Execution System** (MES) can minimize production disruption. The key is a thorough, 360-degree understanding of the supply chain in and out of the plant, along with the many production processes that it feeds and is fed by.

Next is to map this understanding in detail by documenting all the steps involved, not just inside the plant but incoming and outgoing, too – all the way to cash-in-the-bank. In effect, the result is a complete mapping of the plant's so-called business ecosystem.

**Building a roadmap.** With this documentation in hand, a current-state analysis is conducted that overlays all of today's various systems, both automated and manual, for plant operations. This would include existing automated point solutions as well as horizontal ERP and other IT-based systems that cross functional boundaries.

The goal is to understand not only what does what, where and when across the entire ecosystem, but also to identify all existing process interfaces, whether machine-to-machine, machine-to-human or human-to-human. (e.g., "Hey, Joe, how much ESL we got to fill this order?")

At this point, opportunities for process and equipment standardization should appear as will various bottlenecks and time sinks that could be eliminated to improve plant efficiencies and yields. With a written catalog of all these opportunities, a prioritization of their remediation and realization can be made. This becomes the plant's roadmap for implementing TIA and MES systems.

From it, specifications of requirements can be drawn up – both physical, such as what sensors are needed where, and logical, such as what IT interfaces are needed where. Then deployment costs, timings and interdependencies can be compiled into an overall business case and project work plan, with a clear understanding of potential impacts, mitigations and contingencies.
The various components of a synchronized supply chain system would include:

- **Receiving & Put-Away:** Inventory accuracy starts with the automated receipt of raw milk and juice inputs that captures source, quantity, time and any other relevant data, then catalogues into which production stream the material goes.
- **Filling & Packaging:** Automated filling and packaging provide seamless visibility into batch turns and other work-in-progress, so that production can be adjusted in real-time for orders and anticipated demand. This helps prevent products standing in wait of filling and packaging and also help avoid unnecessary inventories standing in wait of orders.
- **Inventory Control:** Optimum inventory levels can help conserve not only warehouse space, especially costly refrigeration, but also cash that would otherwise be tied up in standing inventories. Automated inventory control capabilities help to easily identify fast and slow inventory movers as well as up-to-the-minute information on product types, quantities, location, status and history of every item on hand.
- **Order Fulfillment:** Faster order fulfillment means a plant can increase its capacity turnover while improving its order response times, satisfying owners and customers alike. An automated order fulfillment system can generate pick lists, inventory locations and customer shipping documentation directly from sales orders. No data entry or re-entry is needed, improving speed and accuracy.

- **Shipping:** With an automated shipping system, ware house staff no longer has to check on inventory availabil ity before issuing packing and shipping instructions. Shipping can achieve the “perfect order” every time and much faster, too. Plus, when a shipment leaves the warehouse, all systems across the plant are updated with this information and inventory levels are adjusted accordingly.
- **Raw Materials and Consumables:** A finely tuned process can still produce waste if the raw materials are the wrong type or of suspicious quality.. Products must also be pack aged in the correct container and shipped in the proper carton. The Intelligent Dairy Plant looks beyond just the process and encompasses the full scope of the supply and manufacturing chain.

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By synchronizing their supply chains with TIA and MES systems that can provide multi-level, more standardized platforms, plant operators can ensure much greater responsiveness and transparency of process and production as well as their inputs and outputs.
These benefits can quickly pay for themselves in much greater efficiencies and yields, lower costs due to less spillage, spoilage, errors and overhead, and great customer satisfaction via better quality and response times. Information collected at critical points in the process can enable enhanced product tracking, tracing and genealogy.

# Summary of TIA/MES Benefits

| Dairy/Juice Producer Business Drivers | How TIA/MES Can Help |
|---|---|
| ▪ Milk or juice loss during processing | ▪ Precise, automated control of material transfer from one vessel to another as well as route control<br>▪ Integrated flow meters and totalizers ensures precise delivery and automatic recording of milk volume dur ing processing |
| ▪ Product innovation (e.g., new formulas, new and improved packaging)<br>▪ Getting new products to high-volume production rapidly | ▪ Flexible, easy-to-use process line management system makes it easy to create and manage multiple recipes. Recipe parameters can be entered manually, provided automatically or be populated by an ERP system. |
| ▪ Brand differentiation.<br>▪ Brand management, growth and preservation | ▪ Automation helps improve product consistency & re duce variability (quality) as well as catch problems before they get into the market<br>▪ Key quality parameters can be monitored and analyzed in real-time to ensure quality |
| ▪ Capacity utilization, especially throughput and yield<br>▪ Optimizing production line capacity is a key initiative | ▪ Production Scheduler can be integrated into control system or tied into system<br>▪ Connectivity to SAP<br>▪ Built-in asset management capabilities help keep equipment operating at peak efficiency and eliminates unplanned downtime<br>▪ Advanced process control maximizes yield and mini mizes raw material usage<br>▪ Automation minimizes batch cycle times and maxi mizes throughput |
| ▪ Input commodity costs | ▪ Helps optimize raw material usage throughout production |
| ▪ Reducing the cost of regula tory compliance<br>▪ Reducing the risk of non-compliance | ▪ Control system contains numerous built-in tools to make compliance with FDA regulations, Bioterrorism Act, HACCP and others<br>▪ Tracking and Tracing of all raw materials, intermediate products and finished products<br>▪ Genealogy is provided for every product run |
| ▪ Energy costs | ▪ Automatic temperature control eliminates temperature swings and helps balance / minimize heating and cooling loads<br>▪ Flow control using variable frequency drives (instead of control valves) reduces energy usage (no pressure loss through the throttling valves) and minimizes pressure differential on the milk for gentler treatment to improve product quality<br>▪ Integration of drives, motor control centers and switch gear for power metering, monitoring and management |
| ▪ Time to market | ▪ Coordination of processing and packaging helps reduce time to market<br>▪ Reduced engineering and commissioning times via the dairy/juice functional toolset with software modules already optimized for plant requirements and via OPP/OPL |

# Glossary of Acronyms & Terms

**ANSI/PMMI B155.1 –** This references the Packaging Machinery Safety Standard introduced in 2006 that describes procedures for identifying hazards as well as how to assess and reduce risks to acceptable levels over the lifecycle of packaging machinery.

**BOD – Biological Oxygen Demand** (also known as Biochemical Oxygen Demand) is a chemical procedure for determining how fast biological organisms use up oxygen in a body of water. It is used in water quality management and can gauge the effectiveness of wastewater treatment plants.

**CCP – Critical Control Point** is a point, step or procedure at which controls can be applied and a food safety hazard can be prevented, eliminated or reduced to acceptable (critical) levels.

**CIP – Cleaning In Place** is a process by which plant production vessels and plumbing are flushed on a periodic basis to clean them.

**ERP – Enterprise Resource Planning** is a company-wide computer software system used to manage and coordinate all the resources, information, and functions of a business using shared data stores.

**GMP – Good Manufacturing Practices** is a term recognized worldwide for the control and management of manufacturing and quality control testing of foods, pharmaceutical products, and medical devices.

**HACCP – Hazard Analysis and Critical Control Points** is a systematic preventive approach to food safety and pharmaceutical safety that addresses physical, chemical, and biological hazards as a means of prevention rather than relying on inspection of finished products.

**HMI – Human Machine Interface** is the means by which people (i.e., users) interact with a system, which could be a series of components, a single machine, a computer program or some other complex tool. It provides a means of input, which enables users to manipulate the system, and output, which enables the system to indicate the effects of the users' manipulation.

**LIMS – Laboratory Information Management System** is computer software that is used in the laboratory for the management of samples, laboratory users, instruments, standards and other laboratory functions such as invoicing, plate management, and work flow automation.


**MES – Manufacturing Execution Systems** manage and monitor work-in-process on the factory floor including manual or automatic labor and production reporting, as well as on-line inquiries and links to tasks that take place on the production floor. An MES may include one or more links to work orders, receipt of goods, shipping, quality control, maintenance, scheduling or other related tasks.

**NCIMS – National Conference on Interstate Milk Shipments** is a U.S.-based, non-profit organization focused on the safest milk supply possible. Founded in 1950, it comprises representatives from across the dairy industry who meet biennially to deliberate proposals from inside and outside the industry.

**OEE – Overall Equipment Effectiveness** is a methodology to monitor and improve the effectiveness of manufacturing productivity and is often a key metric in Total Productive Maintenance and Lean manufacturing.

**OPP – Optimized Packaging Plant** is a concept that integrates all plant packaging capabilities – filling, blow molding, capping, labeling, packers, palletizers and stretch wrapping – with the corporate enterprise TIA, MES and ERP systems to help minimize standing inventories and expedite channel shipments, while providing real-time data for tracking, tracing and product genealogy.

**OPL – Optimized Packaging Line** provides for shared automation and communications standards across all packaging functions, at a high level with the HMI and at lower levels with component interfaces, controllers, hardware and software.

**PCS – Process Control System** provides the means for automating an entire production process and typically comprises a process line controller (PLC) and human-machine interface (HMI).

**PLC – Process Line Controller** is a device that controls the motors, valves and other mechanical devices making up a production line.

**TIA – Totally Integrated Automation** takes a process control system (PCS) beyond a process line controller (PLC) and human-machine interface (HMI). The SIMATIC IT MES provides an extensive library of pre-built and pre-configured generic and dairy/juice-specific functions. These are discrete software modules based on best practices from around the world – from across automated industries and from within the dairy and juice production industries

# Siemens Solutions for Dairy & Juice Producers

- **SIMATIC PCS7 with the Dairy/Juice Functional Toolset** provides dairy and juice producers with **Totally Integrated Automation** (TIA). It enables full integration of all plant automation systems including process, batch, discrete and safety and all the field devices. More than 6,000 installations worldwide make it a proven TIA platform.
  It also integrates instrumentation, analytics, motors, drives and safety devices, with tools for engineering, visualization and facility-wide asset and maintenance management. It can provide for automatic scheduling, coordinating and controlling milk and juice flows as well as cleaning-in-place (CIP) operations across an entire dairy plant, small or large.
  SIMATIC PCS7 is more than just a Process Line Controller (PLC) and Human-Machine Interface (HMI), the SIMATIC PCS7 contains a comprehensive library of pre-built and pre-configured generic and dairy/juice-specific functions in the form of discrete software modules based on best-practices from around the world, across automated industries and from within the dairy and juice production industries. Key representative functional software modules include:
- **Tank Manager** is a software object that includes all information on the physical parameters of a production vessel as well as all the production plumbing to and from it. It is notified by the material interface of those ingredients filling the tank or plumbing, what process procedures are to be activated and, when the process is complete, it forwards relevant data up-level to the PCS and beyond (e.g. the MES and ERP).
- **Process Line Manager** (PLM) is a software object that processes orders transferring material of certain quantity, specifying different transfer orders such as recirculation, heating and cooling. It generates a Batch ID for the order that helps tracking, tracing and genealogy. Recipe data is requested from the Recipe Manager, another software object, and other archive data is generated such as Source, Target, Start Time, Target Quantity and other relevant factors.
- **Archive Manager** is a software object that provides an interface for archiving data related to individual material movements within the plant, such as what was described above as generated by the PLM. Other IT systems including the MES and ERP systems can access this data for tracking, tracing, genealogy and reporting purposes.
- **Siemens Optimized Packaging Line (OPL) solutions** reflect a standardized, automated approach to filling and packaging. Using **Component-based Automation (CbA)** interfaces and a common Ethernet protocol Siemens can help dairy and juice producers rationalize and integrate the many diverse filling and packaging elements typically found in this plant function. An OPL solution can tie TIA and MES systems together to provide greater product safety, production efficiency via OEE, line coordination and complete product traceability and genealogy back through production lines to source material. Connection of multiple packaging lines to the MES and ERP systems enable the **Optimized Packaging Plant (OPP)**.
- **SIMATIC IT Manufacturing Execution System (MES)** connects existing automation "islands" across a plant as well as enables manual processes to be automated and incorporated into a plant-wide MES. Unlike other MES systems, which provide just a process line controller (PLC) and human-machine interface (HMI), the SIMATIC IT MES provides an extensive library of pre-built and pre-configured generic and dairy/juice-specific functions. These are discrete software modules based on best practices from around the world – from across automated industries and from within the dairy and juice production industries Based on a modular, object-oriented, open and scalable architecture, the SIMATIC IT MES offers both horizontal integration and vertical integration of plant floor control layers into higher-level systems such as the plant's ERP system. It uses the ISA-95 standard as its architectural blueprint.

# Siemens Solutions for Dairy & Juice Producers

**Additional software modules that can be used stand-alone or integrated with SIMATIC IT include:**

- **SIMATIC IT Unilab,** a Laboratory Information Management System (LIMS) with multiplant capabilities that help centralize and handle all lab quality data including samples, analysis and instrumentation.
- **SIMATIC IT Interspec,** is a specification manage ment systemt that supports lifecycle control, versioning, workflow and access control of the product data, which enhances the internal and external product information management.

- **SIMOTION Motion** Controllers, for integrating drive control and machine automation into a single platform for handling complex hydraulic, pneumatic, vector or servo motion tasks.
- **Safety-integrated for packaging machinery,** which uses globally approved PLCs, drives and motion control systems with the built -in safety functionality dictated by the ANSI B-155 safety standard for packaging machines that was devel oped jointly with the Packaging Machinery Manu facturers Institute (PMMI). This integrated approach allows one system to provide both auto mation and safety task versus the old standard of an automated control system and a cumbersome "hard-wired" safety system.

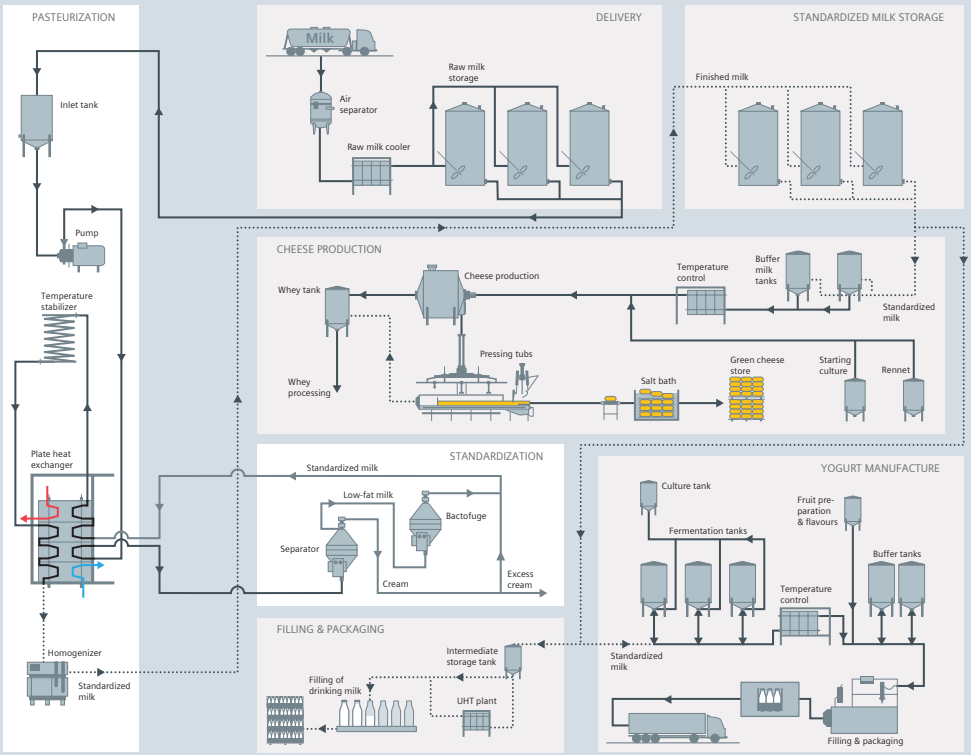
**Scalable industrial Ethernet focuses on two key areas**

- **Ruggedized, fully featured switches, routers, security modules and wireless devices** designed for industrial installation while conforming to all standard Ethernet protocols
- **Profinet,** an open Ethernet protocol allowing automation control, motion control, safety-inte grated and third-party devices to communicate over common network

- **Component-based Automation** is the key to enabling the Optimized Packaging Line. CbA provides a standard interface for each machine, which dramatically decreases engineering and commissioning times while providing enhanced diagnostics and troubleshooting.
- **SIMATIC HMI** are advance human-machine inter face (HMI) operator panels that provide remote monitoring and control of each machine of an Optimized Packaging Line (OPL) as well as remote web based access to monitor real-time status.

- **Support & Training** – Live, U.S.-based technical support is available free during normal business hours. Advanced web-based support and 24x7 technical support are also available without the need for support contracts. In addition, Siemens also has a network of Authorized Solution Partners, each which understand Siemens technology and solutions and can apply them to your enterprise.

# Dairy and Juice Process

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