IndustryWeek

HOW DIGITAL INNOVATION IS TRANSFORMING THE FOOD & BEVERAGE INDUSTRY

Digital Innovation

The oldest industry in the world, food and beverage, now finds that modern technology must be on the menu. Food and beverage companies need digital innovation like the Industrial Internet of Things (IoT) to meet core business needs and manage the challenges of variations in materials, processes and labor skills.

Innovations are always needed when **challenges** begin to change the business equation.

In nearly every segment, the variability in materials, processes, ambient conditions and labor skills results in complex operations management. Iterative processes to extract and add back in ingredients such as sugar and water and painstaking sanitization and changeover processes result in complex scheduling and room for errors. Unless companies in the food and beverage industries are able to adapt their business to these changes and increasing regulatory scrutiny, they risk being uncompetitive.

The pressure to perform means companies want to improve – dramatically. Fortunately, digital technologies – both in information technology and in operational technology and where they meet – can help companies transform their business to be more successful and profitable.

This e-book has been prepared in cooperation with Siemens MindSphere drawing from Siemens industry experience in the Food & Beverage industry.

A new IoT sensor in a bottling line found a motor that would have failed soon within two hours of being applied.

Bottling: Consistently Filling Needs

Those who bottle beverages know they need to keep product flowing…through their plants, distribution network and customer sites. Yet in-plant challenges continue to mount. (Figure 1)

Key Challenges

Tight Margins: Bottlers are often squeezed – and not like juice into a bottle. Tight margins are very common these days as materials and energy costs have risen. At the same time, consumers expect to pay the same amount or less for many products.

Clearly, the bottler can control neither consumer expectations nor variations in ingredients and materials. To keep margins healthy, bottlers must find ways to reduce costs, increase throughout or create premium products that command a higher purchase price.

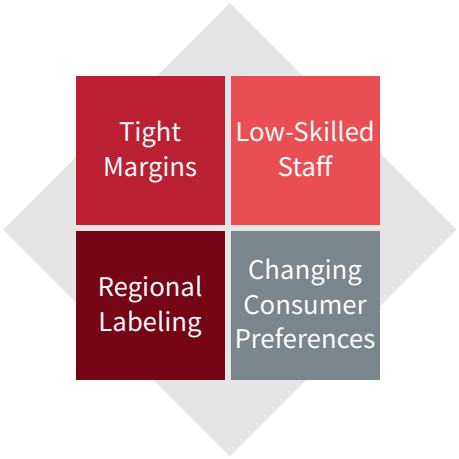


Figure 1

Low-Skilled Staff: In most companies, experienced and highly skilled operators, technicians and engineers are retiring. Younger generations of workers have not been attracted into bottling. This leaves a skills gap, with many of the available workers having little experience in bottling or with production.

As a result, the team in a bottling plant may not have the skills to ensure the process runs as designed. Even if they can run lines optimally, the workforce may not have the expertise or training to create needed improvements.

Regional Labeling: One of the most common challenges in a bottling plant involves proper labeling. The label not only needs to be applied in an attractive way that will read at a store scanner, the information on the label is intricately tied to product quality and sale-ability.

Label requirements by region vary, so this may be something that each plant needs to tweak. And of course, the legislation that dictates what goes on each label changes sometimes, too. So this is a moving target.

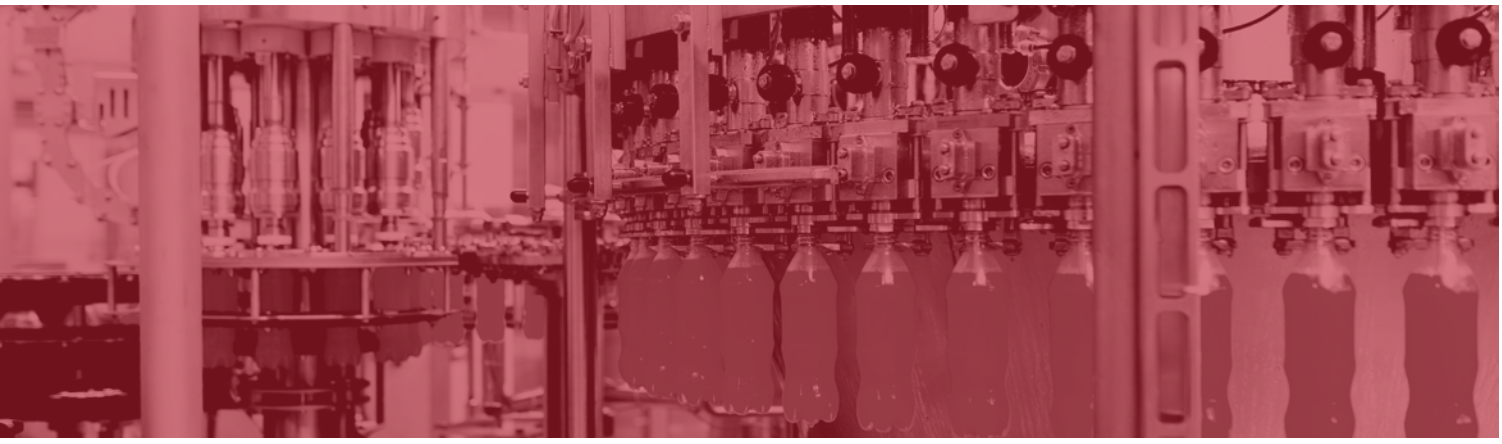
Changing Consumer Preferences: How many variations can one plant handle? Today, it had better be quite a few. In many markets, both the number of bottle form factors and the mix of products being bottled are increasing rapidly. What is convenient for a large family is problematic for an older person living alone. Certain segments of the population want no-sugar; others want products with no artificial ingredients, while others look for products that include certain ingredients to boost health. This trend has continued for many years, and requires continued innovations.

Bottling Digital Innovations

Gaining visibility into the bottling process may be the most critical way to improve margins. As Deming said, you can't improve what you can't see. And many issues are difficult to spot even for the most experienced employees, many of whom are retiring. So what to do?

Digital Recordkeeping: Moving away from paper and partially automated spreadsheets with human hand-offs is important for many reasons. Many current processes not only **waste time**, they have a **high risk of errors.** Excel spreadsheets and other disconnected systems also are not ideal for analysis and troubleshooting. They may not be fast enough, complete enough, and they certainly are backward-looking. This prevents employees from proactively avoiding problems and spotting trends.

Digitally integrated production records are a foundation for any type of improvement program. Most of the time in root cause analysis is spent on data gathering versus the actual analysis, which Industrial IoT can streamline. So digital records enable improvement processes to work faster, more effectively and with higher chance of the changes actually moving the needle on performance.



Smart Sensors: Increasingly, companies can add intelligent sensors for initial data capture and analysis of their lines and equipment to begin to gain views into where they might improve. Some may feed existing systems, and some may go through an Industrial Internet of Things (IoT) platform for feedback and control of a process. Analysis software that might be in the Industrial IoT platform provides visibility of trends and events that even a highly skilled operator can miss.

Key uses for smart sensors include:

Maintenance: Some companies are moving to predictive maintenance. With sensors in place, companies can see when equipment is drifting away from optimum performance. Such an Industrial IoT-based condition-monitoring program reduces costs by preventing equipment breakdowns and problems as well as ensuring maintenance is only done when needed.

Prevent Micro-Stoppages: Bottling lines, whether old or new, can use sensor data to help dramatically reduce short stop times. By gathering the data in Industrial IoT and analyzing it, one company increased availability and decreased mechanical and electrical downtime events by nearly 40 percent.

Confirm Label Integrity: IoT-enabled sensors also can inspect labels. With clear indicators that detect label placement and integrity during the process, companies can prevent shipments that customers cannot sell. Digital software technologies also can help ensure that labels have all required elements for the region where they are to be sold, and that the label matches the product and bottle size for that run.

Fill Level: More accurate sensing of fill levels is another element that can boost margins significantly. By not overfilling but ensuring adequate fill, the products are saleable and there are no product giveaways in the process.

Analysis: Clearly the best results come from not only gathering data from IoT sensors and using them to guide production in real-time, but also from analyzing the results. Analysis also is the foundation of nearly any ongoing improvement program such as Lean or Six Sigma.

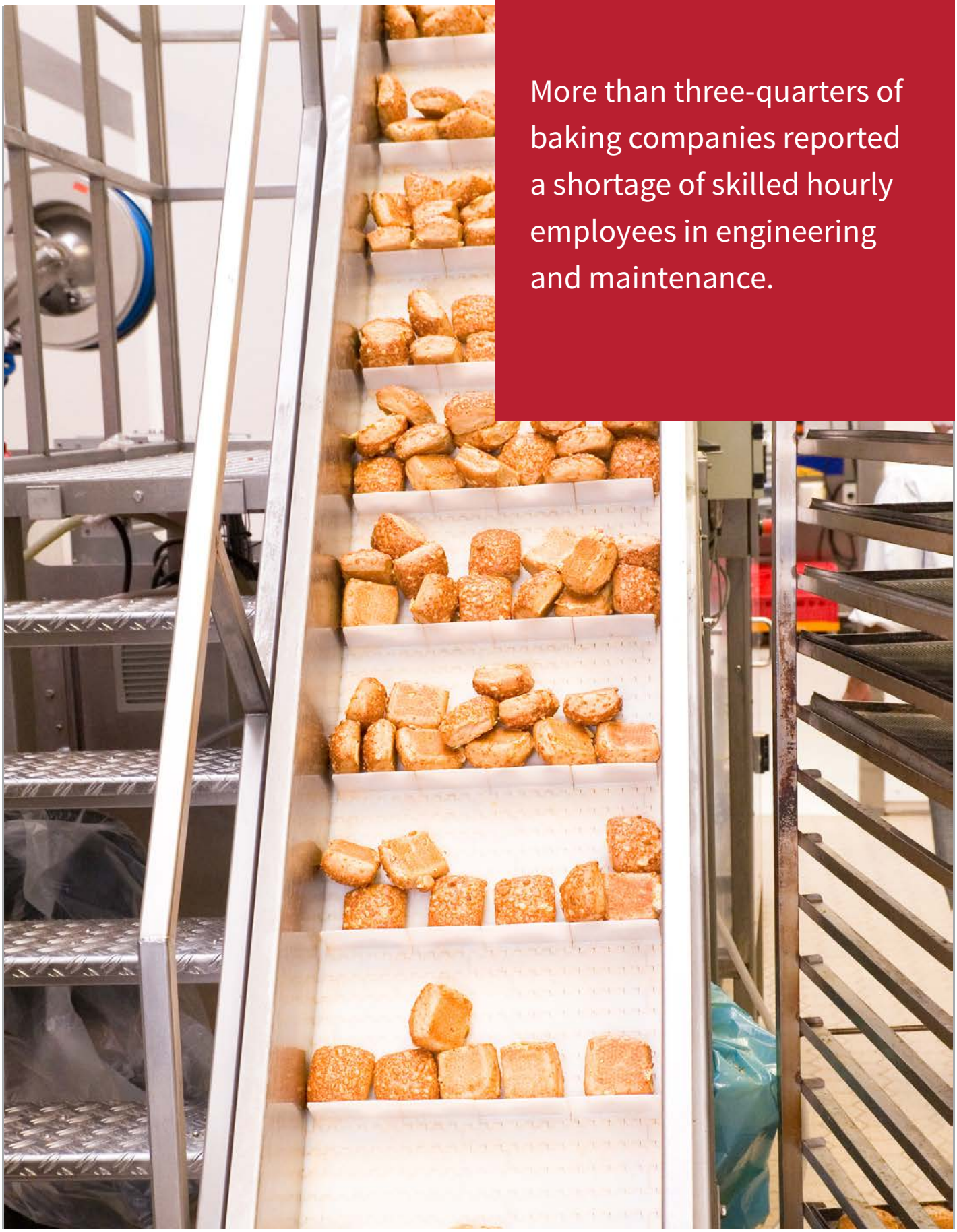
One common bottling industry metric that requires analysis of three separate factors is overall equipment effectiveness (OEE). OEE includes quality, performance and availability. In environments where the mix is going up, OEE may drop, so it's important to use this metric effectively to find the root cause.

Importantly, analysis and simulation also can support faster and more effective changeovers to help keep OEE strong, even when the mix is changing. Clearly, changeovers are a time when equipment is not available for production. Changeovers are often the source of quality and performance problems.

Transformation

Capturing data with added sensors, analysis and recordkeeping software enables highly automated, self-controlled workflows assuring process efficiency and consistency. This can transform bottling companies into agile, effective and far more attractive and profitable businesses. In one instance, a new IoT sensor in a bottling line found a motor that would have failed soon within two hours of being applied. If you knew every time a piece of equipment was about to fail, the uptime and productivity of the plant would soar.

More than three-quarters of baking companies reported a shortage of skilled hourly employees in engineering and maintenance.



Baked Goods: Proofing the Process

Bread and baked goods are comfort foods. Yet the companies making baked goods cannot afford to get too comfortable. Larger bakeries in particular are competing more and more with their retail customers' in-house bakeries and local artisanal bakeries. It is time to rise to the occasion. To compete more effectively, leading bakers are proofing the production processes with digital technologies such as IoT as a leavening agent.

Key Challenges

Product Consistency: Consumers still buy based on taste, so consistency in the product is essential. In the face of waning consumer loyalty, bakers who improve not only the quality of the product, but also the reliability and consistency of the process will be preferred brands. Controlling the process and taking into account ingredient variables is more important than ever.

Food Safety & Sanitation: No bakery can afford poor inspection results, or worse, product recalls. The top three causes of bakery recalls are:

1. Undisclosed Allergens
2. Foodborne Illnesses such as Salmonella, Listeria, Campylobacter, Staphylococcus
3. Foreign Materials

All of these point to a need for very careful control and end-to-end product tracking. Preventing allergen cross-contamination is challenging, particularly for companies that make many products in one facility. Some ingredients and pathogens easily travel through the air and are difficult to detect. Employees must follow sanitation procedures scrupulously.

Skills Shortage: Unfortunately, more than three-quarters of baking companies reported a shortage of skilled hourly employees in engineering and maintenance. According to the report The Workforce Gap in U.S. Commercial Baking commissioned by the American Bakers Association (ABA) and the American Society of Baking (ASB), most also had a shortage in salaried engineering and maintenance employees. And 40 percent had shortages in skilled machine operators. Baking industry skills are in very short supply.

Voltatile and Rising Costs: Both ingredients and energy prices have been variable, which makes keeping a healthy margin challenging. Energy prices are always significant in running baking equipment, particularly ovens. In addition, many of the faster growing segments in baking involve ingredients that are specialized, such as local, organic and gluten-free ingredients.

Digital Innovations

Sensors: Leading bakers are adding intelligent sensors for incoming materials characterization as well as equipment condition monitoring and process checks. Yet, gathering the data is just the first step – that Industrial IoT data must feed information systems and automation to ensure products are consistent and have minimal chance for contamination. This is where Industrial IoT platforms, manufacturing execution systems (MES), recipe management, and weigh and dispense systems play a role, ideally all feeding analytics systems and adjusting to feedback.

Proactive Maintenance: Once ovens and other equipment have adequate sensors connected via Industrial IoT, an area ripe for using the analyzed results is maintenance. Given the challenge of airborne contaminants, facility and infrastructure maintenance also is critically important. While historically maintenance might have been largely unscheduled or corrective, companies are using a combination of sensor data, analysis and maintenance software to also perform predictive and even preventive maintenance.

Systems to Support Employees: Due to a shortage of skilled, bakery-savvy operations employees, leaders have deployed an array of information technology (IT) and operational technology (OT) systems that help those with less expertise reliably follow proper procedures.

On-line Instructions: Bakeries can scarcely afford to have many employees away from their work area for training. Systems can now support training for less skilled operators, engineers and technicians, often while they are on the job. Work instructions and systems like MES help ensure that users follow proper procedures and can walk them through how to complete unfamiliar tasks.

Sanitation: Work instructions provide a way of ensuring that sound sanitation procedures are scrupulously followed. IoT sensors also may play a role here both to detect the presence of contaminants and ensure the proper sanitation of all equipment and areas.

Interesting IT: One approach to attracting the more IT-savvy candidates bakeries need is… to have more modern IT like IoT in operating workspaces. The largest commercial baking companies might evaluate augmented reality as a support and instructional approach. Yet even smaller organizations will find that having computer-driven automation and software for maintenance, operations and engineering tasks will help prompt interest by younger workers.

Robotics: Robots and co-bots can support greater consistency, lower costs and better food safety assurance. Commercial bakers are adopting IoT-connected robots at a rapid pace, extending automation to more of the process. This both attracts and requires IT-savvy employees. At the same time, robots can be easier to install and maintain than older automation that requires programmable logic controller (PLC) programming.

Transformation

Adding new digital information flows based on a coherent data model can transform baked goods manufacturers. Process and product data captured in IoT and analysis in a platform can enable consistent, high quality bakery products. It also can support improvements across the value chain, from farm to table. Better visibility is just the start. From there, the process expands to include analysis to improve outcomes even more in the future. One baker found ways to reduce waste and spoilage by using IoT to monitor filling machine capacity, raw material tank levels and crates for finished products; they expect that to save 4 percent of total production costs.

Production line scheduling can help minimize cross-contamination risk while also streamlining sanitization processes.

Dairy: Milking the Assets

Dairy manufacturers have been chewing away at inefficiencies to make improvements during the recent time of oversupply and low prices. Beyond getting out of the crisis, companies now have an opportunity to stand out in the field and operate in even more efficient and effective ways. The path is through leveraging digital technologies that streamline the farm to table time and support safe handling.

Key Challenges

Very Short Shelf Life: Dairy products are perishable, so companies need to ensure the process moves. From raw materials on the farm through processing and finished goods distribution, every stage is time-critical. Cold chain speed and control are needed to ensure products are available on the shelves for consumers with time for them purchase and consume before expiration. This is not a new challenge, but one that persists and can be met with new technologies and automation.

Food Safety Needs: While dairy now accounts for less than 1 percent of food safety illnesses, recent trends have raised the need for vigilance significantly. One is a push to raw, rather than pasteurized milk. Pasteurization is what keeps milk products pathogen-free. Post-pasteurization contamination is a major threat, too. As one of the big eight food allergies, dairy plants also must segregate materials and products effectively and use rigorous processes for sanitization. Because margins are so low, the plants themselves are often not air-tight and not well designed for cleaning procedures.

Consistency: Customers expect a brand to be consistent, and it's not an easy feat as raw milk often varies considerably. So agile recipe management combined with process reliability and consistency is essential. Aging plant infrastructure and processing equipment means the controls may not be as sophisticated on every line as it could be. Beyond that, the differences between lines of different ages can cause variation in product quality, production speeds, line setup, recipes and work instructions.

Increased Mix: Dairy has seen extreme proliferation of new product and packaging options, and that is not likely to change. Every consumer segment may want different product characteristics and different packaging. Child- or elderly-friendly packages of the same products as those for large families are common. Retail-outlet type makes a difference in the packaging also – whether at a convenience store, grocery chain, big box store, health food market or general retailer. Some want special packaging.

Globalization: In recent years, more and more dairy producers have found markets outside their home country. This trend leads to additional challenges in:

- The speed of the farm-to-table chain.
- Understanding food safety regulations in each region and proving compliance.
- Ensuring global suppliers and providers of materials are compliant.
- Packaging and label proliferation and complications as regulations change.
- Increasing product mix to satisfy varied regional tastes.
- Harmonizing operating procedures across sites in each region, many that might come through mergers and acquisitions.

Digital Innovations

IoT: Adding IoT-connected sensors to not only cows in the field, but also equipment and lines can improve consistency and ensure that post-pasteurization contamination checks are in place. Prices of these intelligent sensors have dropped, allowing experimentation in data gathering. Of course, an IoT platform is critical to make use of the sensor data in a timely and appropriate manner. The platform allows many types of new and existing data to come together for timely status and effective analysis. This might include data from pallets, crates, warehousing, transportation and processing throughout the farm-to-retailer cold chain.

Scheduling: Production line scheduling can help minimize cross-contamination risk while also streamlining sanitization processes. When each line is sequenced with runs that move from no common allergens to one that may be repeated on several products, risks go down. At the same time, plants can minimize the frequency of downtime for cleaning processes. Effective scheduling can help ensure that raw materials are ordered to arrive just in time for minimal storage time. The benefit also flows through to distribution processes.

Work Instructions: On-line instructions for all product options are essential for the increased mix. Even the most experienced employees will struggle to properly handle every single material and stock keeping unit (SKU). Instructions can help those in receiving and shipping as well as operators and maintenance technicians in the production plant. Cloud-based and mobile systems even enable transportation drivers and store delivery personnel to have completely up-to-date handling information at their fingertips.

Equipment Monitoring: Process automation may not require a complete revamp to improve consistency and visibility. We previously mentioned IoT sensors and platforms, and the capabilities of that can hardly be overstated. Adding conditioning monitoring supports proactive maintenance. With the existing control data plus any additional sensing data, dairy producers can get a much more detailed picture to ensure consistency and speed, and to analyze issues.

Supplier Control: To combat the challenges of contaminated dairy and milk protein ingredients, many companies have implemented improved systems for supplier control and remote lab analysis. They should continue to bolster this effort with digital technologies including IoT sensor data, software for reporting and visibility, and analytics to track issues and challenges as well as key parameters of raw materials.

Transformation

Milking assets may be essential with small margins in the business, but today there are more possibilities to improve than ever. Dairy producers can speed up the process while also helping ensure other aspects of food safety and efficiency. In one case, an automated milking system outfitted with IoT sensors senses pressure for the vacuum as well as the flow rate that creates. The system can also sense temperature, conductivity and color. This has reduced cycle time, saved costs and improved hygiene, resulting in increased yield of premium quality milk.

Digital Transformation Possibilities with Industrial IoT

Digital technologies, and particularly Industrial IoT, truly have a transformative possibility for food and beverage companies. While every segment has different pressures and opportunities, there are some common themes to consider.

Process Improvement: Beyond standard control, with Industrial IoT, food and beverage companies can now gain deeper and more complete visibility into the end of processes. With a broader set of data, they also can analyze for trends that might indicate golden batch or upcoming process anomalies or maintenance problems.

Empowered Employees: Because of a shortage of skilled workers experienced in food and beverage, digital projects are needed to provide knowledge and support for them. Robots, schedules, work instructions, Industrial IoT-enabled added process visibility and analysis all assist with minimizing variations and making good decisions.

Streamlined Safety: Food safety is a requirement, so with minimal margins the key is to make it as inexpensive and inherent to the process as possible. Industrial IoT-based digital track-and-trace technologies allow that. Many of the Industrial IoT sensing, process improvement and employee empowerment aspects automate product and batch records, and minimize the risks of safety problems.

Applying Industrial IoT and other digital technologies from the production floor out through the supply and distribution aspects of the value chain can improve operational – and thus business – results.

About MindSphere

MindSphere is a cloud-based, open Platform as a Service (PaaS) connecting products, plants, systems and machines to the digital world and enables Food & Beverage producers to apply advanced analytics to the wealth of data generated.

What is more, MindSphere allows users to do so without having to build their own **applications** and **software infrastructure** or manage **complex software stacks**.

MindSphere also can be used to track material flow and help meet standards requiring traceability of ingredients across the supply chain.

This content has been developed in cooperation with Siemens Digital Industries Software.