SIEMENS
Ingenuity for life

Insights & Ingenuity

Digitalizing the food and beverage industry

Boosting operational efficiency, gaining customer insight

The promise of digitalization looms large over the entire food and beverage industry. Every company in the sector is on the hunt for new ways to grow, develop, process, package, distribute, market, and sell their products faster, cheaper, and more effectively, and the latest advances in digital technology offer huge advantages in getting it all done.

The future of the food and beverage industry is being driven by two factors: the rise of new technologies that promise far greater operational efficiency, and changes in consumer expectations.

On the one hand, technologies such as the Internet of Things, big data and analytics, artificial intelligence, machine learning, offer executives a range of powerful new management tools for understanding and optimizing all aspects of food sourcing, processing, and distribution.

On the other, consumers are becoming much more demanding in their expectations for fresher, safer, high-quality products, made with more organic, less genetically modified and heavily processed ingredients. They want far more information about what's in their food, how it is made, and how it reaches their tables.

The entire food manufacturing ecosystem is on the verge of massive change. Its future, however, will be extraordinarily complex—indeed, impossible without a carefully orchestrated combination of new agricultural technologies, interconnected supply chains, advanced factory automation, efficient distribution, and in-depth consumer insight. Companies that don't learn to leverage the benefits of digitalization to increase efficiency and transparency, and to give consumers the food and beverages they want, will soon find themselves at a considerable competitive disadvantage.

Mapping the New Food Ecosystem

The transparent supply chain, from farm to table

The key to making this vision of the digitalized food and beverage industry a reality lies in the food supply chain—how each link in the chain can be transformed to promote food quality, safety, transparency, traceability, and speed to market, and how that, in turn, can most fully engage and delight customers as their demands and expectations mutate.

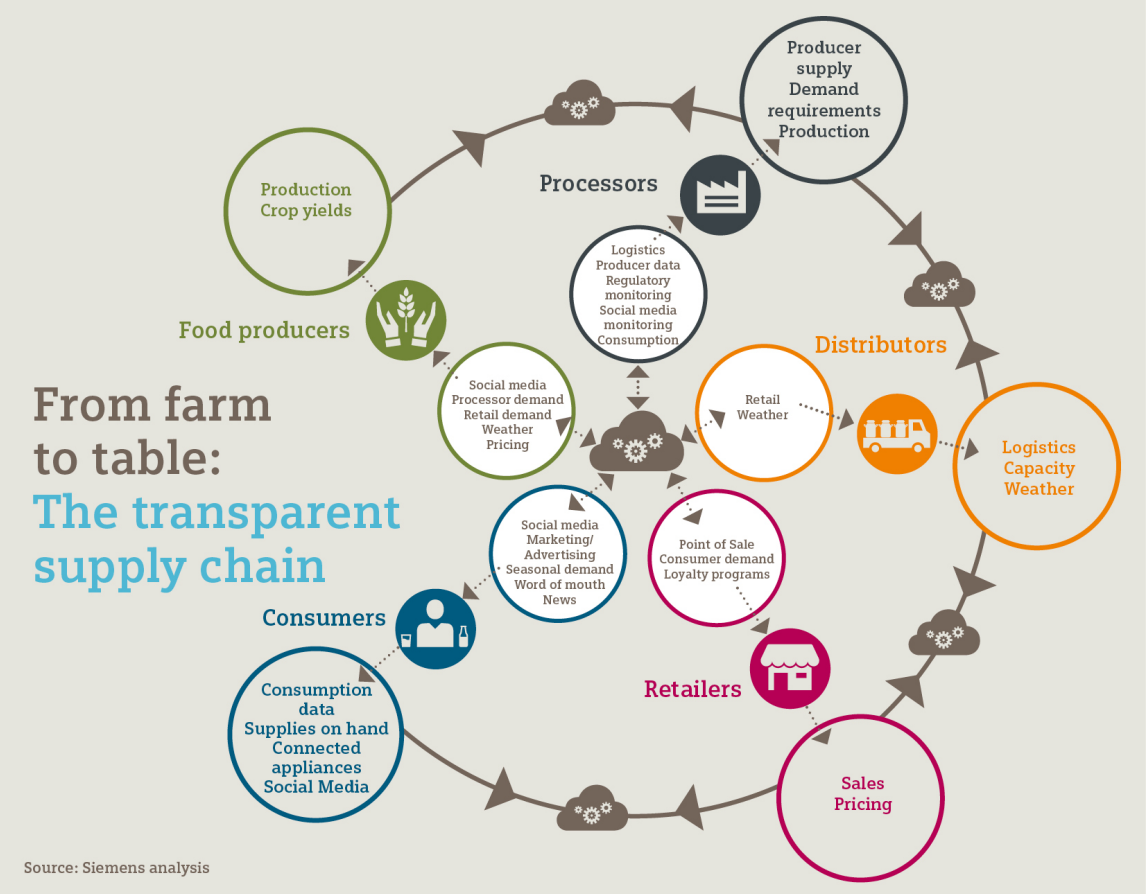
Every food and beverage company's supply chain incorporates the activities of five players: food producers, processors, distributors, retailers, and finally, the customers themselves. But the static, linear supply chain of the past is now giving way to the 21st century food "ecosystem," in which all the players are intimately entangled in a web of causes and effects tied together by an increasingly transparent network of data ceaselessly flowing back and forth throughout the system.

Producers

Sensors at the farm and slaughterhouse already capture large amounts of data regarding weather, soil conditions, the condition of crops, and other data, enabling significant improvements in crop yields and predictability. Data collected at harvest time and shared with logistics companies, including volume in transit and anticipated arrival times, will also help smooth the process of transporting their products to the primary and secondary processors further up the chain.

Processors

The processors will automatically gather all this information into their own control systems at the factory, enabling them to more effectively monitor the production process, accurately predict their production levels to take advantage of just-in-time inventory management, and prepare for disruptions in the supply of their raw materials. This data will be sent back up the food chain to the producers, who can then better predict demand for their products.



Source: Siemens analysis

Distributors

Looking further downstream, sensors at the food manufacturing factory will also pick up such data as production and packaging rates and disruptions in the production process, and send it on to distributors. Together with the data generated by sensors embedded in the palettes and food packaging itself, this will provide the essential information distributors need to fine-tune their warehouse operations and logistics needs, allowing them to schedule everything from warehouse space and labor requirements to the routing of trucks to the final scheduling of deliveries to retailers.

Retailers

This of course will require full integration with the retailers themselves. Most large grocery chains and online grocery purveyors already have considerable transparency into the purchasing behavior of their customers, through point-of-sale systems, loyalty programs, and electronic shelf-reading systems, and so can manage their inventory needs to a fine degree. This allows them to maintain digital contact with distributors, communicating detailed information as to their specific and ever-changing needs—and eventually send demand data further back along the supply chain, to processors and even producers.

Customers

Retailers, in turn, are capturing ever greater and more detailed insights into consumer behavior through a variety of technologies. In addition to data gathered at the individual customer level in stores and on ecommerce websites, many companies now monitor social media to get a jump on sudden changes in buying behavior.

The impact of changing consumer preferences can be severe: The production of high-fructose corn syrup, for instance, declined by fully 10 percent between 2000 and 2015[1], while sales of organic food have increased from $3.6 billion in 1997 to $43.3 billion in 2015[2].

Inside the Digital Factory

The factory floor is the epicenter of the food ecosystem, where food manufacturers can respond effectively to the supply and demand data they receive. The fully digitized factory allows them to manage production in the face of variations in the nature and supply of the products and ingredients they use, while reacting quickly to changes in consumer demand, regulatory requirements and other inputs. The benefits are considerable:

Efficiency

The cost savings to be captured are considerable, due to the efficiency gained through the use of machines and robots, and reductions in direct labor costs. The heavy cost of food recalls can be reduced, since more data allows problems to be pinpointed far more easily than in the case of human error. And the cost of compliance with regulations and food safety audits can be lowered as more processes become automated.

Productivity and flexibility

Increased throughput is key to the ability to keep up with variable consumer demand. Food processors need to be able to reconfigure their manufacturing lines quickly, shifting from product to product at a moment's notice. Thanks to advanced process control software, the latest food processing machines and robots can be changed over from one product or recipe to another in far less time than in the past.

Quality

The use of advanced machines and robots allows manufacturers to maintain high standards of quality and consistency. With operators constantly monitoring the manufacturing process through process control software, quality issues can be immediately corrected through minute adjustments to maintain a high degree of compliance with recipe specifications.

Traceability

No matter how automated a food processing plant may be, problems will arise. Managers in the digital factory can easily trace back and correlate problems to a particular machine at a particular time, determining whether it is not functioning properly or simply out of adjustment.

Connectivity

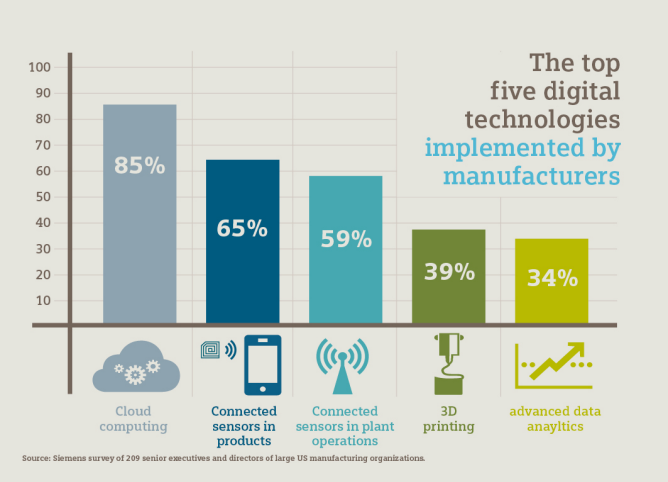
Fully digital machines and robots can communicate with one another, not just inside the digital factory, but with machines and processes entirely beyond the physical boundaries of the factory floor. This has already enabled companies to knit together extended processes along many parts of the food processing line, significantly boosting productivity and flexibility.

[1] https://www.ers.usda.gov/topics/crops/sugar-sweeteners/background.aspx
[2] https://ota.com/sites/default/files/indexed_files/OTA_StateofIndustry_2016.pdf

Beyond the Digital Factory

Extending digitalization throughout the food ecosystem

The end game of digitalization is to turn the entire food production process into a seamlessly interconnected, date-driven web that provides far greater control over what is produced, how, when, and why. The wealth of information at their disposal will give managers the power to fine-tune their operations to maximize efficiency and flexibility. Further up the hierarchy, C-suite executives will better understand larger, longer-term changes in the overall ecosystem, giving them far greater confidence in setting and carrying out overall company strategy.



Without the capacity to make sense of it all, however, the sheer quantity of data spun off by the digital food ecosystem will be overwhelming. The key to capturing, understanding, and benefitting from that data lies in cloud-based analytics.

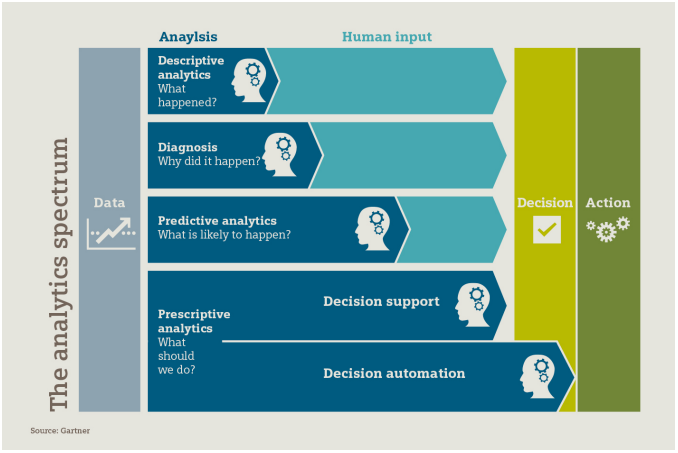
That network of internet-connected sensors that ties together the IoT must span the entire supply chain—from farm to table, in the commonly used phrase. As such, it cannot be restricted to a particular farm, factory, or retailer. But connecting all these players would be effectively impossible without cloud computing, which enables the sensors and other transmitting devices belonging to each of the players to send their data to a central repository.

Cloud-based software can then use that data to control all kinds of operational activities. Process control software can manage the production process on the factory floor, improving asset usage and capturing and sharing production data with suppliers, distributors, and other partners. Open application tools give users the ability to create new applications to fit their specific needs, even create effective interfaces with legacy IT systems.

Predicting the future, prescribing the result

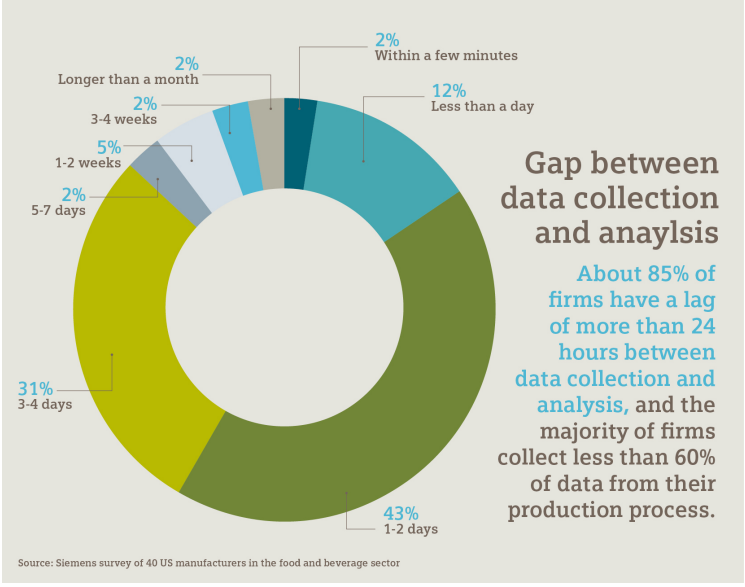
Locating the food ecosystem data in the cloud has the further benefit of making it centrally available to the data integration platforms and analytics engines that enables a full understanding of the entire food ecosystem. Indeed, while less than a third of companies have implemented analytics capabilities—and the vast majority of those that have take far too long to analyze the data they collect—analytics is perhaps the most critical element in the entire effort.

Without further advances in the area, the primary goals of the digital supply chain—transparency and resilience—cannot be met. As new technologies such as the Industrial Internet of Things, artificial intelligence and machine learning are applied to the task, however, the promise will soon become a reality.



Software systems are already boosting transparency through *descriptive analytics*—following the flow of raw materials, processed ingredients, and final products at any point in the food chain, where demand for specific products is coming from, and when they will be delivered. Partners in the chain are also beginning to put together *prescriptive analytics* systems that can anticipate demand through more and more accurate monitoring of the market. That, in turn, enables them improve resilience by determining raw materials requirements, production levels, and storage and logistics requirements more accurately.

Soon, systems will become sophisticated enough to take an even more advanced step on the way to full transparency and resilience—prescriptive analytics, or the ability to flexibly set the conditions under which the food ecosystem should operate. At this stage, partners across the chain will be able to use their understanding of demand planning, distribution activities, digitally automated food manufacturing, and raw material availability to choose among any number of factors the chain might be affected by, create different scenarios for how best to respond, and then to actively modify and adjust the chain in light of the chosen factors.



Imagining the optimized food ecosystem

Consider a situation in which a growing number of consumers concentrated in the Northeast begin posting their delight with a recently introduced brand extension of a particular kind of breakfast cereal. Even before their approval is reflected in increased store sales, the manufacturer's marketers have picked up the demand signals by monitoring social media—perhaps even measuring the rate at which individual consumers are increasing their consumption of the cereal. In turn, they alert all the sourcing, distribution, and retailing partners that contribute to the manufacturing and sale of the cereal.

Depending on the level of intensity of those signals, the analytics systems will create scenarios that reflect different levels of increased demand, and how each would affect all the different players' operations. Each scenario might anticipate the need for varying levels of raw materials, production and packaging capacity and volume, changes in where and how much of the new cereal is warehoused and distributed, and retailers' need for added shelf space.

Each scenario would also offer an analysis of the impact of all the potential scenarios on other key factors, including the likelihood that each scenario could actually be carried out, how each one would affect the financial performance of all the players in the chain, analyses of pricing strategies, even minor adjustments to the marketing plan for the new cereal. Taken together, this information would then enable all the players to collaborate and agree on the optimal solution, or refine it further, and then put it into action. Thus, the entire ecosystem would be ready to meet the increased demand even before the boxes of cereal start flying off the store shelves.

The Key Ingredients

Defining your role in the food ecosystem

The major operational and technological transformation required to capture the benefits of the digital food industry will likely be daunting to many companies. Company leaders need to devise and follow a coherent step-by-step process designed to ease the transition—without introducing time-consuming delays.

1. **Define your end-to-end strategy.** No company should proceed without determining where they currently fit into the food value chain, and where they want to fit in the future. Assess your company's current technological maturity level, determine what your role should be going forward, and devise a strategy for getting there.

2. **Build the business case.** Analyze carefully the benefits you expect to gain in achieving your strategic goal, and then set them off realistically against the costs involved. This is critical—as attractive as much of the latest technologies are, there is no point in implementing them if you can't be sure that you'll get a tangible return on your investment.

3. **Determine and develop the capabilities needed.** Participating in digitalization isn't just a matter of buying some sensors or robots, connecting them, and gathering data. Depending on your strategic goals, you will need to decide which capabilities you'll need to succeed—whether it be the best product development, production processes, supply chain management, speed to market, data analytics, or some other capability.

   Just as important, you will need to determine how to build the necessary capabilities. Few industrial companies have the experience or internal expertise needed to develop and implement the software that run such sophisticated systems, so partnering with companies able to provide the technical capabilities needed may be your best path forward.

4. **Evaluate and nurture your talent pool.** Building the digital food ecosystem require a considerably different range of knowledge, skills and talents from what the typical food company now employs. Already, the race is on to attract and retain the most people, so analyze where your talent gaps are, and put your HR function to work filling them.

5. **Develop a roadmap.** The best strategy cannot succeed if it isn't executed well. Map out your execution plans carefully, and make sure it includes the pilot programs needed to test the new technologies and processes you implement, how you propose to scale up your efforts across your company, and a plan for monitoring and assessing whether you're achieving your expected return on investment.

Conclusion

Digitalization and competitive advantage

While the benefits of the digital food ecosystem are many, reaping those rewards will be no easy task. Complexities abound in the major transformation required, and the effort will take a concerted effort on the part of everyone in your company, from other players up and down the food chain, and from your technology partners.

Most importantly, it will take a full, sustained commitment on the part of your company's leaders, from the CEO on down. Without that, the digital transformation is bound to fail. But with it, your company can move forward with confidence, knowing that the companies that build their digital ecosystem fastest will be the winners in the competition to feed the world.