REVOLUTIONIZING
FOOD & BEVERAGE PRODUCTION
WITH THE DIGITAL TWIN AND IIOT

▶ **JIM BROWN | PRESIDENT | TECH-CLARITY**

Tech-Clarity

The Digitalization Imperative in Food & Beverage

Competition is Heating Up

Competing in the Food & Beverage market is getting increasingly challenging. New competitors are changing the rules of the game with digital processes that allow them to drastically improve speed, agility, quality, and the ability to tailor products to customer and market needs.

In the digital age, it's no longer enough to be big. The barriers to entry have dropped as markets have transformed. Today's markets are omni-channel, allowing even the smallest startups to gain access to consumers. Buyers' preferences have also changed. They are more excited to try a new microbrew than consume the brand from their favorite, traditional mega-brewery. At the same time, customers are expecting food to meet their specific social, dietary, and regional preferences.

Competitive Disruption Puts Pressure on the Plant

The plant has to respond to these disruptions. Production and Operations Managers need to embrace digital, Industry 4.0 capabilities including the Internet of Things (IoT), the Industrial Internet of Things (IIoT), the digital twin, the cloud, big data, and analytics. These digital capabilities can help them increase capacity, optimize asset and resource utilization, and drive productivity gains. At the same time digitalization provides them speed and flexibility to quickly ramp up production to bring product innovations to market and shift more fluidly across different plants, lines, and regions to react to consumer demand.

"…we believe tomorrow's winning CPG company will look different from that of today: streamlined and agile in organization, automated and deeply analytic across functions, dynamic in use of investment, fully omnichannel in go to market, able to respond more quickly and effectively to the market via innovation, and advanced in the ability to connect with individual consumers in many contexts."

Agility@Scale: Solving the growth challenge in consumer packaged goods – McKinsey&Company

The barriers to entry have dropped. It's no longer enough to compete by being the biggest and leveraging scale. Instead, even the largest companies need to innovate faster than ever to stay ahead. They have to leverage all available information to identify market opportunities and react quickly to threats from new upstarts. They have to evolve consumer experiences, perhaps incorporating more personalization and technology into traditional offerings, and flexibly deploy new products into their

"Brand owners, manufacturers, and retailers are facing a changing landscape that will result in a new competitive order, with some major traditional players likely losing favor to smaller, more agile companies. To survive, Food and Beverage companies have to raise the bar to stay competitive. They must continue to drive increasingly higher levels of productivity to squeeze out profits, all despite tight margins, global competition, and complex quality and regulatory demands."

Surviving the New Competitive Landscape in Food and Beverage – Tech-Clarity

Leverage Digital Enablers to Compete

Digitalization is the key to Remaining Competitive

Companies are responding. A recent Tech-Clarity survey shows that more than one-half of companies say that digitalization / digital transformation initiatives are "important" if not "critical" to their business strategy. The study also finds that over 90% of manufacturers believe the IoT is likely to contribute to their business strategy, with over one-half saying the same for the Digital Twin. These initiatives, enabled by analytics, can provide significant business benefits to manufacturers. They aren't new concepts, but they are coming of age and are now within reach of manufacturers large and small.

Model and Simulate Performance with the Digital Twin

The first capability we'll discuss is the digital twin. As the name implies, it is a virtual model that represents a physical asset like a product or plant. The digital twin is a complete model that allows companies to accurately simulate performance. It can be used to help predict and optimize product and production behavior virtually to get designs right.

Significantly Expand Digital Twin Benefits with the IIoT

The power of the twin increases dramatically by connecting physical twins with their digital, virtual models via the IIoT. This digital association allows real-time performance monitoring and feeds the digital thread for traceability. Connecting twins allows companies to actively monitor the physical world in real-time, in the context of the product or plant, so they can identify or predict issues ranging from equipment breakdowns to product quality exceptions. It also allows companies to compare actual with expected performance to validate and improve simulations.

The digital twin is a virtual model of a physical item. The model represents a specific product, configuration, piece of equipment, plant, city, or other physical asset with enough fidelity to simulate, validate, and optimize performance and behavior.

The digital twin is connected and kept in sync with its physical twin over its lifecycle and can be used to collect, aggregate, display, and analyze operational data to improve performance, gain real-world insights, and close the loop between the virtual model and physical experience.

Tech-Clarity

Leverage Digital Enablers to Compete

DIGITALIZATION IMPORTANCE TO BUSINESS STRATEGY

Don't Know
8%

Not Relevant
6%

May Contribute
21%

Critical
38%

Important
27%
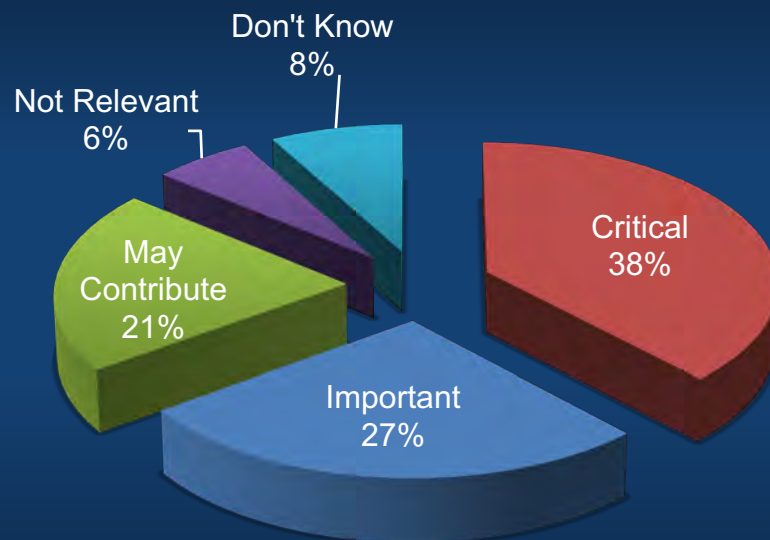
Digitalization and Industry 4.0 – Tech-Clarity

Bring External Perspectives to the Plant with IoT

The IoT expands internal information with data from outside the "four walls" of the plant. It can aggregate data from other plants, the market, retailers, suppliers, and many other sources to help make decisions in a broader context. This connectivity reduces data lag between producers and the outside world and allows them to compete as an integrated, synchronized supply chain.

Add Market and Supply Chain Intelligence with Analytics

The complete digital toolkit also includes analytical tools. These solutions help companies gain market insight and identify trends early to get more advanced notice about market shifts. This information allows plants to react in a more optimal way because time affords them more options. In addition, predictive analytics in the plant can leverage IIoT equipment data to quickly diagnose and resolve equipment or production issues before they escalate and provide data to support continuous improvement programs.

Gain Greater Benefits with Digitalization

These digital enablers are all powerful tools on their own. The benefits, however, are much greater when they are leveraged together. A completely digital enterprise has fully connected product and production digital twins that enable automated commissioning and changeovers. They use the IoT and analytics to identify and capitalize on consumer trends ahead of the competition. Finally, they leverage the IIoT to continually improve performance to gain the highest levels of productivity and quality.

Tech-Clarity

Apply the Digital Twin in the Food & Beverage Industry

Leverage the Digital Twin Concept

Digital enablers are providing value across many industries. Food and beverage companies have found many creative ways to gain value from the digital twin concept. Although most food and beverage companies already have mass amounts of data, they have trouble unlocking the value from it. They are now using analytics and the digital twin to gain intelligence from the data instead of simply storing it away in historians.

Develop a Digital Twin of the Product

One powerful way to apply the digital twin in food and beverage is to develop digital product models. These digital definitions represent formulas and recipes with all of their variations and can be used to predict product characteristics like nutritional values, adherence to marketing claims, and regulatory compliance. A full model includes production requirements to allow rapid recipe transformation to shift production between plants and adapt to site-specific production equipment.

Create a Digital Twin of the Plant

Another highly valuable application of the digital twin is establishing virtual models of equipment, production lines, or plants. These models may include different levels of granularity for different purposes, from high level models for production flow to detailed machine models that can accurately simulate production performance. The models include a fully detailed representation of manufacturing capabilities so processes can be simulated, optimized, and validated virtually. The models help manufacturing engineers and planners improve production planning and plant design.

Tech-Clarity

Connect the Physical and Digital Twins

Connect Digital and Physicals Twins with the IIoT

Digital twins are much more valuable than static models. Modeling and simulating plant performance is not new to food and beverage companies. Production control and monitoring systems are also familiar technologies. While each are valuable, real transformative change comes from tying the digital twin together with actual physical twin performance data collected from the IIoT.

Give Meaning to IIoT Data

The value of the digital twin comes from connecting the virtual and the physical environments. This provides visibility to real-world performance data from sensors on production and packaging equipment collected via the IIoT and provides the context to interpret the information. For example, time series data is meaningless without an understanding of intended performance.

This connectivity helps companies monitor actual performance to optimize the health and condition of a piece of equipment or the plant, and gain insights into how the physical assets actually perform. It also helps companies gain perspective from the market and the supply chain.

Identify and Address Anomalies and Issues

Manufacturers can learn a lot from discrepancies between simulated performance predicted using the digital twin and actual performance measured on the physical twin. Identifying these variances can identify issues in the plant that can be diagnosed and remedied to bring performance back into plan.

VALUE IN FOCUS
Improve Bottling Operation with Low OEE

A beverage bottling operation could find that bottling equipment isn't running at intended speeds. This could be due to an equipment error or perhaps to compensate for poor quality labels. By comparing actual versus intended production parameters, the issue can be diagnosed and corrected.

In another scenario, the plant could temporarily run the line above maximum designed speed and carefully monitor electric motors for heat, current, and vibration. Then, they could use the knowledge gained from the experiment to refine the virtual twin to better simulate the behavior of the line based on real-world data instead of theoretical design constraints.

Improve Models, Plans, and Simulations by Replacing Assumptions with Facts

Connecting the physical and digital twins with the IIoT helps companies learn and continuously improve by interpreting real-world behavior. They can improve planning and optimize production based on observed behavior in the plant as opposed to calculated values. This lets planners use real-world results and scenarios to improve their simulations.

Tech-Clarity

Streamline R&D and NPDI with the Digital Twin of the Product

Develop a Holistic Product Model

First, let's look at R&D and NPDI. Developing a fully digital product specification helps streamline R&D and product development. Digital R&D organizations can start with requirements and add ingredients, labels, and packaging to develop a fully digital specification. Developing the formula digitally allows downstream departments like Marketing or QA to get started in parallel and add their own information to the model.

Working in parallel enhances speed, but more importantly provides visibility so decisions impacting others are recognized and evaluated early while there is still time to change. For example, Compliance can see a change to the formulation to determine if packaging or labeling must be updated to reflect the impact on ingredient listings, nutritional facts, certifications, or claims.

VALUE IN FOCUS
Developing a Nutraceutical for Global Production

Companies have many considerations when they want to offer a food-based health supplement across borders. Digital R&D teams can develop a base formula and create variations to meet local preferences, ingredients, and regulations. Likewise, the process steps can be adapted to fit local production equipment. Managing these transformations digitally allows companies to quickly develop local recipes and maintain them as the core formula or other design data changes.

Extend Product Models to Production

Formulas can be extended with process steps and related production data to create a fully digital recipe. Digital recipes can then be transformed to meet local regulations and equipment availability. Maintaining an integrated model of materials and processes allows companies to readily adapt them to changing demands.

© Tech-Clarity 2018

Optimize Plant Assets and Production Plans

Leverage Plant Models to Plan and Optimize Production

How do these models improve performance? A digital twin of the plant lets food producers get the most out of their plant investments. Digital twins of the plant model production capabilities with enough fidelity to predict behavior and performance. For example, a beverage company could simulate sequencing, changeovers, tanks, pipes, batch sizes, filling, and packaging. They can also incorporate business factors such as seasonal or geographic variability of products and ingredients.

These twins can be used to simulate, iterate, and optimize everything from material flows to equipment. This allows planners to optimize processes digitally before committing to a production plant, changing a line, or commissioning a new product. Twins eliminate bottlenecks, avoid quality issues, reduce cost, and reduce changeover times before committing to physical assets. This get things right the first time and build in the flexibility to react more quickly to changing consumer demands.

VALUE IN FOCUS
Designing a Dairy Plant

Before building a new dairy plant, engineers could create an end-to-end mapping of the process flow from raw ingredients through packaging. They can use this to simulate flow rates, tank storage capacity, pipe fields, intermediate storage, changeovers, shift capacity, and even logistics. Digital twin models can then simulate a variety of production scenarios to ensure the plant and equipment design will deliver optimal throughput and quality in the virtual world before even committing to building the plant.

Tech-Clarity

Get More from Production Equipment with IIoT (and Analytics)

Keeping a Virtual Eye on Production Equipment

Let's explore how to apply the connected digital twin. Although food and beverage producers likely have a control system and/or a data historian that captures large volumes of data, they typically have little understanding of how equipment is performing or when it may have an issue. The IIoT lets food and beverage companies monitor the performance and health of their critical production assets in real-time so they can receive alerts and rapidly identify, diagnose, and correct issues before the problem escalates.

Gaining Equipment Intelligence

An IIoT platform with analytics goes beyond simple alerts. It allows plant personnel to connect, aggregate, filter, and analyze information from sensors and existing control systems to drastically improve uptime and performance. One proven way to gain value is moving away from preventative maintenance to a more predictive model.

VALUE IN FOCUS
Monitoring Motors in a Snack Packaging Plant

To provide high operational availability and throughput, plant operations could monitor motors in a high-speed snack packaging line for warning signs like excess heat or vibration. When these conditions appear, maintenance personnel can replace the failing equipment before it can cause a quality problem, a scrapped batch, or unplanned production downtime.

For example, companies can replace scheduled preventative maintenance based on operating hours or a reactive break-fix approach by using the IIoT and analytical algorithms to identify equipment behavior that precedes a failure.

Tech-Clarity

Enhance Quality and Productivity

Gaining Insight and Intelligence on Production

Beyond monitoring a piece of equipment, food and beverage companies can monitor production as a whole. For example, IIoT data can be shared in a dashboard to make key production KPIs like cycle times or yield visible so operators can quickly identify issues. The IIoT platform can detect anomalies and provide alarms so plant operators can correct issues as they occur, if not earlier.

IIoT data can also provide intelligence to help managers benchmark lines, plants, and geographies for continuous improvement. And, it can help close the loop between R&D and the plant by comparing actual versus predicted batch specifications.

VALUE IN FOCUS
Analyzing Batch Variability in a Confections Plant

A company making candies could use the IIoT to better understand variability across batches. They could correlate information to determine if deviations are linked to ingredient variability, substitute ingredients, machine set points, or plant environmental factors like humidity or temperature. By better understanding the relationship between these factors, they can improve product consistency, drive higher quality, increase yield, and optimize resource usage.

Associating Production Parameters with Quality Outcomes

Combining information from production equipment with lab results can help provide insights into potential quality drifts that leads to scrap or rework. By correlating actual batch results with equipment settings, ingredients, suppliers, personnel, or environmental factors that may be impacting quality or throughput manufacturers can find and alleviate root causes.

Tech-Clarity

Compete as an Optimized Supply Chain

Benchmark Your Manufacturing Network

Digital twin value goes beyond the enterprise. Companies can learn a lot by comparing production across multiple facilities. Plants can share IIoT data with corporate headquarters or a center of excellence through the cloud. Analyzing product data across the network, whether it consists of their own plants or contract manufacturers, can help identify regional variances. Further analysis may uncover additional insights that can be used to identify issues or share best practices to ensure high productivity and product consistency across the globe.

Close Information Gaps in the Supply Chain

Digital companies compete as a supply chain. For example, they can work closely with ingredient suppliers on R&D or collaborate with retailers on promotional packaging. Or, suppliers can proactively share specifications for natural ingredient shipments so that formulators can begin to modify recipes based on data like actual moisture or sugar content. Digitalization allows companies to better share information to improve agility, productivity, and quality.

**VALUE IN FOCUS
Providing a Brewery with Early Market Insights**

For example, a brewery could remotely connect through the IoT with supply tanks at bars and restaurants to better understand beer inventory levels. This can help them with replenishment schedules and allow them to gain a more accurate view of consumption. By correlating this information with external data such as advertising campaigns, weather data, or sporting events, they can improve forecasts by replacing assumptions with data-driven insights to better optimize production schedules.

Tech-Clarity

Next Steps

Getting Started

The value of the digital twin to Food and Beverage companies is significant. To get started, food and beverage companies can choose between a number of valuable initiatives that leverage the digital twin, IoT, IIoT, and analytics. For example, they can:

- Apply the digital twin of the plant to optimize production planning
- Simulate production on the digital twin to optimize plants in the virtual world before committing to physical assets
- Monitor equipment to gain equipment intelligence and improve uptime
- Use IIoT and analytics to shift from preventative to predictive maintenance
- Monitor production to rapidly identify and correct quality or productivity issues
- Connect with the market and the supply chain via the IoT to gain advanced insights into market trends and consumer preferences
- Leverage measured results from the physical twin to improve simulations by providing the digital twin with observed production scenarios and parameters

"Food and Beverage companies that embrace digitalization – companies both large and small – will be better positioned to compete as the market shifts to more connected customers and more customized foods. Digitalization helps companies pivot quickly and confidently to address issues or take advantage of market opportunities, with a digitally connected production network and supply chain that can intelligently respond as one."

Surviving the New Competitive Landscape in Food and Beverage – Tech-Clarity

It's Time to Act

Today's food and beverage companies need to deliver high operational efficiency in order to compete. It's time for them to adopt the digital twin and IIoT to gain important Industry 4.0 benefits – agility, productivity, quality, customer responsiveness – and remain competitive into the future.

Recommendations

It's time to leverage the IIoT to connect the digital and physical twins to improve availability and production performance. The most important recommendation is to get started, learn, and grow benefits over time. Food and beverage companies can start small and expand value by building on the foundation of their first initiatives.

It's important, though, to consider needs like equipment connectivity, security, and analytics. Leveraging an integrated platform of digital solutions designed for the food and beverage industries can help. A platform approach also helps ensure that early investments are repeatable and can be used as a foundation for further value.

www.tech-clarity.com

clarityonplm.com

@jim_techclarity

TechClarity.inc

Revolutionizing Food & Beverage Production with the Digital Twin and IIoT

This eBook is sponsored by Siemens
www.siemens.com/plm

SIEMENS

About the Author

Jim Brown is the President of Tech-Clarity, an independent research and consulting firm that specializes in analyzing the business value of software technology and services. Jim has over 20 years of experience in software for the manufacturing industries. He has a broad background including roles in industry, management consulting, the software industry, and research.

Jim's experience spans enterprise applications including PLM, ERP, quality management, service lifecycle management, manufacturing, supply chain management, and more. Jim is passionate about improving product innovation, product development, and engineering performance through digitalization and the intelligent use of software technology.

Jim is an experienced researcher, author, and public speaker and enjoys the opportunity to speak at conferences or anywhere he can engage with people with a passion to improve business performance through software technology.

Image Credits

CanStockPhoto: Pages 1,4, 7,8,10,11
Dollar Photo Club: 3 (bottom)
Siemens: 2, 3 (top), 9
Tech-Clarity: 4

Tech-Clarity