Food for thought – Introduction to Food Industry 4.0

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Food and beverage manufacturers get excited! Traceability, from the farm to the fork, and greater flexibility will enable bespoke production for each customer and instantly comply with product specifications. "Industry 4.0" is about to shake things up.

What is Industry 4.0?

The term Industry 4.0 denotes the next developmental stage in the organization and management of the manufacturing industry's value chain process. Also known as the ‚Fourth Industrial Revolution,' this concept is widely understood in Europe's manufacturing sector, though in the United States, it may also be referred to as the ‚Internet of Everything'.

Industry 4.0 is based on the understanding that traditional manufacturing and production methods are facing a critical and rather painful digital transformation. Over the years, manufacturing processes have increasingly evolved by incorporating information technology, but new technological advancements in IT and electronics have enabled the creation of a smart network of machines, ICT systems, products and individuals across the entire value chain and product lifecycle. One way to do this is to link machines to manufacturing plants, fleets, networks and individuals via sensors for information-sharing.

Characteristics of Industry 4.0

Industry 4.0 exhibits four characteristics:

1. Vertical networking of smart production systems
2. Horizontal integration through the coordination of production and logistics
3. Virtualization and integration across the value chain
4. Exponential technologies

Let us look at each.

Vertical networking of smart production systems

An introduction to cyber-physical production systems (CPPSs) is necessary to understand vertical networking. CPPSs are an online network of machines organized like social networks. They link IT with electronic and mechanical components to allow communication between each via a network. One of the earliest forms of this technology in the agrifood industry is radio frequency technology (RFID), which has been in use since 1999.

To meet the Industry 4.0 challenge of the increasing pace of newly introduced product and safety regulations, food companies require automated compliance solutions to augment decision making, reduce risk and increase speed to market. Without the ability to discover regulatory change across multiple languages and sources, it is nearly impossible to meet global market requirements at the right speed without automated, intelligent tools.
Dr. Ruud Overbeek, Chief Business Development & Strategy, DECERNIS

Vertical networking uses CPPSs to equip manufacturing plants with the ability to react quickly to changes in stock levels, defects, or demand. Such a smart factory enables customer-specific and individualized production. Some of the other capabilities vertical networking includes are:

- The efficient use of resources – materials, energy and human labor.
- Logging of all processing stages of production, with automatic recording of discrepancies.
- More effective monitoring of wear-and-tear, and better overall management of waste.

In the food and beverage industry, this networking offers real-time data on-demand, enabling smooth communication flow from production to logistics. There are a number of IT solutions available to automate the routine of food laboratory processes and procedures.

For instance, companies are increasingly investing in laboratory information and management systems (LIMS) for automating day-to-day lab processes and workflows, administration, quality control, budget control and compliance with statutory specifications. They are helping companies streamline quality requirements, increase the quality of analysis, and meet regulatory obligations by providing complete traceability.

Horizontal integration across all production sites

Like networked production systems, horizontal integration enables networking via CPPSs, from logistics and warehousing to production, marketing and sales. The history of a product or a product part is logged and accessible at any time to ensure constant traceability and product memory.

Food and beverage companies can integrate vendors in their processes via online interfaces or network their global sites through private cloud solutions. This can create flexibility and transparency across entire process chains, allowing quick changes to be made as required to ordering, planning, production, composition and distribution.

One example of this is the Global Data Synchronization Network (GDSN) solution, which gives suppliers and distributors the opportunity to share standardized and synchronized information with one another as well as with customers. This proactive system enables product data to be updated across supplier-distributor systems in real-time.

The advantages of GDSN include (a) improved accuracy of data received directly from the supplier, minimizing data maintenance (b) an increase in data attributes that improves the searchability of products for customers on the web as well as via backend ordering systems (c) a one-step dissemination of data from suppliers to all distributors, ensuring consistency and time-savings, and (d) process synchronization that makes data and classification consistent across all manufacturers.

Virtualization and integration across the entire value chain

Cross-disciplinary engineering across the value chain and the full product lifecycle is another facet of industry 4.0. This engineering seamlessly occurs during the design, development and manufacture of new products and services, which are integrated and coordinated with product lifecycles. It enables synergistic relationships between product development and production systems.

The key advantage is the availability of data and information at all stages of a product lifecycle, making it possible for flexible new processes to be defined using data modeling.
The virtualization of value chains is making it possible to visualize the entire value chain to ensure the automatic and consistent transfer of information from one process step to another, as well as to enable communication between raw materials and machines aligned to demand and efficiency metrics. Today, it is possible to trace the entire product manufacturing process upstream and downstream, allowing managers to immediately access information at their fingertips on desktop or mobile devices for rapid, high-quality decision-making.

A centralized data system for all the raw data for every product is an effective way to facilitate traceability. For instance, for purposes of food certifications, the system allows a new release to be generated with each change made in the recipe formula, and deactivates the old one. It includes information about what has changed and by whom it is stored.

Exponential technologies

A number of new and emerging technologies are enabling flexibility, cost improvements and increased efficiency in industrial processes. They are best described as autonomous and cognitive technologies, such as artificial intelligence (AI), sensor technology, and robotics.

Some solutions driven by exponential technologies may seem like they are fresh out of a sci-fi novel, such as maintenance robots and drones that fly in to deliver materials or spare parts, or assist with warehouse stock inventories. Simpler solutions include systems that automate processes to eliminate human error that could cause raw material waste or otherwise result in suboptimal use of materials. This can help manufacturers ensure consistency in quality, optimize prices and enhance their bottom line.

In summary, the four characteristics of industry 4.0 offer the following advantages for the food and beverage industry:

- Better traceability across the entire production chain
- Automation of key processes to eliminate errors and inaccuracies, and achieve higher quality standards
- More flexibility for bespoke production and quick response to changing product specifications
- More efficient data sharing between stakeholders
- Optimization of raw materials, processes and effort
- Strict adherence to new regulations

Four Areas Where Industry 4.0 Can Make a Huge Difference

Food recall

Foods or beverages may be recalled for a number of reasons, ranging from complaints by consumers/ customers, due to testing and auditing by the company, or in the upstream supply chain.

The different types of contamination that can occur include:

- Microbial contamination, wherein the food safety and quality is compromised by the entry of disease-causing bacteria, parasites or viruses.
- Labeling errors, which can include non-compliance to mistakes in the ingredients list or date markings.
- Presence of foreign objects such as metal, plastic or glass.
- Contamination by machine oil, pesticides, chemicals and other potentially hazardous substances.
- Contamination by biological toxins in food plants, mushrooms or in aquatic products, such as shellfish toxins or histamine poisoning.
- Packaging faults
- Unsafe levels of additives

There is mounting pressure on manufacturers to initiate product recalls as rapidly as possible, making it imperative to have a robust trace-and-fix process in place. That means, on the journey from farm to fork, the correct source of the raw material must be accessible in the event of a recall. Tracing back to where the contamination originated is often a protracted activity, a challenge that is being addressed by sensor technologies developed exclusively for the food and beverage industry.

Intelligent identification technologies and systems enabling traceability come in various forms. On one hand, RFID tags attached to vegetables from the time they are harvested in order to determine where each batch comes from. On the other hand, there are systems that allow the efficient tracking of all data – from raw materials to semi-finished and

finished goods specifications – and make it easy for users to find the information they are looking for by providing a number of query options and personalizing search patterns.

Managing changing consumer habits

21st century consumers are researching products on their smartphones and making educated choices about what to put in their bodies. To engage consumers, both manufacturers and retailers are looking at point-of-sale (POS) solutions that influence purchaser decisions.

One example would be a POS display that can interact with customers‘ mobile phones. Companies are also exploring strategies such as extending the shelf life of fresh produce and minimizing food and packaging waste.

Smart labeling is an upcoming technology in this regard. A combination of wireless tags, software applications and cloud platforms allows consumers to scan product labels to confirm authenticity and obtain information on ratings, reviews, customer loyalty options, and video. All it takes is a tap on an NFC-enabled device. The analytics that such smart labeling technologies provide to manufacturers and retailers includes the number of taps, location, likes, demographics and social shares.

Data management
One of the biggest advantages of industry 4.0 is improving data management through improved data sharing and collection across machines in the production chain, recording changes and making change history available, automatic archiving of old data, and quick access to data whenever needed.
Data management is a sum of many parts, and for each part, new and emerging technologies hold immense promise. For instance, cloud computing can help manufacturers easily retrieve data about a single product or thousands of products from multiple locations for analysis and sharing.

The next frontier – single-unit batch

While single-unit batches, where products are customized and custom-labeled according to individual customer requirements, have been extremely tough to achieve, some companies are getting there. Smart sensor technology and automation systems have enabled food companies to provide their customers more customization, choice and control over the products they wish to consume, e.g., solutions that enable a breakfast cereal manufacturer to offer its customers the option of creating their own cereal and having their recipe appropriately labeled and directly shipped to them.

The Industry‘s Biggest Challenges

In an over-saturated food and beverage marketplace, manufacturers have to contend with specific challenges. Here is a look at the key issues the industry is seeking to solve in 2017.

Maintaining clean labels without sacrificing taste

Worldwide obesity rates have doubled between 1980 and 2014. The link between sweetened edibles and obesity is well documented. For companies that manufacture soft drinks, children’s drinks, and protein-based drinks, a reduction in sugar will be a priority. The challenge will be to reduce or eliminate the quantity of added sugar while maintaining the same sweetness and flavor. R&D teams are exploring ways to use natural ingredients that ensure the same familiar flavor profile while sending a positive message for public health marketed through clean labels.

Aligning to policy changes

Food standards are never constant. They are

The emergence of disruptive technologies are rapidly provoking transforming changes across the worlds food value chain. The connected shopper is driving this phenomenon, and make no mistake, is now every brand‘s new boss. Today shoppers are less loyal to brands and fancy packaging - they are influenced more by their values - trusted, sustainably grown, nutritionally dense, fair trade foods that support local economies is the new paradigm- it‘s more than a purchase, it‘s a lifestyle. SpecPage empowers food and beverage companies to compete for and meet this demand by enabling transparency and trust from farm to fork.
Mitch Chait, Chief Executive Officer, GREENFENCE

dictated by government bodies and set internally as a strategic measure. Essentially, manufacturers have two standards to adhere to, inevitably creating complications. There is also the added stress of meeting the evolving expectations of an increasingly well-informed audience.

Unless manufacturers can ensure stringent supply chain and safety management, the threat of recalls will loom large, not only affecting reputation and pocketbooks, but even attracting lawsuits and fines.

Though it is a tall order to expect the private sector and governments to come together to brainstorm a joint approach to safety standards, food companies can ensure the efficient management of their data and improved quality control through automation, traceability and streamlined workflows.

Creating differentiation

One of the biggest challenges that food companies grapple with is differentiating themselves from the competition. The reality of today‘s marketplace is that consumers face the problem of overabundance, where there is an inexhaustible number of options. This tends to trigger a tendency for lower consumption as consumers are too overwhelmed to make quick purchase decisions.

The wave of organic and natural products has arrived and is firmly entrenched. Food companies need new differentiation strategies to stand apart from similar competitors and challenge incumbents. Of course, it will be necessary to consider consumers‘ changing preferences to create differentiation that actually delivers business value. As mentioned previously, this could mean anything from clean labeling to more eco-friendly packaging and communicating brand values authentically.

What Food Producers Want

According to the 2017 Trends in Food Processing Operations report from the Association for Packaging and Processing Technologies (PMMI) based on the analysis of data from 40 interviews and 150 references, manufacturers foresee increasing their use of automation and robotics to improve the flexibility of production processes.
On equipment functionality, the report found the following:

- 4 out of 5 companies have over 100 product SKUs, and more than half of those interviewed say that SKUs will continue to increase.
- 3 out of 4 companies will explore reliable machinery to improve uptime.
- Half of the companies are looking to extend their level of automation in the next 3-5 years.
- Robots are used in 30% of processing operations and 90% of packaging operations. The use of robotics is expected to increase in both areas.
- Manufacturers are keen on using processing equipment that can be cleaned easily, ensures flexible turnover, and assures operator safety.
- Food producers are considering the Industrial Internet of Things (IIoT) and data collection solutions to manage production, resources, labor, schedules and maintenance more efficiently.

Over half of all companies prefer customized equipment and OEMs for integration, pointing to benefits such as the availability of parts, faster delivery and service support.

Opportunities from New Technologies

How Can Food Producers Fulfill Compliance Regulations?

Challenge

Food producers are under pressure to meet consumers‘ changing consumption preferences and habits while at the same time developing new products and complying with government regulations at the local and global level.

The US‘s FSMA and EU‘s 1169/2011 or INCO regulations are just a few of the multiple, complex food standards that need to be met. This entails the effective management of all data and documentation related to products across their full lifecycle, from R&D to supermarket shelves. Compliance

management is a function on its own, and unless it is optimized, food companies will struggle to innovate and meet dynamic market demands faster.

Consumers are also a lot more aware than ever of food compliance standards, regulations and quality control. The modern consumer not only wants organic, locally-produced and healthy choices but also demands utmost safety – all at affordable prices. The bar has been set high, and producers need a good compliance management process to stay competitive and grow their market share.

Solution

Some of the requirements food producers need to comply with include:

- Disclosing health, nutrient and function/ structure claims AND/OR warnings in an accurate and qualified manner.
- Display the amount of nutrient for each claim.

Keep in mind nutrient profiles and scientific evidence to support health claims. It is critical that food producers maintain a strong grip on product quality as well as ensure that their labeling reflects correct information which adheres to the latest local and global government regulations. There are two solutions that can be considered for this:

Product data management

Effective data management for food products is necessary not just from a production perspective but also from a safety and compliance point of view. Common data such as ingredients, formulas, raw materials, and specifications is often stored in a conglomerate of paper records and online spreadsheets. And even if the data is stored electronically, it is scattered and decentralized, with each department/team overseeing its own information sets and management habits.
Both product and data development can benefit from a central storage and specifications management system to make information access, sharing and management quick, easy, uniform and cohesive. A single database for different types of customer data standardizes processes and drives better quality control, easing some of the burden of maintaining tight, regulation-ready controls. Some major food brands are already leveraging big data, which includes information from regulatory agencies, to mine for insights into emerging food safety problems. This attitude of staying one step ahead enables early assessment and actions, allowing companies to manage tighter constraints with lesser stress.

Product label review

Though government agencies publish labeling requirements and enforce them, they have the capacity to review only about 5% of the food product labels in the market. Ultimately, the onus is on food producers to follow federal and global labeling regulations and to ensure compliant packaging.

Product label review services are valuable partners to food companies, helping them understand legal requirements and assisting with the development of compliant products labels in different languages. Services can include a review of existing labels and comprehensive support in developing informative labels for food products intended for international destinations.

What is the Best Way to Share Information with Consumers?

Challenges

As mentioned previously, consumers today are asking many questions regarding recalls and the safety of the food supply chain. This has resulted in major changes in the way food producers communicate information with their trading partners as well as with their consumers. There is a shift towards standardization and digitization to demonstrate more transparency with respect to food origin, ingredients and other relevant information sought by consumers.

Traditional data exchange methods between food producers and trading partners are inefficient, preventing rapid sharing of complete product

information to improve customer engagement, and thus sales.

Solution

Enhanced food tracking and tracing is being enabled by GS1 Standards. These standards make it possible for companies to uniquely identify products in the supply chain to improve visibility and optimize efficiency. Companies are using GS1 identification numbers, including the Global Trade Item Number (GTIN), to identify products and obtain information such as expiration date and lot/batch numbers, and to deliver product information when barcodes are scanned.

The Global Data Synchronization Network (GDSN), an important component of GS1 Standards, has been in existence for over a decade, facilitating the continuous sharing of food product information, from ingredients, nutrients and allergens to whether the product is halal, kosher, organic, or vegan. The GDSN is helping food companies eliminate data inaccuracies and share rich data with consumers, which builds trust and confidence.

How Can Traceability and Transparency Be Guaranteed?

Challenges

While traceability and transparency are two different concepts, they are inextricably related. Traceability allows food products to be traced forward and backward along the supply chain. Transparency is an effort that makes the food tracing process open and honest.

Transparency and traceability are also important parameters in a laboratory environment where the route to pathogen testing and food preparation must be easily identifiable. The FDA Food Safety Modernization Act (FSMA) has placed pressure on food companies to not just respond to contamination in food and beverages, but prevent it altogether. As discussed in the previous point, this has obligated companies to provide relevant, accurate product information to consumers.

Unfortunately, while food producers acknowledge the need to be able to trace information quickly and share it openly with stakeholders, they have no means of ensuring that this process takes place. In fact, many food producers are not fully aware of nationally and globally applicable food safety regulations and/or do not have access to industry standards which dictate guidelines for production and product disclosures.

Solutions

PLM

Product data management throughout the entire product lifecycle in the company and with suppliers, as well as with customers, has transformed PLM from an administrative product data management system to a general management system, and thus into a cornerstone of enterprise for food and beverage companies.

Global manufacturing companies need to meet local market demands and develop differentiated offers. These market trends influence product development and production in equal measure.

By implementing a PLM platform, food and beverage companies can meet consumer and retailer demands, while accelerating time to market, driving revenue and maintaining compliance. PLM solutions provide best practices for global product development, including centralized formula and recipe management, process automation and workflow, enterprise change management, master specification management, document control, resource planning, supplier management and improved collaboration throughout the enterprise and extended supply chain.

GDSN

As a network of more than 30 certified data pools connecting over 35,000 companies, GDSN is useful in assuring a high level of data transparency by enabling producers to efficiently share information with retailers, distributors and trading partners. The network allows for country-specific

regulatory requirements, which is especially useful for manufacturers who export to an internal marketplace.

GDSN is one part of the solution; producers need a way to consolidate their data from various sources and connect the data into the global network. GDSN software is the other part of the solution, allowing producers to not only share information but also retrieve it from the network, as well as to obtain confirmation from their partners about received data. Among the various data types that must be provided (dependent on the nature of the product) are shelf life, ingredients, ordering information, organic and nutritional certifications, storage and usage information, details about radiated and irradiated products, alcohol content, diet types, additives/preservatives, packaging hierarchy and details about product tracking (barcodes, RFID tags, etc.).

The GDSN network and software enable producers to meet transparency requirements related to product information. Those who are leveraging this solution are knowledgeable of the rules that need to be followed and the information they must provide regulators, retailers and consumers.

Specifically, food producers benefit in the following ways: (a) better corporate data management (b) compliance with food safety regulations (c) better trading partner collaboration (d) lower administrative costs and more streamlined data handling, and (e) better product lifecycle management support.

Retailers benefit from up-to-date product information and improved engagement, as consumers can obtain the data they are looking for, achieve more efficient category and promotion management, and acquire meaningful methods of promoting food safety.

Laboratory management

A lab information and management system (LIMS) is essential for traceability and transparency at the laboratory level. A system that can automate laboratory processes, workflows and quality control enables the efficient tracking of all registered data, thereby aiding traceability. It helps producers streamline quality requirements in line with new regulations and evolving consumer expectations.
As industry 4.0 seeps into the food and beverage industry, it may give food producers, industry groups, trading partners and regulators the impetus to collaborate more closely to gain cohesive insight into best practices and standards. A better, more comprehensive understanding among stakeholders will be needed to propel the industry to greater heights.

How Can Food Producers Strategize for Industry 4.0?

Build a foundation that supports change and spurs growth

Industry 4.0 heralds an era where intelligent machines do the heavy lifting for companies. However, putting the right mix of technologies and collaborations in place, as well as fully leveraging them, will be up to business leaders. Setting a foundation for technological advancements and business growth will be an early priority.

In the initial phases of digital transformation, companies can be expected to invest their time in the following activities:

- Determining whether a change in business model is necessary, or whether an additional capability or allied service can create new revenue streams.
- Understanding the technological infrastructure necessary to support stringent internal standards and external regulations.
- Building the right human capabilities and a culture that is not averse to change.
- Developing partnerships that are essential in a digital, highly connected world.
- Becoming an active participant in pushing for standardization and positive changes in the industry that help consumers, producers, retailers and all entities along the supply chain.

CIMdata is impressed by SpecPage's integration with Decernis. It embeds compliance management early in the product development phase enabling the right decisions to be made on time so compliant product launches happen on schedule, and also facilitates Industry 4.0 by providing support for single-unit batches and mass customization. This offering continues to extend SpecPage's position as a PLM solution provider to the global Food and Beverage industry.
Tom Gill, PLM Enterprise Value & Integration Practice Manager, CIMdata

Making informed technology investments

Digital transformation is a steady process initiating fundamental changes. The plan and roadmap should reflect the major shift across all aspects of the business. One of the earliest steps will be to evaluate areas of improvement and review technologies that can deliver the targeted benefits.

There are many technological solutions solving critical challenges faced by food and beverage manufacturers. The most advanced and futuristic solution may or may not be the right one for you. It will be necessary to assess the capabilities of the solution, whether it can evolve with new industry developments or regulations, and the kind of support the solution provider can guarantee. The long-term potential and impact of the solution must be determined – if you believe that it may become obsolete in the next ten years, you may want to explore other options.

An effective workforce strategy

A common fear associated with automation is that it affects jobs. While it is true that automation provides an efficient alternative to repetitive and physically demanding tasks, human employees displaced by software/robots can be re-skilled and moved to other jobs.
Those jobs will be more demanding, requiring employees to utilize their problem-solving, creative or newly acquired, future-ready skills. The challenge here is to train the workforce to adapt to digital transformation and slip into new roles in an advanced business environment.

Producers who invest in upskilling and recruiting the right talent are in the best position to achieve measurable business value from innovative production methods, labor and stakeholder engagement.
Companies do not need to shake up their culture to adapt to a new environment. Instead, companies can just modify their processes in order to communicate the importance of being open to new work models and continuing their learning cycles. Leadership needs to step in to model an attitude that welcomes change and flexibility. Only then can companies create a competitive and motivated workforce.

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