Informed Manufacturing: The Next Industrial Revolution

The future of manufacturing is here, compliments of intelligent machines that enable people, processes, products and infrastructure to seamlessly coordinate, creating finished goods that are more time- and cost-efficient to produce – and meet, if not exceed, customer expectations.
Executive Summary

We are at an inflection point of innovation and change in the manufacturing landscape. The change is taking place through the convergence of the real and virtual worlds (cyber-physical systems), as well as the advancement of sensors, processors and Internet technologies. This allows for a faster flow and more efficient use of information on a much vaster scale than previously possible.

The deeper meshing of virtual and physical machines offers the potential to truly transform the manufacturing value chain, from suppliers through customers and at every touchpoint in between. We call this phenomenon “informed manufacturing.”

This white paper explores informed manufacturing innovations that promise to bring greater speed and efficiency to all sectors of the manufacturing industry by following the principle of “meaning-making,” which involves converting information and data into useful business insights to improve operational results.
Informed Manufacturing: A Primer

Informed manufacturing is an envisioned state of operations in which all relevant and synthesized information is made available when, where and in the form in which it is needed across the manufacturing supply chain, to all stakeholders (people, process, products and infrastructure). The core concept is based on Industry 4.0 – the fourth stage of the Industrial Revolution, characterized by the interconnection of highly intelligent cyber-physical systems to create the so-called “Internet of Things.”

Figure 1 depicts the four stages of the Industrial Revolution, which kicked off with the invention of the steam engine and the mechanization of manual work in the early 1800s. Stage 2 began with mass production techniques implemented by Henry Ford in the early 1900s, while Stage 3 took hold in the 1970s with the advent of electronic systems and computer technologies, which automated manufacturing processes. We are now heading toward the fourth stage, with the introduction of cyber-physical systems for mass production.

The explosion of social, mobile, analytics and cloud technologies, or the SMAC Stack™, is impacting manufacturing. Nanotechnology has enabled pinhead-sized sensors to be embedded into products, and software has emerged to simulate and model different manufacturing processes to create more adaptable and flexible production lines. Factories are already beginning to appear in which everyone from plant managers to senior leaders shares information and accesses analytics to improve operational efficiencies.

Figure 1

Four Stages of the Industrial Revolution

Source: Industry 4.0 (or Zukunftsprojekt Industrie 4.0), a German government high-technology initiative to promote the computerization of traditional industries such as manufacturing.

Figure 1
As a result, four essential elements of manufacturing are converging unlike never before, creating a gateway to the world of informed manufacturing, as depicted in Figure 2. They include:

- **Products**: Advanced sensors, controls and software applications work together to obtain and share real-time information as finished goods make their way down the production line. “Informed products” will enable machines to take autonomous actions.

- **People**: By connecting people across all business functions and geographies, and providing them with relevant information in real-time, “informed people” will provide intelligent design, operations and maintenance, as well as higher quality service and safety.

- **Processes**: Emphasizing bidirectional information-sharing across the global manufacturing value chain – from supplier to customer – “informed processes” lead to a flexible and adaptable supply chain.

- **Infrastructure**: Using smart infrastructure components that interface with mobile devices, products and people, “informed infrastructure” will better manage complexities and enable more efficient manufacturing of goods.

### Informed Products

Informed products use embedded sensors to monitor performance and register information associated with their production and operation (e.g., health condition, history of manufacturing and service life). This makes them uniquely identifiable and locatable at all times. They actively support the manufacturing process, answering questions such as, “When was I made?” “Who should process me?” “To which location should I be delivered?” Informed products will be able to control the individual stages of their production, semi-autonomously.

### Key Elements of Informed Manufacturing

![Figure 2](image-url)
For example, GE built a new $170 million plant in Schenectady, N.Y., to produce advanced sodium-nickel batteries. The factory has more than 10,000 sensors spread across 180,000 square feet of manufacturing space, all connected to a high-speed internal Ethernet. Every part that goes into the batteries is tracked via barcoded serial numbers and barcodes, enabling managers to assess how much energy it took to make a specific battery part and compare it with the average.

GE is also able to monitor how long battery parts “soak” in the factory’s ovens and how much time they spend elsewhere on the production line. Alarms flash near battery parts approaching their threshold limit, preventing failed quality tests. Having such information on hand will help companies optimize their manufacturing operations in terms of inventory, maintenance and distribution (see Figure 3).

Informed products can also help trigger new business models and increase customer intimacy. For example, we helped develop the AutoDiag application for a Big Three car maker that uses sensors embedded in automobiles (think telematics device) to gather data on driver behavior and monitor the health of the car (see Figure 4, next page) (For more on this subject, see our white paper, “Exploring the Connected Car.”). This allows insurance companies to base the price of policies on how a car is driven, as well as where it travels. Pricing can be customized based on the actual risks of operating a vehicle rather than on traditional information, such as the age, gender or address of the driver. The sensors would also be able to provide real-time information on the health and condition of the vehicle to servicing companies. Such information will be valuable for service personnel to proactively provide car maintenance services.

**Informed People**

To succeed in a global market, it is becoming critical for all value-chain participants to obtain and share real-time information to make informed decisions with very short notice. Informed people will leverage intra- and inter-enterprise social technologies and mobility tools to link individuals (suppliers, designers, dealers, customers, etc.) across the globe to propel deeper collaboration and information sharing.
Take the case of Juniper Networks and Groupe Adeo, which leveraged social platforms to foster innovation and enable collaboration among previously disconnected business units. Juniper developed its own internal collaboration site named Matrix that cut across the company, enabling its engineers to communicate among themselves to exchange ideas, drive innovation and get project status updates. This helped Juniper resolve technical questions within days, grow the business through channelized problem-solving and enhance knowledge through a combined workforce.

Groupe Adeo is a DIY retailer with approximately 66,000 employees and 27 subsidiaries across 13 countries. Faced with disconnection among teams in its group subsidiaries, the company developed Adeo Community Network, a company-wide social platform that spans multiple business functions and internal communities. This opened communication among subsidiaries, fostering collaboration and brand identity across global teams. The platform also increased efficiency and reduced costs due to shared knowledge and experience across global teams.

Informed people will also allow manufacturers to realize several benefits, such as early verification of design decisions, rapid response to supply chain disruptions, addressing of unique customer specifications and manufacturing for maintainability. Ultimately, informed people will enable companies to deepen loyalty and improve engagement among employees and customers.

For example, we developed a social media analytics solution for the sales and marketing team of a major automotive OEM. This allowed the team to proactively reach out to customers based on their driving experience and address concerns proactively. By leveraging social media analytics tools, the teams can discover, decompose and distill unstructured data from multiple public forums and turn it into actionable customer sentiment regarding the company’s products (see Figure 5, next page).
Informed Processes

Informed processes focus on bidirectional information-sharing across the entire value chain, from suppliers through customers. These processes interconnect and harmonize individual stages of manufacturing production to provide a flexible and adaptable value chain, and advance plant-wide efficiency. Here, product diagnostics data and product performance data are directly infused into manufacturing operations so production activities can be corrected autonomously, sooner rather than later.

For example, GM uses information from climate sensors to indicate whether it is too humid for painting a car. When necessary, cars are automatically sent to another area of the manufacturing process, such as wheel-fitting, and then redirected back to the painting process when favorable conditions return. Such a process helps the car manufacturer reduce repainting procedures and maximize plant uptime. This saves the company millions of dollars in the process (see Figure 6, next page).6

Enabling information to flow across the value chain would also support mass customization, in which an individual customer’s requirements can be met during production. Informed processes can enable car manufacturers to dynamically reconfigure production lines and mix-and-match equipment in vehicles as per customer requirements during the production phase.

Informed processes would also enable manufacturers and retailers – across industry sectors – to create more adaptive supply chains that rapidly adjust to changing requirements. Leading manufacturers are deploying a variety of sensors to gather information across the supply chain, allowing them to react more quickly and effectively to challenges.

Figure 5
For example, a major building materials supplier faced high transportation costs and spoilage as customers repeatedly changed their orders and delivery schedules. Using global positioning system (GPS) sensors mounted on cement trucks and linked to a central control center, the company is now able to reroute trucks dynamically, based on up-to-the-minute information about changing customer requirements. As a result, the company has reduced delivery time from three hours to 20 minutes, cut the number of delivery trucks by 35%, trimmed operating costs by $100 million, and improved on-time delivery.

**Informed Infrastructure**

Informed infrastructure responds intelligently to changes in its environment, including user demands and other infrastructure to achieve improved performance. Here, machines are connected to one another using a feedback loop of data, which provides intelligent decision-making. The system can monitor, measure, analyze, communicate and act, based on the plethora of information within its operational environment.

Informed infrastructure provides the ability to integrate data across multiple plants and make it available over the Web or mobile devices. Through this infrastructure, users can understand and compare the performance of various factories and equipment across geographies and functions.

For example, a global diversified industrial company that sells HVAC systems wanted to better serve its customer base. We delivered a solution to capture real-time data from the HVAC systems through sensors across sites. Through this data, the HVAC system became an informed infrastructure that autonomously provides alerts to technical specialists and provides real-time performance reports. These reports would help site managers improve overall equipment effectiveness, save money by
minimizing equipment failure and allow the company to perform planned maintenance action (see Figure 7).

Informed infrastructure also helps machines make context-based decisions autonomously. For example, computer servers draw power continuously and on a 24x7 basis, but they are sometimes used at minimal capacity as they often support specific activities. But most plant managers lack a detailed view of energy consumption patterns and, hence, are unable to efficiently manage power consumption. Using software and information feedback techniques, informed infrastructure would enable servers to be powered down intelligently during certain times of the day when need is minimal, thus providing significant energy and cost savings (see Figure 8).

Informed Infrastructure Can Conserve Power During Idle Time

A visual representation of how power consumption can be optimized via informed manufacturing.

Source: Cognizant Technology Solutions
Figure 8
Looking Ahead

As noted, informed manufacturing is a critical weapon to speed the response to competitive global market pressures and remain ahead of rivals. Manufacturers are encouraged to consider informed manufacturing to obtain superior value through a data-driven business model. Companies need to consider building new competencies around understanding and applying informed products, people, processes and infrastructure. Here are some steps manufacturers can take to better prepare themselves for the informed manufacturing era:

- **Start experimenting by embedding sensors into products, machines and plants and make meaning from the information collected through business analytics.** Experiments with emerging technologies can be conducted in development labs and in small-scale pilot trials, and established companies can seek partnerships with innovative technology suppliers.

- **Determine the tools and processes that will improve collaboration by offering new platforms for information exchange and rich discussion — perhaps by implementing social business technologies such as Chatter, Yammer, Jive and Newsgator.** At the same time, companies can introduce “bring your own device” policies that enable employees to choose the tools they work with. Organizations also need to enable integration of unstructured data from the Web and other digital channels (mobile and social media) with structured data from systems of record. Such data can provide insights on consumer trends, brand sentiment and even service or quality problems.

- **Look at integrating product diagnostics data, environment information and user demands directly into manufacturing and operations so that the manufacturing process is made flexible and adaptable.** For this, companies need to

Quick Take

**Studying Informed Manufacturing, Worldwide**

As we enter the era of informed manufacturing, we believe companies need to take steps now to position themselves for these changes by using SMAC Stack technologies to optimize business processes and stay ahead of the competition. To understand how this phenomenon is evolving, we are conducting a primary research study with C-suite leaders on informed manufacturing. As part of this study, we plan to interview executives from manufacturing companies, academia, industry consortia and technology providers.

The study will focus on five main hypotheses:

1. **Overall outlook on informed manufacturing:** Determining the strategic impact of embracing informed manufacturing.

2. **Informed products:** Developing a roadmap for embedding context-specific information at the product level.

3. **Informed people:** Enabling intra- and inter-enterprise social networks that allow free-form collaboration to drive higher quality and efficiency.

4. **Informed processes:** Integrating product diagnostics data and product performance data directly into manufacturing and operations so that production activities can be optimized sooner rather than later.

5. **Informed infrastructure:** Assessing how smarter factories can produce energy efficiency to the tune of 20% to 30%.

Study results would help us more effectively implement informed manufacturing with organizations committed to taking these lofty ideals from concept to reality.
first focus their efforts on standardizing data across various systems throughout the value chain, thereby achieving relevant interfaces and integration with the manufacturing environment. Companies would also need to develop a new talent pool beyond the obvious technical skills in mechanical or electrical engineering. A new wave of technical, analytical and leadership roles will be required that are explicitly cross-discipline.

- **Investigate a large-scale supporting infrastructure.** Data centers, fiber networks and broadband will be needed to connect various machines and networks across industries. Companies need to also start integrating and deploying sensors into machines and factory floors, thereby optimizing energy consumption and enabling proactive maintenance of valuable assets.

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*Our "Informed Manufacturing Global CxO Study" will build on this foundation by delivering a fact-based understanding of the industry’s position and the challenges of embracing this emerging concept. For more information, please contact us at InformedManufacturing@cognizant.com.*

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**Footnotes**


2. Industry 4.0 is a component of the German government’s high-tech strategy, which promotes the computerization of traditional industries such as manufacturing.


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About Cognizant

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