

Industry Raises Its IQ: The Journey to Smart Manufacturing



The age of smart manufacturing is here, aided by digital technologies such as the Internet of Things, artificial intelligence, analytics, machine learning and cognitive computing. Companies can now have greater control over manufacturing and the supply chain, including the ability to predict and prevent downtime, bottlenecks and defects. Think of smart manufacturing as a journey that can be successfully managed across six key steps.

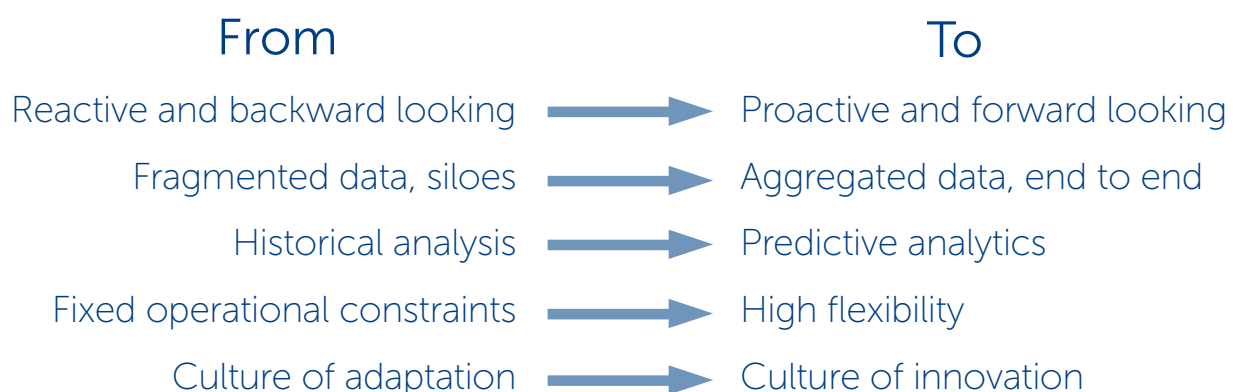
If you walked into a smart factory—one that leverages advanced analytics, artificial intelligence, the Internet of Things, additive manufacturing and other new technologies—what would you notice that's different?

Actually, you might not "see" anything worth noting. But once you started talking to people, you would understand the dramatic contrast between a digital manufacturing environment and a traditional one. In the smart factory, people would feel they have more knowledge at their disposal about operations. They'd be in better control of their processes, and they'd know what's coming—predicting what might happen based on data and analytics.

Then, if you looked at the key performance indicators (KPIs) for the smart factory, you'd notice it has a higher quality level, more efficiency, increased throughput, fewer bottlenecks and more flexibility. It responds more easily to smaller lot sizes, variable customer requirements and changing conditions. Hot weather coming in? The smart factory has a weather forecast built into its algorithms, and it knows when to readjust processes to compensate for the heat.

A smart factory with these capabilities is the goal of every manufacturing executive on the planet. The question is, how can you get there?

The new world of smart manufacturing



Getting smart about today's manufacturing challenges

Uptime, productivity, efficiency, quality: Today's manufacturers have more than enough challenges on their hands when it comes to their factories. The best-laid plans don't always work out. Stuff happens. Machines break down. Parts get lost. People don't show up or aren't where they're supposed to be at the right time. Deliveries of raw materials are late or are damaged. Addressing these challenges requires increased intelligence within the manufacturing process.

As an example, consider Japanese machine tool builder Okuma. By using Internet of Things (IoT) technologies, Okuma's system carries out advanced analysis by combining the data on production progress conditions with the facilities' operational status. The system allows the process to be accelerated, from the detection of bottlenecks (delays in prior processes, failures in the facility, etc.) to the implementation of countermeasures.

Using big data collected from the shop floor and accumulated by the monitoring system regarding progress and operational status, and by using advanced AI technologies (see sidebar), the next step is to develop this into a system that automatically and dynamically generates a high-precision production schedule according to ever-changing conditions on the shop floor.

Digital technologies are also enabling some astounding innovations in the supply chain. Consider additive manufacturing, the industrial version of 3D printing, in which a company does not have to ship a product from point A to point B, but instead sends data or specs which are then produced at the receiving location. Hitachi and Tohoku University in Japan have developed an additive manufacturing technology for high-entropy alloy using a 3D printer for metals. The technology makes it possible to fabricate components with complex geometries where and when they are needed.



AI technologies for human activity recognition

Researchers from DFKI (the German Research Center for Artificial Intelligence) and Hitachi are developing an AI application for human activity recognition of workers using wearable devices. The AI technology performs real-time recognition of workers' activities by integrating technology in eye-tracking glasses to recognize and properly work with gazed objects. The system increases speed and improves quality by helping workers select the right parts for the job and then use them properly. It can help even down to the detail of tightening a screw to the right point of resistance by tracking a muscle activation signal from workers' armband devices.

The recognition ability of each activity is achieved by having the AI understand the tools or parts used at the production site as well as anticipated actions. DFKI and Hitachi are using this newly developed AI technology to assist operations and prevent human error, and to contribute to enhancing quality and efficiency on the front line of manufacturing.

Three ways smart manufacturing creates business value

We are living in a transformational digital era sometimes referred to as “Industry 4.0”—the fourth industrial revolution. Companies embracing this transformation are using technologies such as connected cyber and physical systems (the Internet of Things), artificial intelligence, analytics, machine learning and cognitive computing to create a smart manufacturing environment. With these technologies, companies can deliver greater operational efficiency, create on-demand products, support access to information from any source at any time, and implement environmentally sustainable practices.

Smart manufacturing typically delivers a return on investment of approximately 3X, though we have seen instances where the return is closer to 10X. Value is created three ways in particular:



Predicting and preventing downtime

Reducing the number of products that are out of sync with Takt time, increasing capacity and throughput, and reducing maintenance costs.



Predicting and preventing bottlenecks

Having materials arrive at the right time with each station working at full capacity, increasing throughput.



Predicting and preventing defects

Reducing cost of poor quality (CoPQ) and enabling better product mix.

It's the predictive nature of a smart manufacturing environment that is especially distinctive. For example, Japanese manufacturer Daicel has worked with Hitachi to create a predictive analytics system that collects and aggregates data from a number of sources:



Sensors



RFID Tags



IT Systems



Raw Materials



Cameras

Through agile processing, the system uses algorithms to understand root causes of problems and predict defects or problems before they happen. The system is also strong from the standpoint of social innovation in that it can help reduce workplace injuries as well as movement strains and other health disorders.

The journey to smart manufacturing

Becoming a smart manufacturer is not something accomplished at once or even in a short timeframe. Rather, it's a journey with multiple phases (see Figure 1).



Figure 1. The journey of smart manufacturing transformation

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Level 1: Visualization. The first phase is getting some basic digitization on the shop floor. This might mean installing cameras or microphones or other kinds of sensors to start to visualize what is happening in operations (see sidebar on page 6).

Level 2: Integration. Companies then move up to the point where they can make sense of the data in an integrated way so that the upstream and the downstream parts of the process can begin working more hand in hand.

Level 3: Analysis. At this level, companies improve control over factory processes through analysis of historical data as well as descriptive analysis. Companies can understand what's happening in a factory at any given moment and manage processes more effectively.

Level 4: Predictive. Predictive analytics can unlock a great deal of value—for example, alerting companies that, at current course and speed, bottlenecks and quality problems are likely to arise.

Level 5: Prescriptive. Here, not only do technologies predict what will happen, they will also provide suggestions or prescriptions of what to do to minimize the negative impact of the event.

Level 6: Symbiotic. The final and most advanced stage is a factory that has a high level of intelligence built into the systems. Using artificial intelligence, the factory can be self-healing and self-adjusting.



Delivering value early in the journey

One factory started its journey to smart manufacturing by digitizing the white boards in its factory—boards on which were often written important data and information. With digital white boards, the company could make its key data more shareable across its value stream and start to do some basic historical analysis. The impact was fast and significant, measured in millions of dollars in terms of enabling greater productivity and increasing output capacity in the factory.

As companies progress up these levels, their capabilities become increasingly comprehensive. For example, a system at Hitachi's Omika Works automatically generates medium- to long-term production schedules that look at the entire production process (from the receipt of an order to the design, procurement, manufacture, inspection, and shipment of the product) to take into account the specifications and deadline of the product, and the production capabilities and workload of the entire facility.

As a result, production schedules are remade to conform to changes in items such as customer deadlines and the volume of orders, and estimating the deadlines of orders before they are received is made easier. The amount of time required by production managers for planning and procurement can be drastically reduced, and inventory assets can be scaled down by reducing loss costs and work-in-progress inventories.

Accelerating your journey

Where are manufacturers most likely to stumble on this journey to smart manufacturing and what can they do to increase their chances of success?

For those companies at the early stages of the journey, one of the biggest barriers to getting started is looking beyond the immediate demands of the day. Management at many factories knows that they are operating at a low maturity level, but are so busy fighting fires and just trying to keep things running, that they put off the initial task of beginning to transform.

At later stages of the journey come the challenges of greater system complexity as a company expands its data set and connects more and more IoT devices. An important insight here is to structure the transformation such that you unlock value at each level and can point to a very clear ROI at each phase. Look for quick wins: savings on the bottom line or productivity improvements, or evidence that you've stopped a chronic quality problem from occurring. You don't want people to get disillusioned with the journey. One way to prevent that is to fuel the enthusiasm by communicating real gains, letting people see progress along the way.

Your people are a critical success factor along the journey and should be helped and supported at each step. A big culture change lies ahead for companies moving toward smart manufacturing, in part because people in a factory are not necessarily used to innovating—to experimenting, trying things out and then failing quickly so that lessons can be applied to the next cycle of innovation. By directly targeting resistance with effective change management programs, a smart manufacturing initiative will have a higher chance of success.

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