BPTrends COLUMN

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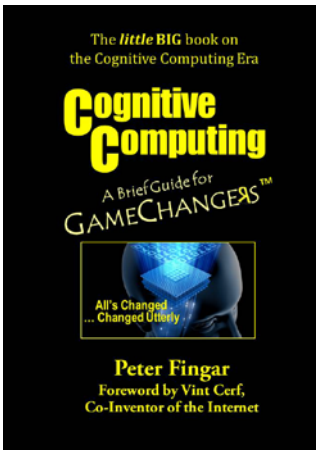
Extreme Competition Peter Fingar

The Fourth Industrial Revolution

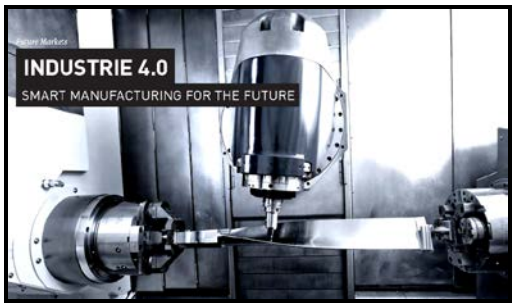
Manufacturing processes have matured significantly since the early days of steam engines, now referred to as the first industrial revolution. Next came the days of Henry Ford's assembly line, and the mass production of the Model T at volumes never thought possible – representing the second industrial revolution. In the 1970s, computers revolutionized the workplace by performing calculations and tracking measurements and processes that were simply unimaginable 100 years ago. Clearly, computers and technology have continued to transform production processes. But now the 4th Industrial Revolution is upon us, representing a giant leap for manufacturing innovation, characterized by "smart devices" that can actually take control of machines on the shop floor by communicating autonomously "device-to-device" to manage manufacturing operations and distribution.

Let's explore using excerpts from ...



http://www.mkpress.com/cc

Industrie 4.0 is a project in the high-tech strategy of the German government, which promotes the computerization of traditional industries such as manufacturing. The goal is the intelligent factory (Smart Factory), which is characterized by adaptability, resource efficiency and ergonomics as well as the integration of customers and business partners in business and value processes. The technological basis is centered on cyber-physical systems and the Internet of Things. Experts believe that Industrie 4.0 or the "fourth industrial revolution" could be a reality in about 10 to 20 years.



Read: http://tinyurl.com/k24q6xw Watch: http://tinyurl.com/krvjn8q

A pan-Europe group has also been formed, Horizon 2020.

http://bit.ly/Jb3s6J

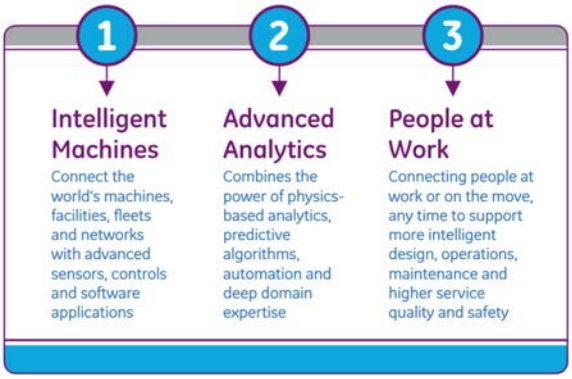
Meanwhile, in the United States, the federal government has established the National Network for Manufacturing Innovation (NNMI) and other federal technology initiatives designed to strengthen the connection between U.S. manufacturing and the nation's success in inventing, innovating, producing, competing, and, ultimately, building future prosperity.

http://1.usa.gov/1xt0gK9

Another initiative known as the Smart Manufacturing Leadership Coalition (SMLC) is also working on the future of manufacturing. SMLC is a non-profit organization of manufacturing practitioners, suppliers, and technology companies; manufacturing consortia; universities; government agencies and laboratories. The aim of this coalition is to enable stakeholders in the manufacturing industry to form collaborative R & D, implementation and advocacy groups for development of the approaches, standards, platforms and shared infrastructure that facilitate the broad adoption of manufacturing intelligence.

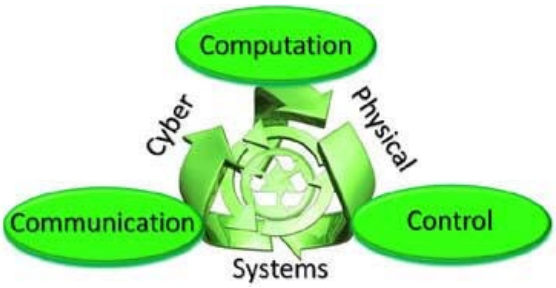
www.smartmanufacturingcoalition.org

Similarly, GE has been working on an initiative called "The Industrial Internet." The Industrial Internet Consortium was founded in 2014 by GE, IBM, AT&T, Intel and Cisco. The Industrial Internet aims to bring together the advances of two transformative revolutions: the myriad machines, facilities, fleets and networks that arose from the Industrial Revolution, and the more recent powerful advances in computing, information and communication systems brought to the fore by the Internet Revolution. According to GE, these developments bring together three elements that embody the essence of the Industrial Internet:



Source: GE's Industrial Internet: *Pushing the Boundaries of Minds and Machines*
http://tinyurl.com/dxu3at8

Smart self-organizing factories and supply chains are driven by *cyber-physical systems*. Despite their invisibility, embedded systems have a big role: they bring intelligence to objects, devices and other artifacts. With the emergence of high speed broadband and the Internet of Things (IoT), the embedded world is meeting the Internet world and the physical world is meeting the cyber world. In the future world of cyber physical systems, a huge number of devices connected to the physical world will be able to exchange data with each other, access Web services, and interact with people.



The Industrial Internet will dramatically improve productivity and efficiencies in the production process and throughout the supply chain. Processes will govern themselves, with intelligent machines and devices that can take corrective action to avoid unscheduled breakdowns of machinery. Individual parts will be automatically replenished based on real time data. Every handheld digital device in the factory will report the status of every fixed device, giving personnel mobile access to real-time, actionable information. Wearable sensors will track the location of each employee in the factory, in case of emergency.

industrial internet CONSORTIUM

www.iiconsortium.org/

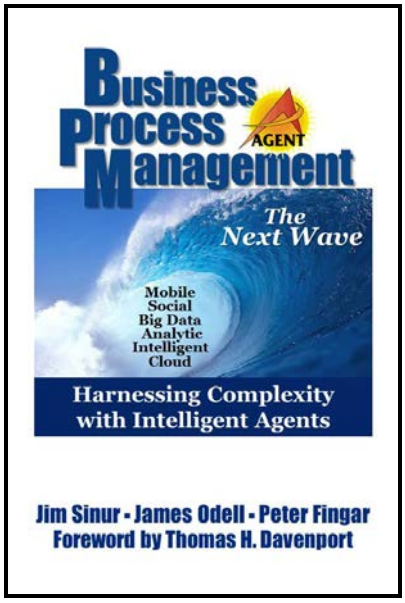
New steering instruments will interlink millions of things to ensure that everything runs as planned across the entire value chain. Changes in one part of the chain automatically trigger adjustments on the factory floor.

Customization will be automatic. Raw materials will be programmed with information that it will be part of product X, to be delivered to customer Y. Once the material is in the factory, the material itself records any deviations from the standard process, determines when it's "done," and knows how to get it to its customer.

At the warehouse level, the bright-orange Kiva robot is a boon to fledgling e-commerce companies. Created and sold by Kiva Systems, a startup that was founded in 2002 and bought by Amazon for $775 million in 2012, the robots are designed to scurry across large warehouses, fetching racks of ordered goods and delivering the products to humans who package the orders. A warehouse equipped with Kiva robots can handle up to four times as many orders as a similar unautomated warehouse, where workers might spend as much as 70 percent of their time walking about to retrieve goods. Coincidentally or not, Amazon bought Kiva soon after a press report revealed that workers at one of the retailer's giant warehouses often walked more than 10 miles a day. [i]

Painting Trucks at General Motors

The opening of this Column mentioned "smart devices" that can actually take control of machines on the shop floor by communicating autonomously "device-to-device" to manage manufacturing operations and distribution. Let's take a peek with this excerpt from ...



http://www.mkpress.com/aobpm

Traditionally, assembly line schedules are centrally developed and controlled. Any change in the schedule must be centrally reconfigured. When the line is small and has few unplanned stoppages, centrally controlled schedules work well. However, scheduling for most real-world assembly lines can be a nightmare: work stations break down, personnel get sick, environmental conditions are not always within acceptable limits, products coming down the line have or acquire unexpected defects, and so on.

Dick Morley, a technology visionary and the father of the programmable controller, swept away old assembly line schedules and developed a better system for painting trucks at GM's trucks in Fort Wayne, Indiana. "How do I schedule the non-

schedulable?" Morley wondered. "Trucks do not come down the line in order of their color and frequently no paint booth is available with the correct color." Morley also discovered that many of the paint booths were typically broken down or being repaired.

In his technique, the scheduling program interacts with each paint booth. Instead of assigning unpainted trucks to booths, GM's solution was to have the booths bid on the paint jobs. To accomplish this, each booth was equipped with a simple software agent that was programmed to keep its booth busy and bid on each paint job. The amount of the booth's bid was based on how busy the booth was at the moment of bidding, whether it had to change to a different paint, and whether the booth was functioning properly.

To coordinate the bids for each paint job, a scheduler agent acts as a broker. For example, when a truck arrives to be painted, the scheduler agent tells the booths, "I have a truck that needs to be painted red. A vacant paint booth already loaded with red paint will bid very high. However, a vacant booth with different color would bid lower because of the extra labor and time to clean and reload the paint gun. A booth that has just started to paint a truck, broken down, or otherwise less suited for the job, would bid even lower. Based on the outcome of the bidding activity, the scheduler assigns the truck to the highest-bidding paint booth.

In a top-down planned "push-through" world, if one booth malfunctioned, a centrally controlled system would re-compute its entire remaining schedule. With bottom-up "pull-through" paint booth agents, other booths would be ready to pick up the slack at a moment's notice by bidding for the job. This new design saved a million dollars in nine months and reduced the lines of computer code from hundreds to four.

Dick Morley and GM tackled a problem where centralized scheduling did not work efficiently by adopting an agent-based approach where each booth acts on its own behalf using a market-based bidding system. Even though the scheduler was a centralized element, it deferred to distributed booth agents. Agent-based solutions do not remove centralization; instead, they try to balance it with distributed solutions *wherever it makes sense*. (Note: this approach is now a standard way of handling assembly lines at Daimler Benz and other German automakers.)

I hope you enjoyed this glimpse into what the fourth industrial revolution might have in store for us. We'll continue to explore what the impact might be of this force, so look out for future posts at http://www.cognitivetrends.com on how this revolution might specifically impact manufacturing operations management processes. And, don't forget, manufacturing processes are just one part of the overall world of business processes and business process management.

Author

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Peter Fingar, independent analyst, internationally acclaimed author, management advisor, former college professor and CIO, has been providing leadership at the intersection of business and technology for over 40 years. Peter is widely known for helping to launch business process management (BPM) with his book, *Business Process Management: The Third Wave.* He has taught graduate and undergraduate computing studies in the U.S. and abroad, and held management, technical, consulting and advisory positions with GTE Data Services, American Software and Computer Services, Saudi Aramco, EC Cubed (for clients including GE TPN, American Express, Master Card and GE Capital), Noor Advanced Technologies, the University of Tampa, the Technical Resource Connection division of Perot Systems and IBM Global Services. He is a sought-after keynote speaker and his latest of 15 books include *Business Process Management: The Next Wave,* which is about the use of distributed intelligence in business and *Smart Process Apps: The Next Breakout Business Advantage*. http://www.peterfingar.com peter@peterfingar.com

[i] http://bit.ly/1cb2sqn