

R&D Solutions for Chemicals

WHITE PAPER

Industry 4.0: Top Challenges for Chemical Manufacturing



Introduction

Industry 4.0 is transforming chemical manufacturing. Companies are adapting to the digital world, recognizing the power of “connection” among products, production equipment and personnel. But transformation entails challenges. Some are specific to organizations, depending on where they are with regard to technology, operations and resources. Others, such as meeting standards and implementing best practices, are challenges that confront all companies, and are key to maximizing partnerships and collaborations.

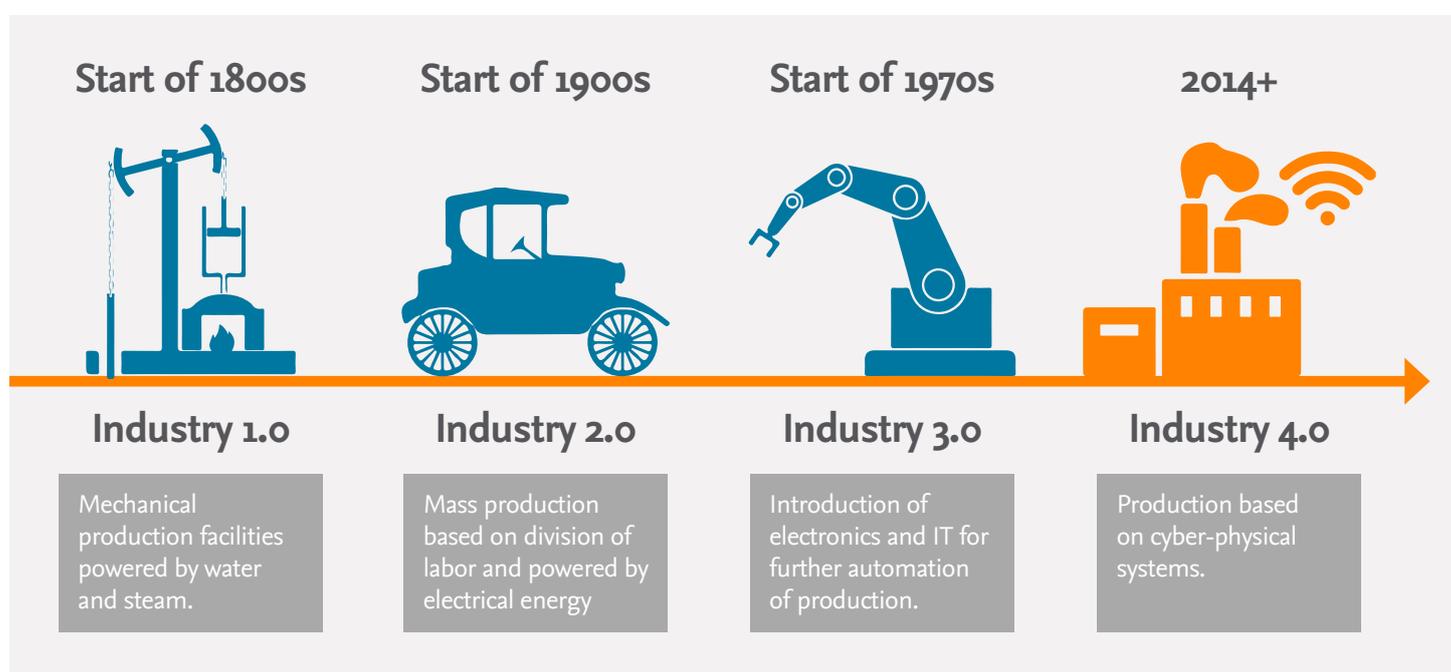


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Summary

Within the past couple of years, the manufacturing world has catapulted into “Industry 4.0.” Industry 2.0 was about focusing on mass production and improving processes through tools such as Six Sigma. Industry 3.0 drove automation and the push to centralize data across departments within a company to make product development more efficient, improve quality and reduce costs.



Also referred to as “the fourth industrial revolution,” Industry 4.0 involves combining both physical and digital technologies to streamline business operations and promote growth. Driven largely by the advent of “smart” factories, underpinned by the Internet of Things (IoT), Industry 4.0 describes the movement by manufacturers to not only connect up all parts of their organization, but also to reach out and connect globally with suppliers, customers and new partners—especially technology firms. It is arguably the most transformative era yet for chemical manufacturing.

A recent report, Industry 4.0 at McKinsey’s Model Factories, describes the new era as “a confluence of disruptive digital technologies that are set to change the manufacturing sector beyond recognition: driven by the astonishing rise in data volumes, computational power, and connectivity; by the emergence of advanced analytics and business intelligence capabilities; by new forms of human-machine interaction, such as touch interfaces and augmented-reality systems; by improvements in the transfer of digital instructions to the physical world, such as in advanced robotics and 3-D printing.”

Exciting, but also potentially overwhelming. What does it mean specifically for chemical manufacturing? Where do organizations who want to keep pace begin to focus their efforts?

This white paper presents three major 4.0 challenges that chemical manufacturers need to address right now to stay competitive.



Internet of Things (IoT)

Simply put, the IoT—also referred to as the “Internet of everything”—involves the use of technology to connect people, processes, assets and products in both the physical and digital worlds.

In 2012, the Global Standards Initiative on the Internet of Things defined it more officially as “a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.”

According to the IoT Institute, by 2020, 30 billion devices will be connected globally. “These connected objects will automate processes, find and self-correct problems, and record and send data to central servers,” where it can be analyzed to modify and improve both products and processes.

The IoT is driving Industry 4.0 innovations. This includes “smart” products, with sensors and RFID tags embedded in packaging, which are being used to create integrated supply chains, enabling product tracking, tracing and authentication. Some chemical manufacturers have begun to use embedded sensors to enable predictive maintenance, whereby machines send signals if something is about to go awry.

The early adoption of these innovations should make the prospect of increasing such connectedness exponentially—e.g., developing “smart” factories and initiating other production and operational enhancements—less daunting.

As a major player in almost every manufactured product, with more than 20 million people employed and annual sales of \$5 trillion, the chemicals industry is the “backbone” of many other industries, and so changes there are likely to have a “ripple effect,” according to a recent Deloitte report. Overall, widespread adoption of Industry 4.0 concepts and technologies will promote strategic growth, build efficiency and reduce waste across all stakeholders, including customers and suppliers.

“Industry 4.0 is fundamentally an all-encompassing ‘no silos’ way of doing business,” said Christina Valimaki, Senior Director, Chemicals Industry at Elsevier. “Chemical manufacturing is in an ideal position to lead the way in connectivity and integration, bringing everyone and everything it touches—both within organizations and globally—along with it.”

“Data is not useful unless it is processed in a way that provides context and meaning that can be understood by the right personnel.”

—Experts at the NSF Industry/University Cooperative Research Center

Actionable data

Industry 4.0's reliance on the IoT essentially means that every single component of a chemical manufacturing organization—equipment, products and personnel—will be spewing forth huge amounts of data. Storage firm EMC predicts that by 2020, more than 44 zettabytes of data will be created by seven billion people with multiple devices connected to the Internet.

A sizeable portion of that data is being amassed by manufacturers and will need to be converted into actionable information. That means the data must be properly acquired, stored, analyzed and shared. To accomplish this, chemical manufacturers will need to invest in integrated cloud- or cyber-based acquisition and storage platforms, advanced analytics systems, and multiple communication tools and protocols to produce secure, readily usable output—i.e., a constantly evolving knowledge base.

“Data is not useful unless it is processed in a way that provides context and

meaning that can be understood by the right personnel. Just connecting sensors to a machine or connecting a machine to another machine will not give users the insights needed to make better decisions,” say experts at the NSF Industry/University Cooperative Research Center on Intelligent Maintenance Systems at the University of Cincinnati.

To transform data into actionable information requires both the right technologies and the right people. The right technologies include systems with analytical and visualization capabilities that enable predictive manufacturing, technical problem solving, process design and hazard analysis, environmental impact mitigation as well as energy efficiency and safety.

The right people, on the one hand, are suppliers—providers of hardware, software, sensors, applications, telematics and mobile devices—who, according to the IoT Institute, are now best thought of as “strategic partners,” as the capabilities they offer are becoming part of doing business.





On the other hand, every chemical manufacturer's workforce also needs the right people. "You need people who can take a bird's eye view at the department level and pull relevant data together to inform department-level decisions," said Elsevier's Valimaki. "And you also need people who can take a global view, making informed decisions across departments and often, across entities that are collaborating on major projects. That calls for a transdisciplinary team whose members are skilled not only in their specific areas of expertise, such as operations or R&D, but also in sharing and communicating digitally-derived insights seamlessly across the organization and its partners."

"Holistic human resource management" was the term used by presenters at the 6th CIRP Conference on Learning Factories held recently in Norway. In the conference proceedings, Fabian Hecklau of the Fraunhofer Institute for Production Systems and Design Technology IPK in Berlin,

Germany stresses that "employees need to become enabled to take on more strategic, coordinating and creative activities" to cope with knowledge and competence challenges in the IoT environment.

"Simple and monotonous processes are being automated, while other processes become more complex and intertwined," they note. "The number of workspaces with a high level of complexity will increase," resulting in the need to hire people with higher level skills and/or train current employees to deal with more complicated processes, thereby ensuring retention in a shifting work environment.

Standards and best practices

The National Institute of Standards and Technology (NIST) refers to IoT-enabled manufacturing as “smart manufacturing systems (SMS),” characterized by digitization to enhance interoperability and productivity; use of connected devices and distributed intelligence; collaborative and rapidly responsive supply chain management; integrated decision making for energy and resource efficiency; and, as highlighted in this white paper, advanced sensors and big data analytics throughout.

Standards—the building blocks that enable repeatable processes—will maximize the possibilities of Industry 4.0 across the chemical manufacturing sector. But we’re not there yet. NIST has devoted an entire publication to the Current Standards Landscape for Smart Manufacturing Systems. In it, the Institute notes that existing standards provide instructions for designers, engineers, builders, operators and decision makers within their own domains (i.e., silos), only occasionally facilitating much-needed communication among stakeholders across domains.

The sheer volume of regional, national and international standards for manufacturing is mind-boggling. Echoing NIST, a recent review published in *Advanced Engineering Informatics* noted, “Equipment, suppliers, factories, production lines, products and customers are integrated under Industry 4.0. Therefore, there are specific standards

for all players.” The authors show an Industry 4.0 standard structure that includes “basic common standards” (e.g., security, detection and evaluation) and “key technology” standards (e.g., smart factory, industrial software and big data)—10 categories in all, likely with multiple standards within each.

Standards bodies such as the ISO and IEC have joined together to form a working group for the IoT. NIST has created a Smart Manufacturing Systems Design and Analysis Program to “deliver measurement science, standards and protocols, and tools needed to design and analyze SMS...”

Various consortia and open-source organizations also are developing standards and best practices for SMS, as are professional societies and trade groups.

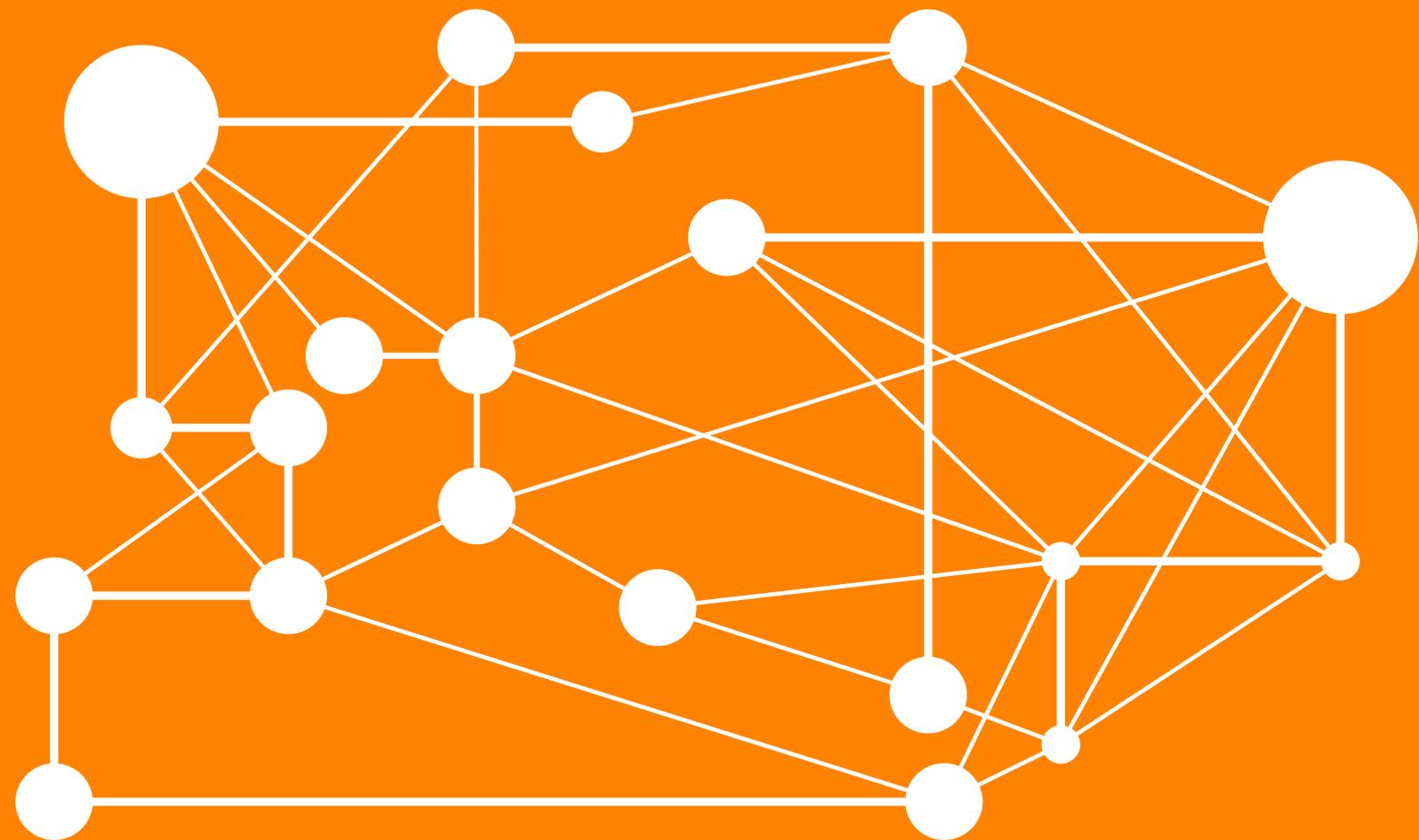
Just as embedding machines with sensors won’t ensure decision making, the existence of all these standards doesn’t ensure adoption, especially given their diversity. Standards harmonization is key to implementation, yet some experts predict it will take at least another decade to create Industry 4.0-specific standards. Meanwhile, to help ensure quality control and security, each partner in a chemical manufacturing endeavor needs to ensure that standards relevant to their particular domains are met.





Conclusion

The challenges presented here can also be viewed as opportunities—to grow, connect, streamline and build your chemical manufacturing value chain. This white paper is intended to raise awareness of some of the key components of Industry 4.0 so that chemical manufacturers can take stock of their current status and create a strategy to move forward. Our next white paper provides a look at pilot projects and evidence-based examples of what some companies are doing to take advantage of Industry 4.0 opportunities, and to survive and thrive in coming years.



R&D Solutions for Chemicals

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