

# Manufacturing and the Cloud

## MANUFACTURING IS AT THE HEART OF WHAT'S DRIVING WORLD ECONOMIES.

The field has progressed through various evolutions, driven mainly by innovations that increase efficiencies while reducing both cost and time of delivery. People take different views about how manufacturing has evolved. But here, I would like to look at the evolution this way:

- industrialization, where machines supported human work;
- optimization, where assembly lines increased productivity;
- automation, where machines largely replaced humans; and now
- digitalization, where information technology with its broad portfolio becomes an integral part of manufacturing.

This most recent evolution, digitization, is often referred to as Industry 4.0, and is where data, cloud computing, and Internet of Things (IoT)—also more generically known as cyberphysical systems (CPSs)

in some communities—become integral components in manufacturing. As in all previous manufacturing evolutions, the goals here include increasing efficiencies and productivity, reducing total cost of manufacturing, and improving the equipment life-cycle. The European Factories of the Future Research Association published an interesting report on factories of the future, which was published under the European Commission Horizon 2020 Programme—one of the biggest European research and innovations programs.<sup>1</sup>

Reaching the full vision set for Industry 4.0 will be a long journey and might not be easy because there are a number of technology, business, and possibly cultural challenges that require more innovations from us all. We need to establish data-driven business models; we need to further optimize manufacturing processes and extend them beyond corporate boundaries; we might need to incorporate prosumers and social media; and much more. But one of the most important requirements is to recruit highly skilled workers who will be able to fully immerse themselves in the new trends in both technology and manufacturing. That is easier said than done as we all need to work together to close such a skills gap through education, training, and open minds.

Cloud computing can play, and is playing, a big role in the evolution of manufacturing to Industry 4.0. For example, clouds are becoming the de facto hosting platforms for manufacturing data and software stacks, including applications, middleware, and manageability. Note that manageability includes full visibility into everything that takes place on a manufacturing floor, all security tooling for applications and data, and all dashboards.

Benefits of deploying cloud computing in manufacturing include, but aren't limited to:

- Manufacturers can rely more on standard cloud services, allowing them to focus on business-critical functions.
- It reduces capital expenses of a manufacturer's hardware/software.
- It relieves manufacturers from having to license, deploy, and maintain services like email, collaboration, unified communication, and human relations because these standard services can be delivered from a cloud.

MAZIN YOUSIF

T-Systems International  
mazin@computer.org



- It allows manufacturers to pilot and start quickly when relying on cloud-based solutions.
- Manufacturers can enjoy operational flexibility, making it easier to scale up or down as demand changes.
- It allows manufacturers to bring virtualization and automation associated with cloud computing to their private datacenters.
- It reduces IT management costs.

Consider the following scenarios where cloud computing can play a big role. A manufacturer can establish a cloud-based hub for supply chain collaboration and information sharing across all its partners, providing the usual business processes such as catalogues, orders, production, and invoices. This is useful especially when manufacturing deals with many trading partners and prosumers on the supply and demand sides. It not only establishes a single source of trust across all partners, but can also improve end-user experience such as order tracking. A second example is when a manufacturer wants to deploy an IoT solution for preventive maintenance, collecting all types of data about its equipment, storing the data in the cloud, and running analytics, also in the cloud, to predict when equipment might break.

As expected, the columns and departments in this issue focus on the role of cloud computing in the manufacturing industry.

In “Cloud Economics,” Joe Weinman addresses the economics and strategy of manufacturing and the cloud. He cites examples of specific manufacturing topics when we bring manufacturing and cloud together. David Linthicum presents the case for mixing cloud and manufacturing in “Cloud Tidbits.” In “Cloud and the Law,” Christian Esposito, Aniello Castiglione, Ben Martini, and Kim-Kwang Raymond Choo look at security, privacy, and forensic concerns when mixing cloud and manufacturing. In “Blue Skies,” Dimitrios Georgakopoulos, Prem Prakash Jayaraman, Maria Fazia, Massimo Villari, and Rajiv Ranjan put together a roadmap for manufacturing and the role of the Internet of Things and edge cloud computing.

In “Standards Now,” Alan Sill extends consideration of this topic to include cloud, data, and business process standards and their role in smart manufacturing.

**AS ALWAYS, I URGE READERS TO GIVE US FEEDBACK ABOUT THE QUALITY OF THESE AND PREVIOUS COLUMNS.** Please send email to me at [mazin@computer.org](mailto:mazin@computer.org). ●●●

#### Reference

1. European Factories of the Future Research Association, *Factories of the Future*, EFFRA, 2013; [www.effra.eu/attachments/article/129/Factories%20of%20the%20Future%202020%20Roadmap.pdf](http://www.effra.eu/attachments/article/129/Factories%20of%20the%20Future%202020%20Roadmap.pdf).

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**MAZIN YOUSIF** is the editor in chief of IEEE Cloud Computing. He's the chief technology officer and vice president of architecture for the Royal Dutch Shell Global account at T-Systems International. Youisif has a PhD in computer engineering from Pennsylvania State University. Contact him at [mazin@computer.org](mailto:mazin@computer.org).

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