Chapter 8
Towards an Industry 4.0–Based Maintenance Approach in the Manufacturing Processes

J. Roberto Reyes García
University of Twente, The Netherlands

Alberto Martinetti
University of Twente, The Netherlands

Juan M. Jauregui Becker
University of Twente, The Netherlands

Sarbjeet Singh
Luleå University of Technology, Sweden

Leo A. M. van Dongen
University of Twente, The Netherlands

ABSTRACT

Maintenance is one of the key application areas of Industry 4.0. Every day, maintenance managers and technicians face the challenge of ensuring maximum machine reliability and availability, while minimizing the utilization of materials consumed by maintenance and repairs. As productivity is pressured to further improve, finding a successful balance between these aspects is becoming increasingly difficult. Therefore, integrating condition-monitoring systems with predictive and prescriptive maintenance principles, a new Industry 4.0-based maintenance can be obtained that enables maintenance engineers to better deal with this challenge. In this context, Maintenance 4.0 expands existing maintenance functions by the integration of Industry 4.0 technologies, like internet of things, cyber physical systems, augmented reality, and 3D printing. This chapter presents the main maintenance areas that are supported and enabled by Industry 4.0 technologies and introduces an Industry 4.0-based predictive maintenance approach for the manufacturing industry.

INDUSTRY 4.0 AND MAINTENANCE

The term Industry 4.0 (I4.0) refers to a new technological vision on how management of manufacturing and production processes can be redefined through the implementation of advanced information technologies, robotics and monitoring devices (Kagermann, Wahlster, & Helbig, 2013) (Deloitte AG, 2015) (Gottorp Jeppesen, 2015). The "4.0" designation suggests that the world is now facing the fourth industrial revolution.

Figure 1 illustrates the transformation of manufacturing industry through the four industrial revolutions moments.

The First Industrial Revolution ran from 1760 to 1840; it was driven by the introduction of mechanical production facilities with the help of water and steam power to replace manual labor. It includes the adoption of structured chemical manufacturing and iron production processes. In general terms, it can be summarized as the rise of factory systems.

The Second Industrial Revolution, also known as the Technological Revolution, ran from 1870 to 1914 and was driven by the introduction of the division of labor and mass production with the help of electrical power. The factory systems were developed to allow mass production through assembly lines. This booming period was characterized by inventions that radically changed the life style: telegraph and telephone, typewriter, lightbulb, high voltage electric current, first car, first plane and compressed-air brake.

The Third Industrial Revolution, known as the Digital Revolution, started in the 1960's and marked the change from analogue and mechanical technology to digital technology that further automates production.

Programmable Logic Controller (PLC) is universally considered the main expression of this radical change in production manufacturing. It enabled to automate several processes reducing the human involvement.

Finally, the Fourth Industrial revolution started in 2010 and is based on Cyber-Physical Systems (CPS) and the use of the internet to create networks in the production environment and bring services to the customers and the organizations themselves (Kagermann, Wahlster, & Helbig, 2013) (Deloitte

Figure 1. Industrial revolutions' timeline
Source: *Gottorp Jeppesen, 2015*
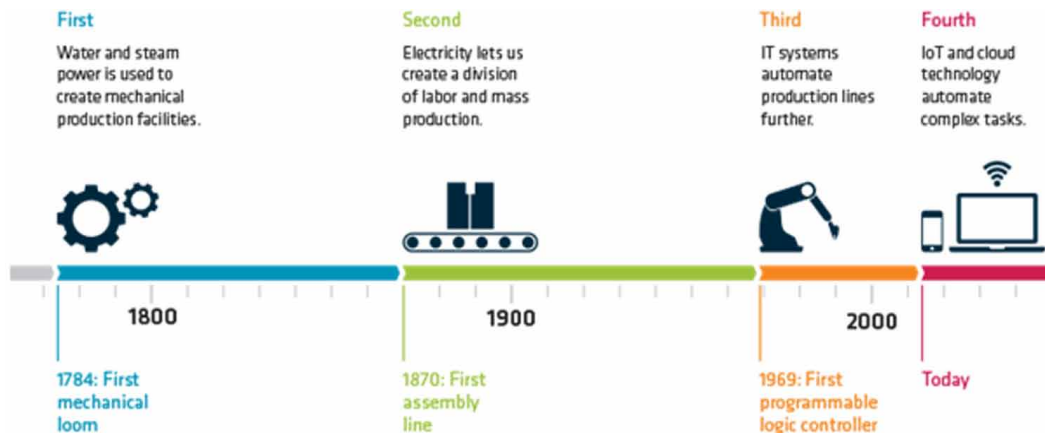
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