

Chapter 36

Role of Additive Manufacturing in Industry 4.0 for Maintenance Engineering

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ABSTRACT

The chapter describes the role of additive manufacturing (AM) in Industry 4.0 (I4.0) for maintenance engineering. A brief introduction of the fourth industrial revolution and related technologies has been included. The different AM processes with significant contributions in the relevant industry sectors have been discussed along with suitable examples. Difference between the manufacturing capabilities of conventional and AM technologies has also been presented. Owing to its high degree of design freedom, AM helps to reduce the spare parts inventory cost, component assembly cost, and can replace the discontinued parts easily. A case study presenting these key distinctive features of AM, which make it an indispensable technology for I4.0, are also discussed. Furthermore, the barriers to the adoption of AM technology by manufacturers and possible remedial actions are also discussed in brief. The knowledge gaps in terms of materials and design tools for AM have been identified and a probable road ahead has been discussed.

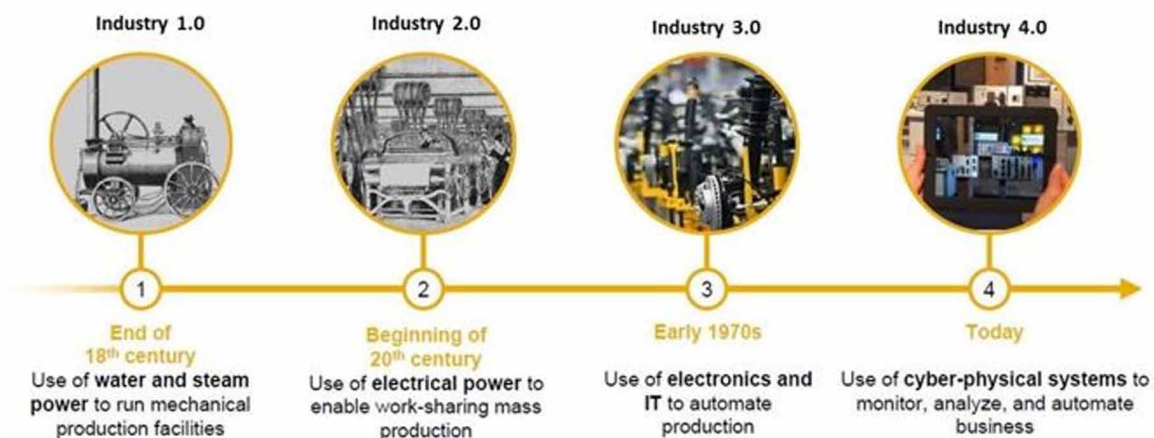
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INTRODUCTION

Mechanical production plants of the late 18th century, based on water and steam power, marked the era of the first industrial revolution, now known as Industry 1.0. The advent of the 20th century was marked by ever more present electricity and factory electrification. This paved the way for the second industrial revolution, i.e. Industry 2.0, characterized by mass labour production based on electrical energy. The third industrial revolution, also known as the Digital revolution occurred in the late 20th century. This phase of the industrial revolution, Industry 3.0, was characterized by automatic production based on electronics and internet technology (Galati & Bigliardi, 2019). In 2011 at Hannover Messe Industry Fair, Germany, a new term “*Industry 4.0*” was coined which is assumed as the fourth industrial revolution. Industry 4.0 focuses on adopting a higher level of automatization, connecting physically to the virtual world (Alcácer & Cruz-Machado, 2019).

Figure 1 presents the timeline of four different phases of the industrial revolution. Industry 4.0 is the convergence of industrial production and communication and information technologies (Hermann, Pentek, & Otto, 2016). Different researchers have given the definition of Industry 4.0 in their adaptive meanings. Shafiq et al. (Shafiq, Sanin, Toro, & Szczerbicki, 2015) identified Industry 4.0 as a “connected and continuously available resource handling scheme” by incorporating cyber-physical systems into the conventional manufacturing setups to achieve the objectives of intelligent factory characterized by resource efficiency and adaptability. (Lu, 2017) described Industry 4.0 as the “cyber-physical systems (CPS) based on heterogeneous data and knowledge integration”. (Leyh, Martin, & Schaffer, 2017) described Industry 4.0 from a production perspective as the setup in which intelligent workpiece can independently coordinate their paths through the factory and machines communicate in real-time with the respective warehouse.

Figure 1. Revolution of industry
Source: Hermann, Pentek, & Otto, 2016



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