Digital Manufacturing- Applications
Past, Current, and Future Trends
Phani Kumari Paritala\textsuperscript{a}, Shalini Manchikatla\textsuperscript{b}, Prasad KDV Yarlagadda\textsuperscript{a}\textsuperscript{*}

\textsuperscript{a} School of Chemistry, Physics and Mechanical Engineering, Queensland University of Technology, Brisbane, QLD 4001, Australia.
\textsuperscript{b} Department of Mechanical Engineering, GITAM University, Hyderabad, Telangana 502329, India.

Abstract

Increasingly the convergence of natural environment (land, water, air and life), built environment (housing, buildings, transportation and infrastructure) and digital environment (computing power, the internet, big data, and technology) is shaping the economies and societies. Smart living is taking root. Mass customization of products and services is preferred over mass production. Businesses wish to serve an individual customer at a competitive cost comparable to the mass production cost, with shortest possible development time and production time. This requires manufacturing to change from a more labour intensive processes to information technology enabled mechanical processes. Digital manufacturing is a broader concept of manufacturing innovation in which the digital and material advancements enable the company to conceive products in a desired style and quantity in time scales shorter than the conventional methods while efficiently managing the entire product lifecycle. It is about defining manufacturing processes and managing manufacturing process information via full digital product definition. It encompasses visualization, manufacturing simulation, ergonomic and human factor analyses, holistic view of product and process design, and product design sensitive to the process constraints and capabilities. This article emphasizes the need and driving forces for adopting digital manufacturing, transformation of manufacturing to smart manufacturing, present applications and future scope of digital manufacturing.

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\textsuperscript{*} Corresponding Prasad KDV Yarlagadda. Tel.: +6-173-138-5167; Fax: +6-173-138-3381.
E-mail address: y.prasad@qut.edu.au.
1. Introduction

The increase in global competitiveness, diversification of customer requirements, dynamic and unpredictable market trends; challenges the manufacturing market to integrate design, manufacturing, and product support processes in order to shorten the product development time and deal with constantly increasing complexity in products and manufacturing enterprises without compromise in quality. Information technology has also dramatically influenced the traditional industry (Lan, Ding, Hong, Huang, & Lu, 2004). In this era, quick response to the business opportunity is considered as one of the most important factors for withstanding competitiveness. Intelligent manufacturing systems such as e-manufacturing, Digital manufacturing, and Virtual manufacturing serve as a new paradigm in the manufacturing environment to refine the manufacturing business, as technology capabilities expand and business conditions change (Kim, Lee, Park, Park, & Jang, 2002). Traditional manufacturing processes designed for mass production of identical products is labor intensive and increases the development time and cost. On this backdrop, the advanced manufacturing or digital manufacturing is becoming apparent.

Digital manufacturing is an emerging area within PLM that supports collaboration across several phases of the product lifecycle which has been evolved from manufacturing initiatives such as design for manufacturability, computer integrated manufacturing, flexible manufacturing, lean manufacturing etc. (Jovanovic & Hartman, 2013). The digital technology is breaching the walls of manufacturing due to the recent developments in areas such as artificial intelligence, 3D printing, human-machine interaction, automation and robotics along with an explosion in data and new computing capabilities. The disruptive and productive impacts of digital on the operations of organizations such as IT, telecommunications, manufacturing, entertainment, media, and publishing etc. are materialized (Hartmann, King, & Narayanan, 2015).

Additive manufacturing (AM) a 3D printing technology that creates parts through the addition of materials have transformed the engineering and manufacturing industries from mass production of identical products to low-volume production of innovative, customized, and sustainable products. The unique capabilities of AM processes to produce intricate shapes with multi-material properties and complex architectures has found its applications in various areas like automotive aerospace, defense, medical, consumer products, architecture, food etc. The purpose of this article is to discuss the driving forces for transformation to digital and the development of manufacturing to smart manufacturing. Applications of AM processes, conclusions regarding the present perspectives and future of digital manufacturing are further discussed.

2. Conventional and Digital Manufacturing

The conventional method is an in-line process in which the product is designed and the drawings are forwarded to shop floor for manufacturing the prototype. While digital technology is a cyclic process in which the product is designed conceptually and innovated in computer-aided design software. These designs and the processes are simulated for checking the feasibility of manufacturing the product. The product is inspected at every stage of the manufacturing process by the inspection techniques and tested by computer aided quality control methods. The supply chain management is also digitized for effective inventory and producing customized products. Marketing of the product is done by using the social media for improving the profitability. Figure 1 shows the conventional and digital manufacturing processes.

3. Driving forces

The manufacturers are burdened with outdated production facilities to meet the market demands which reduce the adaptability to market conditions. In this ever-changing economy, companies realized the importance of accepting new technologies for overcoming the barriers. The driving forces for adapting digital
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