We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900
Open access books available

185,000
International authors and editors

200M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Chapter 1

Introductory Chapter: Product Lifecycle Management - Terminology

Razvan Udroiu and Paul Bere

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.81686

1. Introduction

The enterprise business information technology (IT) domains include four main management approaches [1, 2]: **product lifecycle management** (PLM), **enterprise resource planning** (ERP), **customer relationship management** (CRM), and **supply chain management** (SCM). The ERP goal is achieving the best enterprise resource utilization. This system enables companies to plan their manufacturing processes and control all aspects of manufacturing including inventory, purchasing, process planning, warehousing and delivery, human resources, finance, etc. SCM system is focused on the supply chain, having the main goals the design, planning, execution, control, and monitoring of all aspects related to storage and distribution. Customer relationship management (CRM) is an approach to manage a company's interaction with current and potential customers [3].

PLM is a business strategy for managing the entire life cycle of products. This strategy includes the management of conception, design, design validation and simulation, prototyping, manufacturing, quality control, use, maintenance, and disposal of products, having integrated people, methods, CAx (computer-aided technologies) tools, processes, documentation, and data management solutions. PLM is a digital paradigm, products being managed with digital computers, digital information, and digital communication [4]. The main benefits of a PLM system implementation in companies are faster time to market, improved productivity and collaboration, better product quality, decreased cost of new product introduction, reduced prototyping costs, improved design review and approval processes, identify potential sale opportunities and revenue contributions, maximize supply chain collaboration, and reduce environmental impacts at the end of product life.

IntechOpen

© 2018 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. CC BY

2. Products diversity

Standard living increase of the population has led to the development of new materials and unique services. Those services were hard to be guessed in the past. The diversity of the products is different from one domain to another. All this requires a rigorous planning on waste and resource management in order to obtain some products or to recycle them after end life. The arising problems caused by technological development have begun to affect the life of our planet. This fact has led to the emergence of management measures and decision-making on emerging issues related to the use of this kind of materials, resources, environmental pollutions, and recycling of end-life products.

The world's increasing production has led to the use of special materials [5, 6] as composite materials and smart materials. These have been created and adopted to solve a number of industry production problems, to replace the traditional materials used for manufacturing process of the products. These were created to improve physical and mechanical properties and were developed to solve the production industry problems.

There are different kinds of products on the market. There are different approaches in the word regarding the classification of the products in the world. An approach can be made following their complexity. We can say that there are simple products, or complex ones, which are assembled by another product. From the point of view of materials which is embedded in products, we can say that some products are from a single material, from two, or from many constituents. From the recycling point of view, at the end of the products' life, the products which are made by a single material are easier to be managed. Unfortunately, these products represent a small percentage of the diversity of existing products. Today the materials' constituents are very vast, and the constituents of the products are composed of many chemical substances. These are combined in order to achieve, at the end, a material with custom properties for certain products.

Another type of the products is represented by a large used, a **product in great demand**. These types represented in generally the goods, which integrate more options to use. The beneficiaries of them have the possibility to have more devices integrate in a single one. From PLM point of view, each of the extra options is traded like single one, and all are integrated in a single one. An example of this can be the smartphones or smarts TVs. Each of them is designed for a specific function, to communicate or to watch and get some information. At the same time, we benefit from clock, internet access, calendar, games, and many programs that help us. Also, it is observed in an abundance of mechatronic products on the market. These products contain mechanical, electrical, electronic, and software components.

Another type of the products is represented by **customized goods**. These are customized for each individual customer. They must meet certain specific personalized requirements. In general for these types of products, the cost price is higher, manufacturing time is increasing, and life cycle is bigger.

Nowadays, the life of the products has been getting shorter. This is due to technological progress and the requirements of today's demanding market. The life of the products decreases because new products appeared and those have replaced the old ones quickly.

Passing on to the **complex products** that include a large variety of materials, from PLM point of view, the situation is more complicated. The recycling and the managing of the end life of products are a challenge. We can ask ourselves which will be the costs of a product in reality, if the recycling costs at the end life of the product are bigger than production costs.

The diversity of industrial products is a very vast domain and includes embedded materials, the products themselves, the equipment that led to their fabrication, the resources used, the auxiliary substances, and materials that contributed to the technological process.

3. Product life cycle

The product life cycle includes three main stages: **beginning of product life (BOL)**, **middle of product life (MOL),** and **end of product life (EOL)**. These stages consist of processes which create the PLM process flow.

BOL is the most complex phase of the product life cycle including conceive, design, prototyping, testing, development, production process elaboration, and manufacturing of the product.

In the second phase of the product life cycle, MOL comprises distribution/sales, product use of the final customer, maintenance, repair, and overhaul (MRO) of the product.

End of product life is the last stages of the product life cycle. This stage includes retire, disposal, and recycle of the product.

4. Product lifecycle management

According to the CIMdata Inc. [7], "Product Lifecycle Management is a strategic business approach that applies a consistent set of business solutions that support the collaborative creation, management, dissemination, and use of product definition information" [7]. Integrating people, processes, business systems, and information, PLM supports the extended enterprise [7]. The extended enterprise is a wider entity that includes the customers, the employees, the suppliers, the distributors, etc., who collaborate in the design, development, manufacturing, and delivery of a product to the end user. The PLM concept is focused on six important concepts, as follows: strategic business approach, phases of product life cycle, collaboration within the extended enterprise, unique and timed product data source and consistency, traceability, and long-term archiving [8].

Product lifecycle management for "X field" is a general term to define a type of management within a specific field of work, for a specific product. "X field" is a generic term that is related to a specific industry. Thus, different products require different process developments, resulting the following: PLM for aerospace and defense; PLM for the automotive industry; PLM for the construction industry; PLM for the consumer and retail industry; PLM for the energy, process, and utility industry; PLM for the fashion industry; PLM for the food and beverage industry; PLM for the industrial equipment industry; PLM for the life sciences industry; PLM for the marine and offshore industry; PLM for the oil and gas industry; and PLM for the telecom and electronics industry.

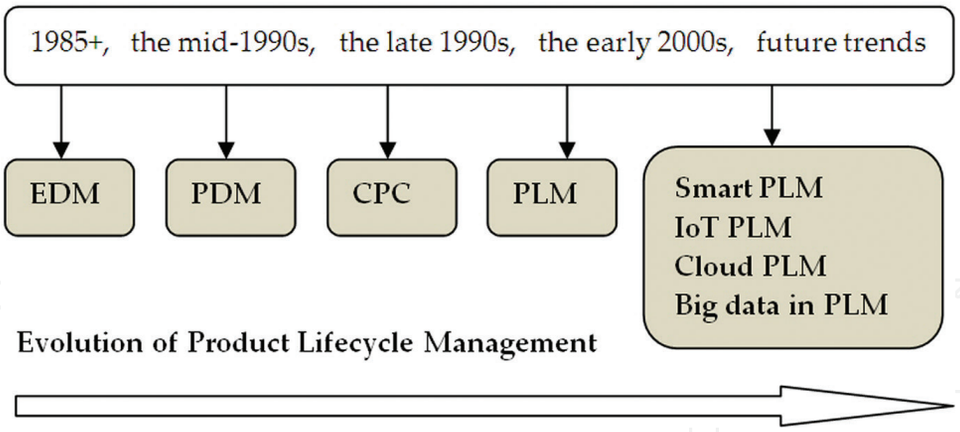


Figure 1. The evolution of the concepts related to PLM.

The evolution of the concepts related to PLM is shown in **Figure 1**. PLM concept was developed based on product data management (PDM). **Product data management** is the business function often within PLM that is focused mainly on design, manufacturing, and engineering data having the purpose of the management and publication of product data. PDM is the link between "islands of automation" such as computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM), being a PLM infrastructure. PDM system provides access and security controls, maintains relationships among product data items, enforces rules that describe and control data flows and processes, and provides notification and messaging facilities [7, 9].

The fundamental terms about PLM are shown in **Figure 2**. Processes, technologies, methods, software tools, and data managed by people are the main fundamentals of PLM that are involved in the lifecycle stages of the product.

Concurrent engineering [10, 11] or **simultaneous engineering** is an approach for product development that integrates all product lifecycle phases and carries out a number of tasks in parallel, minimizing the product development time. One of the most used methods of CE is **design for manufacture and assembly (DFMA)** that integrates two concepts such as design for manufacture (DFM) and design for assembly (DFA). DFM is a design methodology of the parts for their easy manufacturing, reducing the manufacturing costs. DFA is focused on the design of the product for easy assembly, reducing the assembly costs.

Generally, the methods can be classified as follows [12]:

- Methods supporting designers and engineers in the product development stage (e.g., theory for inventing problem-solving (TRIZ, design in context, bottom-up design, top-down design))
- Methods based on past experiences (e.g., design for X) used in BOL, MOL, and EOL
- Evaluation methods of the product responsiveness to needs coming from diverse phases (e.g., risk analysis and failure mode effects analysis (FMEA), fishbone/Ishikawa diagram)

- Management approaches supporting continuous improvement of the enterprise (e.g., just in time, lean manufacturing, six sigma, total quality management, and total productive maintenance)

CAx [4] is a generic term that includes all computer-aided technologies used to process the information and knowledge regarding the product data along the PLM stages. A CAx system is focused on a "X" task, and it contains the following main components: hardware component consisting in computer and interactive devices, software packages, data, knowledge, and human's activities [4]. The "X" task can be product design (computer-aided design) [13–17]; product manufacturing (computer-aided manufacturing) [13–17]; product simulation,

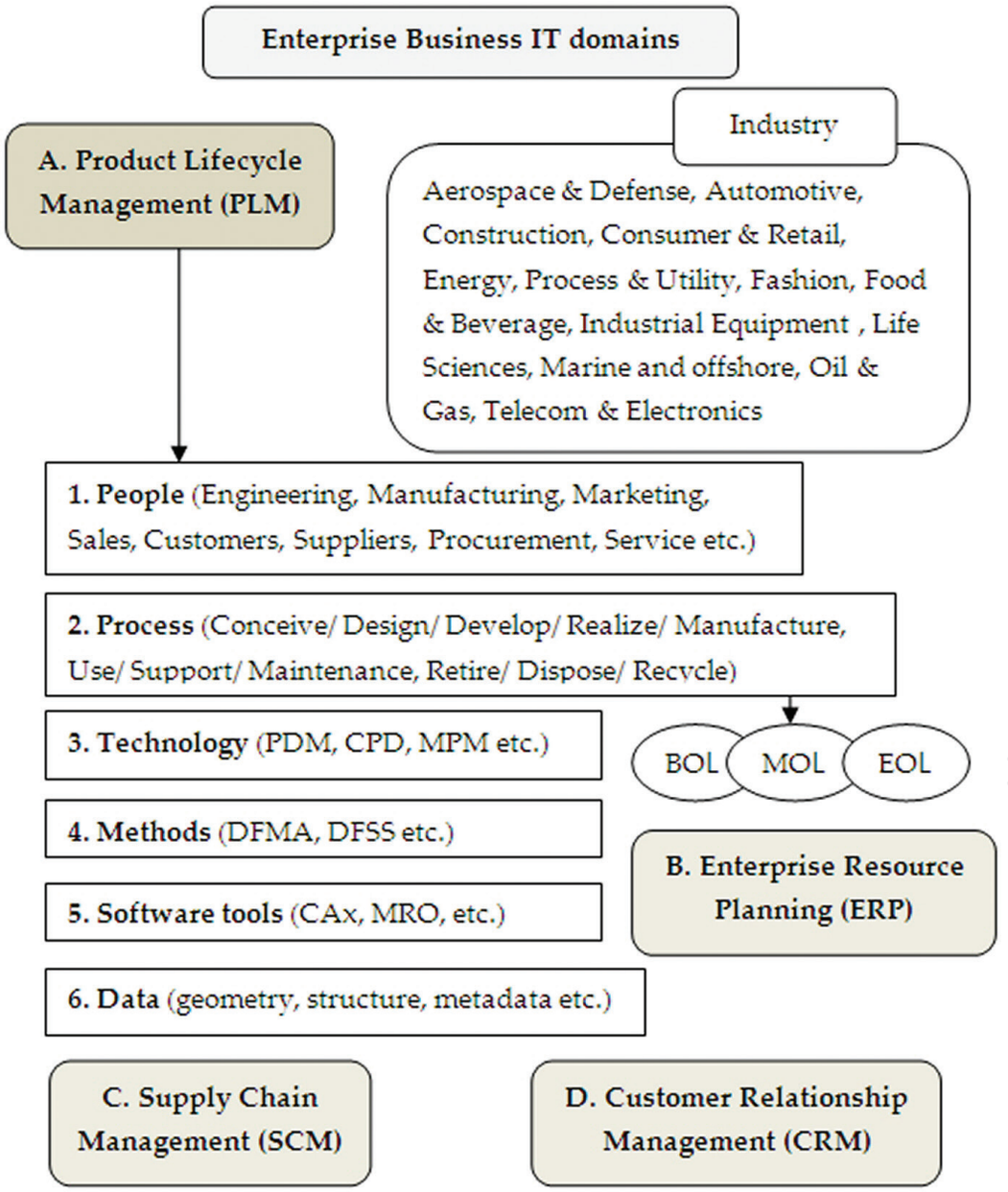


Figure 2. The fundamental terms related to PLM.

Concepts	Remarks
PLM	Product lifecycle management
ERP	Enterprise resource planning
CRM	Customer relationship management
SCM	Supply chain management
EDM	Electronic document management, enterprise data management, or engineering data management
PDM	Product data management
CPC	Collaborative product commerce
PPLM	Product and process lifecycle management
SRM	Supplier relationship management is analogous to customer relationship management
MPM	Manufacturing process management
CE	Concurrent engineering
CPD	Collaborative product development
DFMA	Design for manufacture and assembly
DFSS	Design for six sigma is a business process management method related to traditional six sigma, based on the use of statistical tools
NPD	New product development
Standards of PLM	STEP, DXF, IGES, XML, UML
Virtual enterprise (VE)	Virtual enterprise consists in "a group of people who work together on a project, communicating mainly by phone, email, and the internet, rather than regularly going to a central office to work providing operations as competitive as those in a traditional enterprise" [4, 21]
Digital mock-up (DMU)	Digital mock-up is a concept that allows the description of a product, usually in 3D, for its entire life cycle [4]
Digital manufacturing (DM)	DM links digital product development, digital production planning, and digital facility planning [22]. DM is a manufacturing process in a virtual environment working with digital features (tooling, machining, assembly lines, resources, ergonomics, and factory layout)
Digital factory (DF)	Digital factory consists in a digital mock-up of the factory

Table 1. Terms connected to PLM.

analysis, and optimization (computer-aided engineering); product process planning (computer-aided process planning, CAPP) [11, 14–17]; product quality assurance (computer-aided quality, CAQ); etc. CAE tools are available for a wide range of analyses: finite element analysis (FEA), computational fluid dynamics (CFD), kinematics and dynamic analysis of the mechanisms, etc. The numerical control (NC) of the machine tools and programming of industrial robots that perform tasks as assembly, welding, etc., are the most known applications of CAM.

Also, new technologies such as rapid prototyping (RP), additive manufacturing, and reverse engineering play an innovative role, especially in the BOL phase [18–20].

The main terminology connected to PLM is presented in the **Table 1**.

Digital factory is the foundation of the factory of the future, "a comprehensive approach of network of digital models, methods, and tools—including modeling, simulation, and 3D/virtual reality visualization—integrated by a continuous data management" [23]

New opportunities and future trends for PLM (**Table 2**) have appeared in areas such as **big data**, **smart products**, the **Internet of things**, **knowledge management**, and **SMAC** (social, mobile, analytics, cloud) [30]. **SMAC** is driving business innovation, being a concept that converges of four technologies, social media platforms, mobile technologies and platforms such as the iPhone/ iPad, data analytics, and cloud computing. Cloud computing is one of the key enablers for advanced manufacturing supporting not only storage of product data but also retrieval and reuse of product and process knowledge.

Future concepts	Remarks
Factory of the future/ smart factory	Factory of the future [4, 24] is the combination of "virtual" and "real" that "can self-optimize performance, self-adapt to and learn from new conditions in real or near-real time, and autonomously run entire production processes" [25]
Industry 4.0	Industry 4.0 [26, 27] supposes the introduction of the Internet of things and services into the manufacturing environment [4]
Cloud computing	Cloud computing store, manage, and process data, rather than a local computer by using a network of remote servers hosted on the Internet [4]
CMfg (cloud manufacturing)	Cloud manufacturing [28] uses cloud computing, the Internet of things, service-oriented technologies, and high-performance computing for solving manufacturing applications
Industrial Internet	The industrial Internet "is the integration and linking of big data, analytical tools and wireless networks with physical and industrial equipment, or otherwise applying meta-level networking functions, to distributed systems" [27]
IoT (Internet of things)	The Internet of things comprises of an intelligent interactivity, via the Internet, sensors and actuators, etc., between human and things to exchange information and knowledge
Big data in PLM	"Big data represents the information assets characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value."[29]. Big data challenges include capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating, information privacy, and data source
IoT PLM	Big data and the IoT work in conjunction. Data extracted from IoT devices provides a mapping of device interconnectivity
PLM for digital factory (PLM 4.0)	PLM system within the Industry 4.0
Cloud PLM	The applications of cloud computing in PLM
Smart PLM	PLM system for a smart factory

Table 2. Terms connected to the future PLM.

5. PLM software

On the market today, there are several software solutions for PLM implementation. The most known solutions are offered by dominant players such as **Dassault Systèmes** (ENOVIA™ PLM Software)**, Siemens** (Teamcenter PLM)**, PTC** (PTC Windchill), **SAP Systems, Applications, and Products in Data Processing** (SAP PLM), **Oracle** (Agile PLM), **Arena** (Arena PLM), and **Autodesk** (Autodesk Fusion Lifecycle). **SAP Business Suite** is a collection of integrated applications such as SAP-CRM, SAP-ERP, SAP-PLM, SAP-SRM, and SAP-SCM modules. The most important tools of these software solutions are material management, configuration and change management, design and simulation processes, product planning, project management, document management, deliver projects on time and under budget, collaboration solutions, product quality, and product certification, stocks, and sales management. These tools are increasingly used in large companies, and the offered solutions are customized for different areas of activity. Company databases offer a better management of company resources, of the customers or of suppliers of materials in a timely manner. The PLM software solution increases the companies' productivity, reduces the manufacturing time of the products, and increases the quality. Managing company databases that have workstations in different locations is one of the integrated tools of these software instruments. The companies can manage the common databases, the drawing projects, materials, existing stocks, different stages of product development, as well as the marketing and distribution part or the product phases use throughout their life cycle.

6. Conclusion

PLM systems can manage information across the life cycle of a broad range of products such as manufactured products (airplanes, automobiles, computers, mobile phones, toys, etc.), software product, utility distribution networks (telecommunications), facilities (airports, harbors, and railway systems), and other products (bridges and highways). In the future, every industrial product will be smart like smartphones. These integrated a series of requirements and needs that, besides the basic solution of the product to meet certain needs, will also have a number of facilities which are not strictly necessary but contribute to the comfort of the beneficiary. All this products' facilities not only make it more attractive but also increase its complexity. Requirements and products are increasingly diversified, all contributing to consumer welfare, as time passes.

Author details

Razvan Udroiu[1]* and Paul Bere[2]

*Address all correspondence to: udroiu.r@unitbv.ro

1 Department of Manufacturing Engineering, Transilvania University of Brasov, Brasov, Romania

2 Department of Manufacturing Engineering, Technical University of Cluj-Napoca, Cluj-Napoca, Romania

References

[1] Silva F, Araujo AH, Gamarra CJ, Leonardo J. Product lifecycle management, digital factory and virtual commissioning: Analysis of these concepts as a new tool of lean thinking. In: Proceedings of the 2015 International Conference on Industrial Engineering and Operations Management; 3-5 March 2015; Dubai, United Arab Emirates. pp. 911-915

[2] Stark J. 21st century paradigm for product realization. In: Product Lifecycle Management. Vol. 1. Switzerland: Springer; 2015. DOI: 10.1007/978-3-319-17440-2

[3] Customer Relationship Management [Internet]. 2018. Available from: https://en.wikipedia.org/wiki/Customer_relationship_management [Accessed: 28-08-2018]

[4] Udroiu R. Introductory chapter: Integration of computer-aided technologies in product lifecycle management (PLM) and human lifecycle management (HUM). In: Computer-aided Technologies. Rijeka: IntechOpen; 2016. DOI: 10.5772/66202

[5] Bere P. Materiale Compozite Polimerice (Polymeric Composite Materials). Cluj-Napoca: U.T. Press; 2012. p. 252. ISBN 978-973-662-723-1

[6] Udroiu R. Composite materials. In: Technology and Application in Aviation. Braşov: Transilvania University Press; 2006

[7] CIMdata. [Internet]. 2018. Available from: https://www.cimdata.com/en/resources/about-plm [Accessed: 29-08-2018]

[8] Corallo A. Defining product lifecycle management: A journey across features, definitions, and concepts. ISRN Industrial Engineering. 2013;**2013**:10

[9] Product Lifecycle Management. "Empowering the Future of Business", A CIMdata Report. 2002

[10] Udroiu R. Concurrent systems engineering. Academic Journal of Manufacturing Engineering. 2005;**3**(1):69-74

[11] Udroiu R. Integrated CAD/CAM system the core of concurrent engineering. Bulletin of the Transilvania University of Braşov. 2004;**11**(46):161-168

[12] Terzi S, Bouras A, Dutta D, Garetti M, Kiritsis D. Product lifecycle management—From its history to its new role. International Journal of Product Lifecycle Management. 2010;**4**:360-389. DOI: 10.1504/IJPLM.2010.036489

[13] Li Y, Hedlind M, Kjellberg T. Usability evaluation of CADCAM: State of the art. Procedia CIRP. 2015;**36**:205-210. DOI: 10.1016/j.procir.2015.01.053

[14] Chang TC, Wysk RA, Wang HP. Computer Aided Manufacturing. Upper Saddle River, New Jersey: Prentice Hall; 1998

[15] Kalpakjian S, Schmid R. Manufacturing Engineering Technology. London, New York, Tokyo, Paris: Pretince Hall International; 2001

[16] Lee K. Principles of CAD/CAM/CAE Systems. USA: Addison Wesley Longman, Inc.; 1999

[17] Groover PM, Zimmers EW Jr. CAD/CAM Computer Aided Design and Manufacturing. Englewood Cliffs, New Jersey: PTR Prentice Hall; 1984

[18] Udroiu R, Nedelcu A. Optimization of additive manufacturing processes focused on 3D printing. In: Hoque M, editor. Rapid Prototyping Technology—Principles and Functional Requirements. Rijeka: InTech; 2011. DOI: 10.5772/21433

[19] Udroiu R, Ivan NV. Rapid-X using 3D printers. Supplement of Academic Journal of Manufacturing Engineering. 2008;**2**:199-205

[20] Udroiu R. Rapid prototyping and rapid manufacturing applications at Transilvania University of Braşov. Bulletin of the Transilvania University of Brasov—Series I: Engineering Sciences. 2010;**3**(52):145-152

[21] Virtual Enterprise [Internet]. 2016. Available from: http://dictionary.cambridge.org/dictionary/english/virtual-enterprise [Accessed: 28-09-2016]

[22] Chryssolouris G, Mavrikios D, Papakostas N, Mourtzis D, Michalos G, Georgoulias K. Digital manufacturing: History, perspectives, and outlook. Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture. 2008;**223**:451-462

[23] Sacco M, Redaelli C, Cândea C, Georgescu AV. DiFac: an integrated scenario for the Digital Factory. In: Proceedings of the IEEE International Technology Management Conference (ICE); 14-17 June 2009; Leiden: IEEE; 2009. pp. 1-18

[24] Future Factory. OECD Econ Surv Irel [Internet]. 2011. pp. 8-9. Available from: http://www.oecd-ilibrary.org//economics/oecd-economic-surveys-ireland-2011/executive-summary_eco_surveys-irl-2011-2-en [Accessed: 26-09-2016]

[25] Burke R, Mussomeli A, Laaper S, Hartigan M, Sniderman B. The Smart Factory [Internet]. 2017. pp. 1-19. Available from: https://www2.deloitte.com/insights/us/en/focus/industry-4-0/smart-factory-connected-manufacturing.html [Accessed: 20-09-2018]

[26] Kagermann H, Wahlster W, Helbig J. Recommendations for Implementing the Strategic Initiative Industrie 4.0: Final Report of the Industrie 4.0 Working Group. 2013

[27] Techopedia. Industrial Internet [Internet]. Available from: https://www.techopedia.com/definition/30044/industrial-internet [Accessed: 26-09-2016]

[28] Zhang L, Luo Y, Tao F, Li BH, Ren L, Zhang X, et al. Cloud manufacturing: A new manufacturing paradigm. Enterprise Information Systems. 2014;**8**(2):167-187

[29] De Mauro A, Marco G, Michele G. A formal definition of big data based on its essential features. Library Review. 2016;**65**:122-135. DOI: 10.1108/LR-06-2015-0061

[30] SMAC (Social, Mobile, Analytics and Cloud) [Internet]. 2018. Available from: https://searchcio.techtarget.com/definition/SMAC-social-mobile-analytics-and-cloud [Accessed: 25-08-2018]