A REVIEW ON DIGITAL MANUFACTURING

A.Niharika,UGStudent,Dept.Of Mechanical Engineering ,NRI Institute of Technology,Vijayawada , AP, India
Ch.Srilatha, Associate Professor, Dept. Of Mechanical Engineering , NRI Institute of Technology,vijayawada,AP, India
J.Manikanta,UG Student, Dept. Of Mechanical Engineering, NRI Institute of Technology,AP, Vijayawada,India
B.Vivek,UG Student,Dept. Of Mechanical Engineering ,NRI Institute of Technology, Vijayawada, AP, India

Abstract

Digital manufacturing has product quality, cost, and aesthetics. In general, product companies have adopted a variety of new technologies such as Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE), Rapid Prototyping (RP), Digital Manufacturing (DM), Additive Manufacturing (AM), and others that offer business benefits by shortening the product development cycle. Digital manufcturing had increased customization,as well as cost, increased product quality, and faster response to the market.Together with the digital manufacturing and factory concepts, the technologies considered in this paper include computer-aided design, engineering,process planning and manufacturing, product data and life-cycle management, simulation and virtual reality, automation, process control, shop floor scheduling, decision support, decision making, manufacturing resource planning, enterprise resource planning, logistics, supply chain management.

Keywords:Digital Manufacturing,3D Printing,simulatio,Industry 4.0.

I. Introduction

For many manufacturers, digitization began withcomputer numerical control(CNC). These let machines and equipment run automatically, with superior levels of control to those available from relay logic systems. Then came CAD, CAM, ERP, computerized maintenance management systems (CMMS), and more. Today this patchwork quilt of disparate technologies is overlaid with lean manufacturing, six sigma, and Quality Management methodologies.Digital manufacturing is about integrating these tools, so they work together seamlessly. Product data becomes a digital thread running through the entire manufacturing business, from design and development to distribution and even servicing. Product definition links with simulation and testing, with manufacturing layout planning and machine design, ERP, Quality, and after-sales support.No two manufacturers are alike, and the same should be true for their implementation and integration of digital manufacturing technologies.

II. Literature

Vojin Vukadinovic et,at.[1]This study introduces the digital manufacturing ecosystem and its role in research on sustainable manufacturing models. The digital manufacturing provides offer requests, transforms customer needs into production and planning orders, and generates CAD models, CAM technology, and quality control plans. The ERP forms work orders, calculates workshop costs, and provides final inspections .In a serbia metalac coompany they adopted Industry 4.0 .They took three aspects like decision makers ,scientific community,industry implemented Industry 4.0
Abdulrazak F. Shahatha Al-Mashhadan et,at.[02] This paper reviews on digital manufacturing and ecosystem of digital manufacturing using the 2015 PRISMA framework. It focuses on the basics of digital manufacturing, current solutions, and the gap between the ecosystem and new models in manufacturing. The study introduces new concepts and emphasizes the importance of substainable

manufacturing processes.In the industrial sector, digital manufacturing is constantly growing, and experts are carefully examining these technical advancements one by one. In the current study, which evaluates the effectiveness of digital technologies for the industrial industry, several digital technologies are applied.

Jayanth Soragaon et,at.[03] In this they discussed about Computer-aided design (CAD) systems are essential for modern manufacturing firms due to their integration with ultra-modern techniques. Rapid prototyping is a prime example of CAD systems, while Computer-Aided Manufacturing (CAM) emerged from the evolution of CAD systems. Digital manufacturing, manufacturing processes, reduces costs and development time. Virtual Factory, a fusion-based technology, simulates the entire manufacturing process, enabling simulation and problem-solving in virtual environments. Digital manufacturing has significantly changed the way products are made, enabling designers to create sustainable goods at breakneck rates. As production procedures become more sophisticated, productivity increases, cost reductions, and revenue increases.

Sd. Kalam Hussain et,at.[04]Digital manufacturing technology encompasses more than just CAD technology, enabling the connection between the virtual world and the real world. It includes computer-aided manufacturing (CAM) software, which precedes CAD software. There are two types of CAM systems: standalone and packaged. .Digital manufacturing also allows for greater manufacturing flexibility by allowing cells to accommodate more product variations by altering cell control programs or making minor equipment adjustments. While digital manufacturing technology is commonly used to reduce waste on the factory floor, it also has applications outside of the industry. CIM data, sourced from offices in North America, services clients worldwide, covering America, Europe, and the Asia-Pacific region.

Dr Bharat Chedea e et,at. [05]Digital Manufacturing utilizes advanced technology, such as virtual reality, computer networks, and rapid prototyping, to optimize the manufacturing process and product. This technology enables engineers to establish a unique intelligent model that processes, analyzes, optimizes, and controls the flow of manufacturing processes in a virtual environment. It supports six sigma rules for analyzing variation of dimension . Digital manufacturing also enables faster creation of high-quality factory models and optimizes flow of material and layouts.

DianaA.Fonsecaet,at.[06]Disscused about Digital Manufacturing (DDM) industry,DDM technologies have the potential to shift, focusing on sustainability in various aspects, including materials. Natural materials and composites can play,a important role in additive manufacturing technology offer advantages in industrial production, such as increased design space, . They eliminate cost, while increasing the cost per part, allowing for low batch production. DDM technologies have the potential to shift but sustainability is still a significant concern.

Yuval Cohen et,at.[07] The paradigms include smart manufacturing, cyber-physical production systems, and I4.0, which are flexible products and services like blockchain. Here common objectives of these paradigms are mass-personalization, providing include Vision systems, such as motion capture (MOCAP) technology, are also being used to digitalize manual production processes. Ubiquitous computing is another emerging technology that can help create a consistent goal and transition plan for manufacturing and assembly systems.
Linhan Lin et,at.[08]Developments in aims for additive manufacturing at micro scale, requiring higher manufacturing accuracy and manipulation of nano materials. Integrating materials across multiple dimensions and compositions is crucial for highly utilitarian products.

Rapeepan Promyoo et,at.[09]The Model-Based Systems Driven Product Development CAD simulation is used to create detailed engineering of 2D drawings or 3D models, with computer-aided design (CAD) tools aiding in the creation and optimization of models. CAE simulation is used allowing engineers to cost-effectively evaluate product performance under expected operating conditions.CAM simulation is used to plan manufacturing.

D. P. Zeg zhdaa et ,at.[10]In this paper cyber physical system is self based security system indicator.it improves efficiency and greater flexibility.it uses net work connectivity through out the system.

Dazhong Wu a ,et.at.[11]This paper reviews cyber security in digital manufacturing, focusing on system characterization, threat identification, attack scenarios, control methods, and risk determination techniques. As advanced sensing, high-performance computing, artificial intelligence, and data analytics technologies are used, cyber security is becoming a primary concern for manufacturers. The main challenges include securing legacy machines and equipment retrofitted with remote monitoring, diagnosis, prevention, control, and self-correction technologies, and detecting and preventing embedded defects. New access control, encryption, and intrusion detection techniques are needed to address these challenges.

Efe C. Balta ,et .at.[12] In This PaaS framework is a software-as-a-service (SaaS) framework that simplifies manufacturing processes by breaking down products into components. It consists of three main components: the customer interface, where users submit service requests, and the manufacturer interface, where manufacturers review and submit production quotes. The customer interface allows users to submit production requests and receive notifications, while the manufacturer interface allows manufacturers to receive job notifications and submit production quotes. A genetic algorithm (GA) is proposed for evaluating optimal production schemes based on submitted quotes. The framework integrates back-end, front-end, and database APIs, allowing for the interpretation and translation of user needs into a quantitative abstracted format. This paper presents a simulated case study of a model truck manufacturing process.

Andreea Blaga et,at.[13]In manufacturing processes, improving product quality and worker productivity is crucial. Digital manufacturing, data management systems, and simulation technologies are used to enhance manufacturing processes. Augmented Reality (AR) is a continuous development in virtual reality research that combines the real world with a generated virtual scenario, adding extra information. Smart manufacturing using AR technology and human-robot collaboration is a profitable scenario that includes key characteristics of these technologies. The main objective is to develop 3D vision for daily manufacturing procedures. AR improves task completion time and reduces errors. The use case for cobots with AR involves step-by-step procedures, managing risk and safety, and improving design and visualization. In the future, object recognition combined with 3D printing and the latest HMD devices could further enhance manufacturing processes.

M. Rabe. A.A. Juan et,at.[14] This paper defines digital surrogate as an alternative to digital twin and discusses its concept, technologies, standards, and challenges. It highlights the need for collaboration between industry, government, and academia to overcome challenges and accelerate the adoption of digital surrogates. Key technologies include M&S, virtual factory, optimization, AI, and machining learning. Industry needs include modeling methodologies, frameworks, integration, VVUQ, reusable model components, standard development, and implementation guidelines. Collaborating with industry to identify case studies, develop prototypes, and participate in standard development, testing, and validation is crucial for the successful implementation of digital surrogates in manufacturing.

Lidong Wanga et,at.[15] In this Industry 4.0 is a rapidly evolving technology that aims to make manufacturing more efficient, flexible, and sustainable. It involves integrating computation, communication, and physical processes to control production processes. The Digital Lab for Manufacturing (Digital Lab) will be established to support this technology. Emerging technologies like IoT, 3D printing, and Big Data analytics are transforming the industry, making it easier to modify and update digital information according to customer requirements. Industry 4.0, the fourth industrial revolution, is influenced by digital technologies that significantly impact manufacturing. Key concepts and solution components include CPSs as intelligent entities in production or manufacturing. Industry 4.0 focuses on four fundamental conceptual approaches: CPSs, Internet technology, components as information carriers, and holistic safety and security, including privacy and knowledge protection.B. Beckmann et,at.,The DMC is an open-source platform for secure collaboration during the design-make process, with the goal of developing an initial set of foundational applications. By the first implementation phase, the DMC will transition to the DMDII, becoming the main platform for open-source hardware designs

B. Beckmann et,at.[16]The DMC is an open-source platform for secure collaboration during the design-make process, with the goal of developing foundational applications. By the first implementation phase, the DMC will transition to the DMDII, becoming the main platform for open-source hardware designs. The platform will enable distributed teams to collaborate, share data, and connect to software, analysis tools, cloud computing, and high-performance computing. The architecture allows for adding functionality from a broad DMDII community. The DMC aims to bring together over 100,000 users, SMEs, manufacturing companies, and universities to collaborate on manufacturing and design projects.

Danfang Chen et,at.[17]According to this research, DDM seems to have apromising future, especially 3D printing. DDM has the possibility to combine the advantages of the production paradigms into personalised high quality products with the batch size of one. High skill would not be necessarily as the digitalisation enables online skill acquisition. Basic computer skill empowers the user to become its own manufacturer, generating local value at best with resources that are locally available. 3D printers have long shown their fit to bridge technological and educational gaps for people, and it is foreseeable that DDM is a good candidate to bridge technological, educational and cultural gaps between developing and developed countrires

L. Monostori,et.[18]The paper concentrated mainly of two aspects of the R&Ddomains emphasised in the Manufuture initiative, namely on adaptive manufacturing and digital manufacturing. The authors also wanted to illustrate the interdependence of the related fields, i.e., the possible roles of the digital enterprise technologies in developing adaptive solutions, and in supporting networked manufacturing by increasing the transparency beyond the organizational borders of the production and logistics enterprises.

Ping Yang et,at.[19]This paper uses the fitness of population CO2 to determine non-isomorphic kinematic chains. The algorithm starts with strong local search and gradually extends the search space in the second part of pseudo-crossover, moderate local search. The mutation rate Pmi is selected between 0.3-0.8, which speeds the process to reach the optimal state effectively. The pseudo-crossover operator method is proposed, which combines global and local search efficiently. However, the iterative method takes longer to detect kinematic chain isomorphisms when the number of links increases. The simulation results show that the new adaptive hybrid genetic algorithm is a high-performance method for mechanism isomorphism identification.

XIONG You-lun et,at.[20]Digital manufacturing is transforming the manufacturing industry in the twenty-first century, offering features such as ambiguity-free digital product descriptions, prediction of product development processes and performance, and manufacturing activities' independence in a networked environment. Research on digital manufacturing and equipment is expected to accelerate the development of new disciplines like computational manufacturing, manufacturing informatics, and intelligent manufacturing, advancing the entire manufacturing science.

Zhipeng Wu et,at.[21]This paper presents data interaction techniques for comprehensive monitoring of manufacturing operations, ensuring flexibility in production across entire manufacturing and supply chains. The PicknPack line application demonstrates the design concept, focusing on data-oriented design principles and technologies for industrial manufacturing applications. The M2M communication protocol and machine topology enable flexible messaging, interoperable data presentation, and collaborative automation. Line synchronization and data integration methods are highlighted, enabling module registration and identification of products. RFID technology enables online product information tracing, making data available to all partners in the supply chain and end users. Future work focuses on data analysis methods and extending system optimization to enterprise levels, focusing on the study of data analysis.

Dimitris Mourtzisa et, at.[22]Digital manufacturing solutions are integrating simulation into engineering activities in manufacturing organizations. These solutions provide feature-rich 3D collaborative environments for realistic evaluation of alternative solutions. In the future, digital manufacturing tools and applications will generate more accurate and detailed alternatives for various product and process design activities. Emerging standards and major software vendors' adoption will improve interoperability, performance, and effectiveness of simulation platforms. Simulation experiments will integrate macro- and micro models of manufacturing systems, ranging from manufacturing sites to specific resources and processes, even requiring molecular dynamics-based modeling.

Changho Lee et,at.[23]This study presents digital manufacturing as a method for managing MBOM and BOP data in the manufacturing industry. It presents a reference model for digital manufacturing technologies and a framework for constructing and verifying data from PDM EBOM. The method offers a solution for global
manufacturing companies operating final assembly plants, addressing the problem of constructing standard data for each plant due to diverse manufacturing environments. The method is expected to have a greater impact when design changes occur due to various causes.

Fabio Limaet,at.[24]This article analyzes the insertion of a collaborative robot in a manual automotive assembly line using digital manufacturing software tools. A virtual replica of the product's manufacturing cell was conducted, comparing the current model and the one employing a collaborative robot. The results show that a collaborative robot in conjunction with manual labor can reduce time for operations and provide benefits such as eliminating and reducing time spent on operations. Process Simulate software provided visual information about the feasibility of inserting the robot, demonstrating physical space needs and ergonomics data. The simulations allowed for planning and visualization of the robot's effects. The use of collaborative robots in Brazil has become recent.

Kwaku Adu-Amankwa et,at.[25]The study reveals the complexities of intellectual property (IP) and IP security for digital manufacturing in Digital Supply Chains (DSCs), specifically 3DP or AM applications. Most participants deemed IP to serve a dual purpose, as both a barrier and an enabler to using 3DP/AM in DSCs. This may arise from the participants' benefits of creating and using their own IP for 3DP/AM applications within DSCs (an enabler) and their need to use others' IP (a barrier). However, views of IP being detrimental to 3DP/AM's operations within DSCs or disrupting traditional IP are not prominent in practice.

Phani Kumari Paritalaa et,at.[26]Digital manufacturing revolutionizes sustainable product design and manufacturing, with additive manufacturing (AM) being a valuable technique in various sectors like automobile, aerospace, medical, materials, architecture, construction, food, and fashion. AM technologies enable faster, efficient development of lightweight, high-performance products, reducing costs and improving overall product quality.

Yu. S. Balashova et,at.[27]Digital manufacturing has revolutionized the way products are manufactured, with additive manufacturing (AM) being a significant development in various sectors such as automobile, aerospace, medical, materials, architecture, construction, food, and fashion. AM technologies enable the production of complex, lightweight, high-performance products, reducing product development costs and enabling biomedical applications such as customized implants, prosthetics, tissue engineering, and regenerative medicine. AM also allows for the printing of chemical compounds and materials with complex architectures, making it a valuable tool in various industries. However, further research and development are needed to enhance AM systems and standard processes, focusing on designing complex multimaterial structures, materials with multifunctional properties, electrically conductive materials, bioapplications, micro and nanoengineering, energy, and sustainability implications. In the future, AM technology will drive various industries, including dental, food, construction, architecture, fashion, toys, furniture, and home accessories, with a digital link.

Angelo O,Andrisano et,at.[28]The method focuses on designing human-based reconfigurability in High-Resolution Systems (H-RSs) by defining tasks between robots and operators. Robots' performance meets high-quality specifications, while human dexterity, capabilities, and proactivity ensure sustainable evolution towards new models production with reduced fixed investments. The H-RS is decomposed into a modular architecture with different hierarchical levels, and all layout, mechanical, electrical technical solutions, PLC, and robot code follow interface standardization criteria. The method integrates virtual models of product, process, and resources, promoting standardization and re-configurability. The reconfiguration process consists of changing product-dependent elements, such as 3D visual work instructions for manual loading and fixture of chassis parts. The modular approach reduces the effort in re-programming the system for new model production, focusing on PLC virtual commissioning, robots' offline programming, calibration, and minor adjustments. Further research is needed to improve safety issues for cooperating H-RSs.

Wu D, Rosen DW et,at.[29]In this paper, we discussed and compare the existing definitions for CBDM, identified common key characteristics, defined a requirements checklist that any idealized CBDM system should satisfy, and compared CBDM to other relevant but more traditional collaborative design and distributed manufacturing systems from a number of perspectives. Specifically, CBDM is characterized by scalability, agility, high performance and affordable computing, networked environments, ubiquitous access, self-service, big data, search engine, social media, real-time quoting, pay-per-use, resource pooling, virtualization, multi-tenancy, crowdsourcing, IaaS, PaaS, HaaS, and SaaS. Thus far, a few prototype systems achieved some functions in the requirement checklist; however, none of the existing systems satisfies all the requirements that we defined.

Priyanka mahesh et,at.[30]The adoption of digitalization (DM) in manufacturing requires companies to migrate to a Distributed Supply Network (DSN), which is essential for efficient production and movement of goods. The digitalization of the DM process chain increases the attack surface and introduces new attack vectors. Limited resources in manufacturing supply chains may not allow for the most advanced defenses, especially for MSEs with limited resources. To address these threats, MSEs must prioritize cybersecurity issues and address various elements in the DSN, such as information, financial, and business networks.

Kai Cheng et,at.[31]This special issue includes 12 refereed papers selected from those presented at the 4th International Conference on e-Engineering & Digital Enterprise Technology.e-Design and e-manufacturing e-Supply chain management, e-logistics and mass customization Web-based CAD/CAM/CAPP/PDM Virtual and collaborative engineering Web-based modelling and simulations Remote control, condition monitoring and tele-robotics e-Business, e-commerce and e-services Computing infrastructure for e-engineering Digital factory/enterprise On-line education and industrial training These papers reflect, to some extent, the state-of-the-art of research in digital manufacturing and enterprise technologies, which is a timely and fast-moving subject area.

A. Caggiano et,at.[32]The case study presents the design of an aircraft engine component manufacturing cell for automated robotic deburring. Digital simulation tools were used to enhance cell performance. The objectives were optimizing batch throughput time and improving automated deburring station utilization. The optimal solution involved alternating Phase 1 and Phase 2 operations on the grinding machine and deburring external part numbers separately. The research was supported by the Fraunhofer Joint Laboratory of Excellence on Advanced Production Technology.

Papakostas et,at.[33]This paper addresses the challenges of designing a cooperating robot cell for assembly, focusing on advanced software applications for accurate simulation of coordinated motion.

The authors use engineering intuition and common programming frameworks to improve assembly cell performance. They suggest using lifecycle criteria for evaluating different configurations and integrating digital models with production environments for better planning and planning. The paper also highlights the need for fine tuning of Programmable Logic Controllers (PLC) software, which is a time-consuming task. By integrating digital validation and off-line programming tasks, the paper aims to improve the overall design process and make digital validation an integral part of the overall design process.
W.K. Chiu et,at.[34]This paper proposes a methodology for making FGM prototypes in the 3DP process using CAE analysis results to determine mechanical information of an FGM object. This information is converted to color information, allowing the existing output data format for FGM object transfer without the need for new data formats. However, the range of binder concentration changes is limited, and varying binder concentration affects binder viscosity, affecting process performance and final quality. Further research is needed to overcome these technical issues and make the proposed methodology useful in FGM object fabrication.
C. C. Chang et,at.[35]ACT apparatus is a convenient and economical method for obtaining CT images for complex objects, converting them to STL format for rapid prototyping or 3D CAD models for CNC machining. It also serves medical applications by providing 3D models for surgical rehearsal and producing prosthetics using RP/RT techniques.
Farhad Ameri et,at.[36]This paper introduces the Digital Manufacturing Market (DMM) as a framework for agile supply chains in distributed environments. MSDL is proposed as an ontological language for description of manufacturing services at a semantic level in DMM, enabling unambiguous description of supply and demand entities in terms of manufacturing services. It also enables active involvement of machine agents in the supply chain configuration process due to its formality. The DMM's inherent characteristics, such as multiplicity, autonomy, information distribution, flexibility, dynamic behavior, and collaborative nature, make it suitable for agent-based scenarios
Yong Tae Kim et,at.[37]Their 3D-printed microfluidic channel with an integrated porous barrier is the first step towards advanced functionalities in 3D-printed devices. A stereolithographic co-printing process was developed to demonstrate selective diffusion of small ions or fluorescein molecules through a porous barrier. The process provides an inexpensive, simple, and reproducible molecule delivery platform for tissue engineering, drug delivery systems, and biomaterials. 3D-printed hydrogels could filter particles from bodily fluids and immobilize biomolecules for biosensing applications. The biocompatibility of 3D-printed PEG-DA-258 microdevices and PEG-DA-700 structures makes this strategy suitable for cell-based assays and organ-on-chip platforms.
Jon Kepa Gerrikagoitia et,at.[38]The review paper explores the concept and scope of digital manufacturing platforms, combining technology, policy making, industry, academia, and stakeholders. The development of these platforms is in its early stages, but is supported by a mature IoT ground. RAMI 4.0 is a reference implementation for this concept. Platforms should plan an incremental road map towards digital transformation, focusing on open technological architecture, integrating state-of-the-art technologies like Io T, AI, robotics, cloud, and Big Data. Platforms should aim for openness, avoiding lock-ins, preventing dominant positions, and compliance with standards and regulations.
Dominick Glavach et,at.[39]They concluded DDM systems are an innovative and on-demand technology that represents game changing advances to supply chains, consumer goods and economic growth. In the same manner DDM systems are presenting new opportunities for innovation and creation, they are creating new cyber attack vectors and scenarios that could present potential negative impacts to supply chains, military equipment and consumer confidence. The DDM systems are complex system of systems comprising of multiple Operating Systems, input/output peripherals, networks and process data from media types ranging from CD/DVDs, serial connections and USB thumb drives.
Vidosav Majstorovic et,at.[40]Feature-based modelling is crucial for efficient integration of CAx technologies, including the STEP-NC standard, enabling bidirectional data exchange. This is essential

for the realization of digital manufacturing concepts. In the SME, CAI is integrated using CAD models defined using AP 214, AP224, AP240, AP238, and AP219. Inspection on CMM is performed after machining, providing feedback for CAPP and CAM. Inspection operations are planned and executed based on feature design data, macro process planning data (AP240), and AP219 (dimensional inspection). The measuring report is generated using the PC DIMS 4.3 software. The concept does not involve automatic extraction of inspection features, so the next steps will involve the application of the newly developed AP242 ed.2.

III. Conclusion

This study shows various technologies like Computer aided Design ,Computer aided Manufacturing, Rapid Prototyping, Computer aided enginneering .Digital Manufacturing has a high part of technology for increased quality of the product, reduce in the cost of the object or product , reducing time as well as it is leading us towards need of customization and speedy response to the market.Digital Manufacturing Provides Greater customer satisfaction,product efficiency,Reduce of work in progress(WIP).

References

1. Abdulrazak F. Shahatha Al-Mashhadani , Muhammad Imran Qureshi , Sanil S. Hishan Digital Manufacturing as a basis for the development of the Industry 4.0 model,scientific committee of the 54th CIRP Conference on Manufacturing System 10.1016/j.procir.2021.11.315.

2.Dr Bharat Chedea , Nitin Sawarkarb , Swapnil Choudharyc , Ajay Tinguriad Towards the Development of Digital Manufacturing Ecosystems for Sustainable Performance: Learning from the Past Two Decades of Research Research. Energies 2021, *14*, 2945. https://doi.org/10.3390/en14102945

3. Jayanth Soragaon, Aditya Deshmukh, Kalavathi H BA Comprehensive Evaluation of Digital Manufacturing Technology © 2021, IRJET | Impact Factor value: 7.529 | ISO 9001:2008 Certified Journal

4.Sd. Kalam Hussain, K. Sivamaaran , R. Kalyan, G.Charan Digital Manufacturing – Enabling Lean for More Flexible Manufacturing International Journal of Research in Engineering, Science and Management Volume 4, Issue 9, September 2021 https://www.ijresm.com | ISSN (Online): 2581-5792.

5.Dr Bharat Chedea, Nitin Sawarkarb, Swapnil Choudharyc, Ajay Tinguria Scope of Digital Manufacturing in India after Covid-19 Turkish Journal of Computer and Mathematics Education Vol.12 No.10 (2021), 4197-4201

6. Diana A. Fonseca, Fábio J.P. Simões Direct Digital Manufacturing in the Context of a Circular Economy Applied Mechanics and Materials Submitted: 2017-10-31 ISSN: 1662-7482, Vol. 890, pp 21-33 doi:10.4028/www.scientific.net/AMM.890.21

7. Yuval Cohen & Maurizio Faccio & Francesco Pilati & Xifan Yao Design and management of digital manufacturing and assembly systems in the Industry 4.0 era The International Journal of Advanced Manufacturing Technology (2019) 105:3565–3577https://doi.org/10.1007/s00170-019-04595-0

8.Linhan Lin, Pavana Siddhartha Kollipara, Yuebing Zheng Digital manufacturing of advanced materials: Challenges and perspective1369-7021/ 2019 Elsevier Ltd. All rights reserved. https://doi.org/10.1016/j.mattod.2019.05.022

9. Rapeepan Promyoo,Shashank Alai,Hazim EL-Mounayri Innovative Digital Manufacturing Circulum for Industry 4.0 .

10. D. P. Zegzhdaa, E. Yu. Pavlenkoa Digital Manufacturing Security Indicators 978-1-5386-6572-5/18/$31.00 ©2018 IEEE.

11. Dazhong Wu a, Anqi Ren b , Wenhui Zhang c Cybersecurity for digital manufacturing https://doi.org/10.1016/j.jmsy.2018.03.006 0278-6125/© 2018 Published by Elsevier Ltd on behalf of The Society of Manufacturing Engineers.
12. Efe C. Balta , Yikai Lin , Kira Barton Production as a Service"IA Digital Manufacturing Framework for Optimizing Utilization"1545-5955 © 2018 IEEE.
13.Andreea Blaga and Levente Tamas IAugmented Reality for Digital Manufacturing 978-1-5386-7890-9/18/$31.00 ©2018 IEEE
14.M. Rabe. A.A. Juan, N. Mustafee, A. Skoogh, S. Jain, and B.Johanssone digital manufacturing:Requirements and challenges for implementing digital surrogates 978-1-5386-6572-5/18/$31.00 ©2018 IEEE
15. Lidong Wanga, , Guanghui Wang"Big Data in Cyber-Physical Systems, Digital Manufacturing and Industry 4.0"*I.J.* Engineering and Manufacturing, 2016, 4, 1-8 Published Online July 2016 in MECS (http://www.mecs-press.net)
16.B. Beckmann, A. Giani, J. Carbone, P. Koudal"Developing the Digital Manufacturing Commons: A National Initiative for US Manufacturing Innovation "Elsevier B.V doi:10.1016/j.promfg.2016.08.0bb
17.Danfang Chen, Steffen Heyer, Suphunnika Ibbotson,"Direct digital manufacturing: definition, evolution, and sustainability implications"http://dx.doi.org/10.1016/j.jclepro.2015.05.009
0959-6526/© 2015 Elsevier Ltd.
18.L. Monostori , B. Cs. Csa ji , B. Ka da r, A. Pfeiffer"Towards Adaptive and Digital Manufacturing"doi:10.1016/j.arcontrol.2010.02.007
19 .Ping Yang , Kehan Zeng , A high-performance approach on mechanism isomorphism identification based on an adaptive hybrid genetic algorithm for digital intelligent manufacturing , Engineering with Computers , Springer , 25:397–403 DOI 10.1007/s00366-009-0132-7, 31 July 2009.
20. XIONG You-lun, YIN Zhou-ping , Digital manufacturing—the development direction of the manufacturing technology in the 21st century , Front. Mech. Eng , Springer , DOI 10.1007/s 11465-006-0021-3 , 2006.
21. Zhipeng Wu, Senior Member , Zhaozong Meng, Member, and John Gray , IoT-based Techniques for Online M2M-Interactive Itemised Data Registration and Offline Information Traceability in a Digital Manufacturing System , IEEE , DOI 10.1109/TII.2017.2704613,201.
22. Dimitris Mourtzisa , Nikolaos Papakostasa , Dimitris Mavrikiosa , Sotiris Makrisa & Kosmas Alexopoulosa , The role of simulation in digital manufacturing: applications and outlook, International Journal of Computer Integrated Manufacturing , Vol. 28, Taylor & Francis , 07 January 2015.
23. Changho Lee & Choon Seong Leem & Inhyuck Hwang , PDM and ERP integration methodology using digital manufacturing to support global manufacturing , Int J Adv Manuf Technol , Springer , DOI 10.1007/s00170-010-2833-x,2011.

24. Fábio Lima, Caroline Nogueira de Carvalho, Mayara B. S. Acardi, Eldiane Gomes dos Santos, Eldiane Gomes dos Santos, Alexandre Augusto Massote, Digital manufacturing tools in the simulation of collaborative robots:Towards Industry 4.0 , Brazilian Journal of Operati ons & Production Management, Volume 16, DOI: 10.14488/BJOPM.2019.v16.n2.a8,2019.
25. Kwaku Adu-Amankwa and Angela Daly, Securing innovation in digital manufacturing supply chains: an interdisciplinary perspective on intellectual property, technological protection measures and 3D printing/additive manufacturing, Journal of Intellectual Property Law & Practice, Vol. 00,2023.
26. Phani Kumari Paritalaa , Shalini Manchikatlab , Prasad KDV Yarlagaddaa , Digital Manufacturing-Applications Past, Current, and Future Trends , Global Congress on Manufacturing and Management Science Direct, Elsevier, CC BY-NC-ND license,2017.
27.Yu. S. Balashova, S. G. Zarubin, and I. V. Rybalov, Informational Model of Digital Manufacturing (ISA-95 Standard), Russian Engineering Research, 2017, Vol. 37, No. 4, pp. 332–334, DOI: 10.3103/S1068798X17040074, published in STIN, 2017, No. 2, pp. 8–11,2017

28..Angelo O,Andrisano ,Francesco Leali ,Marcello Pellicciari ,Fabio Pini ,Alberto Vergnano , Hybrid Reconfigurable System design and optimization through virtual prototyping and digital manufacturing tools, Int J Interact Des Manuf, Springer, DOI 10.1007/s12008-011-0133-9,2012.
29.Wu D, Rosen DW, Wang L, Schaefer D. Cloud-based design and manufacturing: A new paradigm in digital manufacturing and design innovation. Computer-Aided Design (2014), http://dx.doi.org/10.1016/j.cad.2014.07.006.2015.
30.Priyanks mahesh,Akash Tiwari,Chenglu Jin,Panganamala R.Kumar , Life Fellow IEEE, A. L. Narasimha Reddy, Fellow IEEE, Satish T. S. Bukkapatanam , Nikhil Gupta, Associate Member IEEE, And Ramesh Karri, Fellow IEEE , A Survey of Cyber security of Digital Manufacturing
30. Kai Cheng . David Webb Special issue on "Digital Manufacturing and Enterprise TechnologiesInt J Adv Manuf Technol (2006) 30: 909–910 DOI 10.1007/s00170-005-0075-0.
31. A. Caggiano R. Teti Digital Manufacturing Cell Design for Performance Increase ,2212-8271 © 2012 The Authors. Published by Elseviers http://dx.doi.org/ 10.1016/j.procir.2012.05.041
32. N. Papakostas , K. Alexopoulos, A. KopanakisIntegrating digital manufacturing and simulation tools in the assembly design process: A cooperating robots cell case2011 CIRP. doi:10.1016/j.cirpj.2011.06.016
33. W.K. Chiu , K.M. Yu Direct digital manufacturing of three-dimensional functionally graded material objects.© 2008 Elsevier Ltd. doi:10.1016/j.cad.2008.10.002.
35.C. C. Chang . M. Y. Lee . S. H. Wang ,Digital denture manufacturing-An integrated technologies of abrasive computer tomography, CNC machining and rapid prototypingInt J Adv Manuf Technol (2006) 31: 41–49 DOI 10.1007/s00170-005-0181-z
36.Farhad Ameri · Lalit Patil ,Digital manufacturing market: a semantic web-based framework for agile supply chain deployment .© Springer Science+Business Media, LLC 2010,DOI 10.1007/s10845-010-0495-z.
37.Yong Tae Kim ,Kurt Castro ,Nirveek Bhattacharjee and Albert Folch
Digital Manufacturing of Selective Porous Barriers in Microchannels Using Multi-Material StereolithographyMicromachines 2018, *9*, 125; doi:10.3390/mi9030125
38..Jon Kepa Gerrikagoitia 1,*, Gorka Unamuno 1 , Elena Urkia 1 and Ainhoa Serna Digital Manufacturing Platforms in the Industry 4.0 from Private and Public Perspectives *A*ppl. Sci. 2019, *9*, 2934;doi:10.3390/app9142934
39.Dominick Glavach, Julia LaSalle-DeSantis and Scott Zimmerman,Applying and Assessing Cybersecurity Controls for Direct Digital Manufacturing (DDM) System**s**© Springer International Publishing AG 2017 .L. Thames and D. Schaefer (eds.), Cybersecurity for Industry 4.0, Springer Series in Advanced Manufacturing, DOI 10.1007/978-3-319-50660-9_7
40.Vidosav Majstorovic a ,Tatjana Sibalija b, Marko Ercevic c , Bojan Ercevic c CAI model for prismatic parts in digital manufacturing 2016 ,doi:10.1016/j.procir.2014.10.006.