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AI for Smarter Product Development and Manufacturing

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Abstract

Artificial Intelligence (AI) is making product development and manufacturing more advanced by helping with smarter design, flexible production and better supply chains. This review focuses on important technologies such as machine learning, deep learning and generative design and how they bring about change in the manufacturing of products. AI is demonstrated in real situations to help businesses innovate, improve work quality and operate more efficiently, as it also manages problems like data quality, bias, creating clear systems and the effect on employees. The importance of ensuring trust and accountability in AI is better explained when using an approach that focuses on people, ethics, understandable AI and close human-AI cooperation. In the end, it proves that using AI responsibly leads to more flexible, open and equitable manufacturing systems. If we use AI responsibly, it could help industries produce creative and durable products which would benefit society and help the economy grow.

Key words

AI, product development, manufacturing, machine learning, deep learning, generative design.

Introduction

Nowadays, because companies are so busy competing and using data, the process of developing and making products is transforming in significant ways. At the core of this trend is artificial intelligence (AI) which was once just about theories and small tasks, but is now deeply involved in all kinds of industrial progress. AI is more than a device; it's a valuable strategy that boosts our creativity, speeds decision-making and introduces new approaches to making products almost everywhere [1].

The old way to develop products which was time-consuming and kept departments separated, is being replaced by a faster, repeated process with the help of algorithms. Design concepts are now being produced with high speed and accuracy by AI and the technology also helps predict limited

resources in production [2]. AI also works closely with robotics, sensors and digital twins in manufacturing to make systems that can adjust on the spot, save resources and ensure quality is not affected.

It is not only one or two examples, but the combination of AI with product ecosystems is used in a variety of ways. It involves a major overhaul, changing everything from research and development all the way to spreading the finished products [3]. With the help of AI, tools are making it faster for industries to come up with more eco-friendly solutions for packaging and textiles. At the same time, intelligent planning is changing the supply chain so that businesses can adapt quickly to changes in demand, world politics or environmental troubles [4].

Still, bringing AI into business brings new difficulties. Apart from advanced infrastructure and reliable data, this work also needs wise rules, ethical guidelines and positive approaches to human relations with artificial intelligence. AI being used in product development relies heavily on matters such as understanding used models, who is held accountable and the changing nature of workplaces [5]. This paper looks at how AI shapes every stage of developing and producing goods, including planning, assembly and quality control. AI and Next Generation Products looks into main technologies, their uses and ongoing research to give a well-rounded account of the role AI is having on market offerings. The review uses case studies, technical explanations and looks into tough moral and operating issues to guide researchers, engineers and decision-makers with this swiftly changing field [6].

From Code to Product: Important AI Technologies Help Products Develop

Many technologies in Artificial Intelligence come together to allow machines to imitate how humans think and act. In this area, several important AI technologies are known for their ability to revolutionize workflows by adding new and helpful skills [7]. At the beginning, we depend on Machine Learning (ML), a field under AI that trains algorithms to notice patterns and to predict outcomes based on data. Using machine learning, systems can pick up from product history, production information and customers' opinions while improving models independently. It is

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important for making design decisions, predicting how many products will be sold and planning equipment service [8].

Based on ML, Deep Learning uses neural networks that have many layers to process images, data from sensors and natural language. On the production floor, DL has allowed computers to spot defects and ensure quality in real time with higher precision than ever possible before. As a result, convolutional neural networks (CNNs) are able to review visual streams and catch flaws or errors that people usually overlook [9].

Generative AI is moving at a rapid rate by using GANs and VAEs to come up with new data based on what it has been trained on. Thanks to generative AI, designers can develop creative prototypes, measure the behavior of products and predict molecules that have the needed properties. It allows both humans and machines to join forces and develop ideas faster [10]. Software for natural language processing is now often a part of product creation, helping AI systems control human language. As a result, knowledge management is better, technical markup is automated and it is easier for humans to collaborate with AI through conversation or helpful assistants [11]. Connected with Digital Twins, AI has a strong capacity to simulate and improve different systems and processes. When real-time data is used, manufacturers are able to check the effects of changes, anticipate the outcome and optimize their operations without dealing with downtime [12].

All these basic AI tools unite to support the process from coming up with an idea to building the actual product. What is valuable is that they not only automate but also support human imagination and vision, so companies can manage faster, more personalized and sustainable services. Knowing about these tools is important to see how AI is affecting product development and manufacturing [13].

New Design and Development with AI

Artificial Intelligence is helping to change the way products are designed by using new, intelligent and automated steps that traditional ways have not considered. When AI tools are applied in design, engineers and designers can create more, work effectively and design products users like and the

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market requires [14]. AI greatly helps in design by supporting the use of data for coming up with new ideas and checking their validity. With the analysis of customer opinions, market trends and results, AI helps to spark new ideas for design [15]. With this approach, teams discover what customers need and modify product features in advance which cuts down the chances of making key mistakes. With AI, designers can test out many design options fast, making it easier to compare cost, durability and outward appearance [16].

Digital twins and rapid prototyping signify the next step in development. Using digital twins, designers can check and improve their ideas without using real equipment. Putting AI and computer models together allows for predicting what will happen to products as they are stressed, worn out and exposed to the effects of the environment [17]. This makes it possible to test and update ideas fast without creating actual physical prototypes. Designers are able to look at new and unexpected ideas by using AI to generate many design options based on set rules and requirements [18].

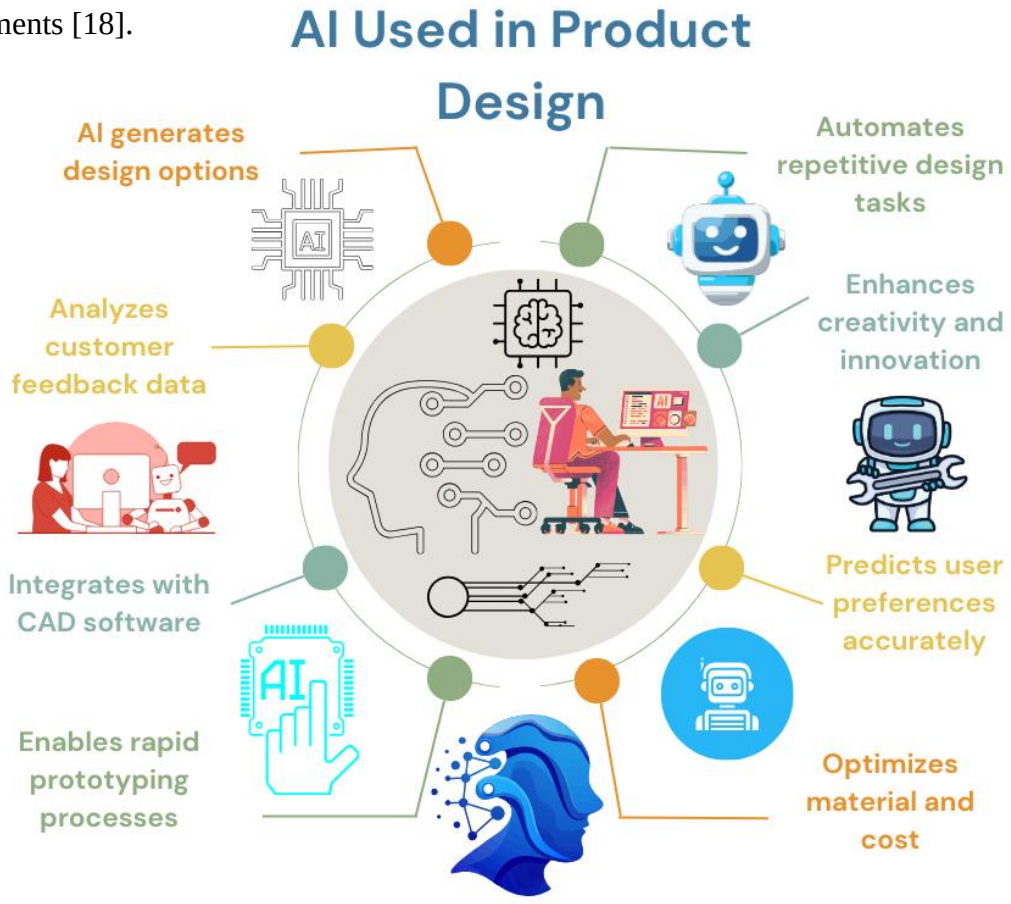


Figure: 1 showing AI used in product design

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In addition to shaping design geometry, AI is having a big impact on finding and perfecting the best materials. AI relies on the study of material qualities and results to recognize and propose new materials that fulfill given goals, for example, strength, flexibility or environmental safety. It plays a vital role for businesses focusing on using environment-friendly materials or long-lasting yet not heavy items [19]. Expected behavior of materials for manufacturing and use predicted by AI helps choose smart options at the start of the product lifecycle, reducing chances for trial and error.

As a result of AI, designers are now using smart tools to make better decisions instead of focusing solely on creating images by hand. When human creativity comes together with AI's capabilities, time needed for development is shortened and the products become more personal, useful and eco-friendly [20]. With these processes in industries, the future of product development is anticipated to respond to any changes made by consumers and the environment.

AI: Helping in the Improvement of Manufacturing

AI is making factories smarter by cultivating intelligence within manufacturing processes which turns regular plants into adaptable ones. Automation in manufacturing is being surpassed by autonomy, as AI helps ensure that production is always running at its best, things are maintained in advance and products meet higher quality standards [21].

Among its many roles, AI helps manufacturing by establishing self-optimizing production systems. Because of machine learning, these systems can automatically modify variables like temperature, pressure and speed to keep performance at its best. If AI processes react to changes in raw ingredients, in equipment condition or different aspects of the environment, they cut waste, save energy and increase the amount of work done. Since factories keep learning all the time, they can act fast to any surprises and run at full capacity most of the time [22].

AI assists in predictive maintenance which means responding to maintenance only when the equipment shows signs of problems. If a machine's sensors are followed and its past failures are measured, AI predicts when it may need maintenance or repairs [23]. Having this prediction makes maintenance teams able to prevent breaks, make equipment last longer and avoid surprise stops in

production. Less money is spent on maintenance with predictive maintenance which supports responsible manufacturing [24].

Computer vision aided by deep learning is now crucial for quality control purposes. Because of their high speed and precision, they can find mistakes and specific problems that cannot be spotted by a human being. Thanks to AI, even the tiniest fault in automotive components or an issue in product labeling can be detected, ensuring both product standards and compliance with rules are maintained [25]. In real time, these systems guide adjustments in manufacturing, so defects are avoided from going any further in the process.

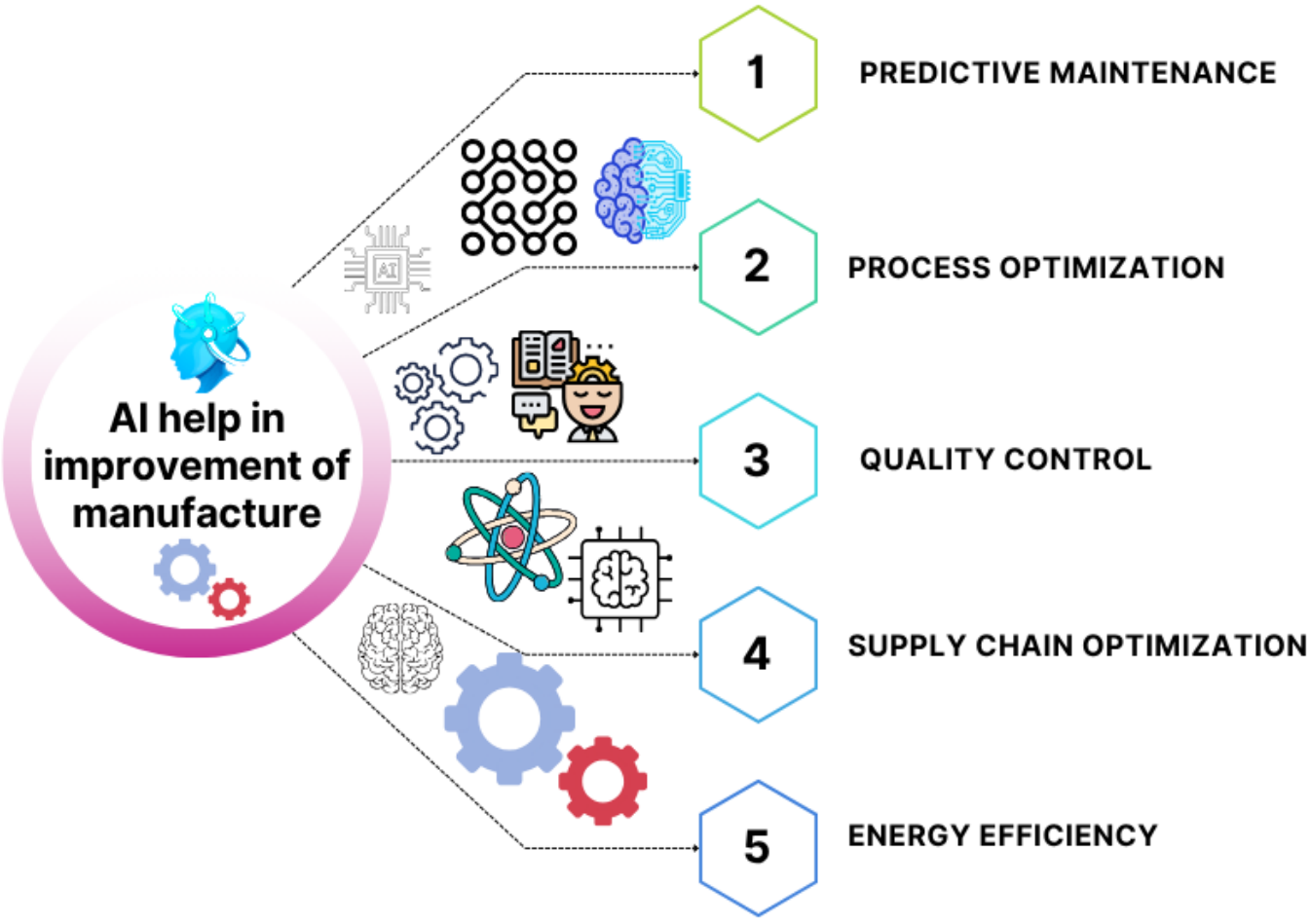


Figure: 2 showing AI help in improvement of manufacture

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Outside the factory, AI-enhanced cognitive automation unites robots with smart thinking, so equipment can do tasks that need to be perceived, reasoned through and adjusted depending on the situation. Such robots ("cobots") cooperate with humans, learn with experience and improve work practices with limited and quick programming [26]. As a result, AI technology in manufacturing brings about factories that are fast, efficient and can produce large amounts of high-quality products. AI improves performance in each manufacturing phase and helps build an industrial network that can easily react to new problems [27].

Using intelligence to bring together the different parts of the supply chain

Nowadays, supply chains are complicated networks that can be quickly disrupted, leading to problems in making and receiving goods and upsetting customers. Traditional supply chains are being upgraded to intelligent ones by Artificial Intelligence, making it possible for them to forecast changes, run effectively and allow all stakeholders to work together smoothly [28].

The power of AI in supply chain management relies on its ability to make use of the latest forms of analytics and machine learning for both demand forecasting and optimizing stock. Clear economic forecasts are very hard to get since factors like seasonal changes, unpredictable changes in the markets and sudden behavior shifts often interfere [29]. Having analyzed a lot of data over different periods, AI models find connections and similarities that are invisible to humans. With access to good forecasts, companies don't have to deal with either running out of products or having excess stock which brings down expenses and increases customer service [30].

Apart from predicting demand, AI assists with planning logistics and distribution by continually monitoring the routes, available warehouse space, the efficiency of suppliers and changing political risks. Cognitive supply chains plan and run simulations to assume different disruptions and respond with better different routes, good use of resources and accurate cost-service decisions. In turn, companies can react promptly to disruptions like natural catastrophes, political issues or sudden increases in demand [31].

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Cognitive supply chains are noted for allowing people and AI to interact. With the help of AI tools and smart assistants, managers in the supply chain handle important duties and let AI handle everyday tasks and data handling [32]. They offer concrete advice, suggest the best actions for each group and facilitate activity between suppliers, manufacturers, distributors and retailers. As a result, this method improves transparency, cuts down on mistakes and makes it possible to fix problems quickly [33].

AI supports missions for sustainability by showing where to lower waste, energy use and the harmful effects caused by big supply chains. By making the best out of sourcing and routes for transport, cognitive supply chains promote organizational efficiency and also care for the environment [34]. Though AI is very useful, having an AI-driven supply chain is challenging because it requires combining data from different systems, making sure the data is quality and handling privacy matters. Firms that use cognitive supply chains achieve higher levels of agility, cut costs and make their customers feel more satisfied [35]. With AI, traditional supply chains transform to become alert and fully capable of adapting to new situations. Using AI in each phase of the company supports high performance, new developments and supports the planet, leading the path to the future of manufacturing and product distribution [36].

Real-World Intelligence: Industry Case Narratives and Lessons Learned

There is a lot we can theorize about artificial intelligence in development and manufacturing, but it only proves itself when truly used in practice. By studying case stories from different industries, we see how AI changes the industry and what issues are faced while implementing it. They show important points that organizations should keep in mind when using AI [37].

Advancements and better efficiency in the auto industry are made possible through the use of AI. By using AI, leading manufacturers are able to develop and check new designs much faster which cuts down the time products take to reach the market. On the production floor, computer vision examines many objects and is very accurate at identifying any issues [38]. These models process sensor information to estimate when equipment might fail which lowers downtime and saves

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spending. On the other hand, the automotive sector stresses that it is challenging to add AI to existing factories and that retraining factory staff is important [39].

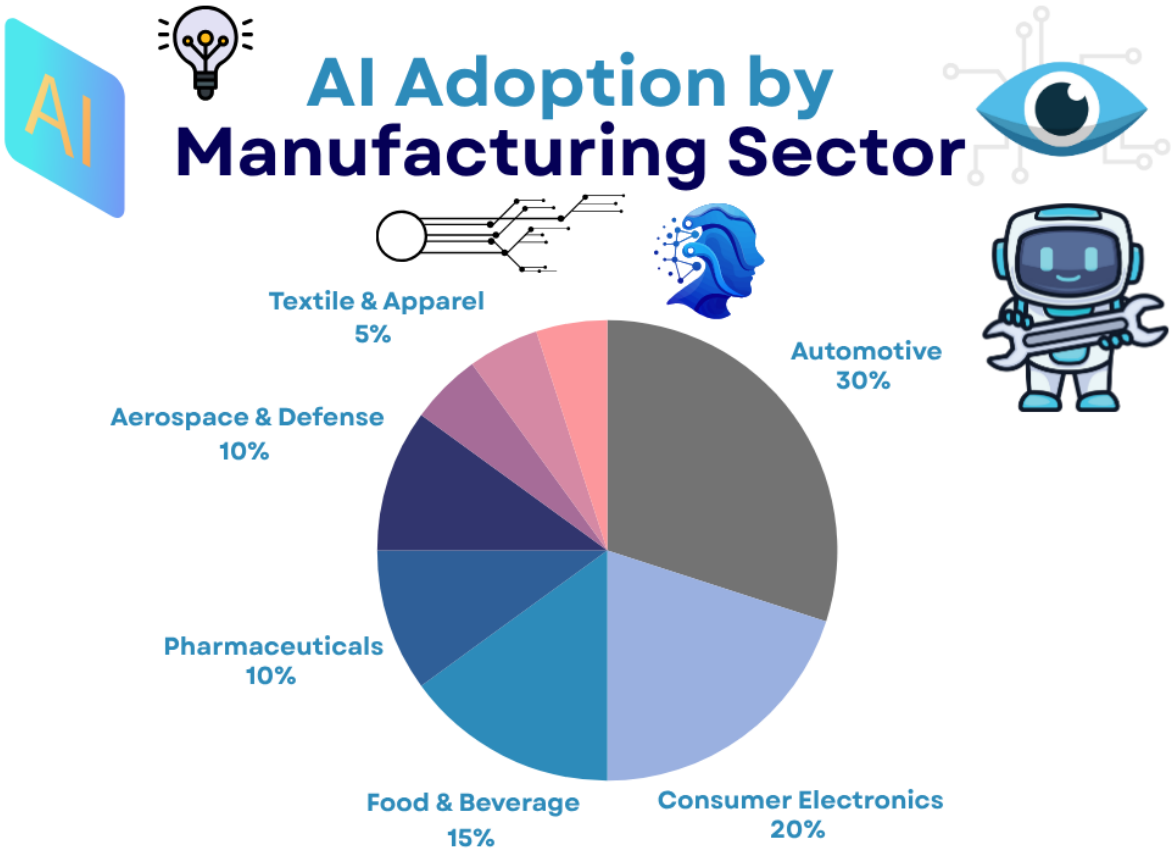


Figure: 3 showing AI adoption by manufacturing sector

AI is important in the consumer electronics industry thanks to its usefulness in managing changing and fast environments. AI in demand forecasting allows companies to plan production better and cut back on extra inventory. Devices that use machine learning can change their work to keep up with changes in design and the variety of components. More efficient use of energy for manufacturing and transportation is made possible through AI. This industry points out that using accurate data and teamwork help in gaining more from AI [40].

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AI supports effective quality control and helps meet rules and standards in the food and pharmaceutical areas. In the food industry, AI systems carefully inspect both visual details and chemicals to detect dangers, keep goods consistent, minimize recalls and boost the safety of consumers. With AI, drug makers can speed up the creation of formulas and trial simulations, making sure their medicines are safe and helpful. To comply with the rules, these sectors rely on AI models that are easy to understand [41].

It is clear from the range of sectors that, for AI to thrive, a business needs good data systems, set strategic direction and a creative attitude. Moreover, specialists in design should pay attention to data privacy, biases and how the business impacts its employees. Such accounts discuss how AI could make sustainability possible by reducing waste and using resources more efficiently [42]. AI shows that it works best when it is carefully adapted to fit the needs of an organization. Industries can grow better equipped to face hardships and achieve the most from using AI in product design and production [43].

There Are Limitations, Bias and Ethical Issues That Hinder the Use of AI

Despite expecting major progress from artificial intelligence in producing goods and developing new products, its introduction involves key issues and raises serious ethical concerns. Being aware of the hidden challenges in technology, behavior and ethics is necessary to use AI properly. Getting consistent data of high quality is a key challenge in many industries [44]. To function accurately, AI systems rely on datasets that contain plenty of good quality information. Because data is missing, inconsistent or not shared properly, AI struggles to work in manufacturing often. In addition, biases in early data sometimes cause a model to repeat or heighten prejudices or errors already present in society [45]. If an AI has learned with inaccurate data on identifying defects, it could miss some types of problems which lowers the product's quality and safety.

The matter of making algorithms explainable and transparent is also related to this. Strong AI models have sometimes been described as "black boxes" since it is difficult for users to find out how these systems reach their conclusions or predictions [46]. Because of this lack of information, innocent mistakes can cause greater difficulties, trouble with regulations and less trust from major

stakeholders in places like pharmaceuticals and aerospace where accountability is very important [47].

We should also consider ethical aspects in relation to data privacy and intellectual property as well as technology. Handling data ownership laws often becomes difficult for manufacturing companies when they share data among suppliers, manufacturers and customers. Ensuring that data remains secure in an environment where people use AI applications is a challenge that never goes away. AI also greatly affects the structure of the workforce [48]. Although AI helps humans, it makes some worry about people losing their jobs and having to learn new skills. Properly dealing with workforce changes requires providing new skills, continuing education and putting together people and technology to make sure employees are valuable and not replaced by machines [49].

Organizations have to face the challenge of governing AI ethically which means setting out policies that ensure responsible AI, address biases and emphasize fairness and responsibility. When AI is introduced without clear rules, there is a threat of it leading to deeper inequalities or unpleasant results which could harm the environment in the future [50]. All in all, even though AI speeds up product development and manufacturing, it is essential to address the challenges related to data integrity, transparency, being ethical and shaping the industrial workforce. To construct trustworthy, fair and value-aligned AI, we need to face and resolve these obstacles [51].

The Future: Making AI Systems Reliable and Focused on People

Now, as AI is changing product development and manufacturing, focus is being placed on developing AI that is reliable, moral and puts people's interests first. The optimization of AI will happen when we find a balance between automation, autonomy, transparency, accountability and meaningful cooperation between humans and machines, so AI helps businesses and society [52].

An important goal as AI grows is to create explainable AI (XAI). It provides more understanding of the factors and rules that influence the decisions and predictions from AI systems. Because complex products involve many steps, being transparent about AI's reasoning helps engineers and managers accept the results, confirm them and fix any issues effectively [53]. By explaining ability,

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support for emerging regulations and industry requirements is provided, especially for the healthcare, aerospace and pharmaceutical industries that require accountability the most [54].

Resilient AI systems should be made to be both strong and flexible. The manufacturing business is fast-changing due to the continuous alterations in its operational conditions. AI models have to be able to handle situations they are not clear about and new data, continuously evolve and stay reliable. Online classes, federated learning and architectures that mix symbolic thought with data-based algorithms are some of the methods needed [55].

AI design in the future will place an emphasis on considering people's needs and interests. It is now more common to consider AI as a tool to boost human skills in problem-solving, creativity and making decisions. To accommodate this shift, AI tools have to be straightforward, including processes based on natural language and visual representations, so they can be used correctly by anyone [56]. In addition, trust and transparency play a key role in guaranteeing that people working in these fields are not left out after automation.

Energy ethics must always be included in the process of making AI. Strong emphasis on fairness, privacy and inclusivity in the design of systems can help keep bias and discrimination away and lead to equal results during the full cycle of the product. Thus, several stakeholders are brought in at this stage to make sure a wide range of insights and inputs are included [57].

Going forward, the idea of self-improving manufacturing is being adopted, making it possible for factories powered by AI to adjust and enhance themselves all the time through learning, modeling and real-time updates. Although AI could make things operate smoothly and efficiently, it also means finding ways to balance AI's use with human supervision and control [58]. All things considered, the growth of AI in developing and producing goods will focus on brilliance, responsibility and cooperation among humans and machines. When AI systems are created to be sturdy, transparent and friendly to people, industries can enjoy sustainable growth, better results and important advancements that help society as well.

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Conclusion

Artificial Intelligence is acting as a key driver in reforming all aspects of product development and manufacturing. With its use in design, adaptable manufacturing and handling complicated supply lines, AI greatly improves the efficiency and greenness of industries. Yet, even as we have seen in our review, introducing AI means addressing both promises and problems with care.

Developing products with AI isn't just about using new gadgets; it is also about changing the way companies approach and implement innovation. AI allows companies to handle masses of information, understand things never seen before and join efforts with human specialists as never before. Simultaneous use of human ideas and machine intelligence results in better products and systems that can easily respond to market changes.

At the same time, there are some difficulties in deploying AI. Matters such as flawed information, biased technologies, hidden business practices and privacy or workforce problems require effective strategies and rules. If these obstacles are not handled, mistrust, waste and disastrous outcomes are more likely which may stop AI from reaching its potential.

In the future, for AI to succeed in product development and manufacturing, it must be powerful, but also able to handle pressure, explain its functions and focus on people. When we use explainable AI, trust and accountability increase and adaptive learning makes sure AI adapts when things in the business change. When humans are placed as the center of AI interaction, they can collaborate instead of fighting for control.

In addition, ensuring sustainability is important, so AI should be used to address waste issues, manage the use of resources and align with the principles of a circular economy. Businesses that value ethics in their AI processes will achieve greater success over time and improve life for people.

To sum up, advancing in product development and manufacturing through AI means considering both emerging technologies and ethical issues, as well as people's well-being. If real-life learning, clear and flexible AI and alliances with broad cooperation are adopted, industries will fully achieve

AI's potential. Achieving this transformation helps companies become more competitive and it also moves industry towards one that is more responsible and advanced.

References

[1]. Akhtar P, Ghouri AM, Ashraf A, Lim JJ, Khan NR, Ma S. Smart product platforming powered by AI and Generative AI: Personalization for the circular economy. International Journal of Production Economics. 2024 Jul 1; 273:109283.

[2]. Wang WY, Zhang S, Li G, Lu J, Ren Y, Wang X, Gao X, Su Y, Song H, Li J. Artificial intelligence enabled smart design and manufacturing of advanced materials: the endless Frontier in AI+ era. Materials Genome Engineering Advances. 2024 Sep;2(3):e56.

[3]. Cooper RG. How to transform your new-product development with AI: From vision to deployment. ISBM (Institute for the Study of Business Markets). 2024 Jan.

[4]. Mourtzis D. Industry 4.0 and smart manufacturing. InManufacturing from Industry 4.0 to Industry 5.0 2024 Jan 1 (pp. 13-61). Elsevier.

[5]. Mishra SB, Liyakat KK. AI-Driven-IoT (AIIoT) Based Decision-Making in Molten Metal Processing. Journal of Industrial Mechanics. 2024 Nov 21;9(2):45-56.

[6]. Qudus L. Leveraging Artificial Intelligence to Enhance Process Control and Improve Efficiency in Manufacturing Industries. International Journal of Computer Applications Technology and Research. 2025;14(02):18-38.

[7]. Kalla D, Smith N. Integrating IoT, AI, and big data for enhanced operational efficiency in smart factories. Educational Administration: Theory and Practice. 2024 May;30(5):14235-45.

[8]. Nuka ST. Leveraging AI and Generative AI for Medical Device Innovation: Enhancing Custom Product Development and Patient Specific Solutions. Journal of Neonatal Surgery. 2025;14(4s).

[9]. Salierno G, Leonardi L, Cabri G. Generative AI and Large Language Models in Industry 5.0: Shaping Smarter Sustainable Cities. Encyclopedia. 2025 Feb 21;5(1):30.

[10]. Ponnusamy V, Ekambaram D, Zdravkovic N. Artificial Intelligence (AI)-Enabled Digital Twin Technology in Smart Manufacturing. InIndustry 4.0, Smart Manufacturing, and Industrial Engineering 2025 (pp. 248-270). CRC Press.

[11]. Li D, Liu S, Wang B, Yu C, Zheng P, Li W. Trustworthy AI for human-centric smart manufacturing: A survey. Journal of Manufacturing Systems. 2025 Feb 1;78:308-27.

[12]. Omidian H. AI-powered breakthroughs in material science and biomedical polymers. Journal of Bioactive and Compatible Polymers. 2025 Mar;40(2):161-74.

[13]. Samblani G, Bhatt DP. Case Studies of Next Generation AI for Intelligent Manufacturing. InIntelligent Manufacturing and Industry 4.0 2025 (pp. 217-236). CRC Press.

[14]. Moustafa AW, Muhammad MA, Essawy AM. The Impact of Artificial Intelligence AI in Enhancing Experience Design of Physical Products. International Design Journal. 2025 Jan 1;15(1):11-30.

[15]. Sahoo S, Lo CY. Smart manufacturing powered by recent technological advancements: A review. Journal of Manufacturing Systems. 2022 Jul 1;64:236-50.

[16]. Wang Y, Zheng P, Peng T, Yang H, Zou J. Smart additive manufacturing: Current artificial intelligence-enabled methods and future perspectives. Science China Technological Sciences. 2020 Sep;63(9):1600-11.

[17]. Liu C, Tian W, Kan C. When AI meets additive manufacturing: Challenges and emerging opportunities for human-centered products development. Journal of Manufacturing Systems. 2022 Jul 1;64:648-56.

[18]. Wan J, Li X, Dai HN, Kusiak A, Martinez-Garcia M, Li D. Artificial-intelligence-driven customized manufacturing factory: key technologies, applications, and challenges. Proceedings of the IEEE. 2020 Nov 23;109(4):377-98.

[19]. Tyagi AK, Bhatt P, Chidambaram N, Kumari S. Artificial Intelligence Empowered Smart Manufacturing for Modern Society: A Review. Artificial Intelligence-Enabled Digital Twin for Smart Manufacturing. 2024 Oct 15:55-83.

[20]. Ahmed MB, Majeed F, Sanin C, Szczerbicki E. Enhancing product manufacturing through smart virtual product development (SVPD) for Industry 4.0. Cybernetics and Systems. 2020 Feb 17;51(2):246-57.

[21]. Shin KY, Park HC. Smart manufacturing systems engineering for designing smart product-quality monitoring system in the Industry 4.0. In2019 19th International Conference on Control, Automation and Systems (ICCAS) 2019 Oct 15 (pp. 1693-1698). IEEE.

[22]. Kusiak A. Smart manufacturing. International journal of production Research. 2018 Jan 17;56(1-2):508-17.

[23]. Malik FS, Sahibzada S, Nasir S, Lodhi SK. Machine Learning-Enhanced Turbulence Prediction and Flow Optimization for Advanced Aerodynamic Design in High-Speed Regimes. European Journal of Science, Innovation and Technology. 2024;4(6):39-46.

[24]. Siddique I. Advancements in Industrial Engineering: Integrating Smart Technologies for Optimal Production Management. European Journal of Advances in Engineering and Technology. 2023 Sep 30;10(9):71-8.

[25]. Praveen RV, Mutya B. AI in Manufacturing: Building Smarter Factories. Addition Publishing House; 2024 Oct 29.

[26]. Subramanian S. Leveraging IoT data streams for AI-based quality control in smart manufacturing systems in process industry. Journal of AI-Assisted Scientific Discovery. 2023 Aug 8;3(3):37.

[27]. Javaid M, Haleem A, Singh RP, Suman R. Artificial intelligence applications for industry 4.0: A literature-based study. Journal of Industrial Integration and Management. 2022 Mar 21;7(01):83-111.

[28]. George AS, George AH, Baskar T. The evolution of smart factories: how industry 5.0 is revolutionizing manufacturing. Partners Universal Innovative Research Publication. 2023 Oct 11;1(1):33-53.

[29]. Xu J, Kovatsch M, Mattern D, Mazza F, Harasic M, Paschke A, Lucia S. A review on AI for smart manufacturing: Deep learning challenges and solutions. Applied Sciences. 2022 Aug 17;12(16):8239.

[30]. Adebayo RA, Obiuto NC, Olajiga OK, Festus-Ikhuoria IC. AI-enhanced manufacturing robotics: A review of applications and trends. World Journal of Advanced Research and Reviews. 2024;21(3):2060-72.

[31]. Jwo JS, Lin CS, Lee CH. Smart technology–driven aspects for human-in-the-loop smart manufacturing. The International Journal of Advanced Manufacturing Technology. 2021 May;114:1741-52.

[32]. Braun, V., and Clarke, V. 2006. Using thematic analysis in psychology. Qualitative Research in Psychology 3(2): 77–101.

[33]. Al-Amin M, Hossain T, Islam J. The technology development and management of smart manufacturing system: A review on theoretical and technological perspectives. The Technology Development and Management of Smart Manufacturing System: A Review On Theoretical and Technological Perspectives. 2021:170-93.

[34]. Schulz C, Kortmann S, Piller FT, Pollok P. Growing with smart products: Why customization capabilities matter for manufacturing firms. Journal of Product Innovation Management. 2023 Nov;40(6):794-816.

[35]. Sadasivan M, Vasumathi MT, Jayanthi M. Artificial intelligence for smart manufacturing using digital twin technology. InArtificial Intelligence based Solutions for Industrial Applications 2024 Nov 20 (pp. 176-194). CRC Press.

[36]. Lal B, Kumar MA, Chinthamu N, Pokhriyal S. Development of product quality with enhanced productivity in industry 4.0 with AI driven automation and robotic technology. In2023 Second International Conference on Augmented Intelligence and Sustainable Systems (ICAISS) 2023 Aug 23 (pp. 184-189). IEEE.

[37]. Capgemini. 2017. Smart factories: How can manufacturers realize the potential of digital industrial revolution? May 17. https://www.capgemini.com/resources/smart-factorieshow-can-manufacturers-realize-the-potential-of-digitalindustrial/

[38]. Zeb S, Lodhi SK. AI and Cybersecurity in Smart Manufacturing: Protecting Industrial Systems. American Journal of Artificial Intelligence and Computing. 2025 Apr 7;1(1):1-23.

[39]. Iansiti, M., and Lakhani, K. 2014. Digital ubiquity: How connections, sensors, and data are revolutionizing business. Harvard Business Review 92(11): 90–99.

[40]. Phuyal S, Bista D, Bista R. Challenges, opportunities and future directions of smart manufacturing: a state of art review. Sustainable Futures. 2020 Jan 1;2:100023.

[41]. Doanh DC, Dufek Z, Ejdys J, Ginevičius R, Korzynski P, Mazurek G, Paliszkiewicz J, Wach K, Ziemba E. Generative AI in the manufacturing process: theoretical considerations. Engineering Management in Production and Services. 2023;15(4).

[42]. Kodumuru R, Sarkar S, Parepally V, Chandarana J. Artificial Intelligence and Internet of Things Integration in Pharmaceutical Manufacturing: A Smart Synergy. Pharmaceutics. 2025 Feb 22;17(3):290.

[43]. Mubarak MF, Biggadike C, Ahumada-Tello E, Evans R. AI in New Product Development: Opportunities, Applications, and Managerial Implications. IEEE Engineering Management Review. 2024 Nov 25.

[44]. Al Bashar M, Khan IH. Artificial intelligence in industrial engineering: A review. International Journal of Scientific Research and Engineering Development. 2017;2(3).

[45]. Tao F, Qi Q, Wang L, Nee AY. Digital twins and cyber–physical systems toward smart manufacturing and industry 4.0: Correlation and comparison. Engineering. 2019 Aug 1;5(4):653-61.

[46]. Puthanveettil Madathil A, Luo X, Liu Q, Walker C, Madarkar R, Cai Y, Liu Z, Chang W, Qin Y. Intrinsic and post-hoc XAI approaches for fingerprint identification and response prediction in smart manufacturing processes. Journal of Intelligent Manufacturing. 2024 Feb 28:1-22.

[47]. Koren I, Jarke M, Michael J, Heithoff M, Tacke Genannt Unterberg L, Stachon M, Rumpe B, van der Aalst WM. Navigating the Data Model Divide in Smart Manufacturing: An Empirical Investigation for Enhanced AI Integration. InInternational Conference on Business Process Modeling, Development and Support 2024 May 31 (pp. 275-290). Cham: Springer Nature Switzerland.

[48]. Li X, Wang Z, Chen CH, Zheng P. A data-driven reversible framework for achieving Sustainable Smart product-service systems. Journal of Cleaner Production. 2021 Jan 10;279:123618.

[49]. Jujjavarapu G, Hickok E, Sinha A, Mohandas S, Ray S, Bidare PM, Jain M. AI and the Manufacturing and Services Industry in India. The center for Internet and Society, India (06/01/2019). 2018 Mar.

[50]. Hu Y, Jia Q, Yao Y, Lee Y, Lee M, Wang C, Zhou X, Xie R, Yu FR. Industrial internet of things intelligence empowering smart manufacturing: A literature review. IEEE Internet of Things Journal. 2024 Feb 20;11(11):19143-67.

[51]. Lodhi SK. Synaptic Harmonies: Applying Graph Coloring Algorithms to Mental Health AI Systems. Global Journal of Emerging AI and Computing. 2025 Jan 26;1(1):83-91.

[52]. Sharma D, Tripathi K. Navigating the digital age: smart manufacturing and logistics. InRecent Trends in Artificial Intelligence Towards a Smart World: Applications in Industries and Sectors 2024 Sep 10 (pp. 99-144). Singapore: Springer Nature Singapore.

[53]. Manimuthu A, Venkatesh VG, Shi Y, Sreedharan VR, Koh SL. Design and development of automobile assembly model using federated artificial intelligence with smart contract. International Journal of Production Research. 2022 Jan 2;60(1):111-35.

[54]. Sarker IH. AI-based modeling: techniques, applications and research issues towards automation, intelligent and smart systems. SN computer science. 2022 Mar;3(2):158.

[55]. Mathew D, Brintha NC, Jappes JW. Artificial intelligence powered automation for industry 4.0. InNew horizons for Industry 4.0 in modern business 2023 Feb 10 (pp. 1-28). Cham: Springer International Publishing.

[56]. Bilal Ahmed M, Imran Shafiq S, Sanin C, Szczerbicki E. Towards experience-based smart product design for industry 4.0. Cybernetics and Systems. 2019 Feb 17;50(2):165-75.

[57]. Rai R, Tiwari MK, Ivanov D, Dolgui A. Machine learning in manufacturing and industry 4.0 applications. International Journal of Production Research. 2021 Aug 18;59(16):4773-8.

Volume2:Issue1 ***ISSN: 3008-0509***

[58]. Malik S, Muhammad K, Waheed Y. Artificial intelligence and industrial applications-A revolution in modern industries. Ain Shams Engineering Journal. 2024 Jun 4:102886.