2 Reimagining Innovation: Where Generative Design Meets Smart Manufacturing

Mr. Adarsh Kumar Pandey[1*], Ms. Sakshi Sharma[2], Mr. Neeraj Kushwaha[3],
***Mr.* Bablu Kushwaha[4] & Ms. Gehna Sachdeva[5]**

[1,2,3]Assistant Professor, Poornima University Jaipur.
[4,5]Assistant Professor, Marwadi University, Rajkot.

Corresponding Author: adarshkumarpandey2311@gmail.com

Abstract

Production has always been the focus of the main technical revolution - from the steam engine to the assembly line from the first industrial dysfunction revolution that allows a large amount of production, robotics and automation that improves factories in the twentieth century. Today, with industry 4.0, a new change is underway by generating design, a powerful approach to designing products and redefining how the built is made. Unlike traditional methods that are based on experience, inward. No and repetitive experiments and errors, the generating design process varies basically. Designers no longer start with fixed forms or layouts; Instead, they set goals and limitations such as weight, strength, size, material, cost and production methods. AI algorithms, imitation and evaluation of thousands, millions of people, evaluate opportunities to provide Optimisms solutions. These results usually exceed human imagination, motivated by natural standards and biomecys to produce more easily, stronger and resource -better projects. One of the main benefits is the pace of innovation. Traditional production development can take weeks or months in prototypes, while normal design can produce and validate options in hours or days. Periodically reduces the market and helps companies to be tight and competitive. In addition, in view of the use of low waste and energy zones, effectively with materials, they are well suited to advanced production techniques such as adorable production (3D printing). The complex assembly can be integrated into unique individual pieces, which can reduce production stages, costs and carbon footprints. It is important in current stability in the world. Geocentric design is re -shaping industries. Aerospace companies are still developing sustainable ingredients to improve fuel efficiency. Automotive manufacturers use it to increase safety and reduce production costs to

reduce the weight of the vehicle. In the field of health, it allows the very personalized implants to adapt to individual patients - impractical from traditional methods. Challenges, including complexity for interpreting AI-generated projects, remaining the need for advanced software and hardware and the need to eliminate the workforce. However, as computer power increases and AI improves, generic design will become more accessible and cooperating. The future may see the right partnership between human creativity and the intelligence of machines. In short, generic design is not just a tool, but a paradigm change in production - which is a human simplicity with computational power to speed up innovation, efficiency and stability in product development.

Keywords: Reimagining Innovation, Technical Revolution, AI-Generated Projects, Product Development, 3D Printing.

Introduction

Throughout history, manufacturing has been a motivational power behind continuous technological progress. From the steam engine that operates the industrial revolution for the use of robotics in modern factories, each advancement has changed how products are made. Today, we stand at the threshold of another significant change - industry 4.0 - which is re -shaping manufacturing through integration of digital technologies, automation and artificial intelligence. One of the most ground innovations to emerge from this new era is generic design.[1]

Generative design is not just a tool, but a new approach to engineering and product development. At its core, it takes advantage of the power of AI and advanced algorithm, which, to detect a wide design space, generates thousands of possible solutions for a given problem. Unlike traditional design methods - where human engineers rely on experience, intuition and recurring tests - the generative design begins with a set of parameters and obstacles.

By processing this input, the generic design system rapidly simulates and evaluates countless design options. This then optimized, ready-to-manufacture solutions-many of which are unconventional or completely unpredictable from human point of view. These results are not only visually; They are often more efficient and durable, which take full advantage of modern manufacturing technologies such as adorable manufacturing (3D printing). The ability to automate and optimize design exploration provides many major benefits to manufacturers. This significantly reduces the time of growth, cuts the prototype cost, and enables rapid time-to-market. In addition, because the software incorporates manufacturing and stability from the beginning, the resulting products are often mild, strong and more resource-skilled.

Generic design is already making waves in industries such as aerospace, automotive and consumer goods, where performance and efficiency are paramount.[2] While challenges remain-as the software complexity and the need for skilled designers that can explain and refine the AI-generated model is evident. This chapter explains how generic design manufacturing is re -shaping driving innovation, and pointing to a future where human creativity and machine intelligence work together, which works to design more smarter, faster and more continuously than ever.

What is Generative Design?

The productive design represents a transformational change of how products are imagined and developed. It is an advanced, AI-operated, recurring design process that enables highly efficient and innovative solutions by discovering vast design possibilities. The root of this approach is intelligent software that can imitrse, evaluate and refine countless design options based on user-defined parameters.

In a generative design workflow, engineers and designers begin to input specific requirements, such as the purpose of performance, physical properties, weight range, cost and preferred manufacturing methods. The software then uses complex algorithms - such as topology optimization, simulation technique and machine learning - to generate different types of viable solutions. Each design recurrence is automatically evaluated for functionality and manufacturer, ensuring that outputs are not only high performing, but also practical for real -world production.[3]

The ability to detect the entire width of the solution location, which is set by traditional methods, that sets generic design, is that is human prejudices or preceding assumptions. While the traditional design depends a lot more on the previous experience and testing-and-testing processes, generic design novels take advantage of computational power to highlight novel geometric and unconventional forms, often resemble the organic structures found in nature. These designs are usually adapted to weight loss, structural integrity and material efficiency.

In short, generic design published creativity and computation, which provides a powerful tool for innovation. This allows designers to advance borders, accelerate development cycles and achieve adaptation levels earlier.

The Evolution of Design in Manufacturing

For decades, traditional manufacturing design has followed a linear and manual process. It usually begins with hand-made sketch or computer-admitted design (CAD) model, followed by several rounds of prototypes and tests. While this method has produced countless successful products, it is naturally a time-consuming, labor-intensive, and often prohibited to discover only a limited number of design variations. The creative ability of this approach is largely bound by designer's intuition, experience and available computational resources.[4]

With the advent of digital tools, parametric design and simulation technologies greatly improved speed and accuracy. Designers can now make rules-based models and can test them under virtual conditions, which can reduce the requirement of physical prototype. However, even with this progress, the design place remained forced. Human designers can only detect certain options within a realistic time frame, often refine existing ideas rather than completely entering new possibilities.

Enter a revolutionary change in the product development scenario. Unlike traditional methods, generic design uses AI and machine learning algorithms to detect a huge array of autonomally design options. Engineers and designers define the location of the problem by specifying goals, obstacles, materials and manufacturing methods. The system then rapidly evaluates hundreds or thousands of solutions and evaluates them, many of which are unconventional or completelynovels.[5]

This approach reduces human bias and pushes beyond the range of traditional creativity. Software recurrent and optimizes each design for performance, manufacturing and cost-effectiveness, distributes data-drive.

How Generative Design Works

The generative design process has changed fundamentally by introducing a computational, AI-operated approach for problems-solution and solution development. This design begins with a careful definition of challenge: engineers and designers input various parameters such as performance goals (eg, weight loss, power, or increase energy efficiency). With these goals, lack of required design is established - from material selection and functional requirements to regulatory standards and capabilities of intended manufacturing methods (such as adorable manufacturing, CNC machining, or hybrid process) to the capabilities or borders. When the design space is mapped, take the advanced AI algorithms and computational tools- directed by user's input.These systems autonomally produce a wide array of potential design solutions, sequentially and discovering forms that can separate human designers.[6] Each proposed option is rapidly evaluated against the set performance criteria, including structural integrity, weight distribution, humility, thermal performance and strict adherence to specified obstacles. This allows for a broad, fair exploration of the entire computational search design solution location.

Next, intuitive vigorous visualization and comparative display analysis presents results for the design team. Engineers are empowered to examine trade and stops between various solutions, such as cost, physical efficiency, mechanical strength, life cycle adjournment and environmental impact. This transparent review process enables the informed decision making, where the most fitting design is selected for refinement based on the unique objectives of the project. The selected design then enters a rig.

Table: Key Steps in the Generative Process

Process Step	Description
Design Challenge Definition	Define objectives, constraints, materials, and manufacturing methods.
Algorithmic Design Generation	AI generates numerous design alternatives exploring vast permutations.
Performance Evaluation	Automated evaluation of designs against performance and manufacturing criteria.
Design Visualization & Selection	Intuitive comparison and trade-off analysis to select optimal design.
Simulation & Testing	Digital simulations for stress, thermal, and operational feasibility testing.
Prototyping & Manufacturing	Physical prototyping, often via additive manufacturing, for real-world validation.

Key Benefits of Generative Design

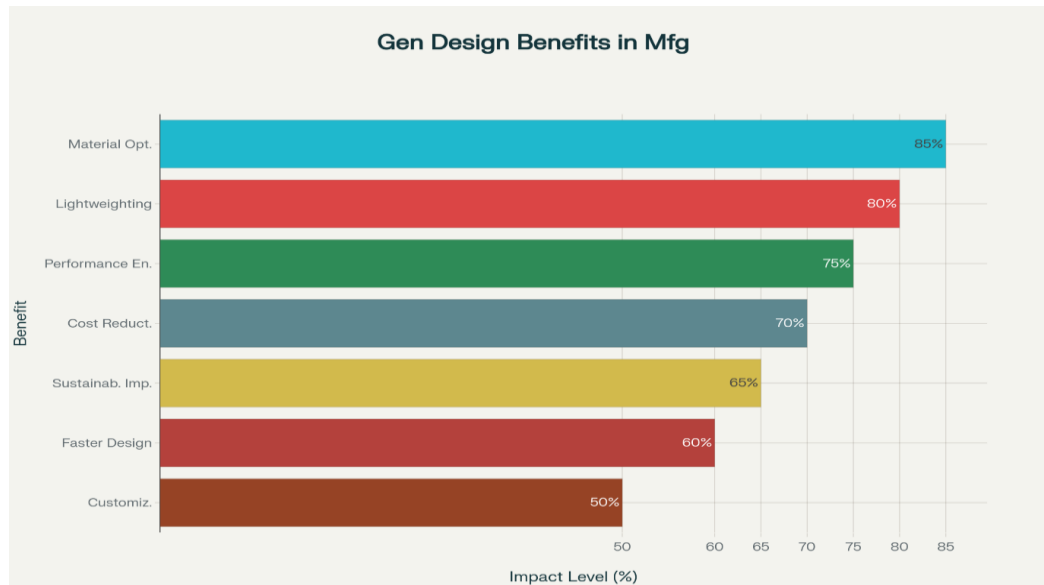Key benefits of Generative Design in Modern Manufacturing:

Producer design is changing the manufacturing landscape by presenting smart, faster and more durable methods to develop products. This offers a wide range of AI-powered approach benefits that affect the cost, efficiency and innovation directly.

One of the primary benefits is the content adaptation. By using the amount of material required to meet the performance goals, the generative design reduces both consumption and production waste - leading to low cost and better stability. It also supports lightweight, which is particularly important in industries such as aerospace and automotive where even small cuts in weight can lead to significant improvement in fuel efficiency and performance. Generative design also increases performance growth. Each design is simulated and tested, ensuring that the final models are not only found, but often more than the target matrix for strength, durability and functionality. This process contributes to adequate cost cuts, as it reduces the requirement of several physical prototypes, reduces dependence on expensive tooling, and the product accelerates verification.

Stability is achieved by reducing energy usage, reducing waste and enabling environmentally conscious material selection. In terms of speed, rapid design cycles are a major benefit. Automatic exploration and adaptation made heavy cuts in the time of development, helping manufacturers to bring products faster.[7]

In addition, generic design supports large -scale adaptation - enables the manufacture of individual products to suit individual requirements without provoking high production costs. This level of flexibility gives manufacturers the right to meet the specific customer demands while maintaining efficiency and scalability.

Together, these benefits

Real-World Applications of Generative Design Across Industries

The generative design has gone beyond theoretical promise and in a wide range of industries in practical applications. From automotive and aerospace to consumer products and healthcare, companies are embracing AI-operated design processes to customize components, lose weight and improve overall performance. This section highlights how major organizations have successfully applied generic design and important results.

- **Automotive Industry**

In the automotive region, generative design is proving significant in light components, improving performance, and increasing space use. For example, General Motors (GM) participated with the autoodesk, which is to re -connect a seat bracket using a generative design. The result was a part that consolidated eight individual components into the same structure. Not only did this innovation reduce the weight by 40%, but it also increased the strength of 20%, showing the power of automatic adaptation.

Similarly, Toyota used generic design to develop lighter and thin seat frames. These designs not only reduced the weight of the overall vehicle, but also made more cabin location and better passenger ergonomics- modern vehicles required for interiors where comfort and efficiency are the major preferences.

- **Aerospace Industry**

In aerospace, where each gram saved translates into a reduction in fuel efficiency and cost, tribal design components bring revolution in development. Jacobs

Engineering implemented generative methods to adapt the component layouts to enable rapid exploration of design options while following strict performance and regulatory requirements. It led the use of efficient materials and innovative designs for parts such as wing components and structural support.

- **Consumer Products**

Consumer goods industry, especially in footwear, has adopted the general design for individual products. The new balance, in collaboration with the design studio, created a custom running shoe midsol using the generative algorithm jointly with 3D printing technologies. These midsoles offered better cushioning, enhanced durability, and consistent with individual users' moves and pressure patterns - completing both performance and comfort.

- **Medical Devices**

In healthcare domains, generic design has enabled the development of excessive ergonomic and patient-specific medical devices. This includes prosthetics and implants that are light, strong and more physically adapted to the last user. At this stage adaptation improves comfort and functionality a lot, especially in orthopedic and rehabilitation care.[8]

- **Tool Manufacturing**

The manufacturers of industrial equipment are also benefiting. For example, a criming tool attachment was re -designed using generative principles, resulting in a 60% weight reduction and quite rapid production time. This not only improved the equipment purpose, but also enhanced productivity on the factory floor.

Table 1: Example Applications of Generative Design in Industry

Industry	Component	Outcome
Automotive	Seat Bracket	40% lighter, 20% stronger, consolidated 8 parts into 1
Automotive	Suspension Mount	40% lighter, rapid prototyping
Aerospace	Wing Components	Material savings, weight reduction
Consumer Footwear	Running Shoe Midsole	Custom fit, enhanced resilience and performance
Tool Manufacturing	Crimping Tool Attachment	60% lighter, faster and more efficient production
Medical Devices	Prosthetics and Implants	Lightweight, ergonomic, highly personalized

These real -world examples outline the wide -purpose and immense value of general design. By automating the discovery of design possibilities and focusing on efficiency, performance and adaptation, changing product innovation in generic design industries.

Generative design and Advanced Manufacturing Technologies

The real ability of generic design is realized when integrated with state -of -the -art construction technologies. By aligning digital design capabilities with advanced production methods, the generative design not only accelerates innovation, but also ensures that the design is practical, manufacturing and cost-skilled.

A major enabled of generic design is an adorable manufacturing, or 3D printing. This technique is ideally conducive to the production of complex, organic geometrics generated by the AI-based algorithms. Shaps are almost impossible to create using traditional methods. The material reduces waste by constructing a layer of components by the additive manufacturing layer and enables rapid prototyping, which allows quick verification of the design and rapid time for the market. It is particularly useful in industries such as aerospace, motor vehicle and medical devices, where weight loss and adaptation are important.

In addition, generic design can be aligned with CNC machining by incorporating specific manufacturing obstacles in the design process. By defining parameters such as tool access, machining direction and minimum feature size, designers can ensure that the final geometric subtractions are compatible with manufacturing methods, leading to infection from digital to physical seamless and skilled.[9]

Casting and injection molding also benefit from the adaptability of generic design. The software can take into account important factors such as the draft angle, undercuts and material flow during the design phase, ensuring that the solutions generated are suitable for high-lecratory processes and mold construction.

Another limit of coordination lies in integration with digital thread technologies and knowledge graphs. By embedding generic designs in a digital thread - connected data flow that tracks a product during its life cycle - outfits from outfits may get more traceability, version control and design reuse. Knowledge gradation enhances intelligent navigation through complex design and manufacturing data enhances it, supporting better decisions and constant adaptation.

Together, these in tergrations ensure that generic design does not work in isolation, but serves as part of a large, intelligent and associated manufacturing ecosystem.

Table 2: Impact Comparison- Traditional vs Generative design

Factor	Traditional Design	Generative Design
# Design Options	2–5	100+
Time-to-Market	Months+	Weeks
Material Waste	High	Low
Customization	Low	High
Weight Reduction	5–10%	Up to 40% or more
Performance	Meets min specs	Optimized to max

The Evolution of Generative Design: AI, Sustainability, and Industry 4.0

Reinforcing the landscape of modern manufacturing, the generic design continues to grow rapidly. With its AI-manufacturing approach to automation and adaptation, it is now extending with many advanced technologies, expanding its scope and practical relevance. -As the manufacturing ecosystem becomes more digital, intelligent and durable, the following trends and directions are defining the future of liberal design:

- **Integration with AI and Machine Learning**

One of the most important events in generic design is its deep integration with Artificial Intelligence (AI) and Machine Learning (ML). These technologies increase the ability of software to adapt to real -time adaptation and simulation, dramatically accelerate the design process. The machine enables learning systems to learn from previous designs, identify patterns and learn clusters and rank solutions wisely based on the performance metrics. It leads to clever, sharp and more relevant design output, which reduces the time from the concept to the final product.

- **Cloud-Based Accessibility**

Step towards cloud-based platforms is democratizing access to general design devices. By eliminating the requirement of high-level local computing infrastructure, cloud solutions allow engineers, designers and manufacturers worldwide to collaborate in real time.[10]This scalability ensures that even a powerful generic design capabilities can take advantage of powerful generic design capabilities without promoting even smaller IT expenses from medium -sized firms.

- **Multi-Material and Hybrid Manufacturing**

Generic design is being rapidly adapted to adjust multi-content and hybrid manufacturing scenarios. This allows development designers to adapt to components that include multiple materials with different qualities, such as hardness, heat resistance or weight. The power to improve the ability to manage these variables is ensured-better structural integrity and more efficient material distribution in parts.

- **Sustainability as a Core Metric**

As industries go to environmentally conscious practices, stability has become a fundamental design goal rather than a later. Generative design platforms now allow adaptation not only for performance and cost but also for environmental impact. Designers can choose materials with low carbon footprints and prefer solutions that reduce waste and energy consumption. It aligns generic design with global stability goals and corporate ESG (environment, social and governance) initiatives.

- **Customization at Scale**

    One of the most promising abilities of generative design is its support for mass adaptation. With algorithm-intensive personalization, it is now possible to produce products to suit individual user needs-it is without great increase in footwear, wareballs, medical devices or consumer electronics. This trend is expected to increase, especially consumers demand more individual, user-centered experiences.[11]

- **Integration with Industry 4.0 Ecosystems**

    The generative design industry is becoming a main part of the 4.0 framework, where manufacturing systems are rapidly smart, connected and data-operated. When IOT is integrated with devices, digital twins, and real -time analytics, the generic design creates a feedback loop where product usage may develop continuously based on data and performance monitoring. This enables adaptive design correction, future stating maintenance and more efficient production strategies.

- **Barriers to Successful Implementation of Generative Design**

    The generative design is changing rapid design and manufacturing landscape through its ability to generate innovative, high-performance solutions. However, despite its promises and increasing implementation in industries, the path to adopt widely is not without its challenges. For organizations aimed at integrating generic design in your product development workflows, many technical, cultural and regulatory obstacles should be addressed. This section examines major challenges and ideas that affect successful adoption and deployment of general design.[12]

- **High Computational Demands**

    One of the most urgent and practical challenges of generic design is required for an important computational power. The generative algorithms run intensive simulation, detect large design places, and evaluate thousands of recurrent before giving customized solutions. These processes often exceed the capabilities of standard workstation, which require the use of high-demonstration computing (HPC) environment or cloud-based platforms. While cloud solutions helps reduce the cost of infrastructure and improve access, they can especially introduce concerns related to data protection, delay and membership costs for small to medium -sized companies. Thus, organizations should carefully assess their computing infrastructure and consider the investment required to support strong processing requirements of generic design.

- **Dependence on High-Quality Data**

    The accuracy and utility of the generative design output is highly dependent on the quality and perfection of the input data. These include information about materials, manufacturing processes, lack of performance and environmental conditions. If the

underlying data is chronic, incompatible, or incomplete, the resulting design can be sub-bound or incredible for real-world production. In practice, compiling and maintaining a broad database of valid design rules, simulation models and material libraries is a considerable effort.[13] Thus the success of generic design workflows rests on a strong foundation of data governance and digital asset management, ensuring that all design inputs are accurate, current and relevant.

- **Regulatory and Certification Complexity**

The generative design presents a unique challenge to industries with strict regulatory standards, such as aerospace, motor vehicle and medical equipment. Regulatory bodies often require complete traceability, repetition and human-understanding logic for design decisions behind a product. However, generic design - complex -operated AI algorithm and recurred adaptation - yield solutions that can be difficult to prove interpretation or justification using traditional methods. This "black-box" of AI-Janit designs increases concerns about nature certification, liability and safety. To obtain regulator approval, companies must install transparent documentation protocols, validate the performance through rigorous testing, and in some cases, develop new structures to interpret and interpret the reasoning behind the generative output. This regulator can slow down adoption, especially in safety applications.[14]

- **Continued Need for Human Expertise**

Although the generative design automates an important part of the creative process, it does not eliminate the need for efficient human designers and engineers. In fact, human inspection is important in the entire generative design life cycle. Experts need to define accurate input parameters, explain AI-borne results and make final decisions based on real-world viability, aesthetics, ergonomics and user experience.

In addition, generic equipment is yet to understand relevant, emotional or brand-specific design ideas-areas where human creativity and decisions are unavoidable. Thus, successful adoption of generic design depends on hybrid cooperation, where AI increases human ability rather than changing it.[15]

- **Integration with Legacy Systems and Mindsets**

Another major obstacle in adopting generative design lies in its integration with existing workflows, systems and organizational culture. Many traditional design teams are accustomed to linear, experience-driven processes and can oppose infection in data-centered, automated functioning. Introduction to generic design requires not only new devices, but requires a change in mindset-by looking at the design as a manually controlled act. Additionally, there may be a lack of compatibility or flexibility required to adjust the output of the generative platform in the Ligi CAD software, PLM (product life

cycle management) system, and manufacturing workflows. To ensure a smooth transition to reduce this difference, workflow integration, employee training and investment management are required.[16]

Conclusion

Generic designs are rapidly emerging as one of the most disruptive forces in modern manufacturing, not only how we design products, but we are exposed to the entire product development life cycle. AI-operated computers strengthens generative design engineers and designers to detect a comprehensive solution location with unprecedented speed, efficiency, and accuracy, by replacing traditional, testing-and-trunk methods with computational creativity. This change is enabling innovations in diverse domains - from aerospace and motor vehicle to medical devices and consumer products - to uncontrollable new opportunities for competitive benefits and permanent growth. At its core, generic design takes advantage of the power of algorithms to generate thousands of viable design options based on specified goals and obstacles. Whether the objective is losing weight while maintaining structural power, optimizing physical usage, improving thermal or aerodynamic performance, or increasing manufacturing, can distribute generative design system solutions that often exceed the capabilities of human designers. These algorithm-borne options are validated through real-time simulation, which is capable of making informed decisions in the design process long before the physical prototype or manufacturing starts.

One of the most visible effects of generative design lies in lightweight. Especially important in areas such as aerospace and automotive, where every gram matters, generic design produces organic, forged structures that significantly reduce weight without renouncing durability or performance. It not only leads to physical savings and low fuel consumption, but also reduces emissions and operating costs - this performance forms the cornerstone of both engineering and stability strategies.

The role of stability in generic design cannot be overstated. As manufacturers provide increasing pressure to align with environmental rules and carbon neutrality goals, generic design offers a powerful tool to reduce physical waste, adapt energy use and select low-effect content. Many platforms are now incorporating stability as a primary barrier with cost and performance, ensuring that the environmentally responsible design becomes default, not at one later. Another major area of change is adaptation. The ability of generic design to solve individual needs without mass cost or time punishment is opening new horizons in individual manufacturing. Medical implants, ergonomic tools and even consumer goods can now be individual on a scale-thanks to the generic workflows that user-specific data suited to input. This change is not only changing the user experience, but also changing how the products are imagined, marketed and distributed.

Genetic design and industry 4.0 technologies-like synergy-like additive manufacturing, digital twins and real-time sensor feedback-increase its effect. Adative manufacturing (or 3D printing) is particularly suited to complex, complex geometric that produces generic design. While traditional subtraction methods such as CNC machining often struggle with irregular forms, adorable processes can easily create them, which can lead to rapid recurrence and tight growth. Since the generative designs are more integrated with digital threads and cyber-physical systems, it allows a comfortable response loop between design, simulation, production and product use, which actually creates intelligent and responsible manufacturing ecosystems.

Despite its promise, adopting generic design is not without its challenges. Computer demands are high, cloud computing infrastructure or advanced local hardware requires access to upgraded local hardware that is capable of handling complex simulation and large -scale dataset. Similarly, the quality of data - including physical properties, manufacturing tolerance and environmental variables - is important to generate reliable outputs. Poor or incomplete data can result in sub - design or even failure during production.

Regulatory compliance adds another layer of complexity. In highly regulated industries such as aerospace, medical and automotive, designs generated by algorithms will have to undergo rigorous certification processes. Since generative designs are often distracted by traditional forms and are produced using emerging manufacturing methods such as 3D printing, verification of their safety and functionality can be a hurdle. In order to remove these concerns, standardization of test protocols and digital traceability framework will be necessary.

In addition, while AI is central for generous design, it does not eliminate the need for human expertise. Skilled engineers and designers are essential in installing problems, explaining outputs and creating final design options. The role of a designer is shifting - not for passive observer, but for curator of possibilities. This requires a mindset and skill development that embraces interdisciplinary knowledge, creative thinking and digital literacy. Organizational changes are also necessary to unlock the full potential of generative design. Traditional workflows and hierarchy often resist paradise changes for computational exploration, recurring from linear design-thought. Teams must be restructured to support cooperation between designers, engineers and data scientists, while existing processes and equipment need to be adapted to integrate with generative platforms. Companies who continuously invest in training, change management and pilot projects are better deployed to overcome inertia and realize the initial win.

Looking forward, the future of liberal design is associated with emerging technologies. The integration of AI and machine learning models promises more intelligent systems capable of learning from previous projects, adaptation in real time

and continuously improving the design based on operating data. Cloud-based platforms are removing obstacles, which are also accessible to high-strength generative tools for small and medium enterprises. Multi-material optimization, hybrid manufacturing strategies, and sustainability-framework embedded features, not alternative enhancements.

In summary, generic design is not just a tool - it is a strategic ability that is re - shaping the manufacturing landscape. It combines the creativity of human simplicity with the power of computational intelligence, boils new fronts in design and production. As its adoption increases, the industry will see an era of rapid innovation cycles, better performing products, low environmental impact and unprecedented adaptation.

However, realizing this vision only demands more than adopting new software. This requires a cultural change - following uncertainty, experimenting with new workflows, and relying as a creative partner. Those who invest in understanding and deploying generic designs today will be the leader of tomorrow's manufacturing renaissance.

References

ASTM. Standard terminology for additive manufacturing technologies. Standard F2792-12a. 2012: 0.1520/F2792-10.

Kempen K, Thijs L, Van Humbeeck J, Kruth JP. Mechanical Properties of AlSi10Mg Produced by Selective Laser Melting. Physics Procedia. 2012;39:439-46.

Hyunjin C. A Study on Application of Generative Design System in Manufacturing Process. IOP Conference Series: Materials Science and Engineering. 2020;727:012011

Maricic S, Haber IM, Veljovic I, Palunko I. Implementation of Optimum Additive Technologies Design for Unmanned Aerial Vehicle Take-Off Weight Increase. EUREKA: Physics and Engineering. 2020:50-60.

Tofail SAM, Koumoulos EP, Bandyopadhyay A, Bose S, O'Donoghue L, Charitidis C. Additive manufacturing: scientific and technological challenges, market uptake and opportunities. Materials Today. 2018;21:22-37.

Park Su Bin 2017 The art of artificial intelligence age : study on the integrated curriculum of art with Google A.I. Experiments. Gongju National University. Master's Degree Dissertation.

Ahn Seong Mo etc. 2009 A Study on Generative Design System through Ecological Concept Application. Journal of Digital Design. 4 Vol 9 pp 279-288

Jeong Won Joon etc. 2018 A Study on the Role of Designer in the 4th Industrial Revolution -Focusing on Design Process and A.I based Design Software-. Journal of Digital Convergence. 8 Vol 16 pp 279-285

Christopher hesse. 2017 https://affinelayer.com/pixsrv/. Accessed: 2017-04-21. 9

Koo Bon Mee 2009 A Study on the Characteristics of Generative Design on digital environment -Focus on Voronoi Diagram applied the Agent-based System-. Journal of Basic Design & Art. 5 Vol 10 pp 15-23

Smith, S.M.: The constraining effects of initial ideas. Group crea tivity: Innovation through collaboration, Oxford University Press, pp 15–31 (2003)

Likert, R.: A technique for the measurement of attitudes. Arch. Psychol. 140, 1–55 (1932)Saadane,Rachid,AbdellahChehri,andMohamedWahbi."6GEnabledSmartEnviro nmentsandSustainableCities:anIntelligentBigDataArchitecture."2022 IEEE95thVehicularTechnologyConference:(VTC2022-Spring). IEEE,2022.

Ruffo, M., Hague, R.: Cost estimation for rapid manufacturing simultaneous production of mixed components using laser sinter ing. Proc. Inst. Mech. B Eng. J. Eng. Manuf. 221(11), 1585–1591 (2007)

Alexander, P., Allen, S., Dutta, D.: Part orientation and build cost determination in layered manufacturing. Comput. Aided Des. 30(5), 343–356 (1998)

Yang, S., Tang, Y., Zhao, Y.F.: A new part consolidation method to embrace the design freedom of additive manufacturing. J. Manuf. Process. 20, 444–449 (2015)

Wohlers, T., Campbell, R. I., Huff, R., Diegel, O., & Kowen, J.: Wohlers report 2019: 3D printing and additive manufacturing state of the industry. Wohlers Associates (2019).

❧❧❧