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MATERIALS AND MANUFACTURING PROCESSES IN AEROSPACE INDUSTRY- A REVIEW

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Abstract

To explore advanced technologies, materials, and methodologies that can enhance aerospace system's safety, and efficiency. They mainly concentrated on the latest manufacturing processes and the different types of materials. In addition to the use of these vehicles, other technologies have been incorporated into manufacturing in the direction of so-called advanced manufacturing. The overall expansion of the use of additive manufacturing in the aircraft industry, as well as the key difficulties and promising prospects, are assessed and presented systematically, outlining the developments. The increasing use of glass fibre/carbon fibre composites has resulted in significant changes in the aerospace industries. The diverse application of composite materials inspired scientists to use them in various fields where their predominant properties added value to the product. However, it generates waste composite material both during manufacturing and at the end of its useful life. Therefore, choosing a suitable composite disposal method that is both economical and environmentally friendly is required at this time for the aerospace industries. Other major factors driving the aerospace sector to adopt additive manufacturing technology include complex geometry thin-walled aircraft engine components and structures, as well as material machining difficulty. The following subjects are covered in this review: Materials needed for the design of aircraft structures and engines, recent developments in the development of aerospace materials, and difficulties faced by recent aerospace materials and future trends in aerospace materials are just a few of the topics are covered.

Keywords: Materials requirements, composite materials, future trends, manufacturing processes.

I. Introduction

The Wright Brothers are the most well-known inventors in the aerospace and aviation fields because they were the first to design, construct, and fly an airplane. On March 16, 1926, American Robert H. Goddard designed, constructed, and launched the first successful liquid-propellant rocket. Goddard demonstrated that rockets could function in a vacuum and that flight is possible at speeds faster than the speed of sound.

1.1. TYPES OF ADVANCED MANUFACTURING

As per the Advanced Manufacturing, the aerospace industry will benefit from six new manufacturing technologies as it embraces a better future. They are,

- Advanced design technologies
- Digital assistants, augmented reality (AR)
- Virtual reality (VR)
- New manufacturing materials

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- Collaborative robots
- Advanced computing capabilities.

First, by utilizing data and simulation, advanced design techniques can enhance the design process, which up until now has relied on training, experience, and intuition. The aerospace industry can now produce parts quickly and affordably thanks to new design tools like generative design (generative design), artificial intelligence (AI), and real data, according to Lockheed Martin.

II. Literature

They are many types of advancements in both manufacturing processes and materials are done. We studied some of the papers and those papers are mentioned as follows:

[1] Hakan Yurtkuran, A manufacturing technology that is rapidly developing is additive manufacturing, also referred to as 3D printing. The power and potential of 3D printing are being established globally through the implementation of new 3D printing processing techniques. In the manufacturing of 3D models, 3D printing is proving to be effective, especially in the aerospace, automotive, and medical sectors. By scanning or designing the specific components with design software, existing and new components in a variety of fields can be manufactured. By using additive manufacturing, we can produce products faster and with greater strength and lightness. The components may also be made from various types of metal and plastic. The aerospace and automotive industries use the time-saving 3D printing technique known as rapid prototyping. By printing human organs through a specific human's tissues, 3D printing is now being used to address issues with human health.

[2] V. Mohanavel et.al., A group of materials called superalloys is frequently employed in aerospace applications. They also go by the name "high temperature materials" because of how well they resist wear and corrosion. Because they have superior mechanical and physical properties, such as superior heat resistance and durability, outstanding resistance to corrosion, and excellent fatigue and creep resistance, Ni-based super-alloy are used more frequently than Ti alloys in the aerospace industry. However, titanium alloys are becoming more and more popular in these sectors due to the fact that they have the highest strength to weight ratio of any metal. Superalloys are shaped into machine parts for the aviation industry using casting, forging, powder metallurgy, and machining techniques. However, many components are primarily made using machining methods because of the part geometry, which is desired size, and quality of surface requirements.

[3] Victor Abreu Nunes et.al., The manufacture of aircraft requires ongoing process modernization and improvement in order to keep businesses competitive in the market. In this context, efforts have been made nonstop to use innovative manufacturing technologies and systems to boost productivity, maintain current production methods, reduce costs, and enhance human welfare. Autonomous robotic systems, such as Automated Guided Vehicles (AGVs), have been used on the shop floor to assist the company in combining these competitive advantages. Additional innovations have been included in manufacturing as part of so-called high-tech manufacturing, or Industry 4.0, in addition to the use of these vehicles. The goal of this work is to use these technologies.

[4] Pawel Balon et.al., While in use, aviation structures are subject to a variety of loads. Each task carried out during flight is composed of numerous motions that result in various aircraft loads. Current aviation constructions must adhere to strict standards for high durability and reliability. This requirement makes it necessary to take into account a number of, occasionally conflicting, regulations while designing an airplane. The most important element in this scenario is the structure's mass, having a significant impact on both the structure's technical and flight characteristics as well as its economic efficiency. The result is that the airplane is one of the most challenging modern technological products.

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The majority of contemporary aviation buildings, or more in particular, their foundations, are built with thin walls.

[5] Kyriakos Ntouanoglou et.al., We can see the prospects for the airline industry given that within 1981 and 2016, there was a 220% increase in aircraft production due to a 4.7% CAGR in travel demand. The global aerospace industry, where demands for reduced production expenses - simpler assembly - and an hour's flying expenditures - better aerodynamic features - are constantly increasing, benefits greatly from the open market and technology itself. By reducing the number of parts and assembly time on the one hand, and by drastically altering the computational fluid dynamics (CFDs) philosophical thought on the other, cutting-edge 4D printing techniques can advance the aforementioned in ways that this paper aims to review.

[6] Jyothish Kumar et.al., Additive manufacturing offers unparalleled flexibility when it comes to of a component geometry, composition of materials, and lead time. With little material waste, it is attempting to transform the aerospace manufacturing industry by producing extremely complicated, small parts. Additionally, it can be used to fix intricate parts like combustion chambers, engine blades/vanes, and so forth. Other significant factors influencing the aerospace industry's adoption of the technology for additive manufacturing include the difficulty of machining materials and the complex geometry of very thin-walled aircraft engine parts and structures. This essay looks into the research and development efforts being made in additive manufacturing for the aerospace sector.

[7] Sarat Singamneni et.al., Production parts for aircraft is frequently difficult and time-consuming due to the strict regulations. In order to accomplish the just-in-time availability of parts that is frequently necessary to decrease airplane ground times, large inventory investments are required due to the multi-million element count, multi-tier manufacturing processes, and serious limitations surrounding the sector. A true just-in-time production saviour, additive manufacturing evolved to enable the immediate manufacturing of intricate parts that utilize digital data without the need for sophisticated tooling or equipment. The aircraft industry may experience fewer supplier and inventory issues if additive manufacturing is properly integrated. These areas have already made significant progress, but lack of certification standards and quality assurance attributes is preventing further development. The major obstacles and potential future applications for additive production in the aircraft industry are analysed and presented systematically, providing a clear picture of the developments.

[8] G. F. Barbosa et.al., This essay focuses on a suitable framework that applies the principles of lean manufacturing to tasks of aviation manufacturing processes that aim to automate production. The main objective of this recommendation is to inform engineers who work on development processes about the advantages of automation that can be realized when utilizing the suggested direction approach of analysis presented here. A real-world instance is provided to support the viability of this approach.

[9] Byron Blakey-Milner et.al., Metal additive manufacturing is the practice of adding material during the manufacturing process to create metallic components, usually layer by layer. This technology has experienced significant growth in part due to the aerospace industry's potential for a commercial and performance benefits. The main advantages of metal additive manufacturing for aerospace applications are significant price and lead-time savings, the use of novel materials and inventive design approaches, volume decreased of components through the use of highly effective and lightweight designs, consolidation of various elements for performance or risk management, etc. In addition to summarizing the main application situations and the related commercial and technical advantages of the use of additive manufacturing for these applications, this presents the state of the art at the time of writing. For each application scenario, challenges as well as potential opportunities for additive manufacturing of metals are highlighted based on these observations.

[10] Sophie I. Hallstedt et.al., When in comparison to other decision support areas, like product performance and manufacturability, design selection encourage is still in its infancy in this regard, despite growing awareness of the significance of taking sustainability aspects into account in product development. The development of a new high-temperature aero-engine component case study illustrates how the sustainability evaluation identifies hotspots, explains ability sustainable development implications for a new product technology, and uses according to the paper, the method accomplishes two main goals: 1) which makes sustainability consequences more tangible and understandable throughout the design idea choosing activities, rather than experiencing an exact measurements, and 2) reducing and prioritizing, methodically asking that which is important in a sustainability evaluation, rather than reducing the environmental sustainability problem.

[11] Claudio Mandolla et.al., Blockchain is a well-known digital technology that enables unbreakable transaction tracking, allowing consumers to trace the complete history of goods and product parts. The aircraft industry, which is heavily dependent on technology and where component manufacturers are subject to strict technical regulations with the aim of certifying and monitoring every aspect of the production process, can benefit significantly from its special characteristics. Additionally, the industry makes a lot of additive manufacturing techniques for quick prototyping of product parts that are noticed through the supply chain, cutting down on time-to-market while maintaining quality and cost control. In doing so, the paper offers a theoretical solution to the problem of securing and organizing the data produced by an end-to-end method of additive manufacturing in the aerospace sector and highlights how businesses utilizing blockchain technology can create safe and interconnected manufacturing infrastructure.

[12] N. Vijay et.al., Composite materials are crucial to the aerospace sector because of their desirable thermal, mechanical in nature, and environmental characteristics. It is a good alternative to metals because it has a better strength-to-weight ratio, especially for aerospace uses where weight is a concern. In addition, it can be manufactured into complex shapes and has an excellent fatigue strength, a small weight, and improved corrosion resistance. The aerospace industries have undergone significant change as a result of the growing use regarding glass fiber/carbon fiber composites. Scientists have used composite materials in a variety of fields where their distinctive properties have added value to the end product because of their wide-ranging applications.

[13] B Haque et.al., In order to promote a change in behavior toward the implementation of lean principles outside of manufacturing, this article discusses the results of research done to establish performance measures (metrics) for the new item beginning procedure in the aerospace sector. It looks into how this was done and the advantages and disadvantages that came up during execution. Seven important metrics are defined and discussed for enterprise-wide use. For use in particular process or product families, eight more have been found. The study's findings show that the metrics created can help with performance improvement and corporate goal alignment, but more work is still needed, especially in terms of the organizational structures and data systems technology needed to put them into practice.

[14] Keith Jackson et.al., Modern manufacturing systems need to be flexible because it enables the seamless integration of new products into making and the adaptation to changing demand. Because they need a lot of production and repetitive tasks to be effective, advanced production technologies, which are frequently used within the automotive industry, have limited application in the typical UK aerospace manufacturing. This paper discusses a framework of key technologies, ranging from flexible fixturing to digital manufacturing concepts, which allow adaptability in aerospace manufacturing systems. The main functions and technologies of the individual components are then discussed, and an industrial use scenario for the suggested framework is then presented.

[15] Xuesong Zhang et.al., In recent years, significant advancements have been achieved with the production of aviation resources for fundamental and engine applications. For the aerospace industry, exceptional alloys are being developed, including alloys based on aluminum, magnesium, titanium, and nickel. Composite materials, a cutting-edge material, are becoming more and more crucial in aircraft. But there are still many problems with modern aerospace materials, like inadequate mechanical characteristics, fretting wear out, stress-induced cracking, and corrosion. In order to improve the performance and lifespan cost, in-depth research has been done to create the future of aviation materials with better mechanical properties and corrosion resistance. The following subjects are covered in detail in this review: (1) materials requirements for designing aircraft structures and engines; (2) recent developments in the creation of aerospace materials; (3) difficulties encountered by recent aerospace materials; and (4) potential future developments in aerospace materials.

[16] Roland Stolt et.al., Lattice structures rather than solid sections are now a viable option for the fabrication of small jet engine components thanks towards the selective laser melted (SLM) process. The objective is to lighten the component by lowering its density. The elements must be overhauled and verified to meet a number of requirements, including strength, aerodynamics, and manufacturing, in order to implement the new manufacturing process. In order to ascertain how the capacity of establishing and assessing elements for the process of supply chain management (SLM) can be built into an organization, an investigation involving interviews was carried out at an aerospace company to ascertain the current state of practice regarding technology and product development. One crucial discovery is the fact that it is now difficult to incorporate the topology the improvement step in the multi goal design assessment the surroundings used at the company, as a result of which the level of difficulty would increase noticeably.

[17] A.P. Puvanasvaran et.al., This study emphasizes how using time studies has increased the overall equipment effectiveness (OEE) of the autoclave process. Two various kinds of time research studies are now being used, as opposed to the direct a stopwatch time study that was initially used to establish the current OEE standard. The MOST study identified important value-added and non-value-added operations at each subprocess. MOST is used to determine the percentage of enhancement that contributes to OEE. The report draws attention to the unreliable data used to calculate OEE and the lack of a system for assessing improvement ideas before they are put into practice.

[18] Kandasamy Jayakrishna et.al., The aerospace and space industries have been primarily responsible for the creation of new material frameworks and improvements in their manufacturing. The main determinants of advancements in aircraft materials are weight reduction, application-specific requirements, and affordability. Both practical and environmental issues are greatly affected by the utilization of cutting-edge materials.

[19] Maria MRAZOVA, Novel components have been required to advance and improve aviation ever since Wilbur and Orville Wright chose to propel their Leaflet with a purpose-built, cast aluminium engines to meet the special demands for strength to weight ratio. By enhancing the performance and functionality of contemporary aircraft, these improvements in material properties have enabled us to move quickly and affordably throughout the world. The author introduces composite materials along with their benefits and drawbacks in the first section of this study. The second section of the thesis introduces Airbus as well as its innovation in materials for composites. The development of new types, like nanotube forms, will undoubtedly speed up and broaden the use of composite technology. The final section of this thesis introduces this problem. In any case, an ongoing trend in material research is the enhancement of processing and manufacturing of existing materials to either enhance their physical properties or enable their utilization in new fields and functions for future use.

[20] Calos Rodriguez Monroy et.al., Their production strategies have undergone a significant change as a result of the development of organizations that operate in global environments. The emergence of

worldwide Production Online Networks, that involve a variety of businesses and production facilities and create new kinds of horizontal relationships between independent businesses as well as competitors who occasionally collaborate on projects, they are unable to undertake individually, has been one of the results. This study examines the factors that led to the development of such networks, as well as their strategy, structure, dynamics, and evolution, taking into account such factors as advantageous intercompany alliances, coordination of their value and supply shackles information systems, and the cultural makeup of the organizations in question, as well as their convergence with one of the more important future production trends: mass personalization. The proposed model will be used in the aerospace sector, one of the sectors that established the GMVN concept. A more thorough comprehension of the development of Rolls Royce's strategic positioning as well as the fluid and dynamic nature of its online relations will be gained from the case investigation of the engine manufacturer. By explaining and placing these organizations in perspective, as well as by examining how they will change over the coming years, this will show how effective it is.

[21] Anna Dziubinska et.al., A number of the most widely used magnesium-aluminium alloys is AZ31. This structural material has a lot of potential for the aviation industry because of its low density of mass and strong mechanical characteristics. In the aircraft industry, flat parts with ribs like brackets are made using the AZ31 alloy. The article presents the findings of a quantitative investigation into the microstructure as well as the mechanical properties of aircraft brackets made of the AZ31 alloy using a novel method of semi-open die forging. A working model of the forging press with all three moving tools was used for the experimental tests to form these flat a ribbed parts at an operating temperature of 410 °C. The AZ31 alloy's microstructure and mechanical characteristics were assessed both before and after hot forging.

[22] Shahir Mohd Yusuf et.al., From beginnings in the research phase to the production of a broad range of functional commercial applications, metal additive production has evolved. Particularly at the moment, metal additive manufacturing is gaining popularity in the aerospace sector for the construction and repair of various parts for both civilian and armed forces aircraft as well as for spacecraft. The various types of AM methods that are frequently used for producing metallic parts are first described in this review. The development of metal additive manufacturing (AM) in the aerospace sector from just designing prototypes to the production of engines and structural elements is then highlighted. Additionally, the creation of standards as well as credentials, sustainability, and supply the chain's development are discussed as current unresolved problems that prevent metal additive manufacturing from being put into widespread usage in the aerospace industry.

[23] Erdal Tekin et.al., The aerospace sector continues to drive the growth of the global composites market. However, the level of risk in composite technology is raised by expensive raw materials and a complex manufacturing process. Our paper describes an information management application in the production of composites at an aerospace manufacturer, taking into account the complexity of composite manufacturing. This production data management application covers everything from the distribution of raw materials from the warehouse to the depicted final composite product. Following an overview of the application, that we will talk about potential issues, potential fixes, and ways to improve data management for composite production in the aerospace sector.

[24] Adrian Uriondo et.al., The focus of this paper's review of recent advancements in the field of additive manufacturing is on those that could be used to create and fix metal components for the aerospace sector. The best candidates to meet this challenge currently considered are electron beam melting, laser melting with selective lasers, and other deposition of metal procedures, such as wire and an arc additive manufacturing. It is essential that these technologies be accurately characterized and modelled for this purpose in order to foretell the resulting mechanical and microstructure characteristics of the part. The most recent developments in the use of additive manufacturing as well as material modelling are discussed in this paper. Although these procedures have many advantages

over conventional manufacturing methods for the aerospace industry, airworthiness and aviation safety must be ensured. This regulatory framework's effects on the use of additive manufacturing techniques for the production and repair of aerospace industry parts are discussed.

[25] James C. Williams et.al., The development of airplanes and their engines is examined in this paper in terms of the contribution improved materials and processing have made. This development involves the relatively recent shift in the aircraft business from producing only products driven by performance to producing products driven through customer value. It is shown that much of the progress since the invention of manned, heavier-than-air flight has been made possible by developments in materials, processing technology, and knowledge. The introduction of new materials has changed as a result of recent cost constraints, which are determined by customer value. These trends seem to represent the new paradigm for the airline and airline engine industries. The role of materials in producing lightweight structures is the larger focus, even though the focus of this paper is on aircraft and aircraft engines. Once they have been cost-adjusted, some of the examples utilized in this paper are applicable to automotive applications. The paper's conclusion includes a brief discussion of this issue.

[26] R.R. Boyer, Due to their excellent corrosion resistance and high strength to weight ratio, titanium and titanium alloys make perfect choices for aerospace applications. However, due to its higher price when compared to rival materials, primarily steels and aluminium alloys, titanium usage is severely constrained. Therefore, the benefits of employing titanium must be weighed against this additional expense. As an extension of earlier reviews of Fe alloy applications, the titanium alloys employed in aerospace applications are discussed, along with some of their characteristics, the justification for using them, and some particular uses of various types of actual usage.

[27]. Alberto Cerezo-Narvaez et.al., The aerospace industry now faces intense competition as a result of globalization. Producers have a wide selection of suppliers. These suppliers must adhere to more rules and technical specifications and take on more duties that previously belonged to producers. Small and medium-sized businesses in this situation have few business opportunities, but suppliers must still work to take full advantage of the ones that do exist. It has been demonstrated that implementing R&D&I practices helps businesses greatly and gives them significant competitive advantages. However, designing, putting into practice, and testing processes related to R&D and innovation is not an easy process, and neither has it been covered in recent studies on SMEs. This essay analyses a case study of a creative small business offering industrial metrology and high-quality services in Spain. An internal decision-making procedure eventually results in the adoption of a research, development, and innovation management structure based on the standards. A trial run is closely monitored to assess how well the system implementation is stable. The company has been able to accomplish a number of things thanks to the research, development, and innovation management system, including streamlining its innovation processes, setting goals for better allocating essential resources, organizing high-performing creativity units within the organizational structure, boosting customer confidence and competitiveness, conducting technological surveillance, and obtaining more patents.

[28] V. A. Dolgov et.al., Considered is a technological audit technique for enterprise technical re-equipment. The method created aims to evaluate technological options for projects involving the re-equipment of businesses in accordance with productivity indicators.

[29] Keshav Sharma et.al., All of the world's most important scientific discoveries have, in one way or another, been reliant on the materials that were accessible at the time. Only because tungsten, an alloy able to withstand high temperatures, was available to Edison was he able to create the light bulb. Since the engines was made of aluminium and not metal, which maintained their aircraft light, the Wright brothers were capable of to let their airplane fly. Materials, which are used in construction, are crucial in determining the structure's purpose. The globe as a whole is moving toward robotics and artificial intelligence in the twenty-first century, so it is essential that the structures that are built be

intelligent and smart in order to respond to their surroundings, boosting efficiency and lowering design complexity. Smart structures that can meet the needs of this growing sector must be developed for use in aerospace. The foundation of the most recent aerospace applications is made up of smart materials like the shape Remembering Alloys, piezoelectric substances, Carbon Fibre Reinforced Polymers, Shape Memory Polymers, etc.

[30] Keshav Sharma et.al., This essay examines augmented reality applications with a focus on aerospace production methods. Lean manufacturing, the aerospace sector, virtual reality, and augmented reality are all introduced in context. Numerous applications for augmented reality (AR) are provided to demonstrate how AR may be used in a variety of endeavours with various focuses. In order to illustrate the advantages and benefits of using AR in aerospace manufacturing processes, this paper presents two case studies from the aerospace industry. It is concluded that the use of AR can result in improvements in labour qualification, training cost reduction, inspection system, and business productivity.

[31] T.F. Burgess et.al., In the aerospace industry, where assignments are about as complicated as they get in contemporary industry, establishing project status is a major concern. Project management, or PM, and management of configurations (CM) are two disciplines that come together to form the practice of project "visibility." Project visibility has gotten a lot of attention from a PM perspective, but its CM counterpart, setup position accounting (CSA), hasn't gotten as much attention. In light of the fact that the products in this study are safety-critical, the research presented here looks at how CSA is implemented in the European aviation sector. The research demonstrates the restricted application of CSA data until the good is almost ready for release to the consumer through a survey and case study, limiting the usefulness of CM encouragement to project management operations.

[32] Parthasarathy Garre et.al., For many medium-sized and small manufacturers, especially older businesses organized and managed by traditional push systems, lean manufacturing offers a new management strategy. Improvements that go beyond a collection of instruments and methods and have been widely adopted by numerous manufacturing organizations can have dramatic effects on quality, time to market, and customer responsiveness. Every employee in lean manufacturing is constantly looking for ways to make processes better. Lean manufacturing, to put it simply, is a methodical approach to removing waste from a production process. It also takes into account waste produced by workload inequity and excess burden. The key idea is to maximize customer value while minimizing waste. Lean simply means providing customers with more value while using fewer resources. Our goal is to locate the production line bottlenecks in a reputable manufacturing sector. The main goals are to introduce the instruments and methods used to convert a business into a high carrying out lean enterprise, present an overview of manufacturing wastes, and give a background upon lean manufacturing.

[33] M.K. Hagnell et.al., An innovative combined manufacturing cost estimation model is presented in this paper. The model's strength is its modular design, which makes it simple to implement various production techniques and case studies. Analysing the expense of a general aviation wing made up of skin, stiffeners, and rib feet serves as an illustration of the cost model. Several typical manufacturing processes for aeronautics are examined. For a total of fewer than 150 buildings per year, layup by hand is the most economical method for the studied structure. The most economical option is automatic tape layup (ATL), followed by hot wrap forming (HDF), for higher production volumes.

[34] Varaprasada Rao Manda et.al., With automation in the majority of its manufacturing and production areas, the Indian airplanes industry is now recognized as one of the world's fastest growing industrial endeavours. The industry has become increasingly competitive over the years as a result of technological advancements, which have also contributed to this growth. The development of 3D printing has created numerous opportunities in this area. In addition to developing an approach to

outsource different automated technologies to tier-2/tier-3 companies based on their own specific parameters and abilities by using 3D printing, this study is focused on clarifying the use of 3D printing technology for production and servicing. If the current situation is practical and in line with industrial needs, 3D printing will play a more significant role in overall aircraft the production and avionics in the coming years. It already plays a good role in the manufacture of aircraft engines at the Indian aircraft industry. According to recent research, the outsourcing of components and goods for the whole aircraft the production will be a reality, thriving on increased production volumes of comparable components for various end users. This will have the advantages of "low or zero" waste, less impact on the environment, aside from the potential for local manufacture and timely delivery, and greater defined cation of the final product. According to additional research, outsourcing firms are planning to make investments in the new techniques.

[35] Amal Benkarim et.al., In an effort to produce better products, many businesses try to emulate Toyota's production model. However, in their attempts, they frequently ignore the function of employees and HRM procedures and instead concentrate primarily on Lean Production tools. In this study, we look into how Toyota's HRM practices are being applied in the aerospace industry. Thirty office and manufacturing workers from a Canadian aviation company were interviewed in semi-structured interviews as part of our qualitative methodology for this project. Our findings demonstrate that Toyota's HRM practices, such as training, communication, respect, manager and supervisor support, fairness, and workplace health and safety, were adopted by the company under investigation. However, it should be noted that not all of Toyota's HRM practices had been implemented, and among those that were, we discovered significant variations in implementation. Overall, our findings show how flexible HRM practices can be implemented to fit the needs of the target company and offer new insights into how they are used in the aerospace industry.

[36] Lawrence E. Murr, Since stereolithography first started to appear in various types of additive production and 3D printing, it has existed more than three decades. These technologies are now widely used in a variety of advanced manufacturing processes. Currently, the fabrication of various polymer components, particularly complex structures that cannot be produced using other manufacturing processes, represents the largest segment of the three-dimensional printing market. In an effort to create human organs, starting with skin as well as various tissue patches, conventional printer the head systems have been altered as well to selectively print different kinds of speciated cells from humans and unique molecules. We'll briefly go over efforts to develop a "living implant" within these implants through eventual vascularization and bone ingrowth. In additional 3D printing systems, novel printer heads for govern metal droplet deposition are briefly described because these ideas will eventually enable the fabrication of extremely big and intricate products, such as automotive and aerospace buildings and components.

[37] Giorgio Petroni et.al., The Italian Space Agency's theoretical approach to transferring technology is presented in this paper. The method sets itself apart from earlier frameworks by making an effort to address some fundamental aspects of the space technology transfer processes, such as the availability of technology, information, and contacts between the actors involved. The model is explained in light of current and potential strategies for technology transfer and development from the perspective of the space industry. According to preliminary data, this system of transfer of technology is remarkably efficient and could have a big impact on the rate of economic growth and people's quality of life.

[38] E. Schubert et.al., Every industry that generate moving masses have a critical interest in lightweight components. The goal of weight reduction must be combined with high component performance and production efficiency. Manufacturing joints of all kinds of light metals and combinations of them is possible with laser beam joining. This essay will provide examples of structures made of aluminium, titanium, magnesium, and their combinations, as well as an explanation of how laser beam join0ing can be used to meet industry needs. For aerospace applications, it will be

explained how aluminium's so-called non-weldable alloys can be welded using powder filler. Another illustration relates to improved process stability when welding aluminium with a laser beam.

[39] Alexander van Grootel et.al., Unstudied is the relationship between production variability and the ensuing environmental impact. We use the reality of overdesign to make a connection between manufacturing variability and the impact on greenhouse gas emissions. This study focuses on the production of carbon-fibre Reinforced Polymers, which possesses high manufacturing variability in comparison to traditional manufacturing procedures and is of interest because of its potential for lightness. The cost as well as energy necessary to fabricate an example combined part are modelled using a process-oriented cost model that includes uncertainty. The model uses manufacturing variability as an input, which enables it to calculate the impact of variability on costs and energy needs. We discover that manufacturing variability, which is the fourth most important variable in our equation for both of these performance measures, has a significant impact upon both part costs and energy requirements. According to our hypotheses, lowering the mechanical properties' coefficient of variation from 14% to 9% minimizes production costs and power by 12.3 and 11.8%, accordingly Additionally, because of weight savings, we predict that this decrease in variability will save 8.3 kton of fuel over the entire lifespan of a Boeing 787, which has a projected value of 3.6 million dollars and could prevent 21.9 kton of carbon dioxide from stepping into the atmosphere every year.

[40] Stephan M. Wagner etal., The use of additive manufacturing (AM) in the aviation sector has the potential to alter how supply chains are organized and how aircraft are created, manufactured, and repaired in the future. The goal of this study was to provide insight into the present and potential future of AM development in the aerospace industry. The widespread acceptance of am will be sparked by the accumulated benefits, according to working groups with almost fifty aviation experts from planes original equipment producers, suppliers, upkeep repair revamp providers, as well as AM service companies and AM production firms. AM industry experience, AM technology stability, and the creation of new aircraft over time. Aircraft have to actively oversee multiple success factors and keep an eye on a number of control factors that have been recognized and addressed in this study if AM is to be successfully adopted. In the short to medium term, AM will complement conventional manufacturing methods, grow rapidly, and benefit those involved in the aviation industry's supply chain.

III. Conclusion

In order to solve the problems of diminishing arable land and the rising demand for food brought on by an expanding global population, improved and more effective methods of crop production are required. Everyone should make it a priority to educate themselves on the importance of food security in relation to environmentally responsible agriculture. The proliferation of new technology that may boost agricultural yields and encourage inventive young people to take up farming as a respectable vocation are two positive outcomes of this trend. This article stressed the role that many of the technologies now employed in farming, notably IoT and AI, play in making agriculture smarter and more successful so that it can meet the demands of the future. Scholars and engineers might benefit from taking notice of the present issues confronted by the sector as well as the future potential. Because of this, every acre of farmland should be used to its full potential in order to maximize agricultural output. This may be accomplished by using environmentally friendly sensors and communication systems that are powered by artificial intelligence and the internet of things.

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