

ADVANCE MANUFACTURING PROCESS FOR CONVENIENT AND OPTIMIZE PRODUCTION

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Abstract: Advance Manufacturing Process has high impact on Traditional Manufacturing Techniques. Since 1960 the use of AMP has been tremendously increased considering high accuracy, better efficiency and improved production. Unique nature of the process permits extremely novel functionality to be realized such as multi-material structures with embedded component. This technique leads to more flexible and advance designing of component. Advance manufacturing industries consist of computer technologies, high-performance computing software and various high-precision technologies. AMP is highly useful in Biotechnology for medical device manufacturing. Also, advanced robotics and other intelligent production systems like automation control systems proves useful to monitor processes. AMP are consider to be sustainable and green technology, which provide new industrial platform, custom manufacturing and well manage methodologies for better manufacturing. Present paper aims to give general overview of technology and feature of an Advance manufacturing system. By combining the application of AMP and Optimization technique, reduction in flow time within production system as well as response time from Customer and supplier can be achieve. This study intends to justify why essential to apply these innovative technology realize the consequence of changes in term of the customers and the different industries.

Index Terms - AMP, Green Technology, Automation, Robotics, Optimization.

I. INTRODUCTION

One of the most advance Manufacturing involves the use of technology to improve Product and process with the relevant technology being describe as advance, Optimize, innovative and cutting edge. AMP has wide range of application over traditional processes its increasingly integrate new technologies. It is also refer as world class Manufacturing (WCM). The process is particularly based on Business Development. AMP center upon improving the performance of industries through and works on rapid transfer of Science and technology. Firstly introduced as a prototyping process, additive manufacturing (AM) is being more and more considered as a fully-edged manufacturing process. The number of AM processes, along with the range of processed materials is expanding⁽¹⁾. AMT is also referred as "Integrated Manufacturing Technology" referring to the use of computers but not all the technologies include computing systems; misconceptions prevail while considering the distinction between the two types of technologies designated "hard" and "soft"⁽¹⁾. AM has made manufacturable shapes that were too difficult (or even impossible) to manufacture with conventional technologies. Modern manufacturing technology is comprised of market need, product design, technological design, processing and assembling, testing, distributing, using, maintaining, and scrapping, etc., to realize high-quality, agility, high-efficiency, low consumption, clean production, and quick response to market needs. The rapid development of cell technology has created direct and indirect production departments such as design, assembly, processing, monitoring, testing, marketing, maintenance, equipment, tooling, and production tools, etc. The accuracy of AMT provides better physical and chemical balance to manufactured component. Considering the base of Industrial Engineering and Management science, AMT provides Industrial Revolution resulted from the advent of new invention, especially in aerospace and automobile industries. The most common and highly preferred AMT are

- a) Additive Manufacturing
- b) Robotics

Key tool for all above technique is Advance Manufacturing Planning, which comprises various manufacturing tools, techniques and trends. Additive manufacturing is disrupting the traditional way of manufacturing. AM transform everything from the assembly line to logistics to the way personnel is trained. Likewise, industrial robotics has had a profound impact on manufacturers, touching nearly every portion of business. AM typically, excels at small batch production runs while robots are more profitable in high volume environment. When combined, however, additive manufacturing and industrial robotics is powerful couple. Manufacturers stand to gain major efficiencies from the combination of these technologies. As these advance manufacturing techniques enable complex and revolutionizing structure and material with intricate details which were not possible before, Topology Optimization is considered the ideal design method to produce such innovative and unintuitive design for AM. User friendliness of Advance manufacturing technologies will increase Quality and improve Productivity for manufacturers. The ease of use of technology has advanced dramatically in recent years. The ease -of- use of technology has advanced dramatically in recent year. The rise of software as a service management platform and subscription based pricing models led to increased adoption rate and now manufacturing software is becoming easier for employees to use. Companies now have ability to access real time information and intelligent system built with artificial intelligence (AI) in mind. Furthermore, advanced manufacturing technologies have the ability to integrate with existing with existing legacy system and application, enabling the immediate use of business data and product histories on new manufacturing software suites and platform, without sacrificing the information held with legacy system. The merging of modern and legacy system promotes faster and more cohesive adoption rates within an organization.

II. ADDITIVE MANUFACTURING FOR OPTIMIZED PRODUCTION

Additive manufacturing is also known as three- Dimensional Printing (3D Printing). Additive manufacturing fabricate structures by adding material in a layer by layer fashion. This technique overturns the traditional manufacturing concept of subtracting material from structure and makes the fabrication of new and complex geometrical feature possible.⁽¹⁴⁾ In today's era there is progress in computer science and technology. With this, structural optimization design has become most important mean of obtaining light-weight and high performance structure. Considering this, Structural optimization is divided into three basic approaches viz. size optimization, shape optimization and topology optimization based on various design variable. In past few years, Topology optimization has reached to various industrial field for design of structure. Topology optimization has the capacity to improve 3-D model with constrain parameter to enhance the shape and reduce the amount of material use .There are lots of individual processes which vary in their method of layer manufacturing. Individual process will differ depending upon structure, material and machine technology used. Most adopted method for industrial field like automobile, aerospace and biomedical are

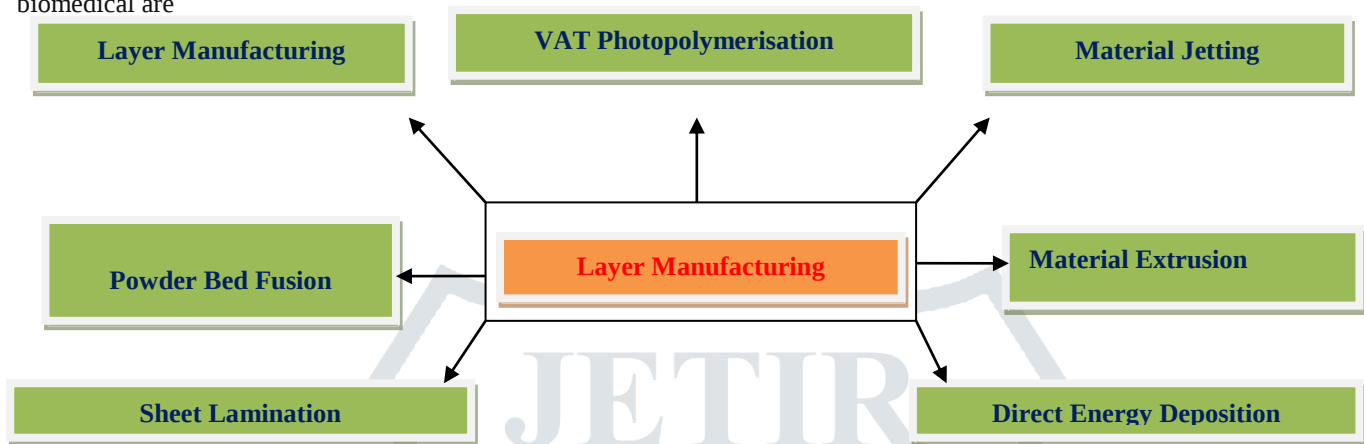


Fig.1 Layer manufacturing techniques used in various fields

Due to processing techniques, additive manufacturing is gaining broader acceptance as a “Direct Production” process due to improved material selection, material property, efficiency and quality. Based on how product is distributed i.e. Supply chain and logistic implication, additive manufacturing changes. In order to be able to fully exhaust the advantages of AM compared to conventional processes, an additional approach is already recommended for the design of component. The implementation of topology optimization in the related conservation of material, integral design and increase in strength is predestined. The component is design using CAD with the least possibly external restrictions in order to provide the optimization, the greatest possible freedom. Input parameters consider for topology optimization are shape, size and effect of load on any component.⁽¹⁵⁾ To execute a topology Optimization , objective must be defined in first step. Engineers prescribe specific volume fraction to reduce volume of module. A stain energy is minimized in order to get more rigid component after optimization. Several steps are required for an optimization. In order to find suitable optimization, several iteration and alteration of the objective function are necessary simultaneously computing effort is very necessary. Basic steps involve in topology Optimization are-

- 1) Defining Product and Material Specification
- 2) Defining Design space by CAD – System (Software like CATIA, Pro-E, Solid works etc.)
- 3) Applying Topology Optimization
- 4) Validation of result (Analysis and interpretation)
- 5) Data Post processing

A very popular well known contribution of additive manufacturing and topology optimization is exemplified by the GE90 Jet engine fuel nozzle. Using additive manufacturing process , the fuel nozzle not only combine all 20 parts of the old design into single unit and which weighs about 25% less and is more stronger than before. The most important parametric change in Additive manufacturing is use of stronger, durable, corrosive resistant, light weight material like alloys of various materials like titanium, steel and aluminum. Additive manufacturing helps in making unit cost far less sensitive to production lot sizes. Unit cost gets isolated from lot size consideration which was manufacturing dilemma since the beginning .As a result of this, it is now possible that one day parts will be made in lot sizes of a few or even one –anywhere , anytime and in reasonable cost. As far as the business model is concerned, manufacturing enabled service is becoming the main driving force for defining the value⁽¹⁷⁾ According to a 2014 report by Wohlers , the worlds wide revenues from AM was \$3007Billion in 2013; in 2016 it was \$5 billion , in 2018 it is about \$12.08 billion and will exceeds \$21 billion by 2020 .⁽¹⁸⁾ These figure depicts AM market that is growing robustly . Increasing requirement of rapid production and feasible manufacturing give rise to produce complex and delicate parts. As previously developed Fused deposition modeling (FDM) and Steriolithography are on the way to disappear new technologies like Selective laser Sintering (SLS) and 3-D Printing are spreading roots.3-D printers provide rapid manufacturing by depositing layer on layer for parts but, in order for 3-D printing to be more functional means of manufacturing, Printers must move beyond the current focus of rapid prototyping. For even more Optimize manufacturing using AM innovation must take on overall 3-D printing performance and perpetuate technological advance in manufacturing. Three key benefits of AM over Traditional Manufacturing are

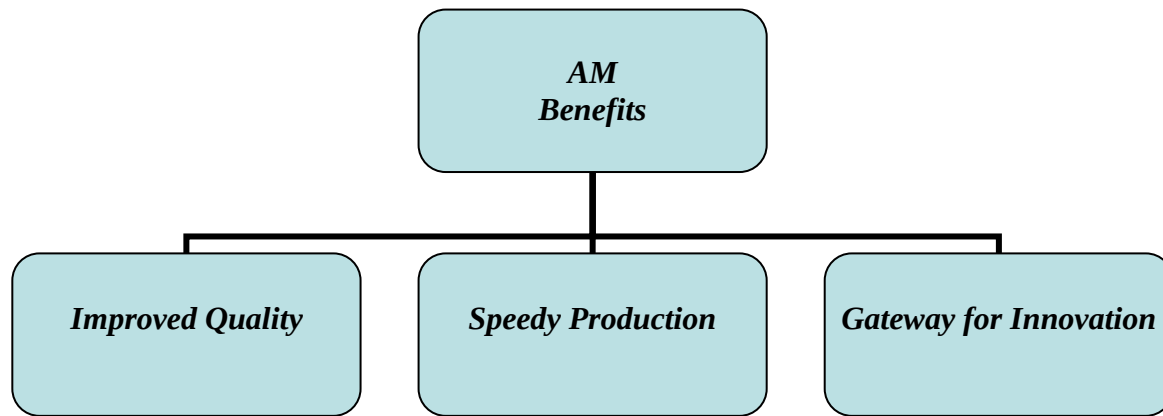


Fig.2 Boons of Advance Manufacturing

AM in its wide range of application established new business models like convergent manufacturing and High-end Service result Topology Optimization is best suitable method for **AM**.

III. ROBOTICS IN INTELLIGENT MANUFACTURING

In recent year, Robotics has gained lot of interest in industrial and domestic areas. Great Industrial revolution led to Higher Productivity, technology used in this revolution was the use of paced conveyor lines that supplemented industrial engineering method. Manufacturing process could thus be broken into multiple stages, each of which contained a limited number of operations for the worker to perform. Robotics provides optimize workspace in efficient manner. Robots are changing the face of Manufacturing as they are design to move material , as well as perform a variety of programmed task in manufacturing and Production .Robots are well know creators for manufacturing tomorrow . Robots are design to move the material, as well as perform duties that are dangerous or unsuitable for human workers, such as repetition work that causes boredom and could lead to injuries because of the inattentiveness of worker. Industrial Robots are significantly improving product quality, as the applications are performed with great accuracy and repeatability on every job. The level of repeatability is difficult to achieve by some other mean. Though initial investment for the robotic implementation is quiet high but considering all further advantages robotic is much cost saving and quality improving technology. Material handling is the most prevalent application of industrial robot with 38% of the robots being used for such purpose. Initially when companies were more prone to use Automation line are now sifting to robotic. Material handling robots can automate some of the most tedious, mind numbing and unsafe task in production. Robots now can be intelligently handle transferring part, packing, palletizing, loading, unloading and machine feeding operations.

3.1 Robot Intelligence

Though industrial robots cannot meet expectation of intelligence like human being but, as an outcome of human hard work robots can win chess Competition or drive cars automatically. In industrial application, many of the task to be performed by robot are relatively confined physical movement that are primitive compared with the gait mobility .For industrial application, the intelligence of industrial robot can be distributed such that the local processing of sensors , vision images, motion , logic and communication collaboratively produces the desired system – level performance⁽¹⁹⁾ .

3.2 Era of Mobile Robot

Industries are widely using automated guided vehicle well known as AGVs in factories which helps to carry various parts to be assembled and perform flexible task on given command. These AGVs can be reprogrammed for some another task based on product and process change ,such quality of them qualify them as mobile robot .These mobile robot system can command varying planning , calling, scheduling and event handling function . These Mobile robots can be customized according to the need, cost and system.

3.3 System Integrated Robotics

Programmable logic controllers (PLC) are used as supervisory control from many years. **PLC** control conveyors, filling system, sealing etc. For robotics system also **PLC** controls the entire operation of the cell. Though, Robot operation and path planning are done on a different control platform, it is at discretion to manufacturer. Traditional robot makers built solid reputation in support, application development, training, and cost-down with their supplier. To compete with traditional robot maker, opportunities are made to use robot with special system integrated features to perform application task. Although system-integrated robot may have lower flexibility, they can realize a higher throughput and lower cost than standard robots. System integrated robots are thus considered in between Specialized machine and traditional robots.

IV. UPCOMING INNOVATION IN INDUSTRIAL ROBOTICS

A recent newsletter published by REDSHIFT by Autodesk has thrown light on upcoming innovation in robotics considering the need of industries in order to reduce human interference. It is mentioned that from delicate industrial – polishing work - picking fruit for breakfast cereals these industrial –robotics innovation could solve some of society’s most pressing issues-such as labor shortage and worker-safety improvement. New ideas and innovation could help democratize robotics for widespread use, meaning an even faster transition to new machine age. Some of them are discussed:

4.1 Project SYMPLEXITY

When it comes to repetitive task such as placing thing together, industrial robotics can make humans seem a bit unnecessary. But, that is not the case with industrial polishing; however, it still requires the human touch. Achieving constant gloss or matte finishes on part has proven to be a stubborn problem for industrial robot which is why the Project SYMPLEXITY is exploring augmented reality and machine learning to find a solution. Industrial polishing is cornerstone of manufacturing and human operators still handle the material and judge the result. What the research hopes to show is that if the metrology system inspects a surface with insufficient quality i.e. machine learning system will change a step or parameters based on the analytical model. The next step correction is for the system to make informed choices about polishing force, angle, speed and so forth based on the needs of the part before it starts. SYMPLEXITY project see a future when **CAD** Files, themselves, contain cues the robot need to best finish the part. This project will bring Metrology Data to life by generating mathematical data assessing performance quality



Fig.3 SYMPLEXITY robot in abrasive polishing

4.2 Enabling an Architectural Renaissance

Some of the architectural use elements are not easy to generate without human interference. So, the new technology by Danish Firm Odico aims to change that complex double curvature shape with its industrial robotics system which uses a bendable heated blade and foam blocks to create casting molds for domes and other structural element ⁽¹⁷⁾.

4.3 Robot Revolution using COBOTS

Expert countries in robotics like Japan and china that enthusiastically embrace technology innovation, are finding new ways to use industrial robots that includes “COBOTS” a lightweight, slower robots that safely work right next to human which has been shown to increase productivity. There is huge opportunity for manufacturers to adopt robotics and artificial intelligence. Yet, Innovation in automation and robotics is happening in pockets across manufacturing sector.



Fig.4 “COBOTS” under work

V. CONCLUSION

This paper discusses various Advance manufacturing technologies adopted worldwide and also focused on trending and upcoming technologies that will provide more optimize production. Use of intelligent manufacturing system helps to provide more precise, robust and sustainable production. Improvement in techniques and operative aspect of production system also increment operating flexibility, that provides series of benefits for reduction of cost and time in production process.

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REFERENCES

- [1] Ben van Lier, Centric - Steinbeis University Berlin, Germany “Advanced manufacturing and complexity science” System Theory, Control and Computing (ICSTCC), 2015 19th International Conference Cheile Gradistei, Romania IEEE issue 10.1109/ICSTCC.2015.7321307
- [2] Germain Sossou ICB UMR 6303, CNRS Univ. Bourgogne Franche-Comté, UTBM “An additive manufacturing orient design approach to mechanical assemblies” S2288-4300(17)30065-9
- [3] Nurul Hayati Abdul Halima*, Noriah Yusufb, Roseleena Jaafarc, Ahmed Jaffard, Nur A'in Kasehe , Nur Nida Aziraf “Effective Material Handling System for JIT Automotive Production Line”. Procedia Manufacturing 2 (2015) 251 – 257
- [4] K. Zakariaa,b*, Z. Ismaila , N.Redzuana and K.W. Dalgarnob “Effect of wire EDM cutting parameters for evaluating of Additive Manufacturing Hybrid Metal Material” 2nd International Materials, Industrial, and Manufacturing Engineering Conference, MIMEC2015, 4-6 February 2015, Bali Indonesia Procedia Manufacturing 2 (2015) 532 – 537
- [5] Qian Yi 1 & Congbo Li1 & Xiaolong Zhang2 & Fei Liu1 & Ying Tang3, “An optimization model of machining process route for low carbon manufacturing”, Int J Adv Manuf Technol (2015) 80:1181–1196
- [6] Anoop Verma1 · Rahul Rai, “Sustainability-induced dual-level optimization of additive manufacturing process”, Int J Adv Manuf Technol (2017) 88:1945–1959
- [7] Anastasiia Moldavska a, b, *, Torgeir Welo, “The concept of sustainable manufacturing and its definitions: A content-analysis based literature review”, Journal of Cleaner Production 166 (2017) 744-755
- [8]) Jorge Luis García Alcaraz1*, Alejandro Alvarado Iniesta2 and Manuel Celso Juárez Castelló, “Benefits of advanced manufacturing technologies”, African Journal of Business Management Vol. 6(16), pp. 5524-5532, 25 April, 2012.

- [9] Nola Hewitt-Dundas, "THE ADOPTION OF ADVANCED MANUFACTURING TECHNOLOGY AND STRATEGIC COMPLEXITY", NORTHERN IRELAND ECONOMIC RESEARCH CENTRE 46-48 University Rd, Belfast, Northern Ireland
- [10] HamidNoori , "Implementing advanced manufacturing technology in organizations: a socio-technical systems analysis," Engineering Management Conference, 1992. Managing in a Global Environment., 1992 IEEE International
- [11] Shutian Liu , Quhao Li, Junhuan Liu, Wenjiong Chen , Yongcun Zhang, "A Realization Method for Transforming a Topology Optimization Design into Additive Manufacturing Structures",Engineering(2018) 277-284
- [12] Stefen Junk, Benjamin Klerch, Lutz Nasdala, Ulrich Hochberg "Topology Optimization for additive manufacturing using component of a humanoid robot", 28th CIRP Design Conference , May2018, Nantes , France, Procedia CIRP 70 (2018)102-107
- [13] Alex Roschli, Katherine T. gaul, Alex M. Boulger, Brian K. Post, Philip C. Cheeser,Lonnie J. Love, Fletcher Blue, Michael Borish "Design for Big Area Additive Manufacturing", Additive Manufacturing 25 (2019) 275-285, Springer
- [14] Ben Wang " The future of Manufacturing : A new)Perspective", Engineering 4 (722-728)
- [15] Mohsen Attaran " The rise of 3-D printing: The advantages of Additive manufacturing over traditional manufacturing", Business Horizon :August 2017 , Elsevier
- [16] Chia-Peng Day "Robotics in industry- Their Role in Intelligent Manufacturing"Engineering4 (2018)
- [17]Mark Smith "Robots on the Rise", Newsletter published by Redshift , Sep 5 2018

