Study of challenges in Additive Manufacturing in the Automotive Industry

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Abstract- Additive manufacturing (AM) and 3-D printing are changing the global manufacturing scenario. The rapid increase in the AM technology has a larger impact on the design and production ability of the manufacturing industry. The technology needs to print real parts. The centre of interest of the article is to understand the rising significance of manufacturing technology in the Computer age, and the basic aspects of AM technology, challenges and its influence on the automotive sector.
Keywords- Additive Manufacturing ; 3D printing

1. INTRODUCTION

Recent advancements in additive manufacturing processes are a boon to the automotive industry and also to the conventional manufacturing and supply chain channel. Additive manufacturing is used in the industry to make variety of vehicle parts, its uses are set to diversify further, as its application is idealized to the automotive sector. These approaches are the roots for newer designs which resulted in lightweight, secure parts, shorter lead times and lesser costs.

Experts predict this technology will explode even further in the near future. A worthwhile choice, AM offers a possibility for even small producers to be able to create new parts and keep up with the market. As opposed to more conventional types of engineering and design, automotive additive manufacturing is capable of producing components very fast. The extended design process can be largely cut down, with simply a click of the mouse to change part of the model. This lets components to get out onto the market considerably more rapidly and also permits changes to be made with the minimal fuss.

The automotive industry is longing to acclimate to this shift in the standard quickly. 3D printing in automotive design is rapidly stepping up. 3D printers not only help the creative design of automobiles but also has the skill to handover working prototype in record reversal time. 3D printing in automotive design promotes innovation, creativity and endless possibilities empowering transportation landscape.

One of the limitations AM face is the range of the materials that can be used as opposed to the conventional manufacturing where a variety of materials as metals, alloys and composites are used. Hence AM process has not been around comfortable to see similar developments. With narrow application of new materials in AM so far, these materials remain costly.

2. PRODUCT NOVELTY BY AM

AM can generate parts with lesser design limitations than traditional manufacturing processes. This flexibility is very worth full during manufacturing products with formal characteristics, making it possible to add improved functionalities such as integrated electrical wiring, lower weight structures, and intricate geometries that are not feasible with traditional processes. Moreover, AM technologies being progressively apt to yield multi-material printed parts with individual properties such as variable strength and electrical conductivity. AM processes play vital role in creating faster, safer, lighter, and more efficient vehicles of the future. Extensive research is currently ongoing to diversify the options to make of available materials larger. Researchers at the University of Warwick have developed a low-cost composite material that can be used specifically for additively manufacturing electronic components. The European FP7 Factories of the Future project is researching methods to reduce production costs of graphene-based thermoplastics for use in the production of high-strength plastic components. Active research is being carried out on the use of Graphene-based thermoplastics for high strength plastic components.

AM processes with inclusion of Nano materials are also being developed in order to increase the tensile strength, electrical conductivity, hardness, and impact strength. Improving strength without increasing its weight is a potential idea of AM which is being used to make BIW for automobiles in the future. Carbon fiber is gaining much importance in making lightweight auto components as fenders, car roofs, and wind shield frames using traditional processes. AM is now using carbon fiber to make commercial AM device that can use carbon fiber.

Not only the new materials, new cost-effective technologies producing existing materials also impact the choice of AM technology. The potential metal like Titanium which possess its low density, high strength, and corrosion resistance is alluring the automotive industry because it is used to make lightweight, high-performance parts but being expensive its use is limited. It costs about $200–$400 per kilogram. Metalysis, has developed a single-step method to produce titanium powder, with the potential of reducing the cost by as much as 75 percent. Jaguar and Land Rover are planning to collaborate with UK based Metalysis to use the low-cost titanium powder in AM.

Titanium –popularly used in AM industry

3. SUPPLY CHAIN TRANSFORMATION THROUGH AM

By eliminating the need for new tooling and directly producing final parts, AM cuts down on overall lead time thereby improving market responsiveness. Moreover, AM employs the material necessary to produce a component, and can exceptionally cut down scrap and drive down material usage. Also, AM-manufactured lightweight parts can reduce handling costs, while on-demand and on-location manufacturability can reduce inventory costs. Lastly, AM supports decentralized production at low to medium volumes. All these AM features allow companies to drive powerful change within the supply chain—together with cost reductions and the enhanced ability to manufacture products close to customers, reduce supply chain complexity, and deal consumer segments and markets without the need for considerable capital requirement.

4. AUTOMOTIVE MANUFACTURING REQUIREMENTS

4.1. *Light weight parts*

Weight reduction is the demanding facet of automotive industry. Auto sector uses advanced engineering materials (polymer composites) and complex geometries for weight reduction at the same time increasing the vehicle performance.

4.2. *Complex geometries*

With AM, parts with internal channels for conformal cooling, hidden features, thin walls, fine meshes and complex curved surfaces can be manufactured which are complex structures yet light weight and stable. AM enables freedom of design, functional integrity of components and mass customization.

4.3. *Temperature*

Auto components need to with stand certain heat deflection temperatures. Materials that withstand temperatures up to 1050°C can be used by certain AM processes. SLS nylon and some photo cured polymers are examples

4.4. *Moisture*

Automobile components must be resistant to moisture otherwise should be made moisture proof. 3D printed parts can be post processed to make them moist proof. Most of the AM materials by nature are humid resistant.

4.5 *Part consolidation*

Material usage can be controlled by Part consolidation which affects material consumption and cost. Hence material inventory can be reduced. Number of components going into to assembly can also be decreased by redesigning as a single component.

5. CHALLENGES OF AM IN AUTOMOTIVE SECTOR

5.1 Economics Of Am Limited To Low-Volume Production

Profitability in the automotive industry is driven by volume. In 2013, 86 million automobiles were produced globally.2 Given the enormous volumes, the low production speed of AM is a significant impediment to its wider adoption for direct part manufacturing. This has made high-speed AM an important area of research. Improving build rates through the AM technology of SLM has been an important focus in recent years, yet major breakthroughs have so far been elusive.

5.2 Improved am-manufactured product quality and reduced postprocessing

Fabricated AM parts may contain voids because of which they exhibit variable thermal stresses which results in lower repeatability and is a challenge for high-volume industries like automotive where quality and reliability are extremely important. One of the solutions to this is to follow machine qualification standards.

The dimensional accuracy of final AM parts is not the same as parts made by conventional manufacturing processes. As an example, it was seen sand molds produced using AM could lead to reduced dimensional accuracy in metal casting tools. The surface finish of AM parts is of the order of 10–100 microns, is not considered to be a high-precision range. Automobile applications may not need high precision parts but surface finish quality becomes critical for high-performance components of which electron beam melting may help.

Most of the AM components need post processing, to remove unused material, enhance surface finish, and removal of support material. This is insignificant for simpler parts. For complex components, the post processing is employed on a larger scale for companies seeking AM in the production of critical components like engine manifolds. Hybrid manufacturing, unification of AM with traditional techniques such as milling and forging, directs a promising solution for current variability and finish quality issues. Ultrasonic additive manufacturing, an advanced technology based on AM, using sound, combines additive (ultrasonic welding) with subtractive (CNC milling) techniques to create metal parts. The use of AM allows these parts to have special features such as embedded components, latticed or hollow structures, complex geometries, and multi-material combinations, and the use of CNC milling ensures uniform finish quality.

5.3 Manufacturing Large Parts

Larger AM components are joined together by welding or mechanical joining process. The low-cost AM technologies that can support larger build sizes for metal parts need to be developed which is a research area. “Big area additive manufacturing,” is being developed by Oak Ridge National Laboratory and Lockheed Martin, can fabricate parts without any restrictions on size. Stereo lithography process developed by Materialize, with a build volume of 2,100 mm x 680 mm x 800 mm—can manufacture most of the large components of an automobile. The outer shell of the race car “Areion,” developed by Formula Group T, is built in just three weeks.

5.4 Talent Shortage

AM technology is requiring skilled personnel specific to its operation in the areas of Computer Aided Design, AM machine building, operation, and maintenance, raw material preparation and management, analysis of finishing, supply chain and project management. There would be a need for formal training and skill development programs in the application and management area of AM. Academic institutions, AM service providers, and end-user industries need to standardize the training to produce capable workforce.

5.5 Intellectual Property Concerns

AM parts can be patented but cannot be copyrighted. According to the market research firm Gartner, the global automotive aftermarket parts sub-industry, along with the toy, IT, and consumer product industries, could report as much as $15 billion in intellectual property theft due to AM in 2016.

5. FUTURE OF AM IN AUTOMATIVE INDUSTRY

In spite of challenges, AM is an all-round technology that can support auto industry in terms of performance, growth, and innovation. Consideration of the wide scope of capabilities of AM, leadership automobile companies seek advantage of AM technologies to stay ahead of competition.

In the very near future AM can be possibly explored in new ways for

(a) Seating and car interiors where using SLA and SLS the dashboard and seating can be made

(b) Car tyres, wheels and suspension where the Aluminum alloys and polymers can be modified with selective Laser sintering, selective laser melting and inkjet technology to create suspension springs and hub caps.

(c) Electronics as Selective laser sintering can be used on polymers to manufacture a range of delicate components including parts which have to be embedded, such as sensors, and single part control panels.

(d) Framework and doors where Selective laser melting can be used on metal compounds such as aluminium alloys to create body panels, including framework and doors.Engine components where various functional parts of the engine can be made from metals such as titanium and aluminium allows when techniques such as electron beam melting and selective Laser melting are used.

It is clearly visualized that AM is a significant shift in the automotive businesses. The freeform capabilities of AM and drastic reduction in design-to-final-production time will allow OEMs to produce complex, high-performance parts for end use.

The traditional manufacturing processes are extremely rooted yet additive manufacturing is making its way in the automotive industry. AM may not be the only process that exist but it takes up the prominent position encompassing the automobile industry.

6. INNOVATIONS of TOP 10 3D PRINTED AUTOMOTIVE INDUSTRY

(a) Koenigsegg One:1

3D printing allowed a narrow inner turbo housing and a larger unit in one that allowed to get the best possible acceleration and high end performance. 3D printing allowed the company to solve a conundrum that has vexed the likes of BMW and Mercedes.

Every Koenigsegg has at least 300 carbon-fiber components, too. and when you're making the very best car in the world then you simply have to make plastic models, test them and make the final parts based on the results. Outsourcing this proved complex and delayed the whole production schedule.

A Dimension SST 1200es 3D Printer saved 40% of the cost and the parts were developed 20% faster

Gas flow is critical too, and with fewer parts, Koenigsegg was able to tune the flow through the turbos and print the casing tightly round the interior parts. Even the MAN himself says you just could not cast this and the turbo is just the start of the 3D printed technology on the Regera and upcoming Koenigsegg models.

(b) Audi Spare Parts:

It is using 3D printing in a variety of ways, but the most interesting on a commercial level might be the way it is producing spare parts and disrupting the whole supply chain. 3D printing has allowed Audi to disrupt its own internal supply chain. It 10

7. CONCLUSION

Automotive industry though high capital intensive and highly competitive, runs with less margin. Hence these industries must invest for other ways of developing manufacturing and assembly processes. AM would be one of the best options to invest for these industries to improve upon lead times and margins.

Along with enjoying the benefits and best use of AM, also it is important to protect its IP as new techniques of AM are invented. Automotive companies must spend money and time with educational institutions and other engineering service providers for the research and development and creating the talent pool of skilled resources to work with AM(A.1)

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