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IMPACT OF 3D PRINTING IN AUTOMOTIVE INDUSTRIES

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Abstract— This is a paper on 3D printing, often reffered as an additive manufacturing process, which has become a notable topic in todays technological world, especially in automobile sector. This is one of the widely used mechanisms in the latest scenario mainly to minimize materials and energy, thereby accelerating the innovation. In this paper, what we mean by this term and why is it so beneficial and notorious in automotive sector is discussed. Then, we shall see about impact of 3D printing in automotives resulting in recent innovations. We shall also see how 3D printing in automotives is developed in comparision to other traditional manufacturing methods. This paper also illustrates how additive manufacturing in automotives is done through details provided by various manufacturing companies.

Keywords— 3D Printing, Automotives, Impact, Manufacturing.

I. INTRODUCTION

3D printing has actually been around for 30 years. Chuck Hull invented the first 3D printing process called stereolithography in 1983,which is defined as a method and apparatus for making solid objects by successively printing thin layers of the ultraviolent curable material one on top of the other. But soon he realized his technique was not only limited to solids,expanding the definition to any material capable of solidification or capable of altering its physical state. This stereolithography format is still the most widely used format today in 3D printing.3D printer sales have been growing ever since,as there are roughly 30000 consumer 3D printers in the world-and this figure is doubling every year.

3D printing is basically a method of making 3-Dimensional objects of solid type from a digital file. This 3D printed odject is obtained through additive processes, where an object is created by laying down successive layers of material until the object is created.Each of these layers can be seen as a thinly sliced horizontal cross-section of the final object.Every 3D print starts as a digital,like a blue print,for a physical object.This design file is sliced into thin layers,as mentioned above,which is then sent to 3D printer.This process of preparing a 3D model before getting 3D printed is called slicing.Every industry is impacted by additive manufacturing.Over the past 10 years,additive manufacturing techniques have rapidly changed our way to design,develop and manufacture new things.In the automotive industry,those technologies have made wonders to bring new shapes,allowing for lighter and more complex structures at best possible cost. While it remained true that 3D printing is still mainly used for rapid prototyping when developing new models or in concept cars,the evolution of different manufacturing techniques has led a way where it is also used as final parts in various situations.

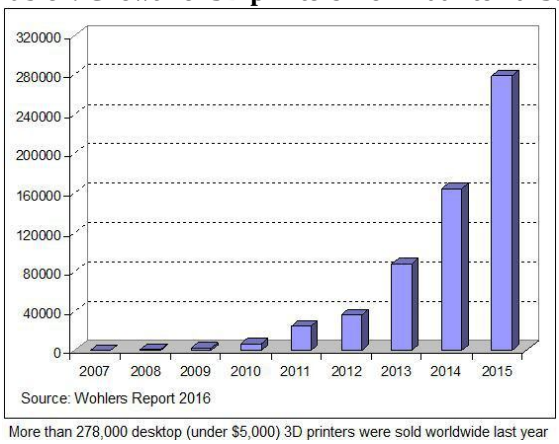
Growth of 3D printers and how Additive manufacturing processes transformed the automotive industry,with the help of reports and statistical data is studied.This article also includes how 3D printing became a major innovation in Automotive sector by overcoming all other possible methods.

II. DETAILS OF 3D PRINTERS AND ITS PART IN CORRESSPONDENCE TO AUTOMOTIVE INDUSTRIES:

2.1. 3D printers and their growth rate from past years:

Although 3D are expensive,recently there has been a steep decline in the price of 3D printers.There are many affordable 3D printers which are available for much less price that they actually cost.Companies have also recognized customer market for 3D printers,thereby developing better models at low price.According to Wohlers Report 2016,there is a healthy growth in 3D printer industry.The findings,which are based on information from 51 industrial system manufacturers,98 service providers,15 third-party material producers,various desktop 3D printer manufacturers and 80 3D printing exports from 33 countries worldwide,the 3D printing industry has increased its growth from 2007 to 2015 as represented in **Table1.**

Table1: Growth of 3D printers from 2007 to 2015:



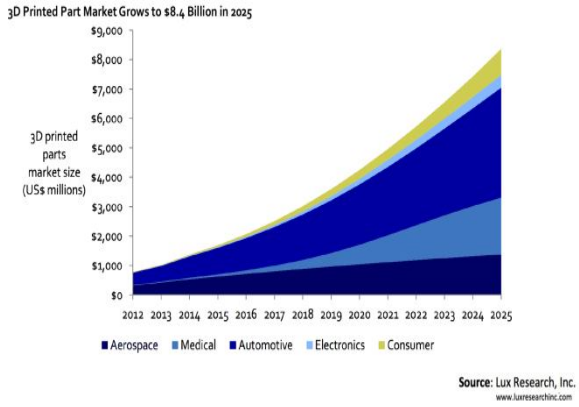
More than 278,000 desktop (under $5,000) 3D printers were sold worldwide last year

2.2. Growth of 3D printing in Automotive sector:

One of the most innovative application of 3D printing techniques in the present scenario includes automotives.The automotive industry is a good example of how additive manufacturing drives efficiencies and productivity from design to manufacturing floor.Manufacturing individual parts can be a tedious process for an automobile company.Now,by using a 3D printer,they can print the parts on demand,thus saving resourses and generating less waste.The North American market for 3D printing is projected to register steady growth, primarily due to early adoption of 3D printing technology. The Asia-Pacific and European markets are in the early stages of adopting 3D printing, and are projected to grow at a relatively higher rate than the North American market. The lag in Asia-Pacific and Europe is attributed to lack of awareness about 3D printing and reluctance to adapt to new technology.

Table2:Estimated growth of 3D printing in automotives from 2012 to 2025:

According to Automotive 3D printing Market by Technology and Material-Global Opportunity Analysis and Industry forecast,2015-2022,Automotive 3D printing market is expected to reach $2391 million by 2022,from 2015 valuue of $621 million,growing at a rate of 21.8% from 2016 to 2022.The below table represents enormous growth of 3D printing techniques in Automotive sectors compared to other fields,according to Lux research,Inc.



III. ADVANCEMENTS OF 3D PRINTING IN AUTOMOTIVE MANUFACTURING

The first 3D printed electric car is printed by local motors in 2014 from an ABS carbon-filter blend called strati, which was manufactured in just 44 hours. Strati is printed from thermoplastic using a big area additive manufacturing machine. This machine is fully recyclable, which can be chopped and reprocessed to be used for manufacturing another 3D printed car. After the car is printed, The mechanical and electric parts such as battery, motors and suspension are manually assembled.

Local Motors sources parts from micro-factories, which are highly automated factories of smaller dimensions that enable manufacturers to save resources such as space, energy, materials and time, and as such require highly detailed software to run seamlessly. That's where Siemens comes in; with its specialized Solid Edge software, the team at Local Motors was able to quickly transition from concept to car with the simplicity of direct modeling (a method of designing which allows one to interact with designs like pushing, pulling or twisting items) and the flexibility of synchronous technology (a type of software that enables you to edit designs across different CAD systems—in this case Solid Edge).

For a company like Local Motors, which is strongly rooted in its decentralized manufacturing process, 3D printing proves ideal for meshing designs from the cloud of some 60,000 users to create a joint byproduct. Imagine that the frame is brainstormed by someone from Italy, while a Michigan native models the engine, and a third person crafts the wheels over in China, and finally it gets printed in numerous micro-factories to get pieced together for the final product.

Local motors also worked on two models,LM3D and RALLY FIGHTER.LM3D goal is to consolidate as much of the traditional bill into a single,3D printed piece as possible,eventually making about 90% of the car using 3D printing.Nearly all of the body panels and chasis are produced using 3D Printing.This design company is testing new types of materials and blends in additive manufacturing,currently using a blend of 80% plastic and 20% carbon fibre.

Not only cars,the 3D printing extended its wide range of applications to a bus,OLLI,manufactured by Local motors.This 3D printed bus can transport upto 12 people,being one of the sophisticated 3D printed automobile ever to hit the road.OLLI is an electric,driverless,partially recyclable and extremely smart 3D printed bus.The user interface is provided By IBM,which will enable passengers to have communications with olli by means of natural language.The vehicle relies on more than 30 sensors and streams of data from IBMs cloud.

Leaders in the use of 3D printing, such as Ford, also apply the technology to prototype parts that are of such strength that they are installed on running test vehicles. The company uses engine parts, such as intake manifolds, from 3D printing white silica powder, to install it in its running test vehicles. With the use of 3D printed prototypes of components such as cylinder heads and intake cylinders in test vehicles, Ford is successful in avoiding the requirement of investment castings and tooling, and in turn saving significant amount of time and dollars.

"Since the days of Henry Ford, the automotive industry has defined efficiencies based on economies of scale—limited product mix, high volume production, low profit margins, and amortization of product-specific tooling and productive capacity over

many years. Local Motors is defined by our economy of scope—we generate higher profit margins on fewer units of more models, because we don't need to re-tool to produce new products." . The incorporation of additive manufacturing will enable Local Motors to melt broken 3D-printed parts into a base for reuse in future products. At the pre-printed stage, it may even be possible to upgrade swapped parts, making for a more modular and customizable experience.

BMW uses 3D printing's FDM technology to build hand-tools for vehicle assembly and testing. In addition to the financial advantages, FDM process helps the company to make ergonomically designed assembly tools that perform better than traditionally made tools.

For one such tool, BMW worked with 3D printing company, Stratasys, to reduce the weight of the device by about 72%, thereby enhancing its ease of use considerably. Apart from improving the handling abilities of tools, the technology has helped enhance functionality. The company has managed to print parts with complex shapes that allow workers to reach difficult areas specific to BMW-produced vehicles. In one such instance, the company created a tool using 3D printing for attaching bumper supports, which features a convoluted tube that bends around obstructions and places fixturing magnets exactly where needed.

GM uses 3D printing technologies of various kinds, such as selective laser sintering (SLS) and stereolithography (SLA), across its design, engineering, and manufacturing processes and rapid prototypes for about 20,000 parts. Chrysler uses 3D printing for prototyping a wide variety of side-view mirror designs and then selecting the one that looks and performs the best. Ford, on the other hand, has been one of the earliest adopters of 3D printing technology. It runs five 3D prototyping centres, of which three are in the US and two are in Europe. The company churns out about 20,000 prototyped parts per annum from just one of these centres (Michigan, USA).

While 3D printers continue to be widely used for rapid prototyping across the industry, several large vehicle manufacturers have advanced into the next stages of 3D printing technology adoption. Although still in nascent or experimental stage, these OEMs have applied 3D printing to produce hand tools, fixtures and jigs to enhance production efficiency at floor level. Ford, which is one of the most advanced users of 3D printing, uses this technology to produce calibration tools.

Another advancement in 3D printing encompasses the use of new and innovative materials. While most companies use silica powder, resin, and sand, few OEMs are innovating with forming test parts out of clear plastics. This allows them to validate designs as the team can visualise what is happening inside the part. Chrysler uses transparent plastic in 3D prototyping their differential and transfer cases. By inserting oil, they can monitor whether the gear stays well-lubricated under the prototyped design/model.

The use of metal as a printing material is an innovation that, although still in its nascent stage, is being used by OEMs such as BMW to 3D print (using SLM technology) a metal water wheel pump for its DTM racing car. Auto-parts manufacturer, Johnsons Controls Automotive Seating, also uses 3D printers to print metal parts that have complex shapes and are difficult to produce using traditional welding.

Ford published in October 2015 an announcement about how it used 3D printing to develop the new Ford GT. The car manufacturer insists on how its use of 3D printing changed its capacity to quickly develop new parts for both its concept cars and production cars. Ford says : "3D printing can deliver prototypes in a matter of hours, enables designers and engineers to quickly test and refine new designs and innovations – sometimes hundreds of times". In total, the company states that it bought the third 3D printer ever produced back in 1988, and that it has produced 500.000 parts this way in total.

Unlike other companies that have been quite secret on how they use 3D printing in their internal process (focusing mainly on the result), Ford is revealing a bit more about how teams are actually using 3D printing. The first part of the job to bring a car idea to life is to have the sketched made by the Ford Design team. Once it's done, the job is divided between both the "old fashioned war" and the "new way". On the one hand, the clay modellers make a scale (or full size model later) to assess proportions, while designers and CAD engineers develop a 3D model of the car. Depending on the requirement, either the clay model or the 3D printed parts (from the 3D files) are used. This process is repeated multiple times in order to find the right shape, the right mechanism or the right material.

3D printing has enabled Ford to try hundreds of different designs for the all-new Mondeo Vignale. Among prototype parts manufactured using 3D printing processes were the unique hexagonal Vignale design used in the upper front grille, with aluminium surround, dark matt metallic finish, and polished aluminium surround; and the high-gloss lower grille, with chrome bars and door detail designs. Designers also employed 3D printing to evaluate Vignale badges and exterior ornamentation, cut from nylon.

3D printed Spare Parts (for production and after-sale)

Spare parts are a huge topic for any industry being disrupted by 3D printing. Being able to reorganize the whole supply chain by producing at the end of the chain, on-demand, customized and closer to the customer is the dream of many sector. There is no reason why the automotive industry would dream it differently. Many car manufacturers sees in their early uses of 3D printing (for prototyping and production on high-end vehicles) the first experiments that paves the way towards a broader use

of the technology in the supply chain. While it's a reality that 3D printing is moving more and more towards real production, the volume moved by the Automotive industry remains yet problematical for the productivity of additive manufacturing technologies.

In November 2015, the car manufacturer Audi announced that it was experimenting with the production of complex metal parts made directly with 3D printing. Especially Audi is focusing on part that incorporate key features in their complex geometries and that would be as such very time-consuming and expensive to produce through traditional techniques. Using different technologies (like DMLS or EBM) the company is hoping to 3D print large complex parts.

IV. FUTURE OF AUTOMOTIVE INDUSTRIES INVOLVING 3D PRINTING:

As technologies evolve, we upgrade existing vehicles and incorporate updates into new units produced, as needed and on demand. One of our core values is to safely reuse, recycle and repurpose locally.

With these new applications taking the industry by storm, several OEMs are increasingly investing in and exploring the uses of additive manufacturing. While few companies have been slow in adopting to 3D manufacturing initially, it is expected that they will soon come up to speed with the advances in the use of this technology, given the holistic benefits it offers.

CONCLUSIONS

The impact of 3D printing in automotives is studied and the following conclusions are drawn.

3D printing is an emerging technology which has scopes for new developments and innovations in automotives. Finally,what will ultimately drive the use of 3D printing on production sidewill involve efforts in mass production.These efforts will lead a competency and confidence in design for additive process in automotives that could enable much greater mass reduction, minimize materials used (sometimes enabling property of recycling)

Additive manufacturing open up designs to whole new level. Because undercuts, geometry and complex automotive parts are difficult to manufacture using traditional methods,but are sometimes very simpler with 3D printing. In addition,the mathematics behind 3D printing is simpler than other conventional methods,since in 3D printing each layer is separately analysed.T he mathematical difference, while hard to explain is the fundamental reason why 3D printing in automotives is superior to other manufacturing processes.

With so many potential benefits of 3D printing, there is no surprise that this method is making its way through a diverse number of automotive industries and quickly becoming an essential tool of progressive marketers.

Comparing the statistical data, future scope and information provided by the industries, we can conclude that 3D printing and its technology in Automotive industries is able to create next industrial revolution.

REFERENCES

[1] http://m.machinedesign.com/3d-printing
[2] www.stratasys.com/industries/automotive
[3] http://www.3printr.com/local-motors
[4] www.theverge.com/2016/6/16/11952072/local-motors-3d-printed-self-driving-bus-washington-dc-launch
[5] http:/localmotors.com/3d-printed-car/
[6] www.popularmechanics.com//cars/a16726/local-motors-strati/
[7] computer graphics C version,second edition by Donald.D.Hearn and M.Pauline Baker
[8] http://blog.think3dprint3d.com/
[9] 3dprintingindustry.com
[10] www.itechpost.com/articles/54509/20161115
[11] 3D printing,the next industrial revolution by Christopher Barnatt

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