Rise of Hybrid Additive Manufacturing

Hybrid additive manufacturing will be the key to transform the manufacturing future

Additive manufacturing comes under the broader purview of 3D printing. While metal 3D printing has been largely used to develop metal parts considering it as an alternative or in some cases even the substitute to traditional CNC machining, the technology has not evolved to the extent of producing parts that are ready for application right out of the 3D printers. More often than not, the parts or models produced need additional work to be done on them after producing them through the 3D printer, for example, smoothing of the surface. This is called post processing. The parts produced out of the 3D printers in large cases require post processing to give them a feel or quality of a CNC machined or manufactured part. According to Ravi Patil, National Manager Technical Support - Rapid Prototyping (RP), DesignTech Systems Ltd, "While metal 3D printing can be ideal for small batch productions, when it comes to large-scale manufacturing or machining, CNC has no alternative. But together these technologies could be harnessed concurrently for production."

In this technology, a tool manufacturer will be able to develop accurate parts even with intricate designs very precisely with the finishing of the CNC milled machine. This can greatly augment the throughput and productivity of a company. Though this technology has been around since the 90s, it was not off to a thumping start making it a slow runner in the race of commercialisation hindering its popularity amongst the engineers and production facilities, informed Ravi Patil.

Additive manufacturing is a methodology or a process of building the parts or models layer by layer. On the other hand subtractive method is exactly the opposite. It refers to extracting the material to develop the desired shape or geometry. Hybrid manufacturing technology, involves application of both these methodologies i.e. additive as well as subtractive. It deploys the best of both the methodologies to develop parts or models. For e.g. complex geometries or intricate designs are best developed using additive manufacturing, whereas subtractive manufacturing which works on removal of material like CNC machining is good for mass machining or production of standard parts with great surface finish. "Additive manufacturing combined with the capabilities of CNC machining is collectively known as hybrid additive manufacturing," said Ravi Patil while defining the advanced technology.

According to L. Krishnan, President of Indian Machine Tool Manufacturers' Association (IMTMA), "Additive manufacturing opened the possibilities for reproducing complex designs in to real objects. Originally started for prototyping applications, additive manufacturing has come a long way."

With the invention of hybrid machines technology has taken a giant step forward. Metal parts formed by additive manufacturing have sub-standard surface finish. This necessitates post-machining. Also many manufacturers have found metal additive manufacturing systems to be costly. They have found it to be equally costly even for the high performance components. Hybrid machines aims to reduce this gap between additive and subtractive technologies. Hybrid additive manufacturing combines both the aforesaid technologies and fine tunes it for the end product, observed L. Krishnan. He said, "Hybrid additive manufacturing will reduce part production time from a few months to a few days."

How does hybrid additive manufacturing work?

"Hybrid process is a combination of additive manufacturing and traditional machining process. It is ideal when all the features of the product can't be achieved through additive manufacturing alone and requires secondary machining of the part," said L. Krishnan.

Hybrid additive manufacturing technologies use the methodology called laser cladding. In this process, the layer

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of metal power is deposited on the surface or the build bed area and a high power laser beam or ray liquefies it to a molten stage. Once cooled, the molten metal solidifies. After the cladding process is completed and the molten metal is solidified, the machine shifts the mode from depositing the layers and casting the laser beam, to the milling or machining mode. So wherever there is excess material or additional material that needs to be removed, the milling or machining functionality of the machine will remove it. In traditional 3D printers, the support material needs to be removed before getting the actual or desired part in hand. "In hybrid additive manufacturing technology, the milling mode of the machine takes care of removing the additional material or cut it wherever needed to give it a desired shape. So a tool manufacturer gets ready part out of this machine," explained Ravi Patil. These machines operate on the standard CNC machining language called the 'g-code' generated out of the CAD or CAM software. The nozzle or the head or the source of laser beam, based on the inputs of the g-code language create a tool path according to which the metal power is deposited on the envelope surface of the machine and laser beam melts it. This deposition and welding process back-and-forth helps create the part which is further finished or completed with the milling process as required. This technology thus deploys the metal power addition or deposition i.e. additive in nature as well as metal milling which is a subtractive methodology to the developed parts.

Hybrid additive manufacturing would work great in following areas:

- **Product validation:** It can be used to create prototypes for product performance and design validation.
- **End-use application:** Depending upon the nature, application and volume of the parts required, it can be used for parts production for end-use applications.
- **Repair:** Because it uses the duel additive and subtractive methodologies, it can be used to repair the final parts. If a part has been grazed or chipped or damaged in any way, then through this machine it can be repaired, making it a perfect solution to refurbishing the parts at lesser costs.

Laser sintering combined with the capability or potential of 5 axis milling machine, makes this a great and a perfect system to achieve fine accuracy, solid finishing and build a ready-to-use part. Avoiding dual work of part development and post processing, it helps expedite and compress the development cycle. "By best combining the strengths of additive manufacturing which is detailing and CNC milling which is finishing, the companies can achieve better part accuracy and quality thus helping them to successfully surpass all the quality control tests and inspections," said Ravi Patil.

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What industries could employ hybrid additive manufacturing?

According to Ravi Patil hybrid additive manufacturing would be ideal for tool manufacturers. Whereas L. Krishnan said, "Tool rooms, industrial design studios, consumer durables, automotive, aerospace industries, medical implants to name a few benefit from additive manufacturing."

Hybrid additive manufacturing is useful in industries such as aerospace and defence that require production of highly complex parts. Pharmaceuticals is another industry in which manufacturers can switch to creating personalised parts from predefined metal titanium parts matching to the physiology and bone structure of the patient. Hybrid manufacturing comes handy where it is needed to create a part urgently for complex repairs. One can simply build when and where required. There is no need to store the spare parts. "With hybrid manufacturing there is good option for small quantity customised production of complex parts now," said L. Krishnan.

Hybrid additive manufacturing is extensively used in medical implants. The principle of additive manufacturing lends itself to be used in different industries with varieties of work materials.

Hybrid additive manufacturing in Indian manufacturing sector

Additive manufacturing technology is at its nascent stage, it will evolve further. Indian market is moving from early adopters to early majority stage in the adoption of 3D printers.

L. Krishnan opined, "Additive manufacturing is beginning to be used commonly by industries for prototype, limited run tooling, styling or industrial design etc. Certain segments like medical implants, aerospace and other engineering industries are using metal additive manufacturing followed by finish machining to produce custom-made parts for high technology applications."

However, hybrid additive manufacturing is a distant consideration for Indian manufacturing sector. Also, experts believe, the technology is not yet completely proven and hence has not found wide adoption even in the developed industries and markets across the globe. According to Ravi Patil, "Indian industry is more cautious of adopting a technology that is still at the stage of evolvement or is at experimental phase. Once the use, applications and benefits of these technologies and ROI and the value it will help companies achieve is proven, then the Indian market will be more open to investing in it." ■