Revolutionising design

Additive manufacturing, though at a nascent stage in India, is still being touted as the new revolution in manufacturing

BY TEAM MT

COURTESY: STARPROTOTYPE INDIA

Additive manufacturing (AM) proliferated years ago because of its usefulness in building prototypes. Since then, companies abroad have increasingly used the techniques to make production parts. However, in India the market is growing slowly but steadily.

Guruprasad Rao, director, technology and operations, Imaginarium, agrees, "Additive manufacturing arrived more than a decade ago and was known only within the confines of the industry or institutes. For the past three years, we have seen an upsurge in its popularity. Today, people have seen, heard and read about the remarkable things that can be created using 3D printing. The industry knows where to use it."

It is not only the industries but also the design and engineering institutes that want to include teaching about AM in their syllabus. "There is a lot of demand for metal prototypes and end use parts. With the AM technology being widely used today in automotive, aerospace, defence, space and engineering industries the IITs, NITs, IISc and engineering colleges are engaged in core additive manufacturing R&D activities," avers Jyothish Kumar, president, Additive Manufacturing Society of India (AMSI).

Additive manufacturing has numerous advantages but what tops the list is freedom to design, faster lead times and efficiency. AM has opened a whole new world for design engineers to reach out and design products, which were otherwise impossible to manufacture first. Seconding, Nishant Shah, head, India, Starprototype India, avers, "These products increase efficiency, reduce cost and decrease production times. Additive manufacturing also saves a lot of time for very low volumes."

Today, you can buy a table top 3D printer, feed a CAD file in that machine, go out for lunch, have a meeting, come back and the part is ready and printed. This was never so easy and fast using traditional techniques. Anand Prakasam, country manager, EOS Electro Optical Systems, India, elucidates how AM is beneficial over traditional machining techniques.

"Where conventional manufacturing techniques are manufacturing-driven, the AM process is design-driven which allows much more freedom of design. The technology can enable, based on part-redesign, the optimisation of conventionally manufactured parts. At the same time, it can also enable completely new applications that weren't possible before. Other advantages include lightweight parts, part complexity, functional integration, bionic structures, customised products, product individualisation, shortened R&D times and reduced manufacturing costs."

Additive manufacturing has emerged as one of the most advanced and high value manufacturing. "It is tipped to be one

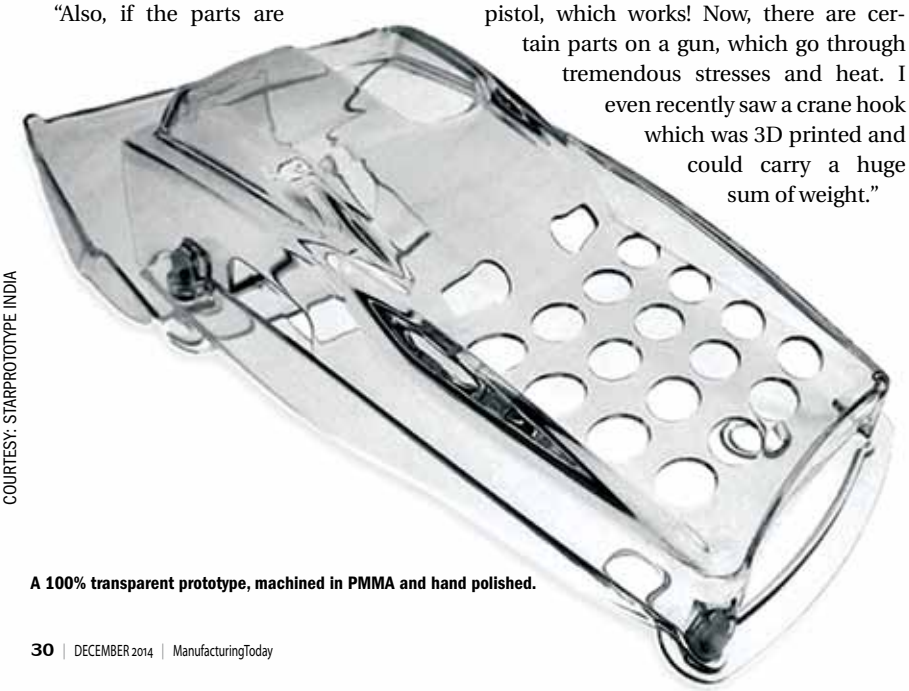
of the biggest changes to take the industrial sector by storm in the early 21st century," says Colin Price, director, Renishaw. "Additive manufacturing methods are fast, use less energy and generate less waste material. Increasingly they are seen as effective manufacturing technologies for production of complex parts and devices which are costly (in terms of time and materials required) to build by conventional means."

This is quite true especially in metal printing. Imagine building a part in titanium, which is hollow and has some internal features, which were impossible to machine even on a five-axis CNC machine? This is now possible in 3D printing.

"AM is going to be revolutionary," affirms Shah. "I have seen parts 3D printed in metal alloys, which were absolutely astonishing. As an engineer, I am happy to see that such complexity for manufacturing is now possible. If you were to give me or any engineer that part design a decade back, we would say it is impossible to make. The possibilities to use this technology for any industry are endless. A lot of industries have started adopting additive manufacturing as their normal manufacturing process," he further asserts.

Even when it comes to highly stressed load-bearing applications additive components can be used but this will always depend on a certain number of prerequisites. "The part design must be adapted to the AM process. And the choice of material certainly also plays a key role here," puts in Prakasam. Component design plays a very important role too.

"Also, if the parts are not designed to withstand high stresses, no process can help you," warns Shah. "But, yes, certain additive manufactured components can definitely be used for highly stressed load-bearing applications. In fact, it is being used widely in the aerospace and automobile industry for engine parts which are constantly under high stresses and pressures. Recently, a Corporation in Texas, USA 3D printed an entire 0.45 caliber1911 pistol, which works! Now, there are certain parts on a gun, which go through tremendous stresses and heat. I even recently saw a crane hook which was 3D printed and could carry a huge sum of weight."



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A 100% transparent prototype, machined in PMMA and hand polished.

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>
> **Anand Prakasam, country manager, EOS Electro Optical Systems, India**

> In AM, the design process itself is iterative where the designer has a dialogue with his/her creation. Today, virtual reality is still a fiction while 3D printing has become a tangible reality"
>
> **Guruprasad Rao, director, technology and operations, Imaginarium**

> We have been creating awareness about AM by organising various activities in India through workshops, symposium and conferences, user group meetings, helping academics and R&D organisations"
>
> **Jyothish Kumar, president, Additive Manufacturing Society of India (AMSI)**

Even with such enormous benefits AM still hasn't picked up as much pace in India. "This is because of lack of awareness," asserts Rao. Also, the industrial machines are quite expensive and there is limited availability of application specific materials. Design for manufacture is crucial to the business case and currently there are not enough people trained in designing for AM.

Another challenge that remains is tolerance and reliability. Most of the machines, if not all, still lack the ability to produce components that demand high tolerances. "You can see stepping in parts regularly which is unacceptable for many engineers and industries. You still can't use certain materials and expect them to have the same characteristics as an injection moulded or a pressure die casted part. Plus if you are using this as production processes the lead times are going to be huge," states Shah.

You cannot have hours to make one part when you are into production. Another very important aspect is that it is a very expensive process in terms of buying machines and running them. Again, for production one will never be able to justify the costs, unless the volumes are in hundreds. Maybe

to solve this, as Price says, "International standards and practices for performance measurement and monitoring must be developed which will mean collaboration and partnerships between competitors – both users and system manufacturers."

While there are challenges, AMSI has been doing their bit by organising various activities to promote the technology in India through - workshops, symposium and conferences, user group meetings, helping academics and R&D organisations. "We also organise the 'Additive Manufacturing Global Summit' every year. This summit brings global AM experts to India and helps Indian AM users and researchers to interact and exchange the information about latest developments in AM technology," informs Kumar.

Though there are challenges that engulf the AM process, one cannot deny the immense benefit it offers. What then will it take for this technology to attain centre stage in India? "Well, for starters, I think it is acceptance," opines Shah. "A lot of companies are still not ready to accept the concept and importance of prototyping and additive manufacturing. And the ones, which do, shy away from spending on the same, as it is quite expensive after all. India has a great potential and we have seen this in the last five years. India can take its low cost advantage and become the hub for this technology and for manufacturing otherwise."

Prakasam avers that the integration of this process should happen at the grass root level from Universities and technical colleges where students should be exposed to this manufacturing method in their curriculum. "Then OEMs should encourage their vendors to use the benefits of this technology. Nearly 30% of the designs coming globally have an Indian connection to it. While Indian engineers can pride on making world class designs, this has not translated into parts being produced in India."

He would like for some strong government initiatives to be provided to support companies embracing this innovative technology. "If this is done, I think India can also become a hub for high tech manufacturing using additive manufacturing technology," adds Prakasam. Rao too wants a national AM policy that can benefit AM adopters and service providers.

"This could happen through rebates on import duty/excise duty/taxes. What can also be done is research into AM technologies could be promoted with funding under PPP model. I would also really like to see AM being introduced in secondary schools."

As India is home to major production facilities for many automotive brands, it is unsurprising that 3D printing is making its most confident steps in this sector. In the past five years we have seen a rapid growth of the technology, the unheard or misunderstood technology is now known to the industry and it is making all positive efforts to change the future of manufacturing. Agreeing Price asserts, "Absolutely, in fact, the Deputy UK Prime Minister visited India with an UK trade mission a few months ago during which he announced the news that Renishaw were expanding its operations and the company was making a big investment in its first Indian additive manufacturing technical centre. All of this indicates that the technology is here to stay and grow." MT

FIRST METAL 3D PRINTED BICYCLE FRAME

Renishaw, is UK's only manufacturer of a metal-based additive manufacturing machine that prints parts. It collaborated with a leading British bicycle design and manufacturing company to create the world's first 3D printed metal bike frame. Empire Cycles designed the mountain bike to take advantage of Renishaw's additive manufacturing technology, allowing them to create a titanium frame that would be both strong and light using topological optimisation - the new frame is some 33% lighter than the original. The frame has been additively manufactured in titanium alloy in sections and bonded together. This offers advantages like rapid iterations; flexibility to make design improvements right up to production, ability to make shapes derived by topological optimisation and ultimate customisation and tailoring - make one-offs as easily as production batches. The seat post bracket is 44% lighter than aluminium alloy version and is corrosion resistant.

Titanium alloys have a high Ultimate Tensile Strength (UTS) of more than 900 MPa when processed using additive manufacturing and near perfect densities of greater than 99.7% are achieved; this is better than casting and, as any porosity is both small and spherical, it has little effect on strength.

The project's aim is to produce a fully functioning bicycle, so the seat post bracket was tested using the mountain bike standard EN 14766; it withstood 50,000 cycles of 1200 N. Testing continued to six times the standard without failure.

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