Framework to Assess Applicability of 3D Printing in Manufacturing

Abstract

3D printing has been hailed as a game changer in the manufacturing sector, with major imprints across multiple domains. Players from several industries are investing heavily in 3D printing, with the possibility of extending its applicability to daily use products coming to the fore. With speculation and limited information blurring the line between reality and fiction, it is critical to analyze the key challenges to adopt 3D printing technology. A comprehensive framework can help current or potential users of this technology understand 3D printing and take an informed decision on its applicability as an alternate manufacturing process, especially for engineered products and components for Industrial use.

CFM, a GE-Snecma joint venture, recently tested a jet engine with nozzles made from a special ceramic composite that can be 3D printed. Much lighter than the previously used nickel based ones, these new nozzles save close to US $1 million worth of fuel annually, per plane.[1]

Introduction to 3D Printing

Many forms of commercially active additive manufacturing processes are used by industries today. Though additive manufacturing has been around since the eighties, recent developments in the machine and material capabilities of these processes have spurred the imagination of industry players and observers about the future possibilities of 3D printing.

Almost all of the additive manufacturing processes use a 3D computer-aided design (CAD) model as an input that is exported into 'slicing software' in the form of a StereoLithography (STL) file. The slicing software then slices the CAD model into thin slices along the height of the built part or assembly. The sliced data is sent to the 3D printer that builds the part by each slice or layer. Broadly, these processes are popularly known as 3D printing.

Current 3D Printing Limitations and Challenges

3D printing was initially conceived to verify or validate products early in the conceptualization and engineering phases. It has now matured into an alternate form of manufacturing, though with certain limitations.

Some of the commercially active 3D printing techniques such as Fused Deposition Modeling (FDM), PolyJet 3D printing, Stereo Lithography Apparatus (SLA), Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM) and Selective Laser Melting (SLM) cover a wide range of materials. However, it is still not as exhaustive as the universe of materials available for traditional manufacturing techniques.[2]

The limited range of materials that can be 3D printed is one of the biggest challenges. Significant research is being carried out to overcome this limitation, with efforts directed at even including biomaterials for printing food, tissues, and organs for transplants and drug testing.

One of the advantages of 3D printing is the consolidation of geometry or parts, without much of the manufacturing limitations. The flip side of this is the lack of flexibility in the repair or maintenance of individual parts and assemblies. It should also be remembered that some assemblies of parts require relative motion between the components such as gears and pulleys, and this is not always possible to achieve once the parts are integrated.

From an assurance perspective, we too need to go the extra mile to assure Big Data quality. While we have well-defined, time-tested assurance and testing strategies for data warehousing, these traditional approaches, when directly applied to Big Data could result in compelling insights that are outright wrong!

Hence, these points have to be carefully addressed before identifying 3D printing as the manufacturing process of choice. 3D printers also have job-size limitations. Also, most 3D printing processes today cannot produce excellent surface finishes. In most cases, some secondary finishing operations are necessary to get the required surface finish. Another big challenge with 3D printing is the lack of a regulatory framework to protect intellectual property and control the printing of unregulated medical devices and surgical equipment.

Although 3D printing is becoming popular, the high capital and operating costs of 3D printing are still a deterrent for high volume production with the technology available today.

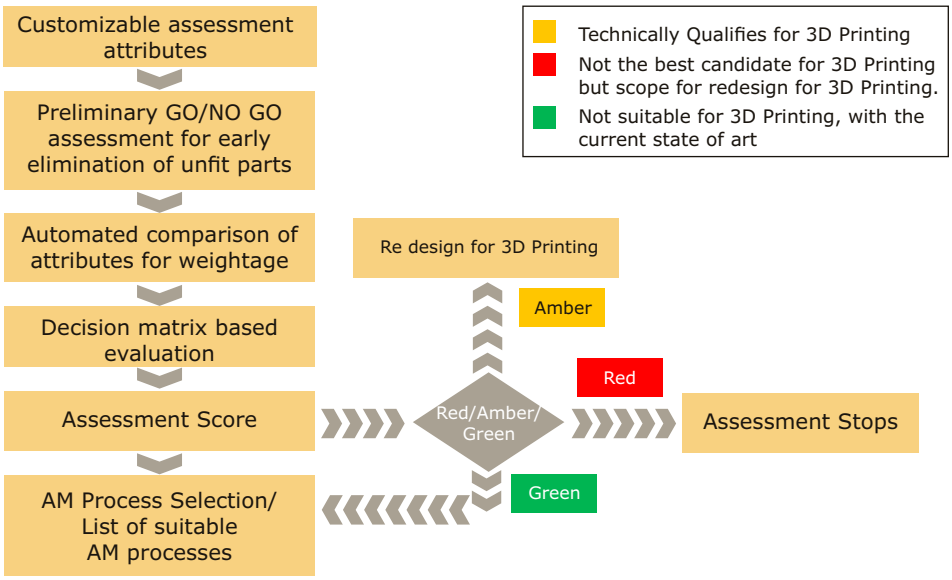
Leveraging a Framework to Determine Eligibility for 3D Printing

The framework needs to be based on first identifying key parameters that influence the decision-making process. The parameters may also be customized for a particular application or product. Each of these parameters can be assigned an importance rating—either relative or arrived at by paired comparison using a predetermined minimum point method. The summation of all such scores on a weighted average basis indicates the potential for 3D printing of that part or assembly.

Such a framework offers many advantages:

- Helps select the right part to leverage the benefits of 3D printing
- Helps narrow down on the ideal 3D Printing process for the qualified parts
- Enables early elimination of unfit parts
- Reduces subjectivity by using paired comparison of attributes
- Ensures faster assessments
- Reduces dependency on 3D printing vendors, enabling unbiased and neutral qualification
- Enables identification of more items that may be 3D printed and personalized

The schematic of such a framework is shown in the below figure



Conclusion

As the lines between traditional manufacturing methods and 3D printing methods blur, it is very important to have a clear framework for qualifying components or products that can be manufactured using 3D printing techniques. This framework should also be dynamically updated to be in sync with the latest developments in 3D printing processes.

A comprehensive assessment framework can open up more possibilities for 3D printing and, at the same time, screen products and parts for 3D printing and monitor developments in the field.

References

[1] 3D Printing Industry, Can 3D Printed Jet Engine Parts Save Us from Global Warming? (May 31, 2013), accessed April, 2014,http://3dprintingindustry.com/2013/05/31/can-3d-printed-jet-engine-parts-save-us-from-global-warming

[2] Stratasys, Materials: Explore the Widest Range of Materials in the 3D Printing World, accessed April, 2014, http://www.stratasys.com/materials/3D Systems, accessed April, 2014, http://www.3dsystems.com/materials/professionalystems, accessed April, 2014, http://www.3dsystems.com/materials/professional

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