3D Printing's Impact on the Metalworking Industry

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Summary: Summary: This research focused on understanding the possible impacts of 3D printing on the metalworking industry. We conducted interviews with metalworking industry companies and an on-line survey with clients of the sponsoring company. Survey results were analyzed and compared with the data gathered from interviews. The results indicate that very small and very large business in the healthcare, aerospace, automotive, and machinery sectors are most likely to adopt 3D printing. Finally, most businesses are considering 3D printing mainly for prototyping

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KEY INSIGHTS

1. Design freedom is one of 3D printing's main benefits as perceived by businesses, while high initial investment is one of the biggest barriers.
2. Healthcare, aerospace, automotive and machinery are the sectors most likely to adopt 3D printing.
3. Prototyping seems to be 3D printing's number one application for most businesses, followed by small batch production.

INTRODUCTION

3D printing is a process in which materials are joined to create a three-dimensional solid object. This is done using data computer-aided-design (CAD) software to direct where the metallic powder layers should be placed, forming the desired shapes. This process offers several advantages when compared to the traditional manufacturing processes:

- Speed: 3D has an overall lower cycle time of material acquisition, design, production, and finishing compared to traditional manufacturing. Designs can be uploaded from a CAD model and printed in few hours, whereas traditional manufacturing processes can take weeks just to make a prototype.
- Single step manufacture: 3D printers can complete the creation of a product in a single step, providing designers greater control over the final product. Opposingly, traditional manufacturing requires many manufacturing steps.

- Competitive cost at low production volume: when considering the individual unit cost, 3D printing is cost competitive for small volumes. However, traditional techniques become more cost effective as volume increases, justifying high set up costs by the large production volume.
- Complexity and design freedom: 3D printing gives design freedom, allowing the creation of very complex geometries. As the parts are created one layer at a time, design constrains are reduced.
- Sustainability: 3D printing techniques generally use materials only as needed to build a part, unlike traditional techniques that remove material from an initial block, resulting in a large amount of wasted material.

However, as with any new technology, the real improvements may or may not live up to the promised benefits. The sponsoring company wanted to understand the real impact 3D printing could have on its customers, since this industry could experience major changes in the next few years with the advance of the technology.

METHODOLOGY

To evaluate the impact of 3D printing on the metalworking industry, the researchers studied current metalworking companies that have adopted the technology and evaluated the benefits realized. The real-world benefits were compared with the ones promised in the literature, in order to understand 3D printing capabilities. This information was then used to predict the impact on other customers with similar characteristics. To collect data, the researchers conducted site visits to observe current operations of traditional metalworking businesses and businesses in which 3D printing is already a reality. In addition, an on-line survey was sent to customers of the sponsoring company, and secondary research was conducted to understand the industry landscape, applications and trends.

RESULTS

After the survey was launched, we received 133 responses out of 20,000 customers. Due to the low response rate, the data cannot be a statistical representative of the overall population as the confidence level is low. However, we drew some useful observations and insights from the survey that the sponsoring company can consider when prioritizing customer segments based on 3D printing opportunities and risk profile.

Overall, the combination of customer segments mirrors that of the sponsoring company, since the largest respondent sectors were Aerospace & Defense, Automotive, Machinery, and Equipment & Parts. Customers in these industries make up a high percentage of the sponsoring company's revenue. These four segments contributed to over half of all the responses. In terms of the company size, we used number of employees as a proxy. We found that most responses were from small (less than 50 employees) and large (151-1000 employees) businesses.

INDUSTRY SEGMENTATION ANALYSIS

When looking by segment, Aerospace, Automotive, and Machinery industries seem to be the most familiar with 3D printing, with some customers currently using the technology in part of their manufacturing processes. This connects with secondary research, in that the application of 3D printing is in line with what these industries manufacture, i.e. customized parts and components. Also, we see high familiarity with 3D printing in the healthcare industry given the high need for customization (i.e. implants and protheses).

Most companies say that they will not replace a large part of the manufacturing line with 3D printing, but rather just 20-50%. The same trend was found in interviews, due to materials and quality constraints. 3D printing will be used as a "supplemental" process. In terms of the technology application, most players indicated that 3D printing will be primarily used for prototyping. However, aerospace and healthcare companies intend to use the technology for small batches and customized part production. Most segments also answered that adoption and implementation will happen in the medium (3-5 years) to long term (5-10 years).

Figure 1 shows the key benefits segmented by industry. The automotive and aerospace industries value the cost reduction and lead time reduction more than other benefits, as mass production is a key element in their manufacturing process. Also, design freedom and complexity reduction are important to these industries, given the high quantity of complex components produced.

In contrast, healthcare businesses value more the benefits of greater design freedom, lead time reduction, and ability to customize products, given the high customization required in making medical parts. The machinery industry sees the ability to customize parts and design freedom as the biggest benefits, given the customized nature of the industry as well.

Regarding barriers to adopt 3D printing, different barriers were found among different industries. For example, the biggest barrier in the automotive and aerospace industries is the limited type of materials

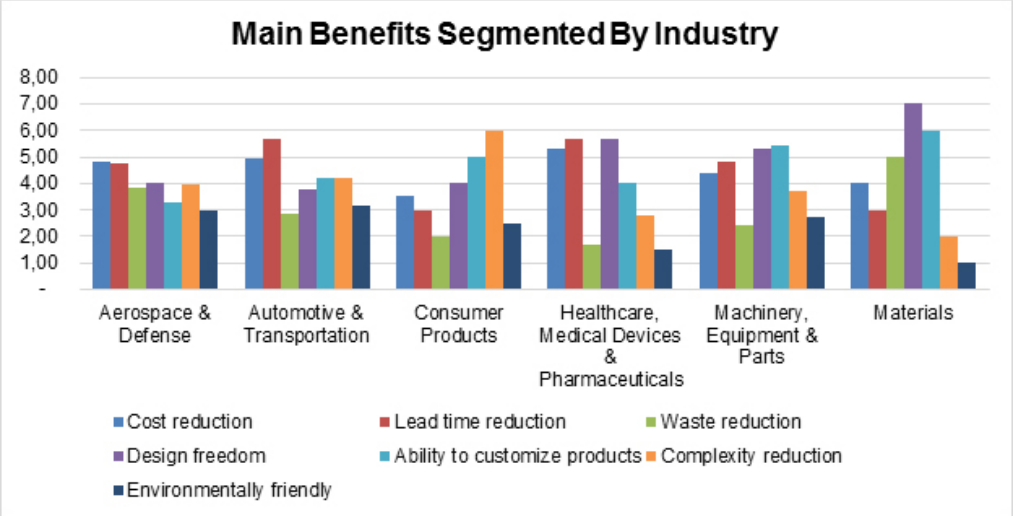

Figure 1 - Main benefits segmented by size

available, given the need for diverse types of materials in automobiles and aircraft. In addition, the lack of standards is a problem, as these industries require extremely high precision to build components. In the healthcare business, the major barriers to adoption are high capital investment and limited type of materials available.

SIZE SEGMENTATION ANALYSIS

Most of the survey respondents are small companies, which is similar to the sponsor's customer base. However, independent of size, the main application for 3DP is prototyping, with some application to customized part production, especially for very small and very large business (more than 100 employees). The benefits claimed to be the most interesting for all business, independent of size, are cost and lead time reduction and design freedom.

The same applies to the main barriers (Figure 2).

There is no big difference based on size segmentation. As one would expect, high initial capital investment is the biggest barrier. Surprisingly, more very large firms classified it as the biggest barrier, compared to small firms. One explanation may be that many small businesses were "born" using 3D printing, in contrast to large businesses, which were established before the technology development.

The second major barrier is the limited diversity of raw materials, followed by the size limitation of what can be printed.

CONCLUSION

Like most new technologies, 3D printing needs to evolve before it can be widely adopted by the metalworking industry. While it is already viewed as a viable and useful technology, it still has barriers to overcome. Currently, the main barriers for most

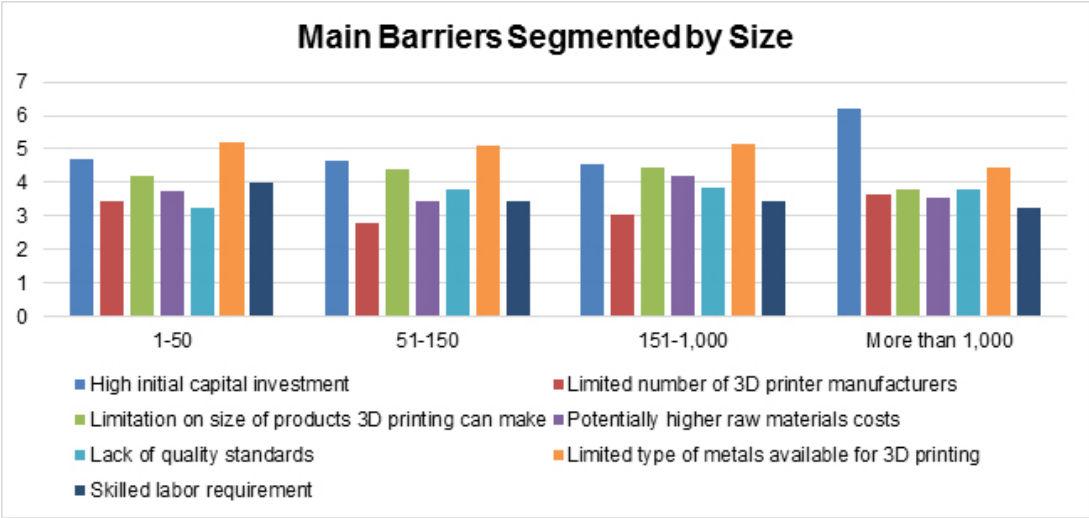

Figure 2 - Main barriers segmented by size

business are the high initial investment required and the limitation of materials type available. Limited printable size also is a main concern, independent of the industry segment and business size.

The present study points out that 3D printing tends to be used primarily for prototyping, even though it has more capabilities. This may indicate that there is a gap for better prototyping techniques in the metal working industry that has not yet been filled.

IMPLICATIONS FOR THE SPONSORING COMPANY

Using our customer prioritization framework combined with the potential adoption data from the survey, the sponsor will be able to identify target segments on which it should focus its offerings of 3D printing products. In the framework, the researchers prioritized customer segments based on two main criteria:

- Attractiveness of the 3D printing market within the segment:

We determined the attractiveness by multiplying the manufacturing revenue potential of each segment by the 3D printing adoption fraction data. The 3D printing adoption fraction is the percentage of the manufacturing line that will be replaced by 3D printing technology in that segment, based on the survey answers

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- Sponsor company's ability to compete within that segment: is a measurement of the company's capabilities to win in that segment. In this context, a high ability to win means that the company has established strong brands, a distribution network, and relationships with customers. However, there is a challenge in obtaining data related to organizational capabilities, so the sponsoring company's market share within the segment was used as a proxy.

The customer segments in which the attractiveness and the ability to compete are high will be prioritized. This means our sponsoring company should go after those customer segments first, followed by segments with lower attractiveness and ability to compete.

According to figure 3, small and medium machinery manufacturing companies, and medium healthcare manufacturing companies are the ones our sponsoring company should prioritize. Based on the survey, machinery companies have high potential to realize great benefits with 3D printing regarding ability to customize parts and design freedom, in addition to lower cost and reduced lead time, since this industry seems to make more customized parts than the automotive and aerospace industries. Also, small and medium companies have high attractiveness and potential for our sponsor to compete, as the machinery manufacturing industry is relatively fragmented, with small and medium sized companies making up a large share of revenue potential. Moreover, our sponsoring company has a relatively high market share within this segment, making it a high priority. Medium-size healthcare companies are also relatively attractive, given the sponsor's market share. These companies make customized medical parts, so 3D printing could offer design freedom, reduced lead time, and customization.

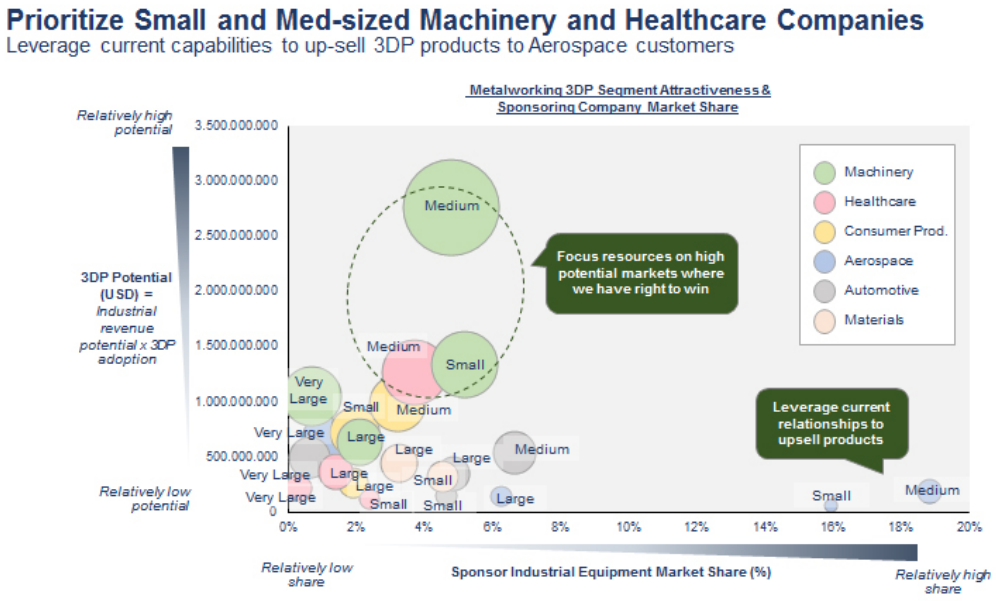

Figure 3 - Customer priorization framework