3D Printing’s Impact on the Metalworking Industry

By

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Today’s Agenda

• What is 3D printing?
• Research Motivation
• Our sponsoring company
• 3D Printing and the Metalworking industry
• Benefits of 3D Printing
• Challenges of 3D Printing
• Methodology
• Results
• Implication to our sponsoring company
3DP is a process where materials are join to create 3D object
Powders and binders are deposited layer by layer to form the desired shape.

Computer Aided Design (CAD) is used to direct where powders should be placed.

Source: Imperial Machine & Tool Co.
Research motivation: How big is 3DP impact to metalworking?
The new technology with potential to transform the way metal parts are made

“What would happen to traditional CNC if 3D Printing becomes widely adopted?”
Our sponsoring company…

- Large industrial distributor in the United States
- Distributor of metalworking and maintenance, repair and operations (MRO) product and services in North America
- Over 1 million products and provide inventory management solutions to its customers
- Customers range from small shops to large manufacturing companies from various industries
Few companies are using 3DP in their operations
GE prints fuel nozzles for its LEAP jet engines production

25% lighter and 5X stronger than the previous design

The single piece replaces what would be 19 different parts previously

Source: http://www.machinedesign.com
Several benefits of 3DP to the metalworking industry
Key benefits being cost effectiveness and steps reduction

**Shorter Value Chain**
- Only three steps required
- Minimal need for standard inventory policy, complicated logistics, and long supply chains

**Low Waste**
- Use only metal powder and binder
- Scrap rate is minimal at only 1-3 percent

**Greater Design Freedom**
- No need for the assembly step
- Product performance can be optimized without manufacturing constraints

**Cost Effective at Small Scale**
- 3D Printing is set up with less investment than the traditional manufacturing facility
- Lower cost per unit at small scale

Source: McKinsey & Company
At the same time, 3DP also has limitations. Key challenges include product quality, high investment, and the type of raw materials.

**Materials variety**
- Limitations on the number of materials that can be used.
- Limited the number of properties that can be embedded into the products.

**Cost of raw materials**
- Prohibitive cost of production of the metal powder.
- Small scale and low production yield (50%) making powder production inefficient.

**Quality and reduced post processing**
- Variability due to thermal stress or the presence of voids, resulting in lower repeatability.
- Low dimensional accuracy.

**Manufacturing large parts**
- Parts larger than 30 cm sq are difficult to produce.
- Larger components produced though 3DP still have to be attached together.

Source: Deloitte University Press
Comprehensive methodology to tackle this problems
Combined primary and secondary research

**Site visits**
- Traditional CNC machine users in various industries
- Companies adopted 3DP
- 3DP makers

**Interviews**
- Component manufacturers
- 3D printing software developer

**Questionnaire**
- 133 respondents from customer list of our sponsoring company

**Literature review**
- Industry report
- Business journal
- Articles
- Websites
- Past researches
Results of the study divided in two sections
We looked at the data from various angles
Overall, main benefits and barriers are what we expected
This is in line with our secondary research

Average score on the question “What do you see as the main benefits 3D printing you will realize?”

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity reduction</td>
<td>3.84</td>
</tr>
<tr>
<td>Waste reduction</td>
<td>3.09</td>
</tr>
<tr>
<td>Environmentally friendly</td>
<td>2.70</td>
</tr>
<tr>
<td>Ability to customize products</td>
<td>4.48</td>
</tr>
<tr>
<td>Design freedom</td>
<td>4.66</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>4.72</td>
</tr>
<tr>
<td>Lead time reduction</td>
<td>4.86</td>
</tr>
</tbody>
</table>

Average score on the question “What do you see as the biggest barriers to adopting 3D printing?”

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>High initial capital investment</td>
<td>5.10</td>
</tr>
<tr>
<td>Limited number of 3D printer manufacturers</td>
<td>3.09</td>
</tr>
<tr>
<td>Limitation on size of products 3D printing</td>
<td>4.25</td>
</tr>
<tr>
<td>Potentially higher raw materials costs</td>
<td>3.86</td>
</tr>
<tr>
<td>Lack of quality standards</td>
<td>3.78</td>
</tr>
<tr>
<td>Limited type of metals available for 3D printing</td>
<td>4.93</td>
</tr>
<tr>
<td>Skilled labor requirement</td>
<td>3.51</td>
</tr>
</tbody>
</table>

Cost reduction and Lead time reduction are main factors attracting businesses, followed by the Design freedom…

… While the biggest barriers are High Capital investment, Limited materials type and Limited size of products that can be printed

Overall, main benefits and barriers are what we expected
This is in line with our secondary research
Though most familiar with 3DP, likelihood of adoption is low
When looking at the results by industry

Though most companies are familiar with 3DP and some currently using it…

…Most companies will not be replacing the entire manufacturing line with 3DP, but rather 20-40% of it.

Responses to the question "How much do you know about 3D printing?" by industry

- I am very familiar with 3D printing, and have used or currently using 3D printing
- I am very familiar with 3D printing, and am aware of this process and benefits
- I am familiar with 3D printing and I am aware of the process
- I have heard about 3D printing but I don’t know much about it
- I am not familiar with 3D printing

Response to the question “On scale of 1-10, how likely are you to adopt 3D printing in the future?” by industry

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 10
This is because the application is limited within prototyping and some are used for small batches, customized production.
Change in the industry is not happening anytime soon
Most companies are still in early stages and the plans are either med to long term

Most companies are still in early stages, with automotive and healthcare manufacturing companies making more progress…

… And full adoption of 3DP will happen in medium to long term (3-10 years)

Response to the question "If you are likely to adopt the technology, which stage are you currently in?"

- We have set up and are testing and evaluating the effectiveness of the technology
- We finished the implementation and 3D printing has become a part of our operations
- We are in the process of implementing the technology for our business
- We are developing the plans to implement the technology
- We have decided to adopt but we haven’t started the project

Response to the question "How soon will you adopt the technology?"

- Short term (within 1-3 years)
- Medium term (within 3-5 years)
- Long term (within 5-10 years)
Cost and lead time reduction still key benefits for most ind. Greater design freedom and customization are important for some others

Response to the question "What benefits of 3D printing are the most important to you?"

**Key benefits**
- **Cost reduction**
- **Lead time reduction**
- **Complexity reduction**
- **Design freedom**
- **Ability to customize products**

**Mass production key components in these industries**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Cost reduction</th>
<th>Lead time reduction</th>
<th>Complexity reduction</th>
<th>Design freedom</th>
<th>Customization</th>
<th>Design freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace &amp; Defense</td>
<td>4.8</td>
<td>4.8</td>
<td>3.3</td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive &amp; Transportation</td>
<td>4.9</td>
<td>5.7</td>
<td>3.8</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Consumer Products</td>
<td>3.5</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Healthcare &amp; Medical Devices</td>
<td>5.3</td>
<td>5.7</td>
<td>5.7</td>
<td>2.8</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Machinery, Equipment &amp; Parts</td>
<td>4.4</td>
<td>4.8</td>
<td>5.3</td>
<td>5.5</td>
<td>3.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Materials</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>6.0</td>
<td>7.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

**Cost and lead time reduction still key benefits for most ind.**

**Greater design freedom and customization are important for some others**

**Design is critical to making medical components**

**High customization required in making parts**
While limited materials types and quality main challenges
High capital investment also key issues in most industries

Response to the question "What do you think are the biggest barriers to adoption of 3D printing?"

<table>
<thead>
<tr>
<th>Key challenges</th>
<th>Aerospace &amp; Defense</th>
<th>Automotive &amp; Transportation</th>
<th>Consumer Products</th>
<th>Healthcare &amp; Medical Devices</th>
<th>Machinery, Equipment &amp; Parts</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited material types</td>
<td>3.8</td>
<td>5.1</td>
<td>5.0</td>
<td>5.7</td>
<td>6.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Lack quality standards</td>
<td>2.9</td>
<td>3.3</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
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<td>High capital inv.</td>
<td>5.5</td>
<td>4.4</td>
<td>6.0</td>
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<td>4.0</td>
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Diverse materials and high precision required in these industries
Relatively high initial investment compared to current application
3DP still needs to evolve before becoming widely adopted
Still some barriers to overcome including high inv., limited materials & size

Source: Mercatus Center, George Mason University; US Department of Commerce, Census Bureau, Consumer Electronics Association
Two key criteria for our sponsor to prioritize customer seg. If our sponsoring company were to enter the 3DP market

What segment should we prioritize?

A 3DP Potential (External lens)
- Large industrial equipment market
- High potential to adopt 3D printing

B Sponsoring company position (Internal lens)
- High current market share (proxy)
- Established relationships
- Strong salesforce and distribution channels
Focus on small and med machinery and healthcare companies
High relative Market Attractiveness and Right To Win

Metalworking 3DP Segment Attractiveness & Sponsoring Company Market Share

3DP Potential (USD) = Industrial revenue potential x 3DP adoption

Focus resources on high potential markets where we have right to win

Leverage current competitive advantage to upsell products and expand our position

Focus on small and med machinery and healthcare companies

High relative Market Attractiveness and Right To Win

A

B

Sponsor Industrial Equipment Market Share (%)
Thank You

Q&A