Fab Labs: A Blueprint for Decentral Production?

3D Printing Technology Landscape for Metal Production in Digital Manufacturing Workshops

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Agenda

1 Motivation and state-of-art

2 Technology landscape

3 Summary and conclusion
Yes, 3D printing currently being hyped...

Source: Gartner (2012), http://www.gartner.com/newsroom/id/2124315
... as search volumes indicate, too

Source: Google Trends Peak Search Interest for “3D print”
… with “enlightenment” being reached for industrial applications

Source: Gartner (2013), http://www.gartner.com/newsroom/id/2575515
Emerging business opportunities for consumer & industrial applications with market size of 10.8 billion USD by 2021

### Consumer applications
- 3D printing services
  - 3D model repository (e.g., Thingiverse, Shapeways)
  - 3D printing capacities (e.g., Sculpteo, Trinckle, Panashape)
- 3D printer for home use
  - E.g., Makerbot (just recently acquired by Stratasys for 400M USD, a ~30x sales multiple), Cubify
- 3D printed, customized products
  - E.g., Twikit (Medals, Trophies), 3DMe (figurines)

### Industrial applications
- Professional 3D printing services
  - Rapid prototyping
  - Rapid manufacturing
  - Rapid tooling
- 3D printer for professional manufacturing use
  - E.g., EOS, Stratasys, ExOne

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A new industrial revolution?

The Economist, April 2012
Fab Labs: globally distributed but (yet?) concentrated in Europe & North America, many offer 3D printing

Number of Fab Labs as of August 2013

- **Europe**
  - France: 47
  - Netherlands: 22
  - Germany: 13
  - Other: 61

- **North America**
  - United States: 41
  - Canada: 6
  - Curacao: 1

- **Africa**
  - South Africa: 9
  - Saudi Arabia: 2
  - Afghanistan: 2
  - Other: 11

- **Asia**
  - India: 4
  - Taiwan: 2
  - Turkey: 2
  - Other: 7

- **South America**
  - Chile: 3
  - Colombia: 2
  - Other: 7

- **Australia**
  - Australia: 5
  - New Zealand: 1

Source: FabWiki (2013)
The “fabbing world” is more than Fab Labs

Source: Troxler (2010)
What professional users (SMEs, start-ups) expect from digital mfg. workshops partly differs from requirements of “makers”

<table>
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<tr>
<th>“Makers”</th>
<th>“SMEs &amp; start-ups”</th>
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<td>Local access to 3D printing resources</td>
<td>Low / affordable production costs</td>
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• Education
• Personal empowerment (make things)
• Fostering innovation (“peer-production”)
• Community-building
• Knowledge exchange

• Speed
• High quality of parts
• Reliability and reproducibility
• Availability of support and documentation
• Securing intellectual property
• Access to community and open design

**Mostly “plastic gadgets” for home use**

**Mostly industrial metal end-use parts for e.g., automotive, aerospace, medical**
Digital manufacturing workshops that commercially offer 3D printing solutions emerge, too

“The UPS Store Makes 3D Printing Accessible to Start-Ups and Small Business Owners

San Diego, July 31, 2013

The UPS Store® today announced it is the first nationwide retailer to test 3D printing services in-store. Select UPS Store locations will be offering the services to start-ups, small businesses and retail customers, beginning in the San Diego area with locations in additional cities across the United States in the near future. […]”

Source: https://www.theupsstore.com/about/media-room/Pages/3D-printing-accessible.aspx

“How TechShop is changing the way hardware companies are born

By Signe Brewster Aug. 6, 2013 - 5:30 AM PDT

TechShop members get access to $1 million of equipment for $125 a month. Since the first location opened in 2006, they’ve built some amazing things. tweet this

Walk around TechShop’s San Francisco location and you feel the hum. There’s $1 million worth of equipment creating a physical hum, but also the murmuring hum of dozens of people working on making their small business a reality. […]”

Source: http://gigaom.com/2013/08/06/how-techshop-is-changing-the-way-hardware-companies-are-born/
Limited diffusion of AM for metallic parts in digital mfg. Workshops / Fab Labs...

Source: Shapeways

Source: Materialise, Tinkercad
Bringing digital mfg workshops / Fab Labs to the next level?
—Technology landscape for 3D printing of metal parts

**AM technologies**

- **Electron Beam Melting**
  - Direct Metal Laser Sintering
  - Selective Laser Sintering
  - Selective Laser Melting
  - Laser Cusing
- **Laser Based Melting**
- **Photo-polymerization**
- **Extrusion Based Technologies**
  - Fused Deposition Modeling
  - Other
- **3D Printing**
Selective Laser Melting, a technology for dmf. Workshops / Fab Labs?

3D-CAD model in slices

+ Powder

Deposition of powder layer

Melting of the powder

Lowering the platform

Part
Individualisation for free offers great opportunities for Fab Labs...
Complexity for free is more a opportunity for more advanced users…
Why is AM for metallic parts not used in FabLabs?

- Main differences between plastic and metallic processes
  - Machine (Investment) Costs
  - Material costs
  - Process costs
  - Design rules / guidelines
  - Process environment
  - Process know-how
  - Safety
Main drivers to boost the diffusion of AM for metallic parts…

- Competitiveness
- Productivity
- Part Quality
- Material Range & Design
Main hinds for AM for metallic parts are high costs and lack of know-how…

- AM is being hyped as a promising technology
- AM for plastic parts are common in Digital Manufacturing Workshops and FabLabs
- Main reason for the diffusion of AM for metal parts are costs and know-how
Fab Labs would be an ideal platform to foster exchange…

- Productivity, Part quality and Material Range / Design as main critical success drivers for the application in FabLabs
- FabLabs could help spreading know-how in an interaction between process experts and “makers”