Additive Manufacturing in Aerospace & Defence

Facts and Forecasts

Dr Bryony Core
Helping you profit from emerging technologies

Research
- Technology landscape
- Company assessments
- Market forecasts

Events
- Conferences
- Exhibitions
- Masterclasses

Consulting
- Custom research
- Analyst access
- Advisory service
Additive manufacturing

How did we get here?
The seven different types of AM:

...3D printing is defined as a form of Computer Numerical Control (CNC) in which a product is manufactured additively through the interaction of software with physical hardware such as a scanner, printer and materials.

<table>
<thead>
<tr>
<th>Process</th>
<th>Related acronyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vat Photopolymerisation</td>
<td>SLA, DLP, CLP, CLIP</td>
</tr>
<tr>
<td>Material Extrusion</td>
<td>FDM, FFF, TPE, ADAM</td>
</tr>
<tr>
<td>Material Jetting</td>
<td>Polyjet, MJP</td>
</tr>
<tr>
<td>Powder Bed Fusion</td>
<td>SLS, SLM, DMLS, EBM</td>
</tr>
<tr>
<td>Directed Energy Deposition</td>
<td>DED, RPD, EBAM</td>
</tr>
<tr>
<td>Binder Jetting</td>
<td>MJF, SPJ</td>
</tr>
<tr>
<td>Sheet Lamination</td>
<td>LOM, UAM, CBAM</td>
</tr>
</tbody>
</table>
The explosion of interest in 3D printing

In 2016, desktop printers constituted 95% of the total installed base of 3D printers globally.

- Installed base is a foundation for the demand of AM consumables such as materials and software.
- The breakdown of installed base according to desktop (<$5000) or industrial printer types has shifted dramatically in the past five years.
- Desktop printers now constitute the overwhelming majority of the installed base of all 3D printers.
- The media frenzy of 2012 established the term 3D printing in common lexicon and desktop printers have seen the greatest boom in demand.
History of polymer AM: the rise of the hobbyist

- 1986 – Patent protecting SLA granted to Chuck Hill
- 1986 – Patent protecting SLS granted to Carl Deckard
- 1989 – Patent protecting FDM granted to Scott Crump
- 2009 – Stratasys patent expires and Makerbot is founded
- 2013 – Makerbot acquired by Stratasys for $400m
- 2014 – Makerbot become the most popular brand of 3D printer in the world, soon overtaken by XYZPrinting
- 2017 – Over 200 individual desktop TPE printer manufacturers known
Additive manufacturing metals

- Metal additive manufacturing was commercialised in the 1990s by EOS who developed powder-bed direct metal laser sintering and commercialised their first printer in 1995.
- Arcam AB commercialised EBM technology in 2003.
- 2017 witnessed a flurry of new technologies commercialised.
AM isn’t going away any time soon

- Unit sale per annum are set to almost double between 2018 and 2028 for industrial printers.

- In total, industrial printer market will see a CAGR between 2018 and 2028 of 6.2% to be worth $22 billion.

- Metal printers will fuel this growth: metal + polymer extrusion and metal binder jetting printers will experience a CAGR of 41 and 43% in this period.

- Material jetting and sand binder jetting printers will see the most pronounced decrease in unit sales.
Additive manufacturing

Advances and new developments
A barrier to adoption of additive manufacturing in aerospace is the rigorous certification requirements for components on aircraft.

Norsk Titanium have completed certification of their Rapid Plasma Deposition process by the Federal Aviation Authority (FAA).

Boeing have placed a production purchase order with Norsk Titanium using RPD for a part on the 787 Dreamliner.

Norsk Titanium estimate that the 3D printed titanium parts represents a potential manufacturing cost reduction of $2 to 3 million per aircraft for Boeing.
RUAG Space and Altair: antenna mount

Altair Hyperworks is a simulation software package that has been used to algorithmically optimise product design solutions for over 30 years. Collaboration with a number of printer manufacturers and end users have showcased their ability to apply these concepts to AM.

Using Altair’s topology optimisation and design packages, OptiStruct and ProductDesign, they designed an antenna mount for RUAG Space, printed on an EOS M 400 system.

Compared to the existing support mount, the 40 cm long 3D printed component offers 43% weight reduction from 1.626 to 0.936 kg and increased eigen frequency of 70 to 90 Hz.

Altair do not provide software solutions specifically required for additive manufacturing, such as g-code generators, but do provide middleware to allow printer load management.
Hofmann: oxygen supply tube

- IDTechEx spoke with prototype manufacturer Hofmann who designed and manufacture a component for BAE Systems’ auxiliary oxygen supply system on the Eurofighter Typhoon.

- This supply tube comprises a single part and is capable of withstanding pressures of up to 900 bar, significantly higher than the standard operating and burst pressure thresholds of 200 and 400 bar, respectively.

- The original component comprised 5 parts, welded together with semiautomatic orbital welding which led to gas leakage and quality control difficulties.

- Approximately 100 units are made p.a. and design improvements to the radius of the inner tunnel with a 90° angle enabled by AM ensured gas was supplied at a continuous flow rate.
3T RPD continue to push AM boundaries

- At FIA2018, 3T RPD discussed the future of additive manufacturing innovation that 3T RPD was undertaking.

- Their development of a copper chromium zirconium alloy for powder bed fusion is unrivalled in industry: the result of two years research and development, 3T RPD have successfully developed the process to enable the production of a unified rocket nozzle with integrated gas channels (pictured left).

- Forthcoming innovations to watch out for later this year include the world’s largest topologically optimised structural component that was manufactured on two powder bed fusion printers.
Additive manufacturing

The Forecasts
The Forecasts

Market size of AM in aerospace & defence

Total AM market in 2028F: $38 billion

- Aerospace & defence
- Healthcare
- Automotive
- Consumer goods
- Energy
- Construction
- Other

AM in aerospace & defence

- $16B
- $12B
- $8B
- $4B
- $0B

2018
- $2B

2028F
- $14B
- Materials
- Hardware and software
Drivers and restraints of growth

Affordable desktop metal printers increases SME adoption.

Increasing awareness of additive manufacturing.

Improved part quality with inbuild monitoring and quality control software.

New entrants to market due to expiration of key patents reducing printer prices.

Lack of appropriate personal training in AM.
Price point of printers and metal powders is out of reach of SMEs.
Restricted material choice.
Conformity and certification standards increases cost and lead times
Significant post-processing required, including support removal and hot isostatic pressing.
Macroscopic properties of AM parts not identical to traditionally manufactured parts.
Restricted build volumes and speed limits application to low volume production.
Existing investment in traditional manufacturing PPE.

Market growth in additive manufacturing currently facing barriers in areas of cost, technical capability and education.
Additive manufacturing: technology roadmap

Key enablers:
- Increased production rates
- Greater material range
- Effective AM supply chain

Local repairs
Spare parts
Cabin reconfiguration
Lightweight structures
AM designed airframes

2018 - 2030:
- A330neo
- C919
- B777x
- MoM
- R-80
- C929
Additive Manufacturing and Lightweight Materials for Aerospace and Defense

Technology assessments, player profiles and strategies, market forecasts 2018-2028

Dr Richard Collins and Dr Bryony Core
IDTechEx supports your strategic business decisions on emerging technologies.

Dr Bryony Core  
b.core@idtechex.com  
www.linkedin.com/in/bryonycore

Research  
IDTechEx conducts detailed examinations of emerging technologies, which are delivered through our Market Research Reports and Subscription services.

Consulting  
Our expert analysts deliver custom projects which identify markets, appraise technologies, define growth opportunities and perform due diligence.

Events  
IDTechEx conferences and tradeshows match end users with the latest innovations, providing networking, sales and knowledge sharing.

Offices:  
USA: + 1 617 577 7890  
Germany: + 49 3991 669 3591  
UK: + 44 1223 812 300  
Japan: + 81 90 5566 1533  
www.IDTechEx.com