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Learning Advanced Industrial Technologies

Additive Manufacturing
or: 3D Printing

Friday 3rd November 2017

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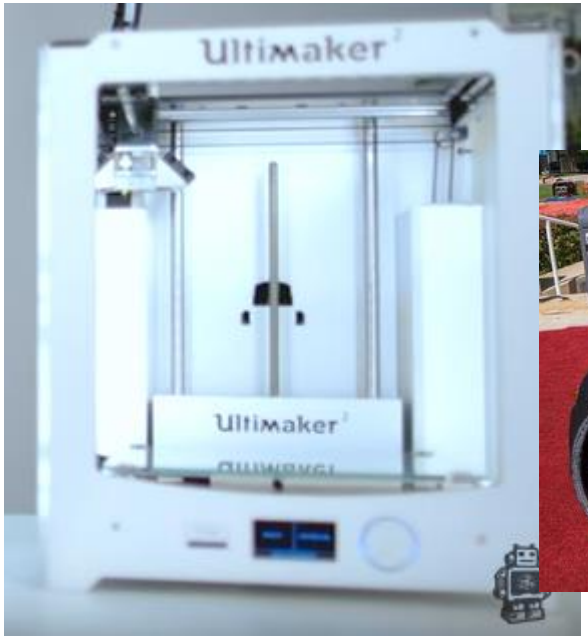
Additive Manufacturing

What is additive manufacturing?

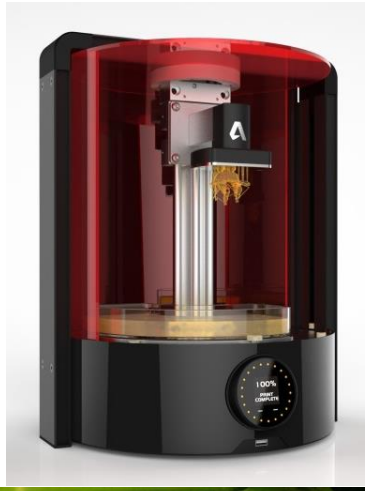
[Ultimaker – YouTube Overview]

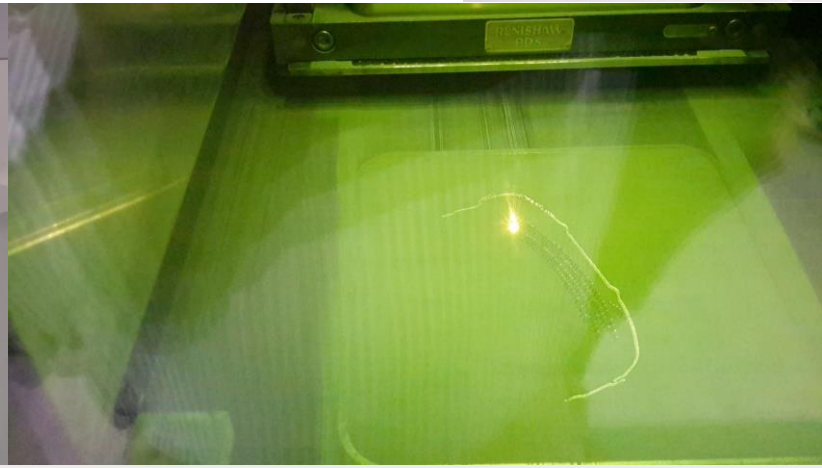


Additive Manufacturing

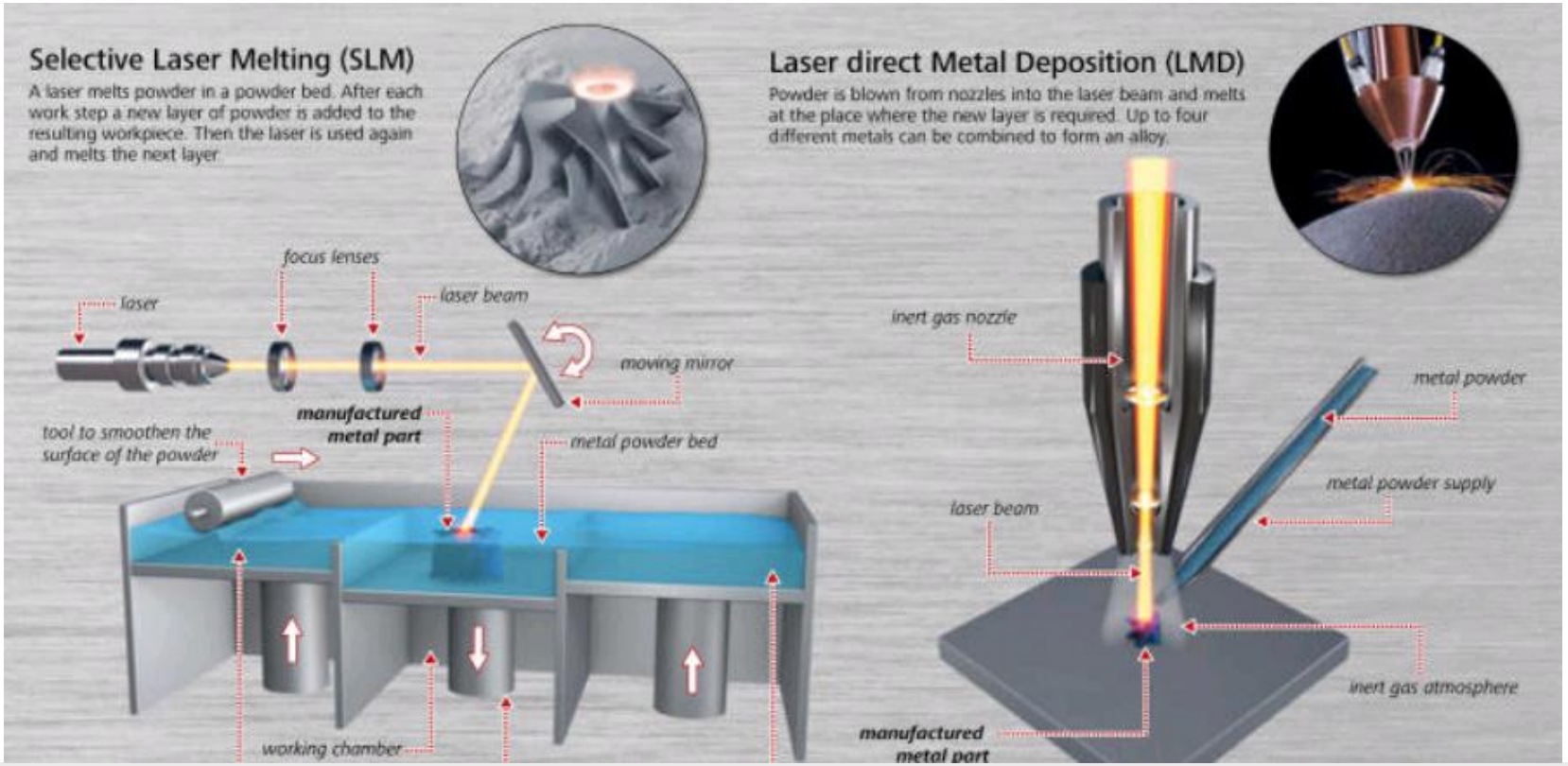
What are the technologies?

- FDM – Fused Deposition Modelling
- SLA – Stereolithography e.g. Ember
- SLS – Selective Laser Sintering e.g. Renishaw (click below, right)





Metals


Selective Laser Melting (SLM)
A laser melts powder in a powder bed. After each work step a new layer of powder is added to the resulting workpiece. Then the laser is used again and melts the next layer.
focus lenses
laser
laser beam
moving mirror
manufactured metal part
tool to smoothen the surface of the powder
metal powder bed
working chamber
Laser direct Metal Deposition (LMD)
Powder is blown from nozzles into the laser beam and melts at the place where the new layer is required. Up to four different metals can be combined to form an alloy.
inert gas nozzle
metal powder
metal powder supply
laser beam
inert gas atmosphere
manufactured metal part

Metals

YouTube: Metal Laser Sintering

Costs & Benefits

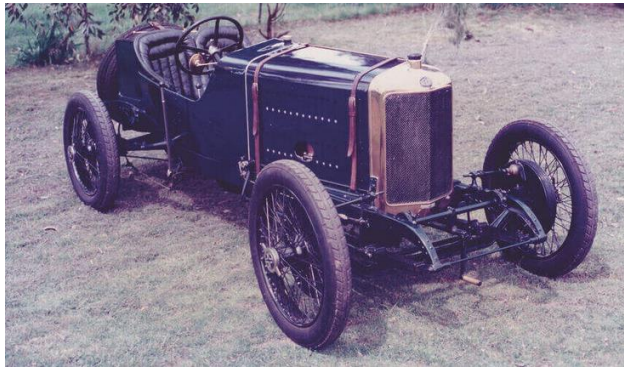
Cost and time savings
Some machines are very cheap (£100s) some are very expensive £100k +

Material costs:	FDM £25/kg filament
	SLA - £150/litre resin
	SLS - £250/kg powder

Renishaw Metal Laser Sintering – £500,000+

Vintage Delage kept running – what price?

"over 70% of manufacturers have found a way to use 3D printing, according to a 2016 survey by PwC and the Manufacturing Institute"

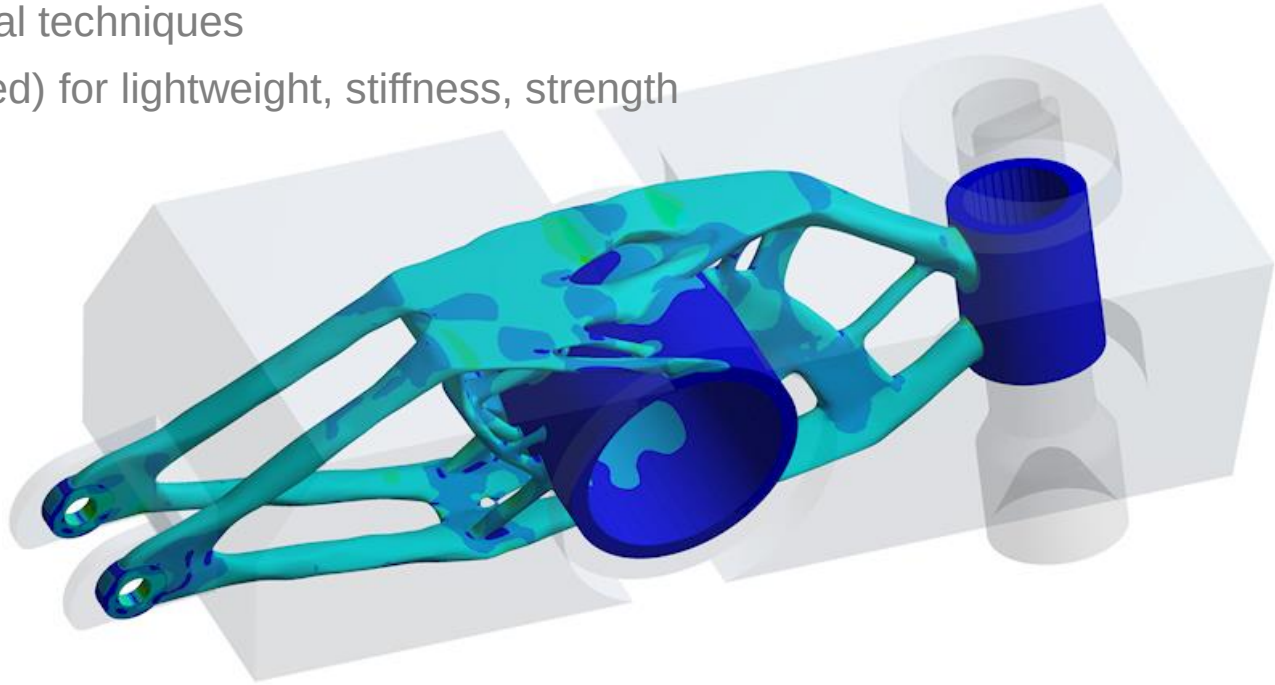


Topology Optimisation

Now possible to manufacture parts whose geometries would have been all but impossible using traditional techniques

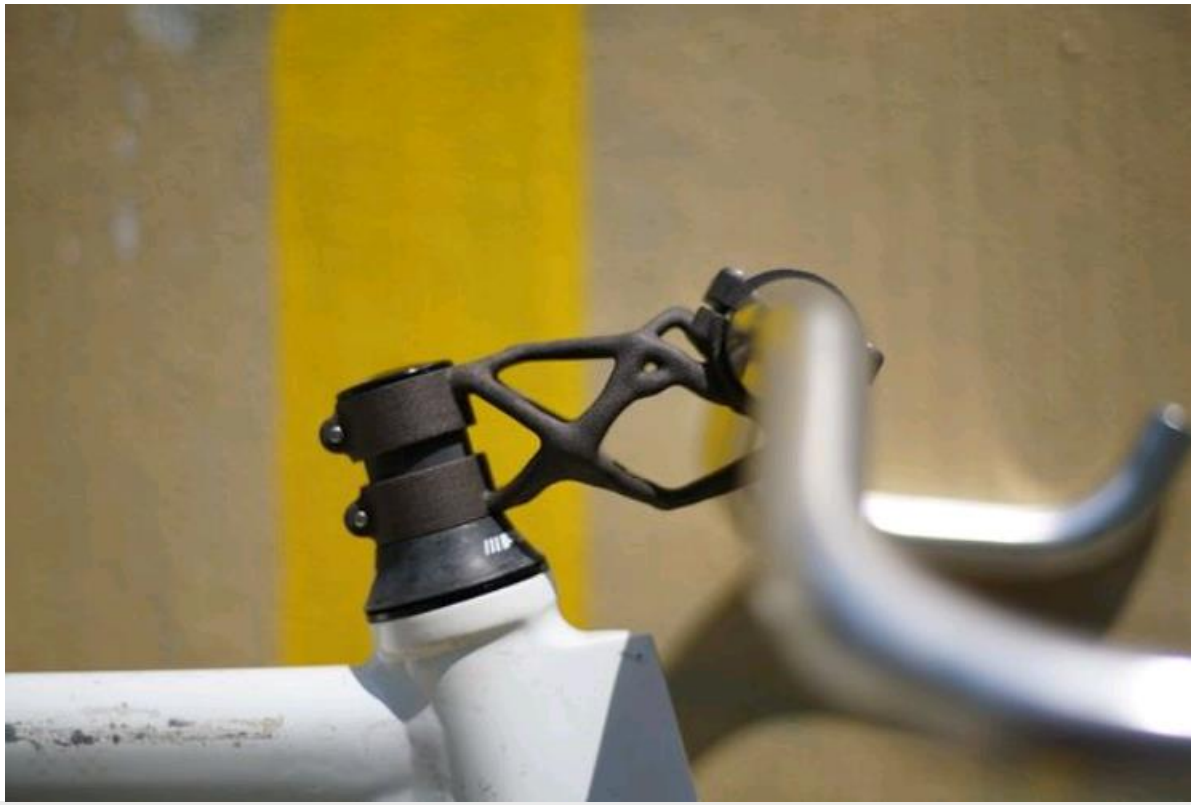
Iterative design (automated) for lightweight, stiffness, strength

FEA



Topology Optimisation

- Bike Stem
- Describe the terminating geometry (i.e. constrain the design)
- Refinements to the shape
- Tested using FEA
- Instructables Link



Topology Optimisation

Complex Geometry:

weight, strength and geometric optimisation in the Aerospace industry

Hinges for the Airbus A320 - conventional (background) and 3D printed (foreground)

Complexity

3D printed with nylon
using SLS technology

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Breaking News

New developments in 3D printing improve the strength of stainless steel

According to a recent article in Science Magazine:
“3D printing has taken the world by storm, but it currently works best with plastic and porous steel - materials too weak for hardcore applications”

References and Bibliography

- www.renishaw.com/en/metal-3d-printing--32084
- www.sciencemag.org/news/2017/10/3d-printing-doubles-strength-stainless-steel
- https://3dprint.com/28786/luna-3d-printed-bike-design/
- www.instructables.com/id/How-to-Design-a-Bike-Stem-in-Dreamcatcher/
- www.3ders.org/pricecompare/3dprinters/
- www.bbc.co.uk/news/science-environment-24528306
- Ultimate Beginners Guide to 3D Printing (video)
- https://all3dp.com/1/3d-printed-car-3d-printing-cars/
- https://all3dp.com/1/useful-cool-things-3d-print-ideas-3d-printer-projects-stuff/
- http://searcherp.techtarget.com/feature/Why-benefits-of-3D-printing-are-attracting-more-manufacturers
- www.3dhubs.com/knowledge-base/advantages-3d-printing