

Additive Manufacturing State of the Industry & Reality Check

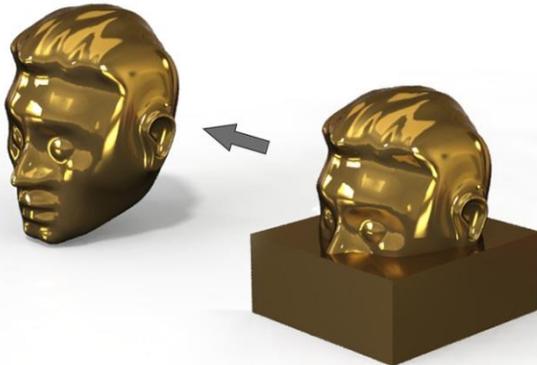
Olaf Diegel



Additive Manufacturing (3D Printing)

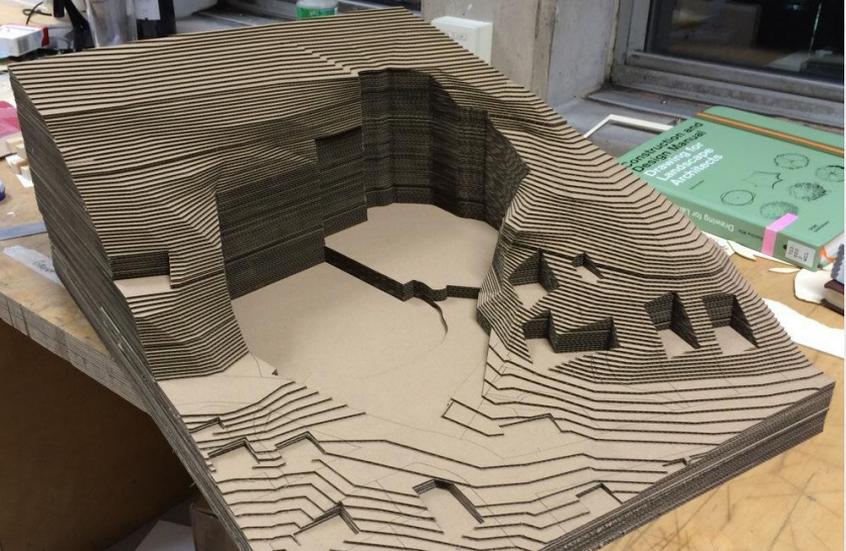
- Generate a **3D CAD model**
- Software slices the 3D model into thin slices
- Machine builds it **layer upon layer**

Subtractive Manufacturing



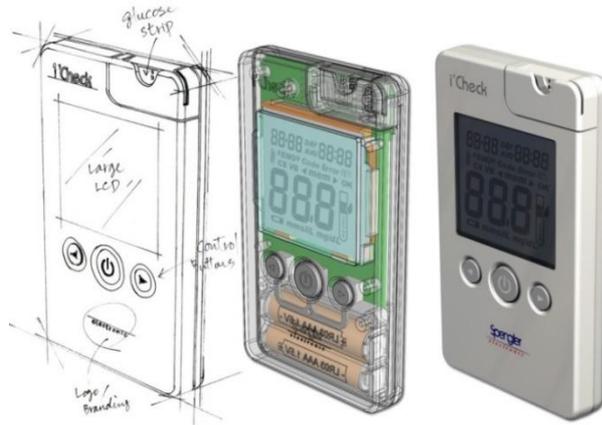
Additive Manufacturing



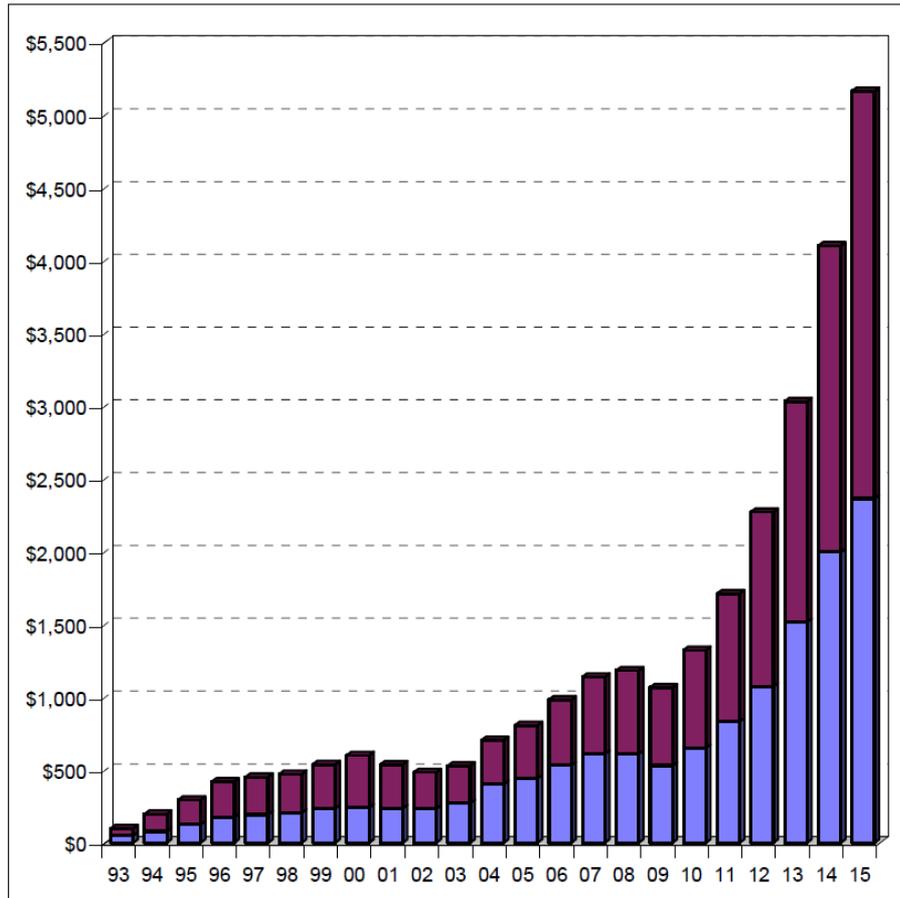


The Past

- For most of its first 3 decades, Additive Manufacturing (AM) was known as **Rapid Prototyping**, and used for prototyping.
- In the last decade AM has begun to make appearances in real products, ie. moved to **Rapid Manufacturing**.
- This has generated a lot of **hype and a few myths**



Industry Growth



Unprecedented worldwide growth!

Growth in Sweden in 2015 was greater than in the last decade years combined.

In the high-end industrial machine category (over US\$100,000) 2016 saw the installation of, at least, 7 metal systems and 25 polymer systems in Sweden.

Myth

- Additive Manufacturing (AM, or 3D Printing) will **NOT** replace conventional manufacturing!
- It is a **complementary** technology that, for **certain products**, and if used the **right way**, gives **huge advantages** over conventional manufacturing.
- But, for it to offer advantage everything needs to be **designed for additive manufacturing (DfAM)**.
- **Not everything should be 3D printed!** Only use 3D printing when it truly offers you that **advantage!**

DfAM: Complexity for Free: Aesthetic



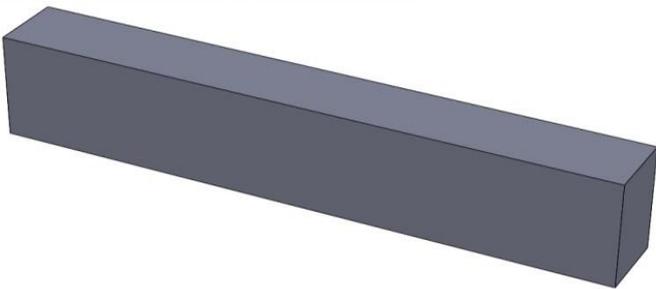
Deluxe Tapware by American Standard

DXV
AMERICAN STANDARD

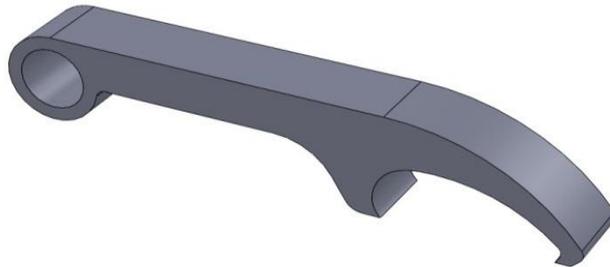
DXV
AMERICAN STANDARD

DfAM: Topology Optimisation

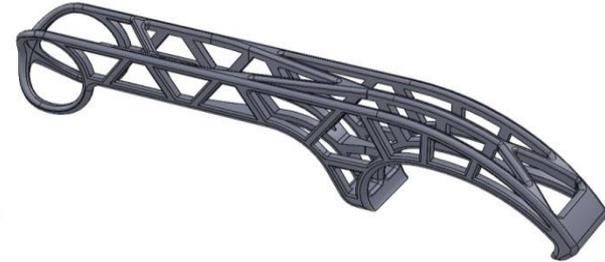
Topology Optimisation: Using maths to remove whatever material is not contributing to improve the mechanical characteristics of a part



Solid Billet: 10.39gms



Solid Machined/Cast: 4.22gms



Topology Optimised AM: 0.95gms

DfAM: Mass-Customisation: Medical



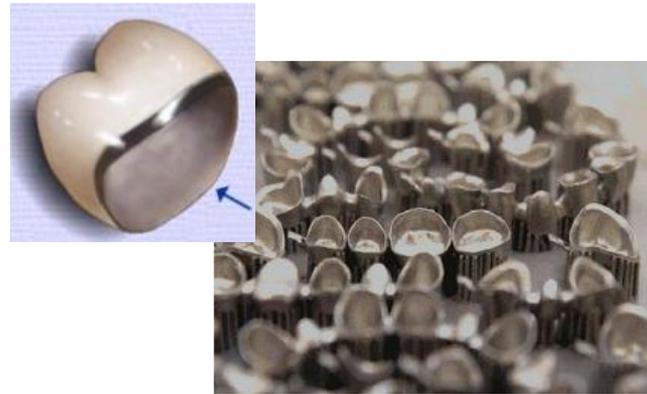
Inner-ear Hearing Aids, **60 million** produced since 2000



Surgical guides, **400,000+** to date



Hip replacement acetabular cups, **100,000+** produced to date



Dental copings, **6.8 million** / year



Dental aligners, **14 million** / year

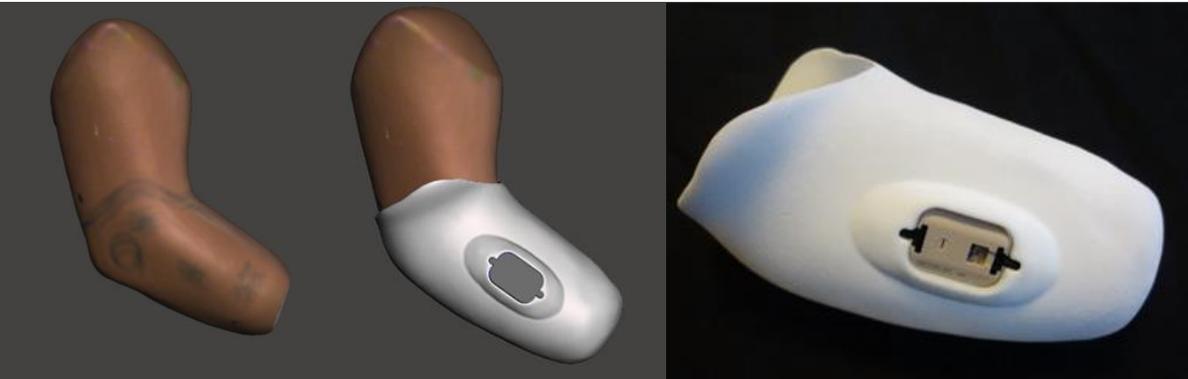
DfAM: Mass-Customisation: Medical

The old way

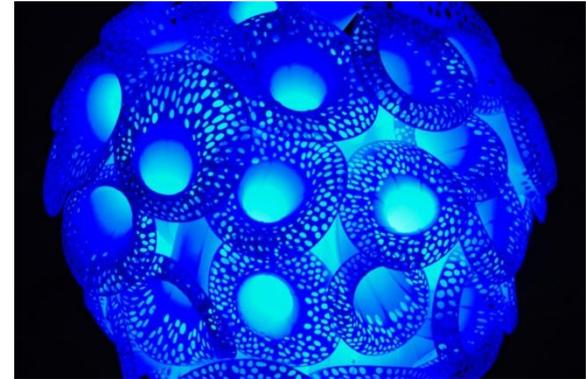
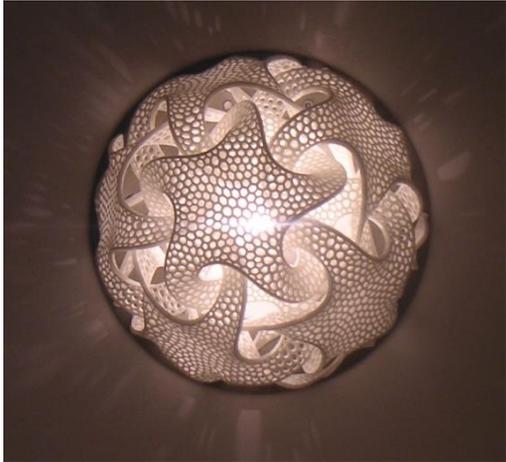


Custom prosthetic 3D
printed for 2 ½ year old
Neya
by Emelie Strömshed at
Lund University

The new way



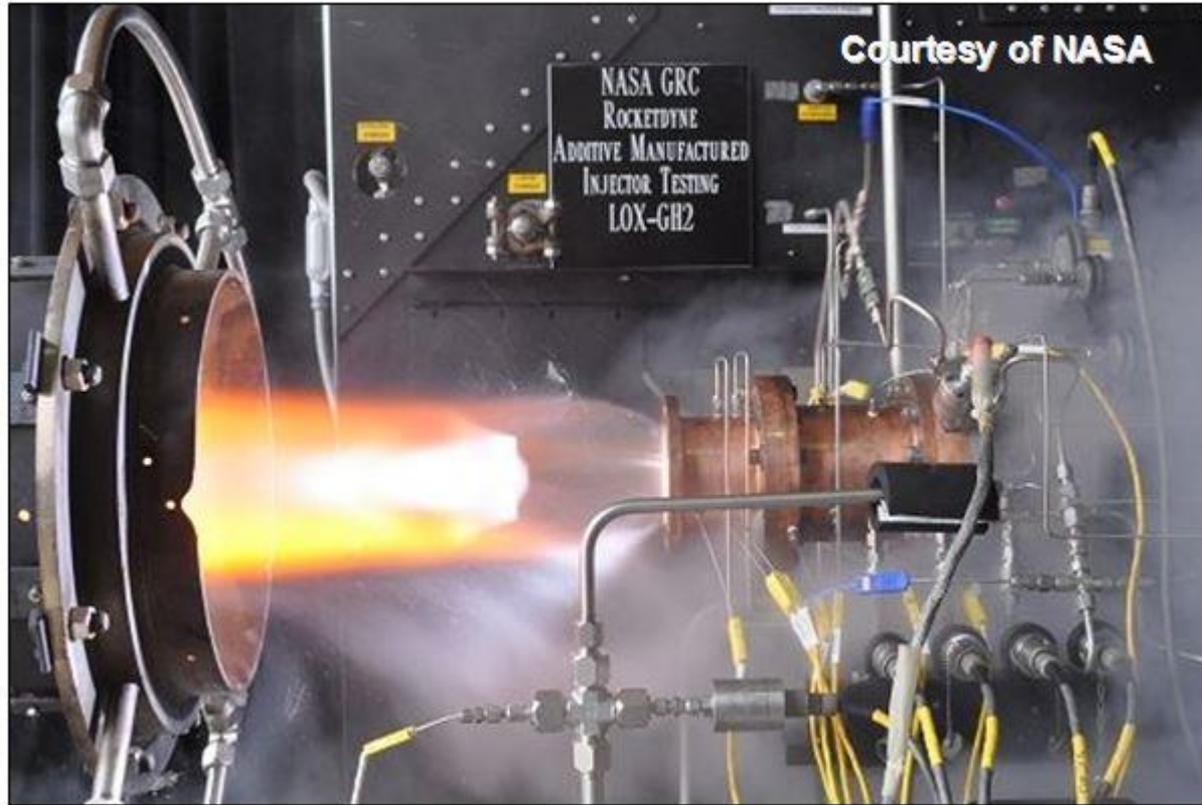
Lighting



Mass-Customisation: Printing People



Part Consolidation



Consolidated 115 parts to 2

Getting products to market at no risk

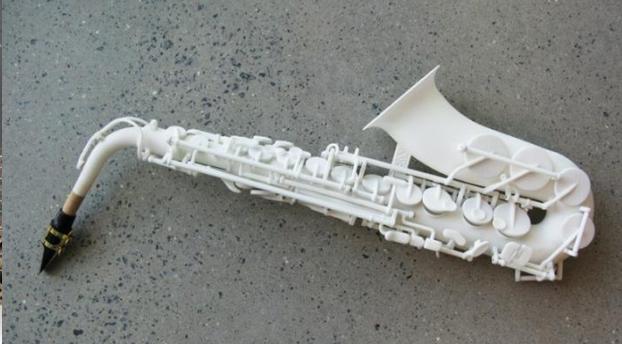


Jenna Makgill, AUT University

Instant Production: Drone in a Week

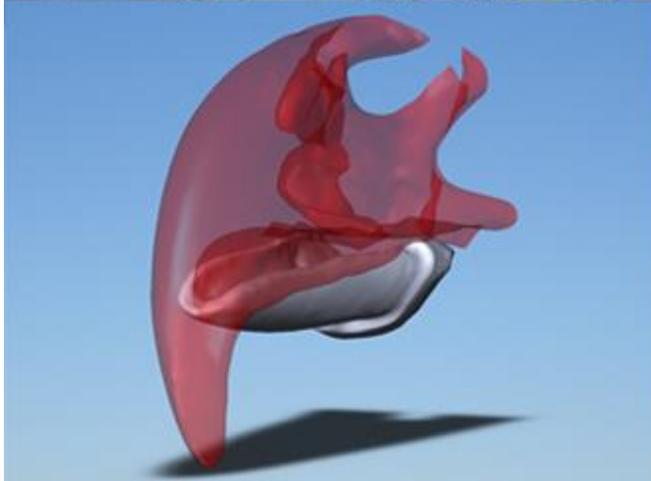
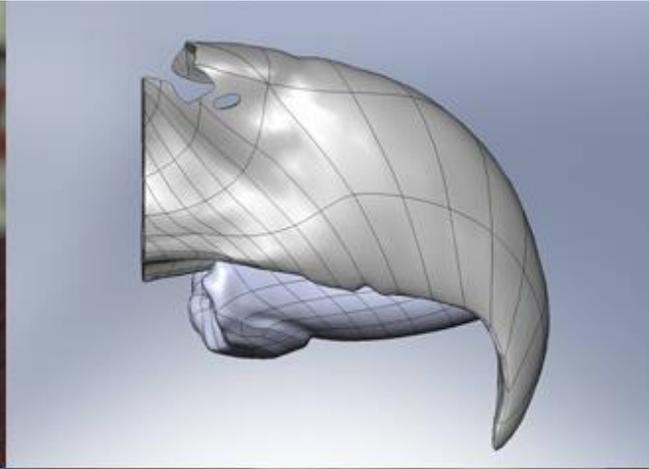


Products to market at no risk





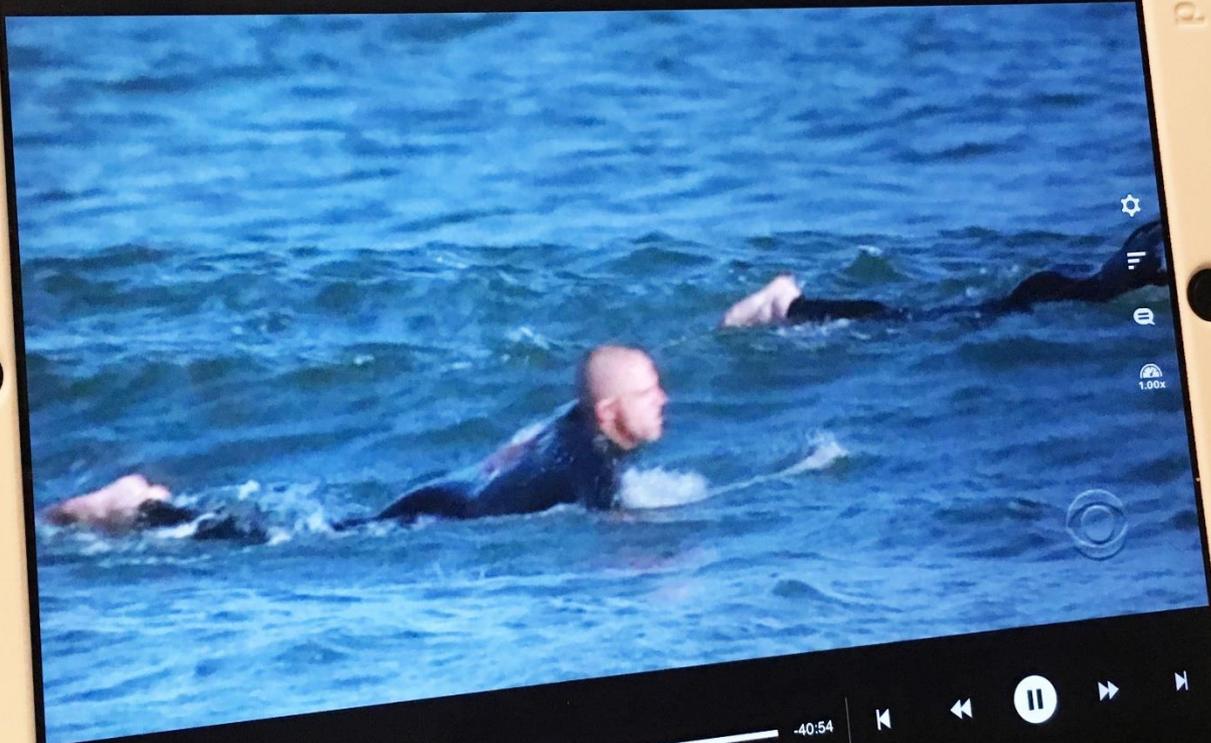
Encouraging Creative Thinking



iPad

19:42

90% 



1.00x



02:45



-40:54

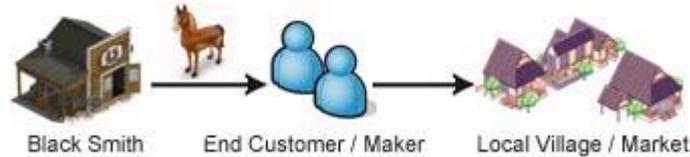


iSound

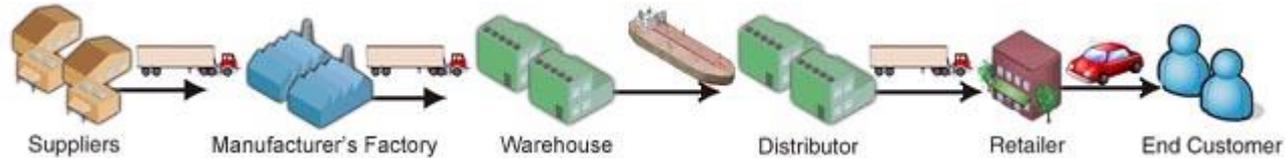
iSound

Additive Manufacturing & the Supply Chain

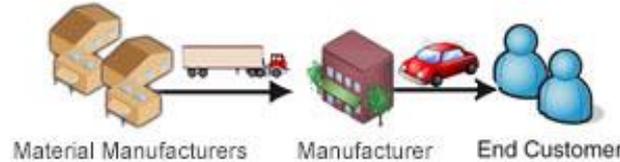
- Yesterday



- Today



- Tomorrow

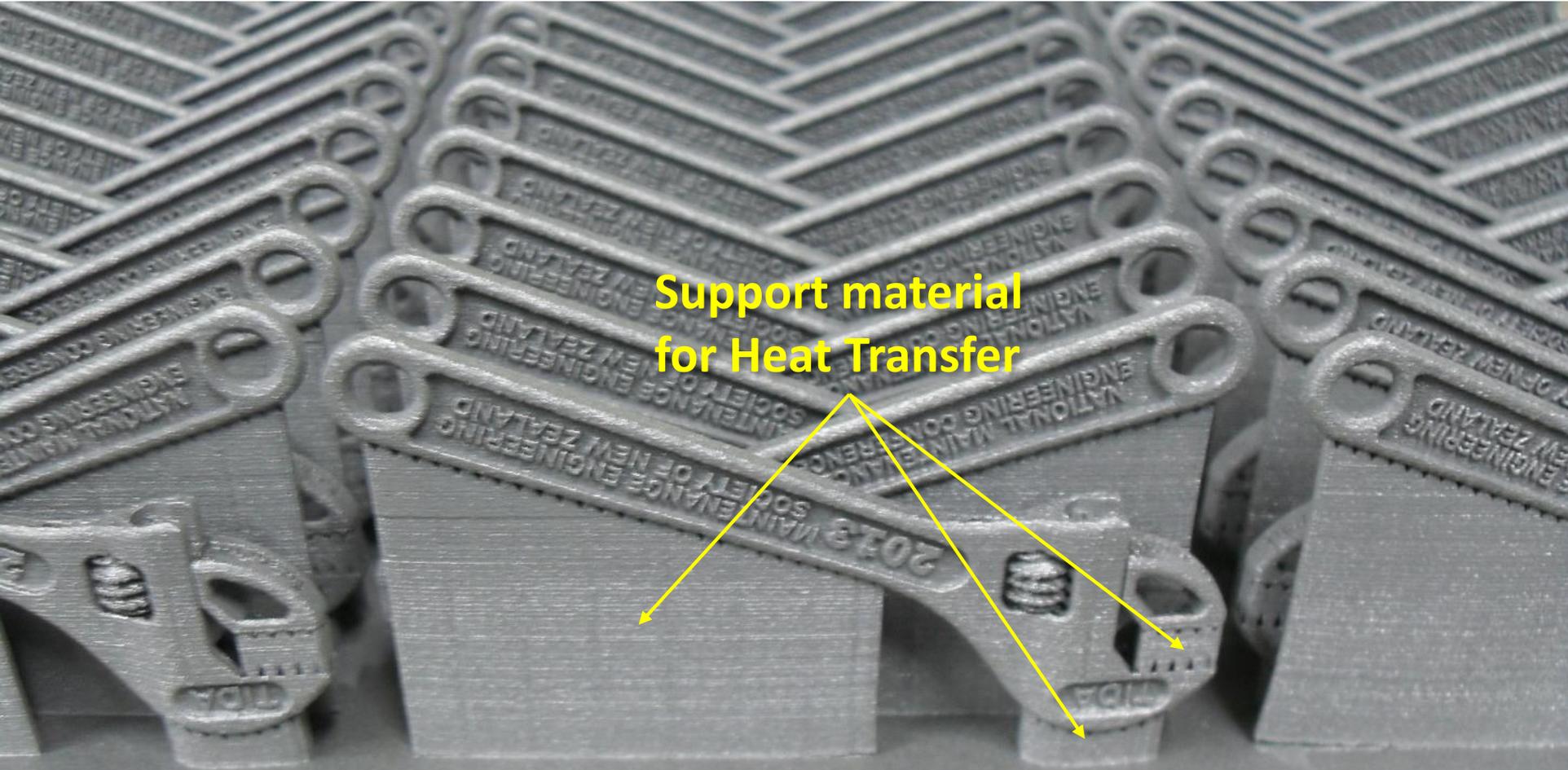


Myth

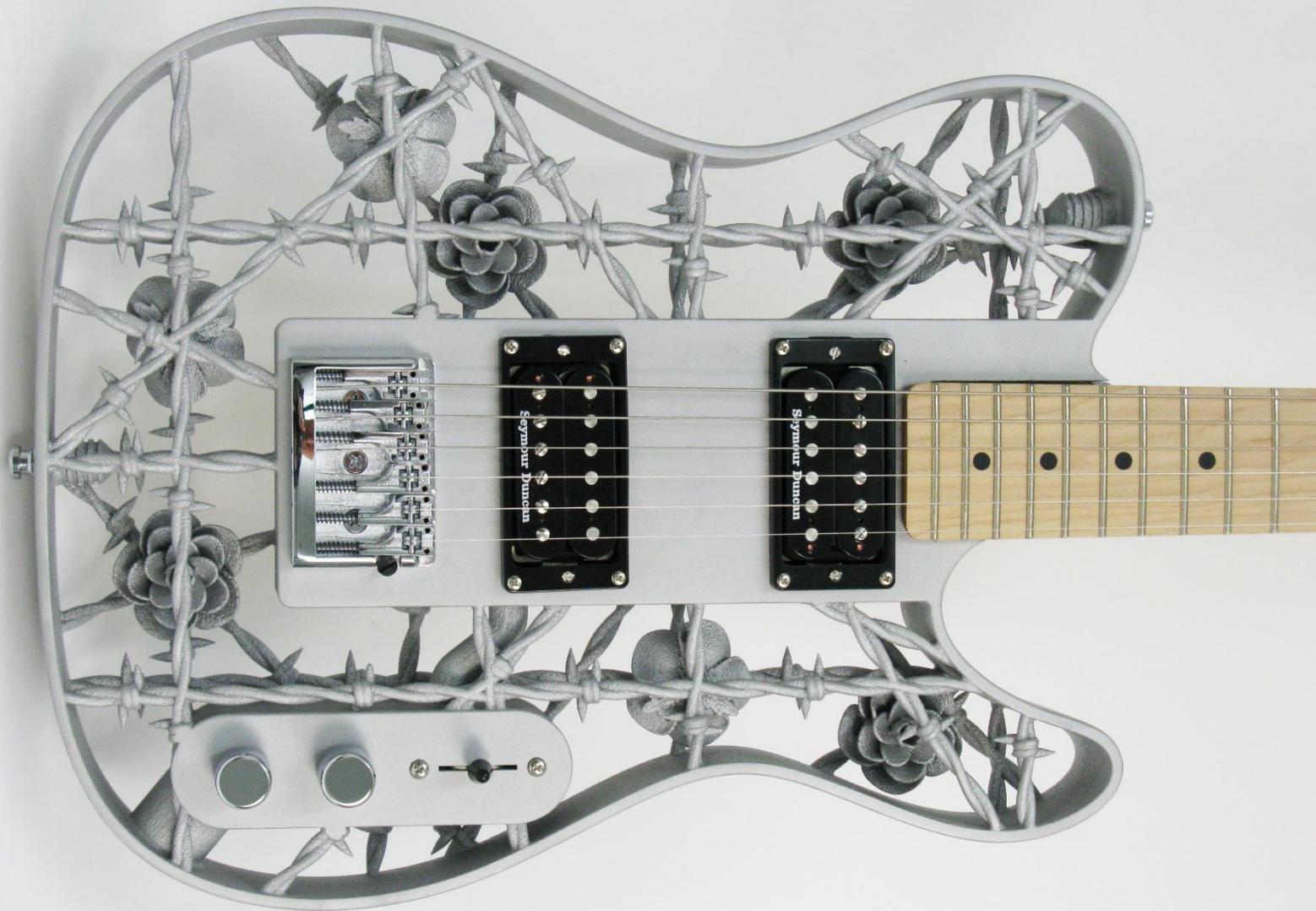
Just hit print and you are done!

- **The vast majority of 3D printing entails a large amount of **post-processing**.**
- **This ranges from removing support material, to polishing, to machining, to coating, to heat-treating and HIP, to colouring, to sanding and painting, etc.**

The Forgotten Part of AM: Post-Processing

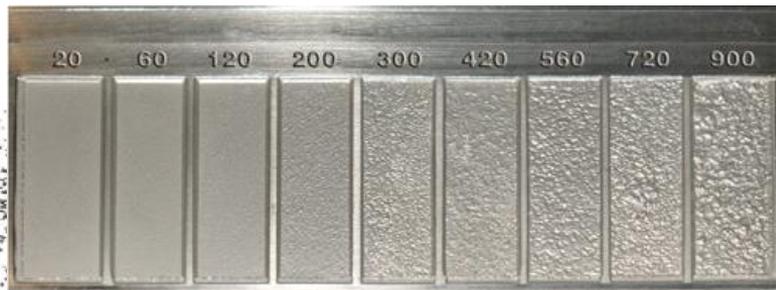


- 2 hours of file preparation in Magics
- 30 minutes of file preparation in EOS Software
- 2 hours of machine preparation
- **9 hours of printing**
- 2 hours of machine cleaning & preparation for next build
- 3 hours of stress relief
- **30 hours of cooling**
- 15 minutes of bench saw
- **4 days to remove supports**
- **4 days of filing, sanding, and shot-peening**



So what's missing?

- We need **more materials**, **better surface finishes**, and **certifiable** processes
- We need **design tools** that will allow us to design safe products that are **optimized for AM**.
- We need to update our engineering and design education programs to include **design for AM**.



**And now, onto the
wonderful world of
3D printing in
Construction...**

