



<https://www.youtube.com/watch?v=zIP-284Ond0>

<https://www.youtube.com/watch?v=k0poVtBhlsQ>

<https://www.youtube.com/watch?v=DMWzMpjSJM>

3D Tech revolution

Riccardo Magni

What is Additive Manufacturing ?

ISO/ASTM definition:

"Process of **joining materials to make objects from 3D model data**, usually **layer upon layer**, as opposed to subtractive manufacturing methodologies, such as traditional machining."

Different materials:

Polymers / Metals / Ceramics

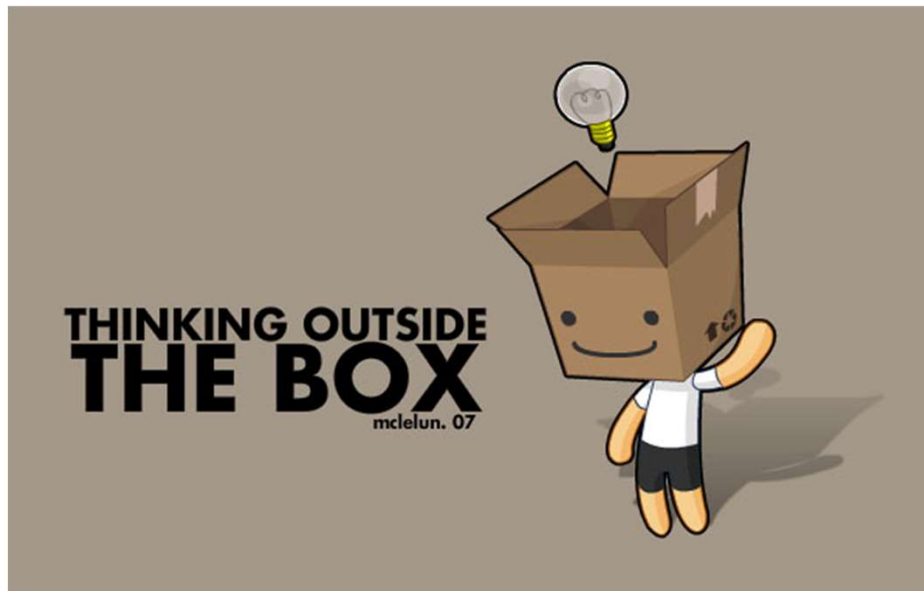
Different terms used since AM started:



Different technologies: SLA / SLS / 3D-Printers / FDM / DLP / DMLS / EBM / LMD / LC / ...



What people need



KNOW ADDITIVE

THINK ADDITIVE

DESIGN ADDITIVE

New young designer, in deep knowlege of traditional technology, of additive and thinking in a new way



Market Application



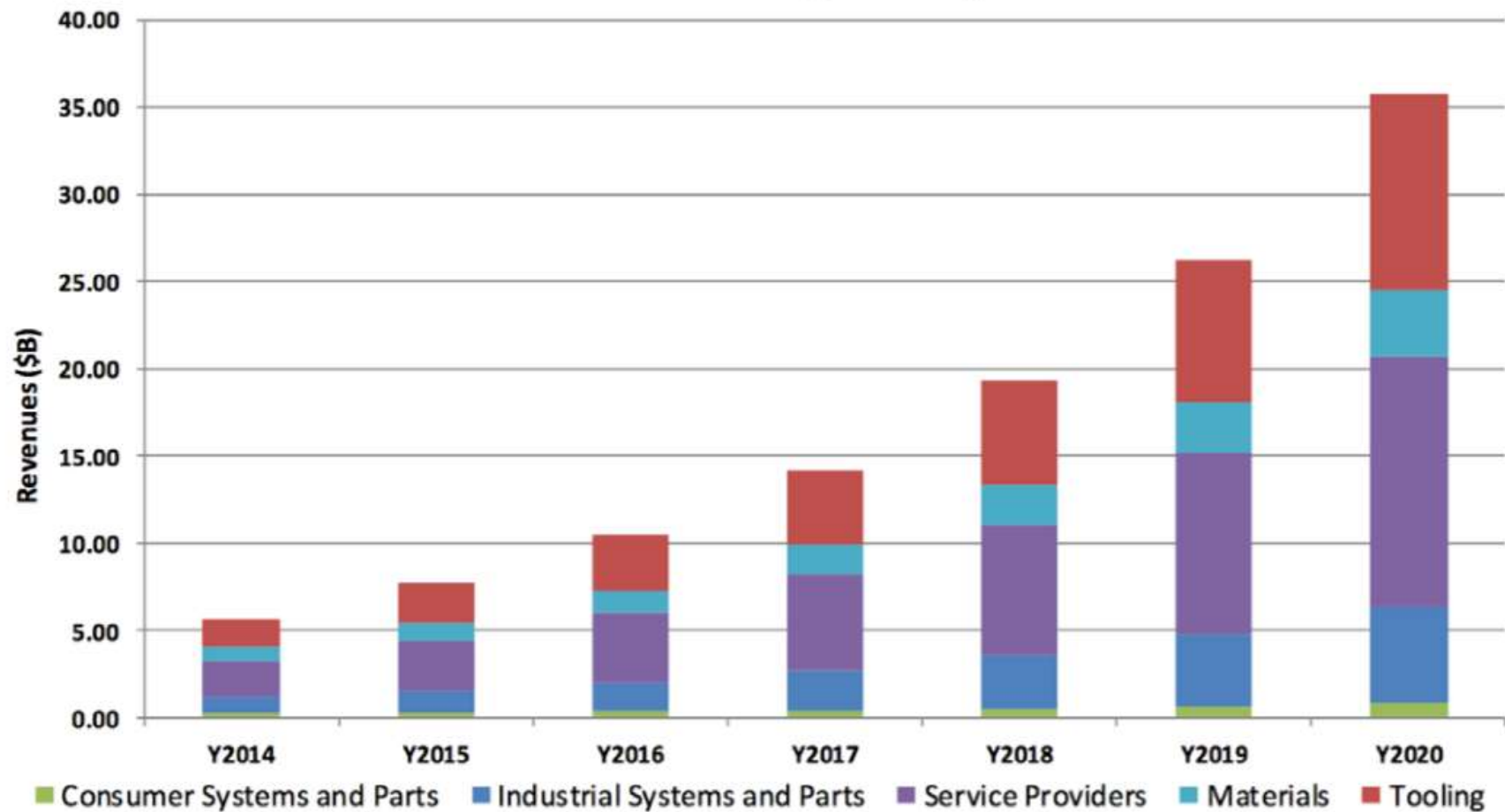
Markets Leveraging Additive Manufacturing



Application Across Industries

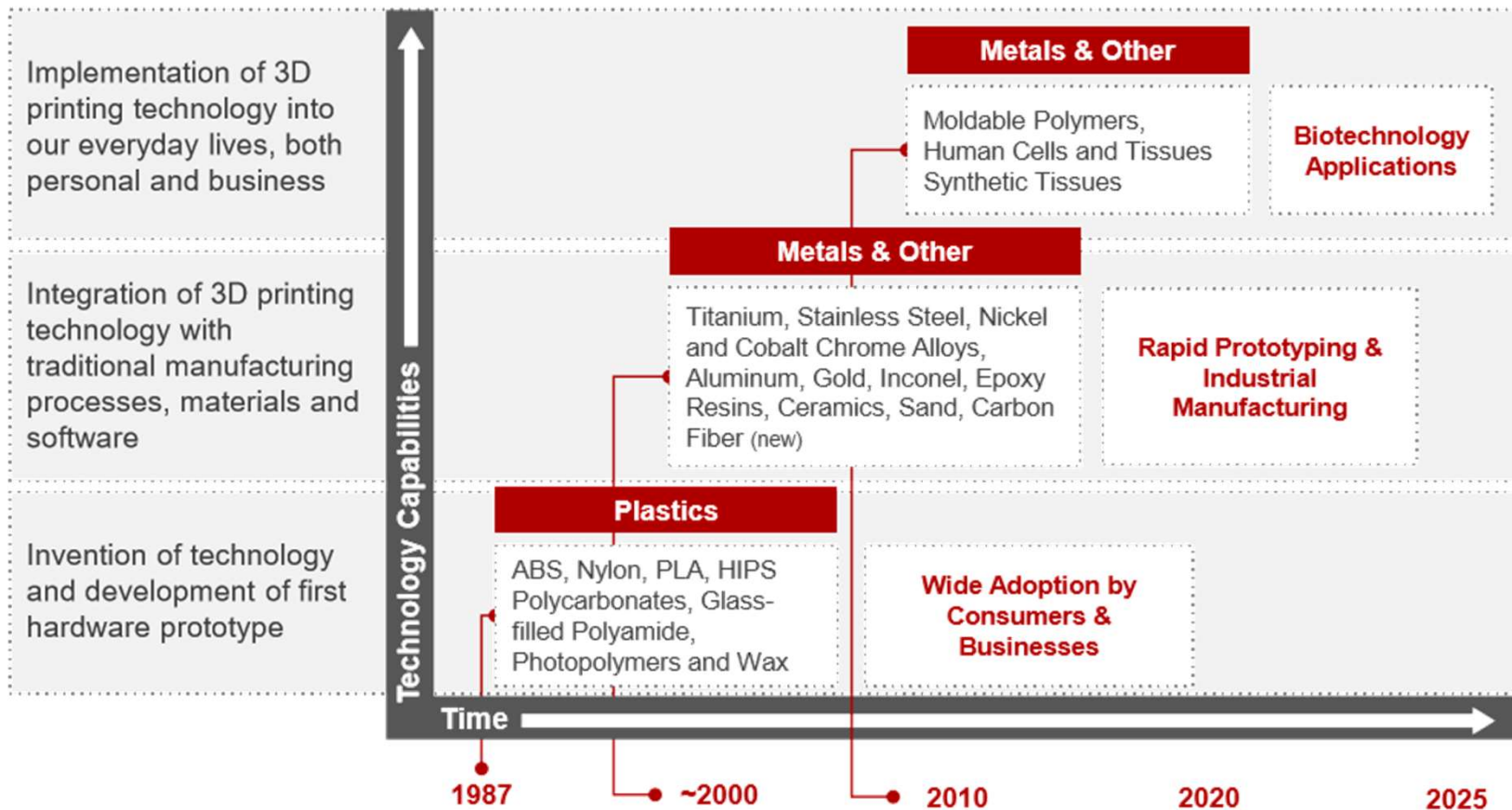
- High-design parts
- Rapid prototyping
- Fixtures
- Part consolidation
- Lightweight options
- Mass customization
- Reduced material cost
- Molds
- Short lead-time
- Tooling
- On demand production
- Reduce labor cost
- Replacement parts
- Complex geometries
- Micro scale modeling
- Small lot sizes

Revenue Forecast for the 3D Printing Industry from 2014 to 2020

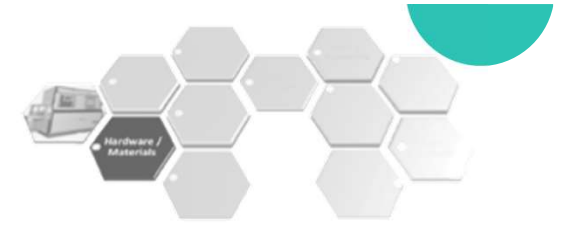


Data Source: IHS Technology (January 2015)

The Impact of 3D Printing Technology



Technology / Metal

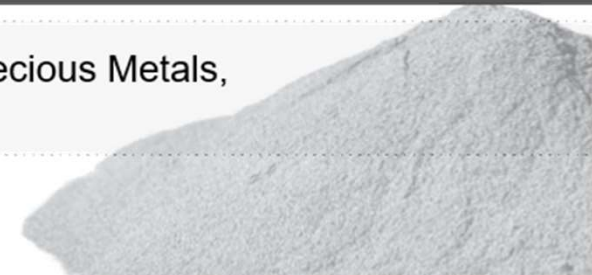


Powder Bed Fusion: Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Selective Heat Sintering (SHS), Electron Beam Melting (EBM), and Electron Beam Welding* (EBAM, uses wire fed material)

Sample - Metal Additive Equipment Manufacturers



Metals: Titanium, Stainless Steel, Aluminum, Nickel Alloy, Precious Metals, Inconel, Cobalt Chrome and many others in development



Technology / Polymers

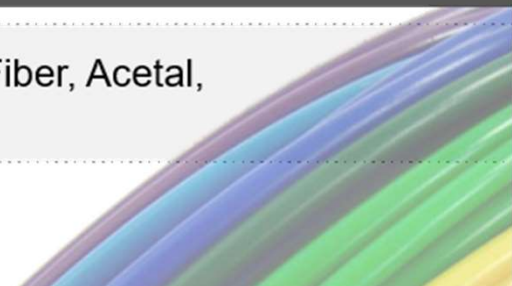


Vat Photopolymerization: Stereolithography (SLA), Digital Light Processing (DLP) Liquid photopolymers, Selective Laser Sintering (SLS) a photo-reactive resin are selectively cured with a UV laser or similar power source

Sample – Polymer Additive Equipment Manufacturers



Polymers: ABS Plastic, Nylon, Polypropylene-like, Resin, Carbon Fiber, Acetal, Polycarbonate-like, and many others in development

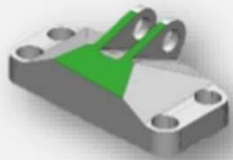


Software / Design Tools



A wide variety of tools are used when designing for Additive. Some aide in the design, others analyze for structural conformity, while others optimize the topology of the object to be printed. Together they work to produce an **STL file** that is ready to print.

Design
(CAD Interpretation)



- AutoCAD
- SOLIDWORKS
- CATIA
- Siemens PLM

Analysis
(Finite Element Analysis)



- Altair - OptiStruct
- MSC Nastran
- ANSYS

Optimization
(Topology / Layer Optimization)

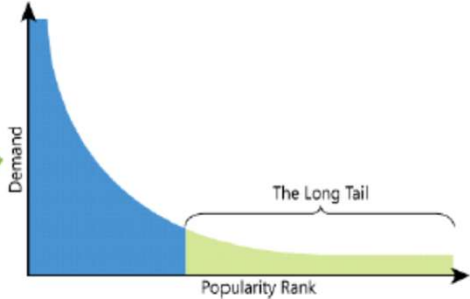
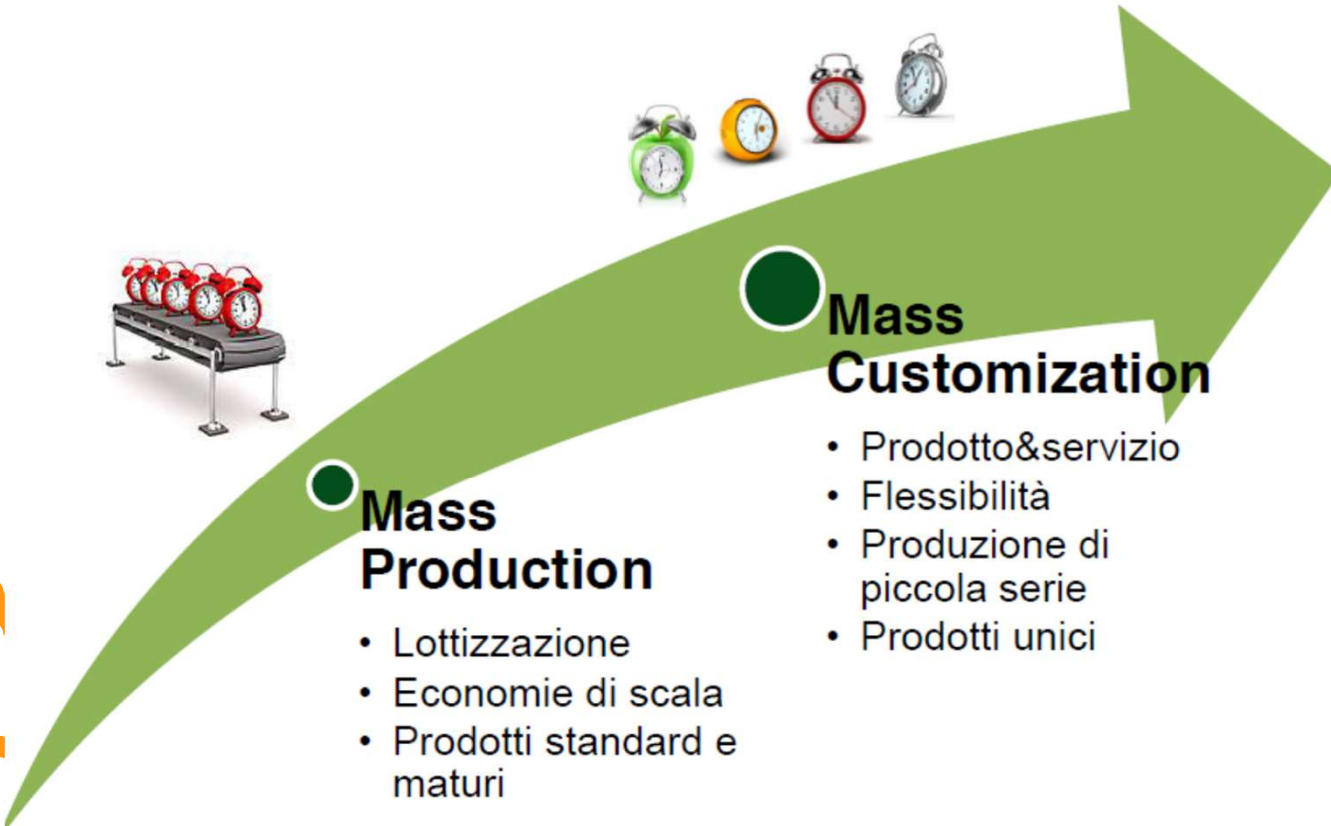


- Netfabb
- Materialise
- TOSCA





... DI CONSEGUENZA ANCHE I PARADIGMI PRODUTTIVI



Fonte: Chris Anderson, "The Long Tail: Why the Future of Business is Selling Less of More", 2006



**SOCIETAL
CHALLENGE**

TRANSPORT

Combining several KETs for advanced AM products

ADVANCED MATERIALS



NANOTECHNOLOGIES



MICROELECTRONICS



PHOTONICS



ADVANCED MANUFACTURING



- ✓ CUSTOMIZATION FOR REAL END USER NEEDS
- ✓ NEW FUNCTIONAL DESIGNS FOR NEW VEHICLE CONCEPTS
- ✓ REDUCING COSTS INCREASING PERFORMANCE
- ✓ FAST RESPONSE TO HIGH DEMANDING SECTOR
- ✓ NEW TOOLS FOR NEW MINDED PROFESSIONALS
- ✓ NEW CONCEPT OPTIMISED INTRICATED STRUCTURES TO FIT FUTURE USABLE SHAPES
- ✓ MANUFACTURING ON DEMAND



Market Size

2020 Expected Market Size
\$21+ Billion

\$3.1 billion \$12.5 billion \$21.0 billion

Estimated Global Market for
Additive Manufacturing Products &
Services

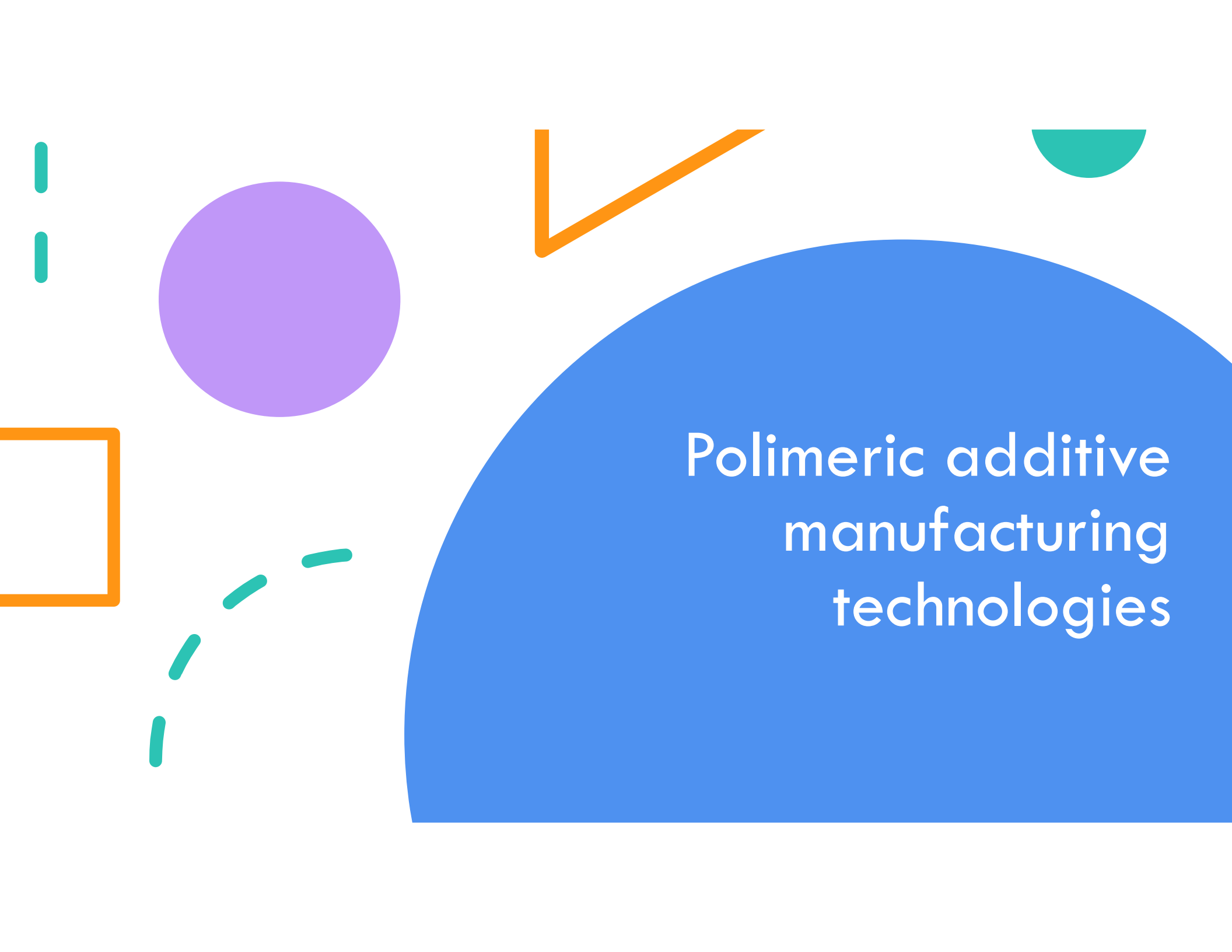
2013
Actual

2018
Estimate

2020
Estimate

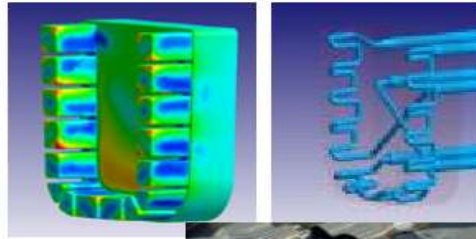
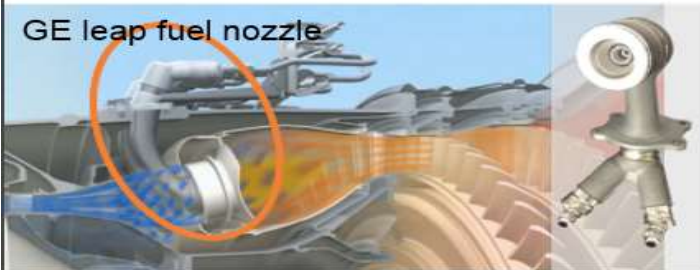
Source: Wohler's 2014





Polimeric additive
manufacturing
technologies

The diverse industrial uses of AM



Conventionally machined bracket (left) and redesigned bracket (right) using topology optimization, courtesy of Laser Zentrum Nord GmbH and Airbus

Airbus



Tooling: Linear Mold, Triform



Shoe cleats: NIKE

Skyfall



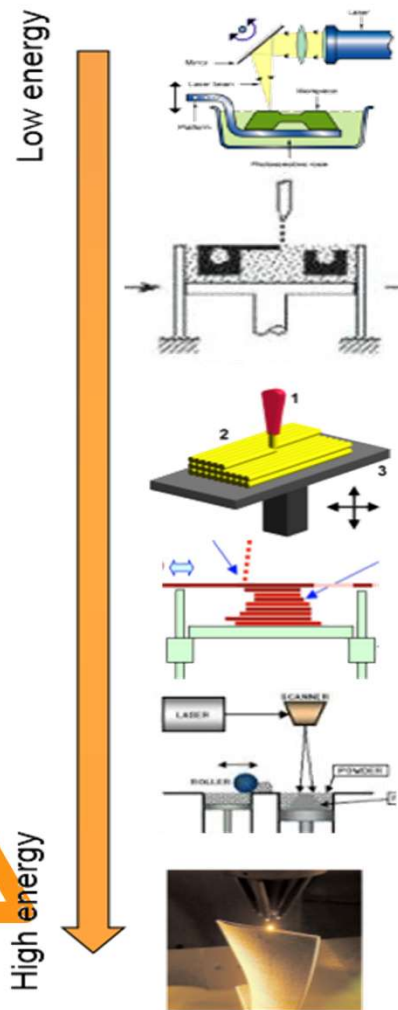
Custom airway stent: U. Michigan



Modular products: Google Ara

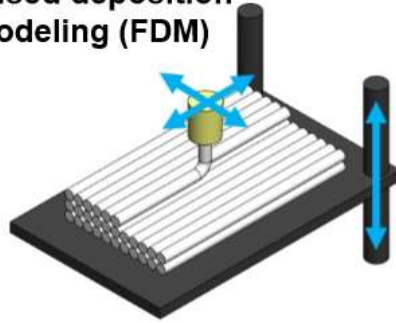


The 7 AM methods (from ASTM F42)

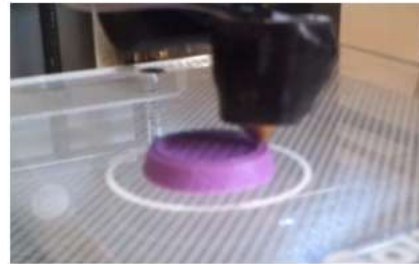


- **Vat photopolymerization (→ SLA)**: material is cured by light-activated polymerization.
- **Material jetting (→ Objet)**: droplets of build material are jetted to form an object.
- **Binder jetting (→ 3DP)**: liquid bonding agent is jetted to join powder materials.
- **Material extrusion (→ FDM)**: material is selectively dispensed through a nozzle and solidifies.
- **Sheet lamination (→ LOM)**: sheets are bonded to form an object.
- **Powder bed fusion (→ SLS/SLM)**: energy (typically a laser or electron beam) is used to selectively fuse regions of a powder bed.
- **Directed energy deposition (→ LENS)**: focused thermal energy is used to fuse materials by melting as deposition occurs.

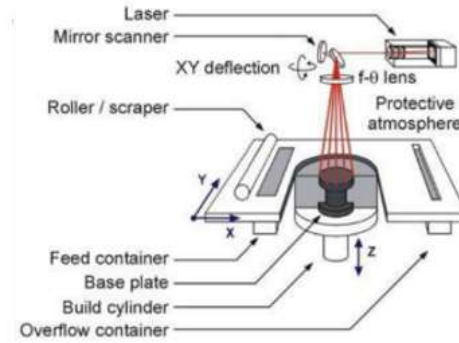
Fused deposition modeling (FDM)



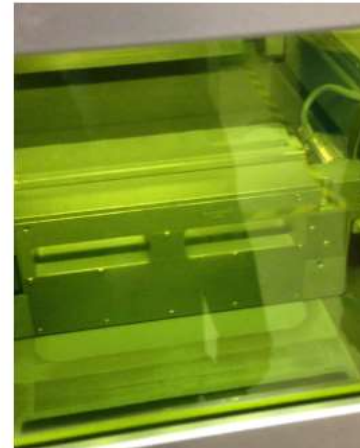
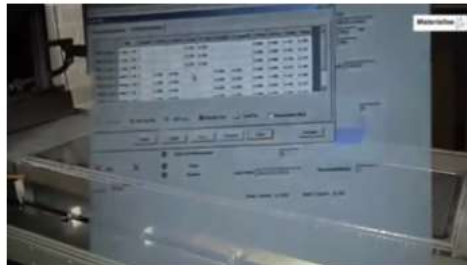
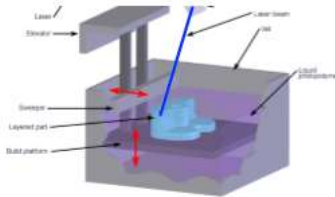
Northrop Grumman



Selective laser sintering / melting (SLS/SLM)

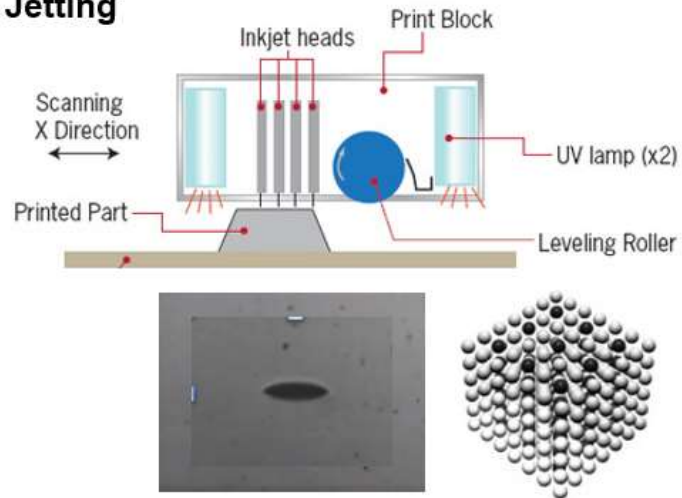


Stereolithography (SLA)

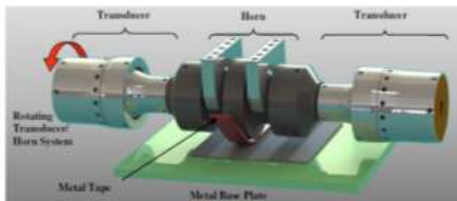
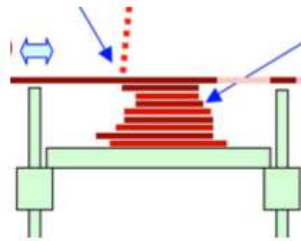


EOS/Materialise

Material and Binder Jetting



Laminated Object Manufacturing (LOM)

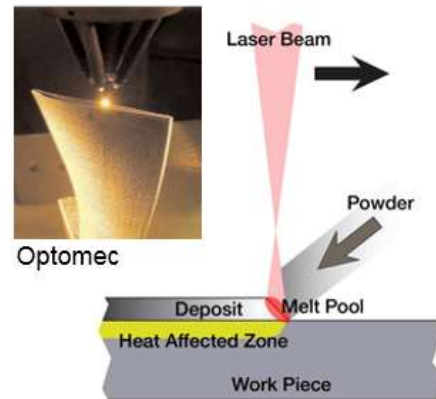


Fabrisonic



mCor

Directed Energy Deposition




Sciaky



Processes	Machines	Build volume [mm]	Build rate [cm ³ /h]			Layer thickness [mm]
			10	100	1000	
FDM	Dimension 1200	254x254x305	20			0.25
Polyjet	Objet 30 Pro	294x192x148	56			0.016
B-jet	M Flex	400x250x250			1780	0.1
	Projet860Plus	508x381x229		968		0.1
SLS(P)	SPro60HD Base	381x330x437			1000	
SLM	EOS M400	400x400x400		105		0.03
	EOS M290	250x250x325	27			N/A
EBM	A2X	200x200x200	60			N/A



The Promise of 3D Printing for Manufacturing



01 Changes in the Economics of Production

02 Design Freedom

03 Increased Part Functionality

04 Product Personalization

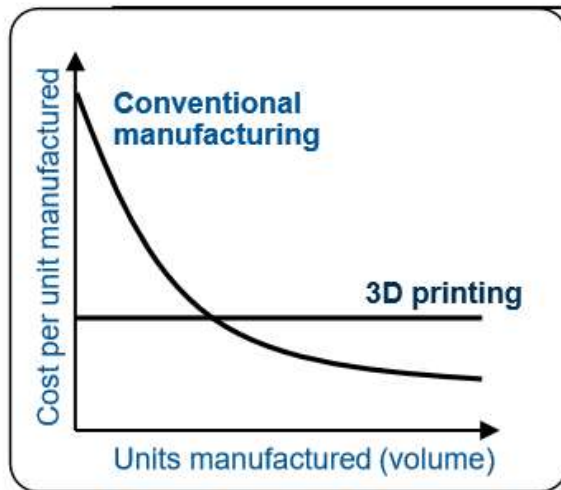
05 Environmental Sustainability

06 New Supply Chains and Retail Models



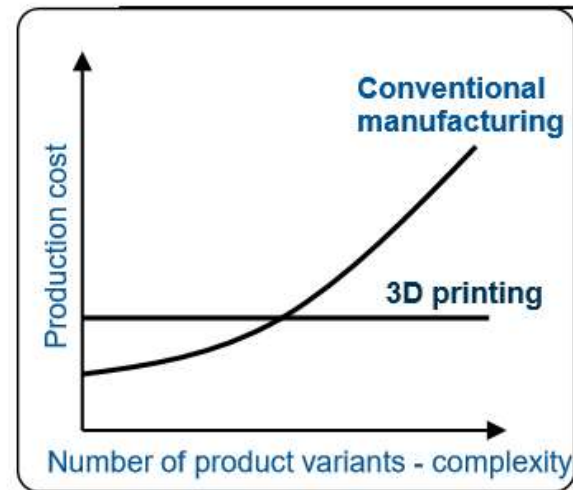
Changes in the Economics of Production

Economies of Scale



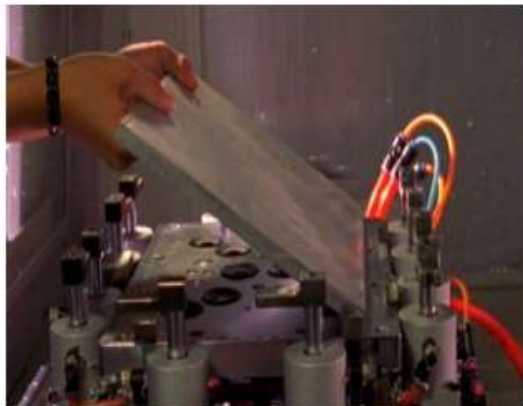
- **Marginal costs** do not change with **volume**
- 3D Printing reduces the **minimum efficient scale**
- Efficient alternative for **low-to-medium-sized production** runs

Economies of Scope



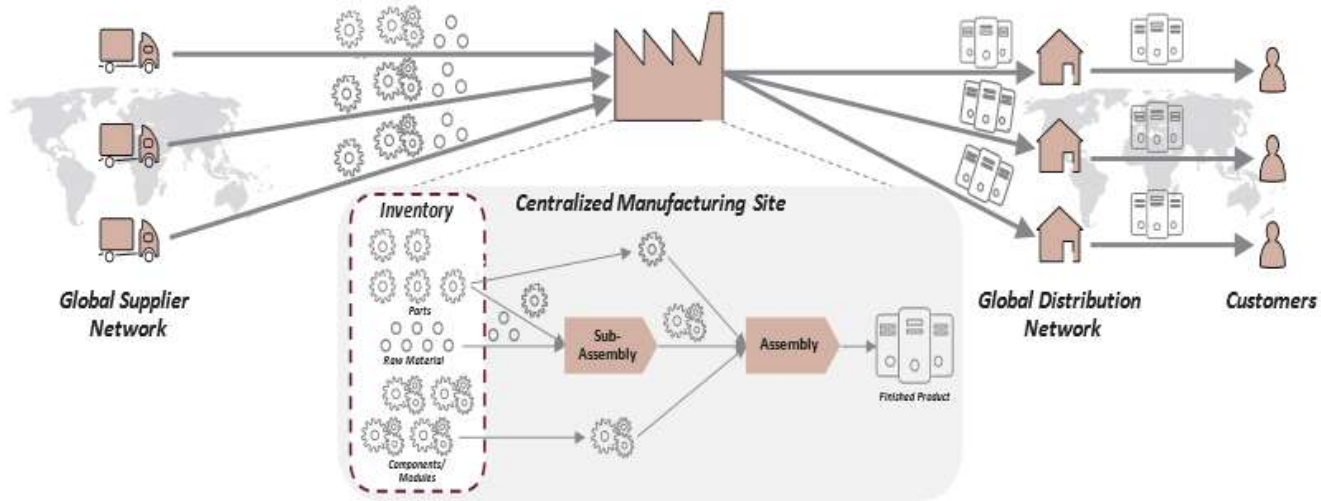
- Production of **multiple product variants** using the **same equipment, materials** and **processes**
- Manufacturing of **complex shapes** with no additional costs
- Enablement of efficient **product individualization/personalization**

3D Printing Provides Design Freedom

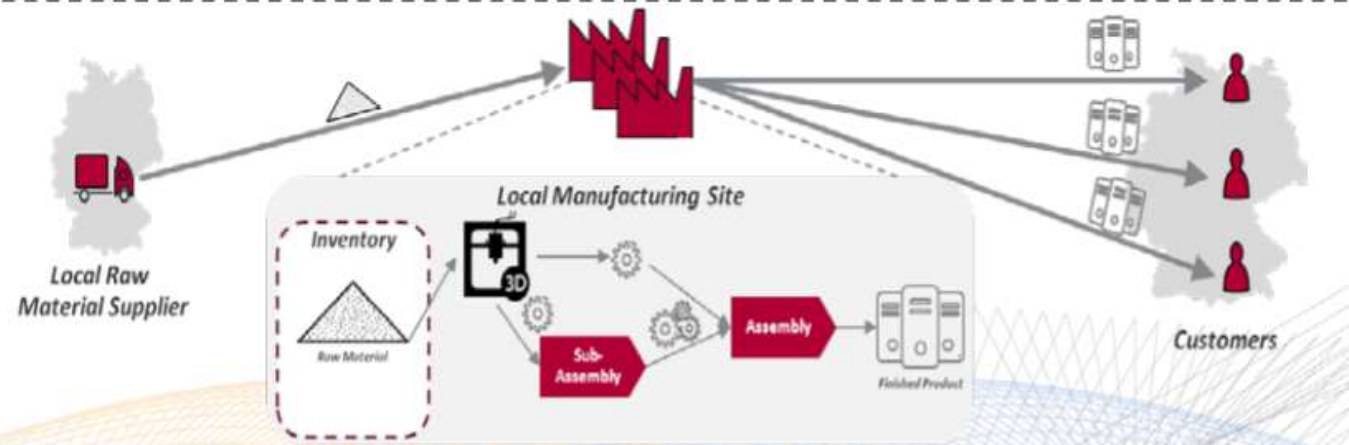


New Supply Chains and Retail Models

CONVENTIONAL SUPPLY CHAIN



3D PRINTING SUPPLY CHAIN



Airbus A350 XWB Program includes over 1000 3D printed flying parts



Airbus A350 XWB program contains more than 1000 flight parts 3D printed on Stratasys FDM Production Systems

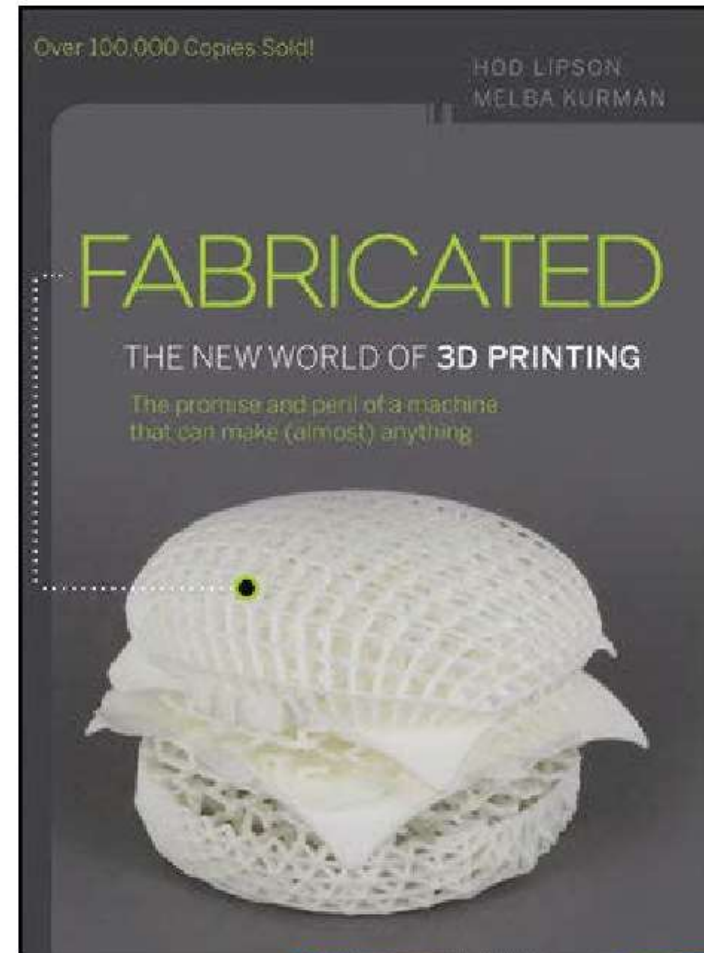
Increased supply chain flexibility and geometric freedom

Provided valuable weight reduction compared to traditional components



Novel Design Strategies

- Creative
- Design for Functionality, topology optimization
- Cellular structures
- Part Consolidation
- Compliant mechanisms
- Multiple materials, multi-functionality



Housewares, Clothing, Jewelry

Freedom of Creation

Prior 2 Lever



N-E-R-V-O-U-S System

Silver



Gold



AM: Additive Manufacturing

Re-Engineering

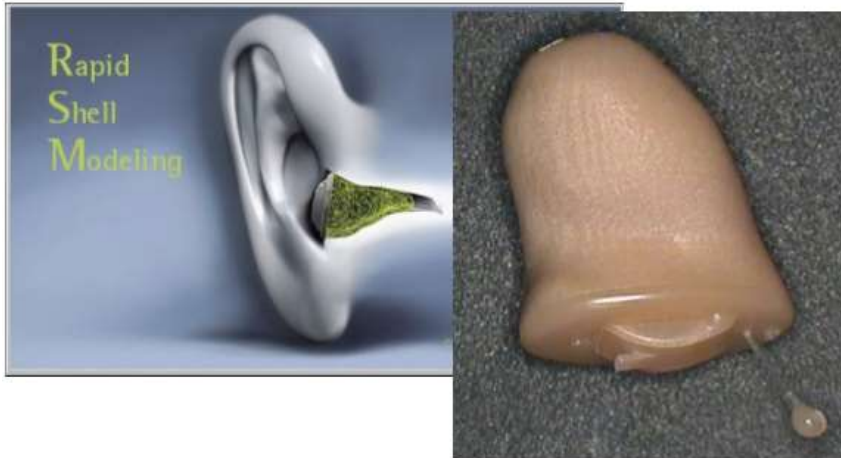


Custom Geometries

OsteoFab Patient Specific
Cranial Device fabricated in
polyetherketoneketone (PEKK)
on EOS P800



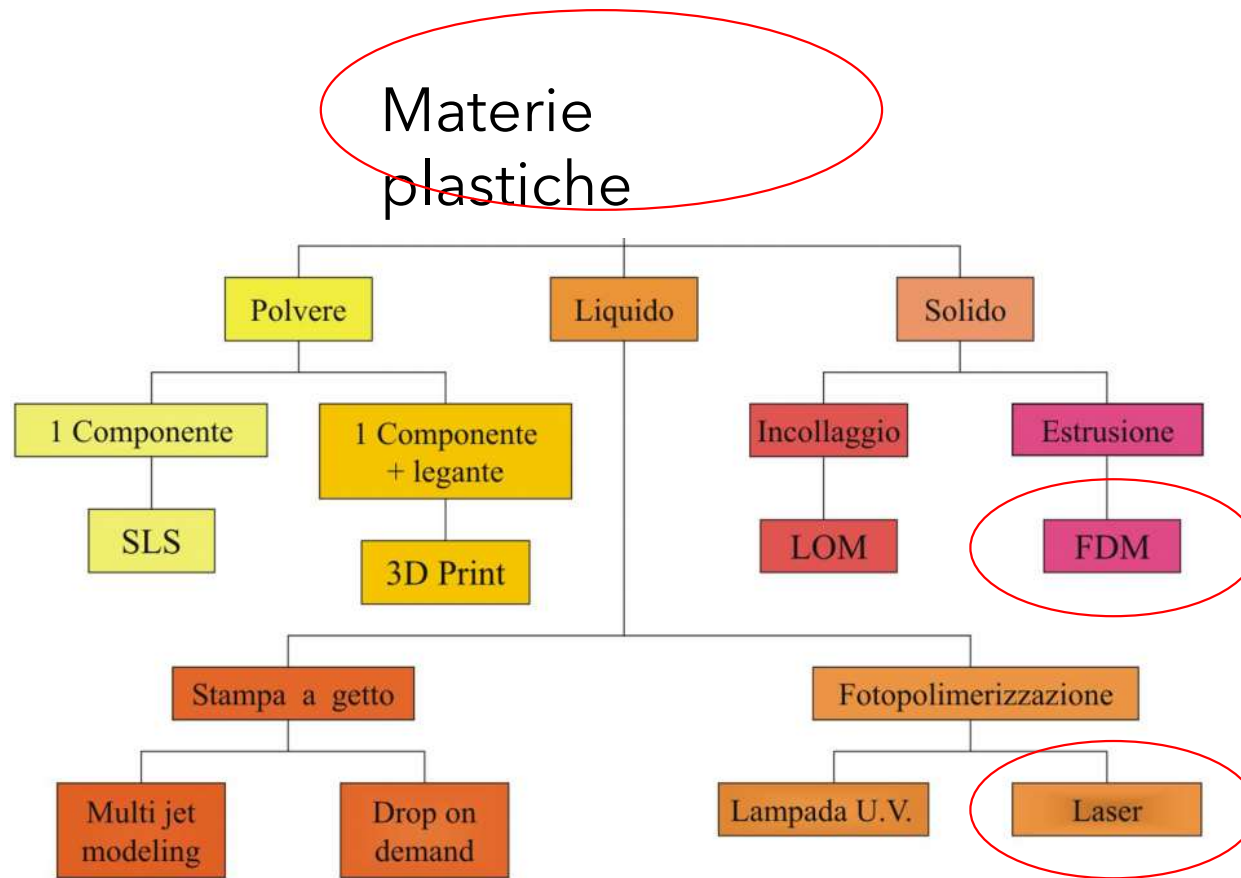
Siemens, Phonak, Widex, etc.



Align Technologies



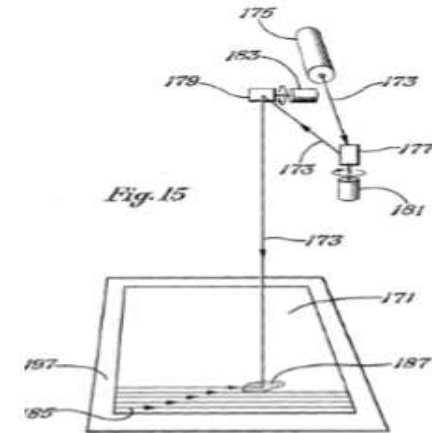
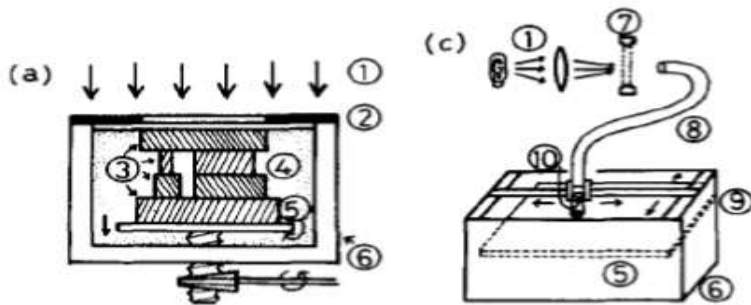
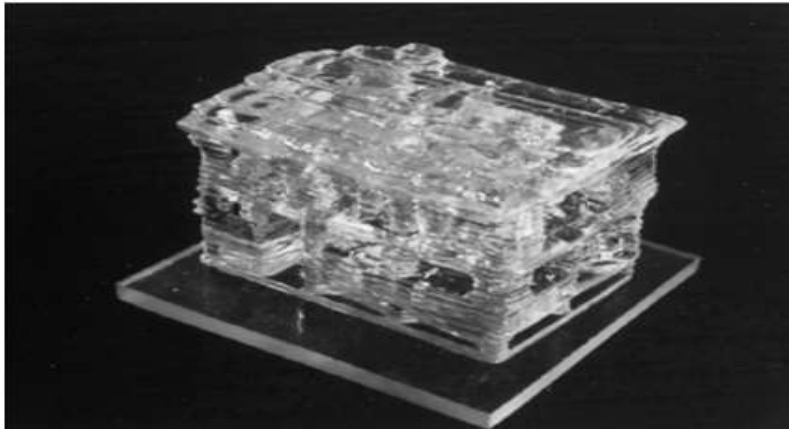
AM: Additive Manufacturing



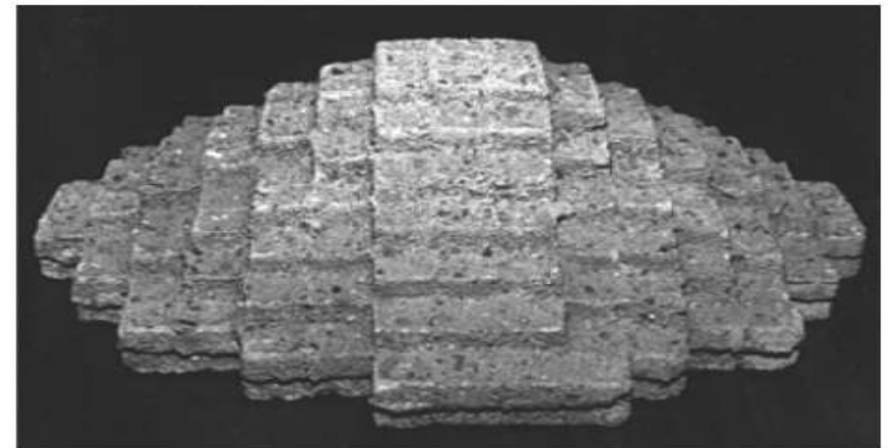
THE FIRST IDEA ->

Earlier AM parts (arguably not the earliest)

Photopolymerization
Kodama, 1981 (Rev Sci Instr)



U.S. Patent Jan. 27, 1981 Sheet 6 of 6 4,247,508



Sintering of metal/ceramic powder
Householder, 1979 (Patent)

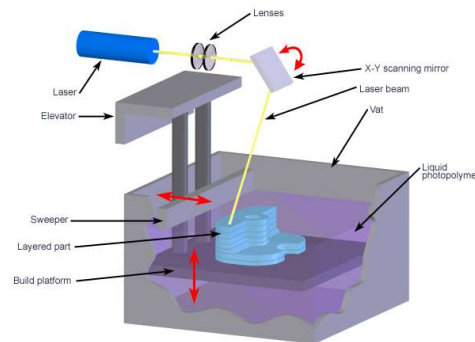


Gli albori della tecnologia, la prototipazione rapida

Stereo **L**ithography (STL) - nasce negli anni 80 e si sviluppa negli anni '90

Attraverso l'impiego di un laser viene tracciata la sezione di un pezzo. Il laser cede energia, la resina fotosensibile polimerizza e si ottiene uno strato solido.

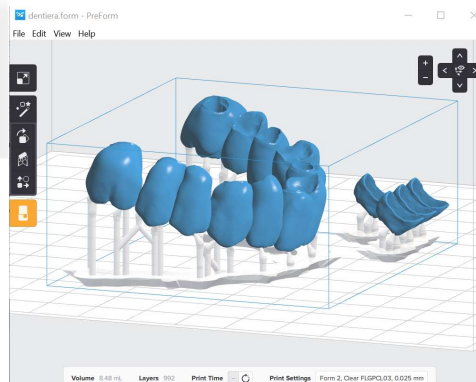
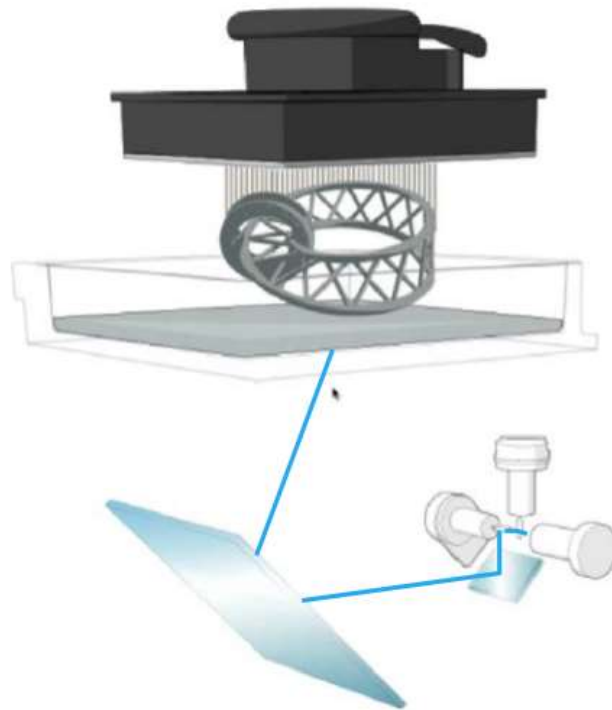
Successivamente viene aggiunto un altro strato di materiale liquido ed il procedimento si ripete fino a che da strati successivi si ottiene il prototipo.



Copyright © 2008 CustomPartNet



Form 2
The most advanced
desktop 3D printer
ever created.





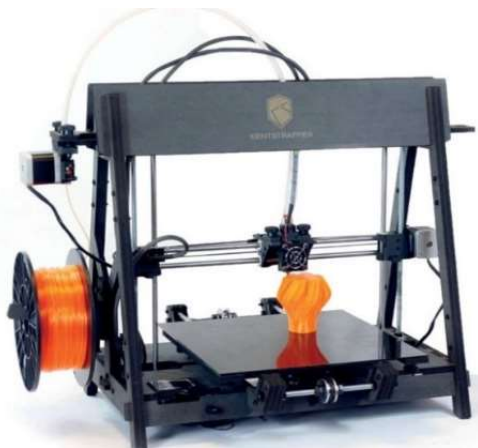
HOBBYIST FDM
Part Cost: \$0.41
Machine Cost: \$2,500

DESKTOP SLA (FORM 1+)
Part Cost: \$1.67
Machine Cost: \$3,299

INDUSTRIAL SLA
Part Cost: \$6.00
Machine Cost: \$300,000

Fused Deposition Modeling (FDM)

Scalable Technology



General 3D Printing Process

CAD Model ----- **3D Object**



**3D CAD
Model**



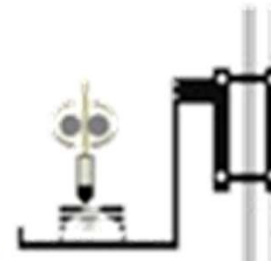
**Printable
File (e.g. STL)**



**Slicing
Software**



**Layer Slices
& Tool Path**



**AM
Process**



**Physical
3D Object**



Hypothesis of process – step 1

- Going to find the resource you want to print





Hypothesis of process – step 2

- Choose the resource

The British Museum

Menu

coin

Object Type
[coin](#)

Museum number
1884,0704.2

Denomination
[stater](#)

Description
Silver coin. (whole) (whole)
Turtle with row of dots down shell and three across the top. (obverse) (obverse)
Trisceles with central dot, all in incuse square. (reverse) (reverse)

New search

Use this image



Hypothesis of process – step 3

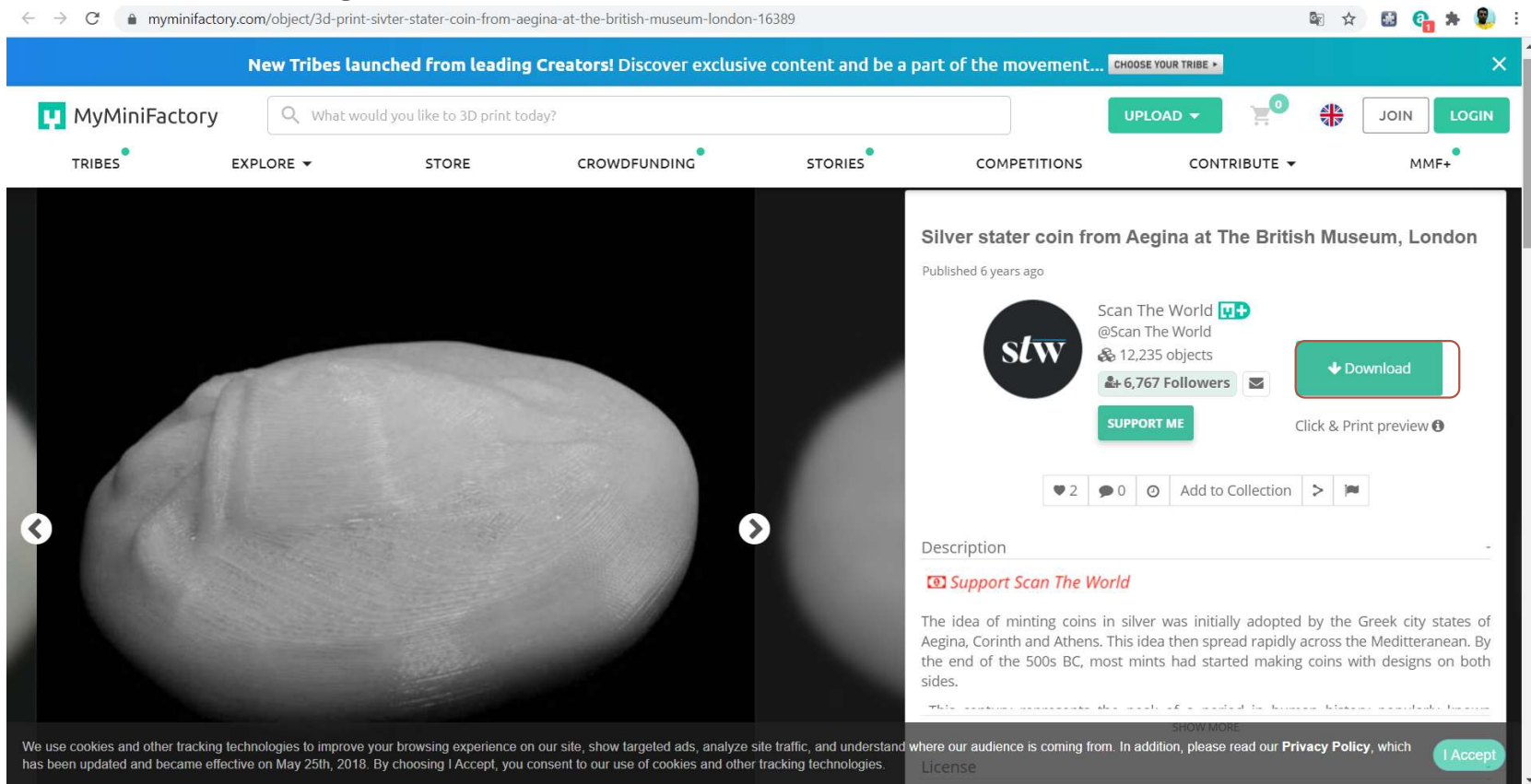
- Downloading the STL file

The screenshot shows a web browser window with the URL `stlfinder.com/3dmodels/aegina-stater/`. The search bar contains the text "aegina stater". Below the search bar, the page title is "aegina stater 3d models" and it indicates "44 3d models found related to aegina stater." The results are displayed in a grid of five items:

- Silver stater coin from Aegina at The British Museum, London**
myminifactory
The idea of minting coins in silver was initially adopted by the Greek city states of Aegina, Corinth and Athens. This idea then spread rapidly across the Mediterranean. By the end of the 500s BC, most mints had started making coins.
- Silver stater coin (Wappenmunzen) from Athens, British Museum**
myminifactory
The earliest known stamped stater (having the mark of some authority in the form of a picture or words) is an electrum turtle coin, struck at Aegina that dates about 700 BC. It is on display at the Bibliothèque Nationale of Paris.
- Celtic Gold Coin. Złota celtycka moneta.**
sketchfab
Photogrammetric model of celtic coin dated on 2 half of first century before Christ from Kujawy region. ...Prepared by Miron Bogacki. Moneta celtycka (bojska), stater typu Gąski wybity na Kujawach, 2. poł. I w. przed Chr. oprac. ...Miron Bogacki
- Relief**
myminifactory
A relief from the West Pediment of the Aegina Temple. The artist who conceived the west pediment of the Temple of Aphaia was faced with a double challenge: on the one hand he had to make the confused, chaotic shambles of a fierce, tumultuous battle...
- Archer for the East Pediment of the Temple of Aphaia**
myminifactory
Herakles seated Greek, archaic 485-480 BC origin found on Glyptothek, München From Aphaia temple, Aegina, east gable V, KAS541e. The Royal Cast Collection (Copenhagen, Denmark). Made with Memoto.

Hypothesis of process – step 3

- Downloading the STL file



The screenshot shows the MyMiniFactory website interface. At the top, there is a navigation bar with the MyMiniFactory logo, a search bar, and buttons for 'UPLOAD', 'JOIN', and 'LOGIN'. Below the navigation bar, there is a main content area. On the left, a large 3D model of a silver stater coin is displayed. On the right, the details for the object are shown, including the title 'Silver stater coin from Aegina at The British Museum, London', the creator 'Scan The World' (@Scan The World), and a 'Download' button. The description below the object reads: 'The idea of minting coins in silver was initially adopted by the Greek city states of Aegina, Corinth and Athens. This idea then spread rapidly across the Mediterranean. By the end of the 500s BC, most mints had started making coins with designs on both sides.'

myminifactory.com/object/3d-print-silver-stater-coin-from-aegina-at-the-british-museum-london-16389

New Tribes launched from leading Creators! Discover exclusive content and be a part of the movement... CHOOSE YOUR TRIBE

MyMiniFactory

What would you like to 3D print today?

UPLOAD

JOIN

LOGIN

TRIBES EXPLORE STORE CROWDFUNDING STORIES COMPETITIONS CONTRIBUTE MMF+

Silver stater coin from Aegina at The British Museum, London

Published 6 years ago

Scan The World @Scan The World

12,235 objects

6,767 Followers

Download

SUPPORT ME

Click & Print preview

2 0 Add to Collection

Description

Support Scan The World

The idea of minting coins in silver was initially adopted by the Greek city states of Aegina, Corinth and Athens. This idea then spread rapidly across the Mediterranean. By the end of the 500s BC, most mints had started making coins with designs on both sides.

SHOW MORE

We use cookies and other tracking technologies to improve your browsing experience on our site, show targeted ads, analyze site traffic, and understand where our audience is coming from. In addition, please read our Privacy Policy, which has been updated and became effective on May 25th, 2018. By choosing I Accept, you consent to our use of cookies and other tracking technologies.

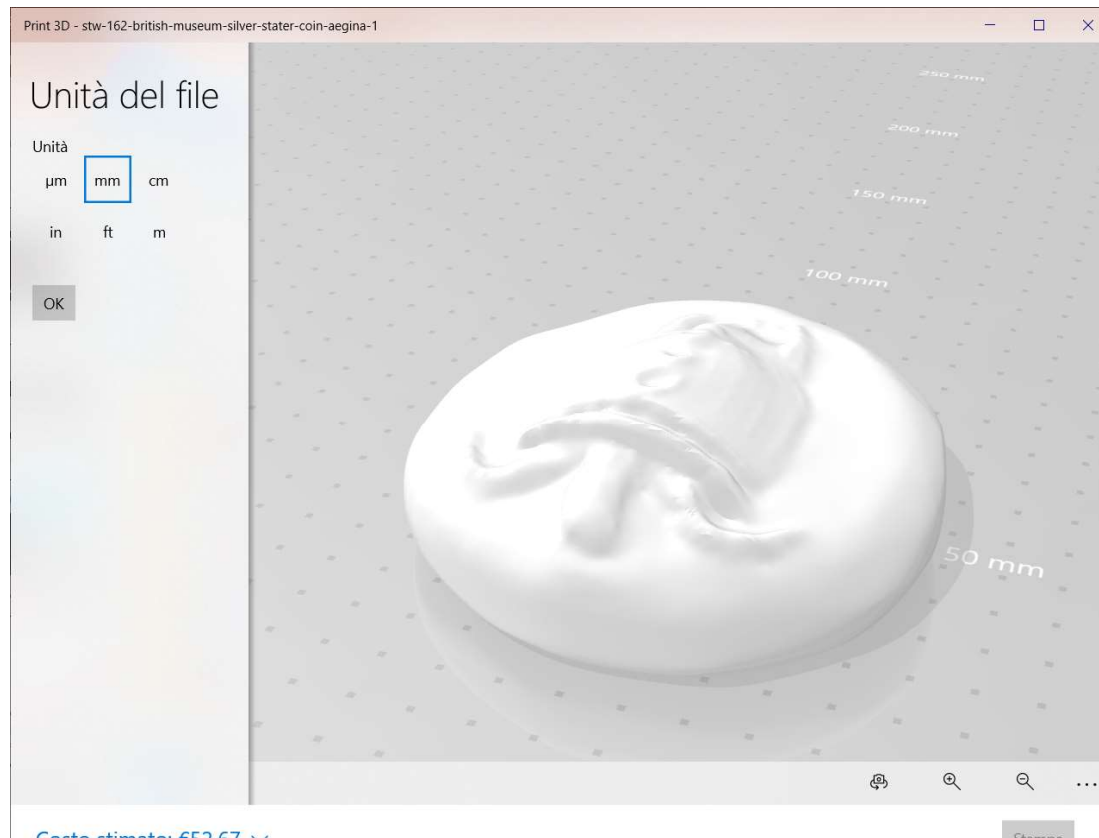
License

I Accept



Hypothesis of process – step 4

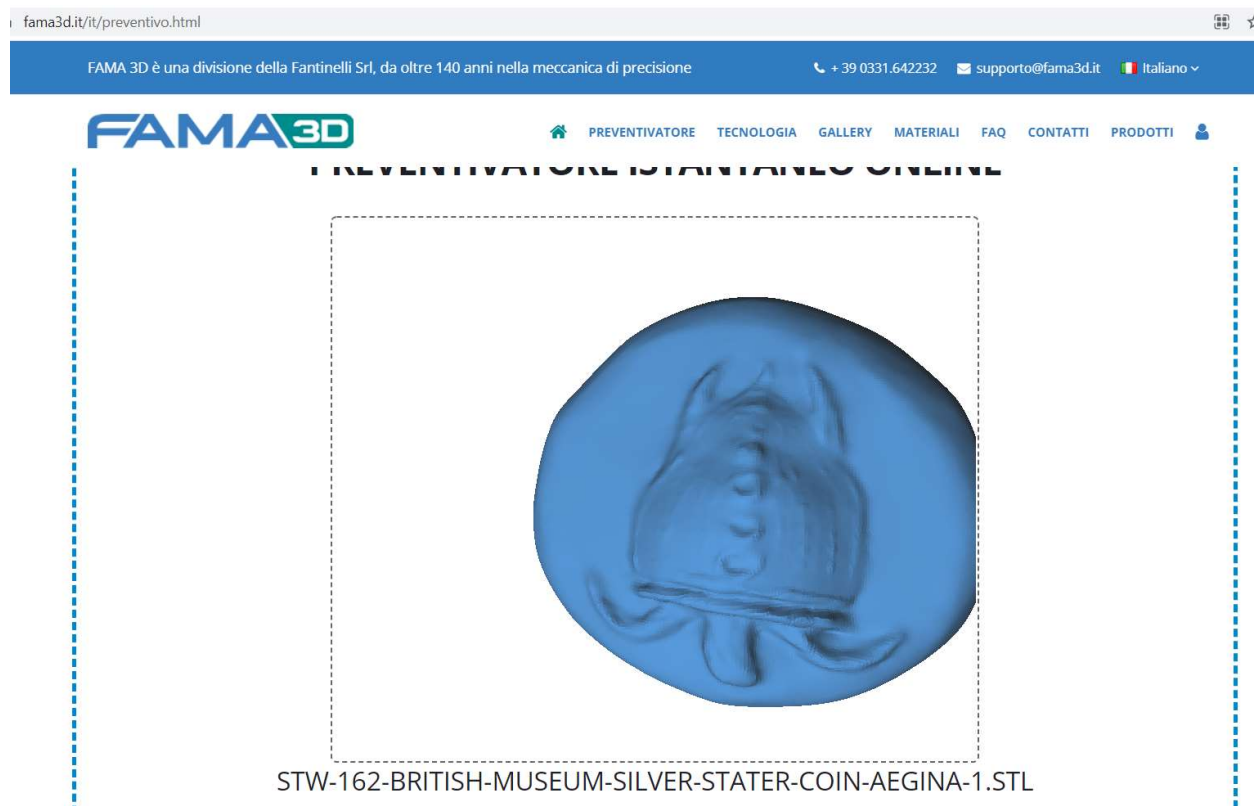
- Review of downloaded file (free *.stl viewer – viewstl.com)





Hypothesis of process – step 5

- Remote 3D print cost estimation





Hypothesis of process – step 5

- Remote 3D print cost estimation

ma3d.it/it/preventivo.html

FAMA 3D è una divisione della Fantinelli Srl, da oltre 140 anni nella meccanica di precisione + 39 0331.642232 supporto@fama3d.it Italiano

FAMA3D PREVENTIVATORE TECNOLOGIA GALLERY MATERIALI FAQ CONTATTI PRODOTTI

Carica un altro file

Seleziona Quantità desiderata

Materiale Nylon PA12 Classic

Grigio (grezzo) -- Colore Verniciatur Standard No, non richiedo il s Prodotto in 14 giorn

Vapor Fuse SI

Fissa orientamento di stampa (+15%)
Per Utenti Esperti No

Note

Totale **61,66 €**

Prezzo pieno: ~~68,51~~ € (Sconto applicato: 10%)

COSTO UNITARIO: 61,66 €/PEZZO

Gràcies

Σας ευχαριστώ

Gràcies

Gracias

Thank you all

Riccardo Magni