



# Materials and Manufacturing

Ian Williams  
Senior Innovation Fellow - ATiC



**Swansea  
College of Art**  
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau  
Transforming Education; Transforming Lives*

# Additive Manufacturing

History

Workflow –Software demo

Technologies

Design Considerations

Sectors

End master parts/ casting prototyping

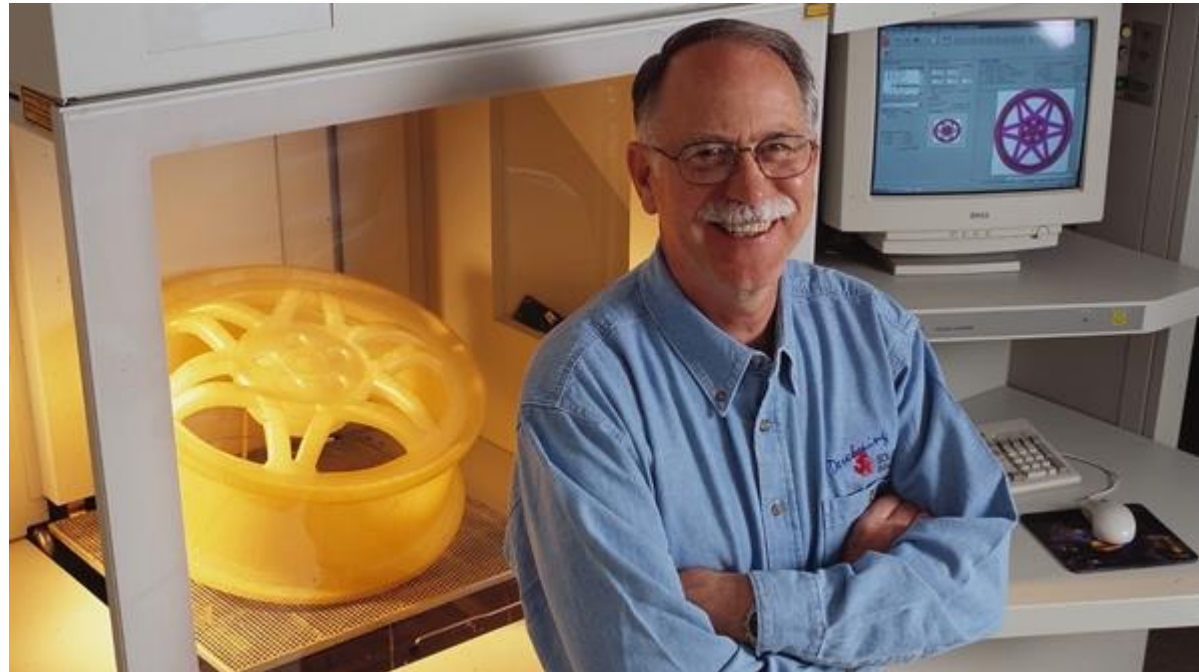
Production systems / automation

Future technologies

Business utilising the technology

# Additive Manufacturing

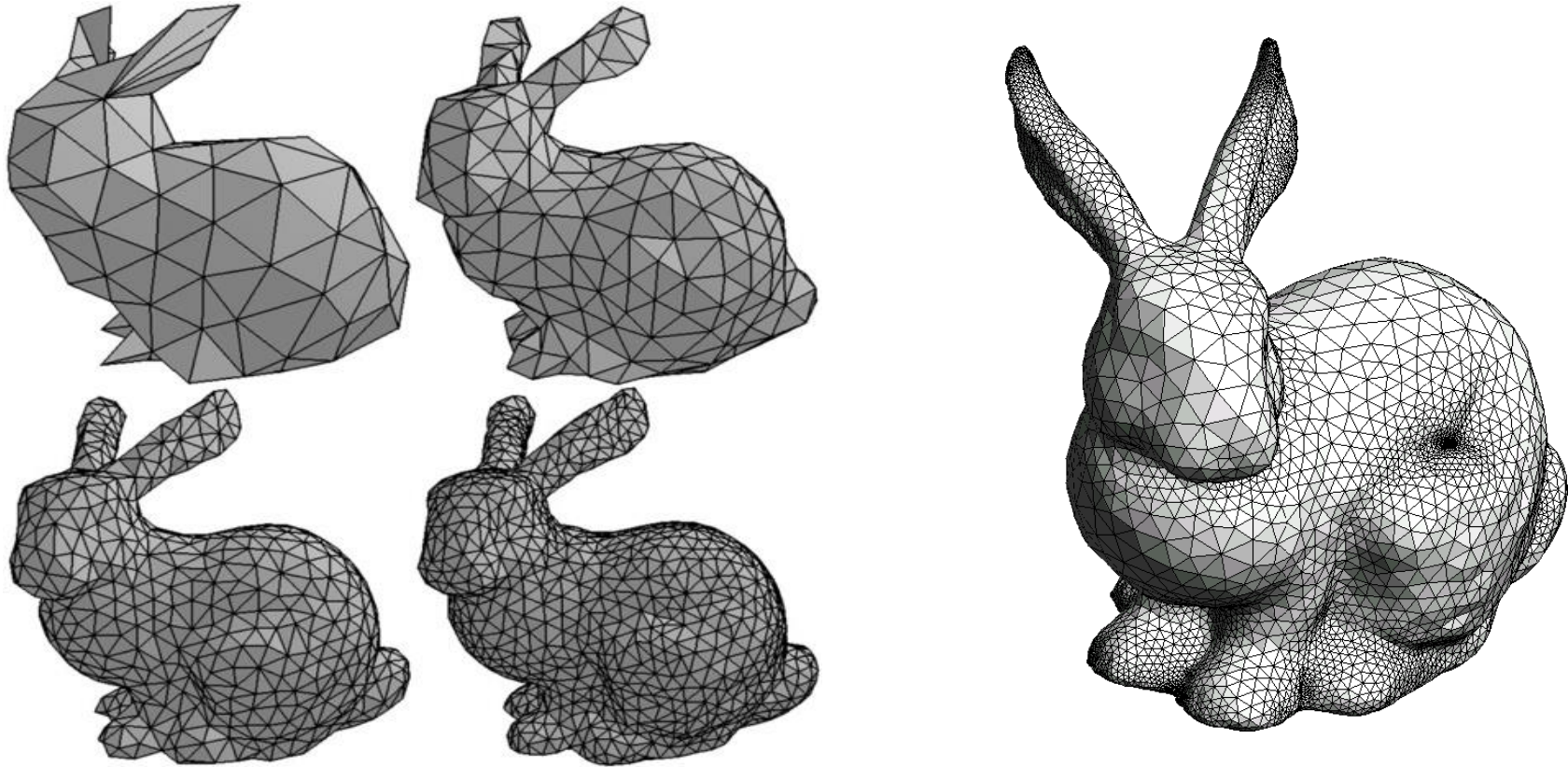
- History – 1986 in California – 3D Systems (Worth 2 billion)
- The process of taking a **3D digital Data** and creating a tangible object. An additive process utilising a layering technique



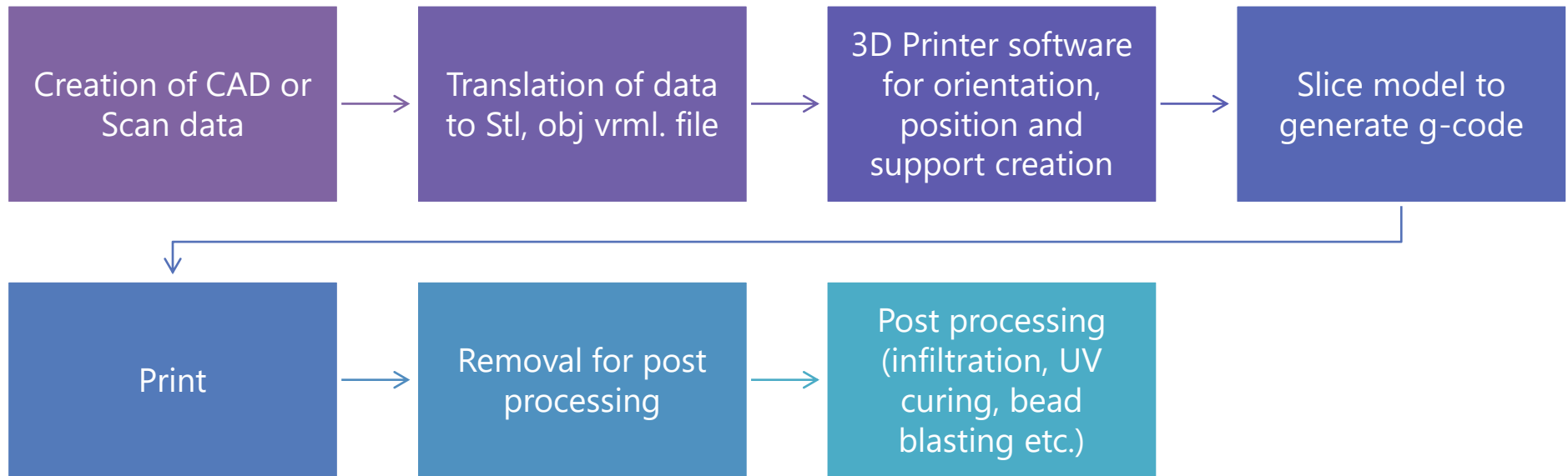
# CAD modelling software

- SURFACE BASED
- PARAMETRIC MODELLING
- MESH BASED

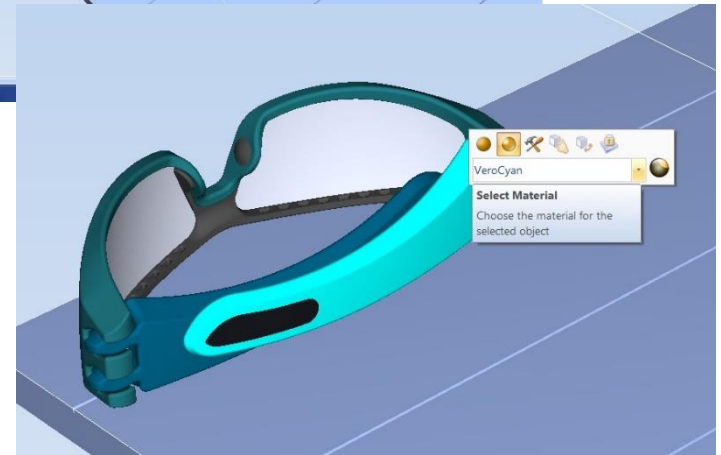
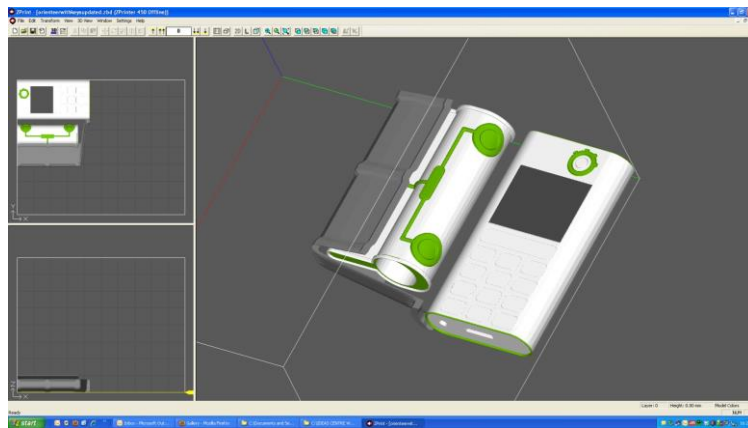
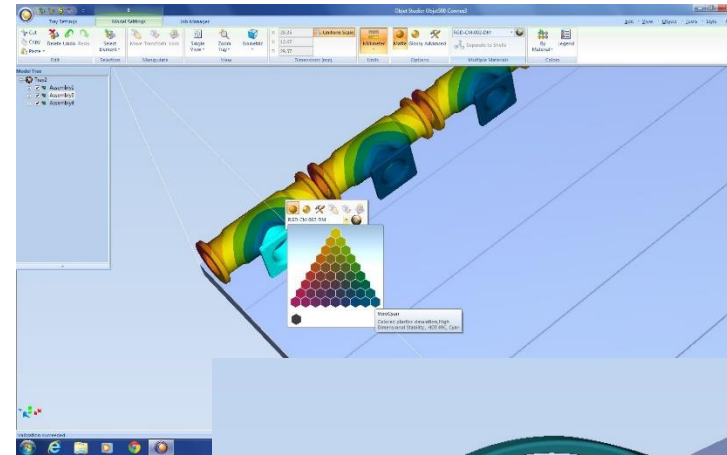
# Mesh model



# 3D printing Digital Workflow



# 3D printing Software



# Demo

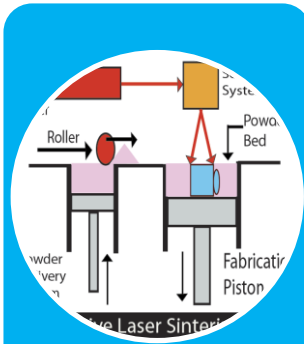
- Auto desk Fusion
- Cura Software
- Autodesk print studio/Meshmixer

# Digital Data

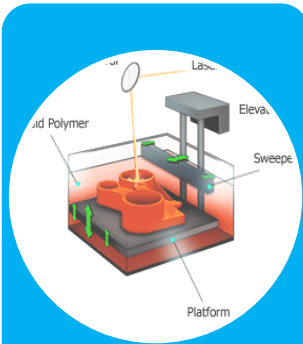
Free Software:

- [Meshmixer](#)
- [Meshlab](#)
- [Scuptris](#)
- [Blender](#)

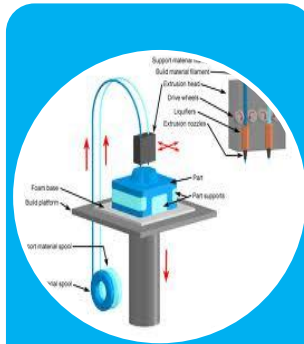
# 3D Printing systems



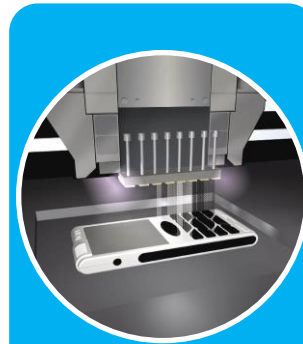
Powder



Liquid



Solid

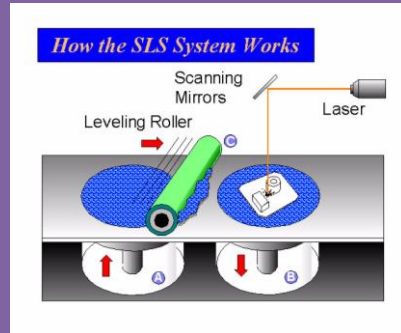


Jetting

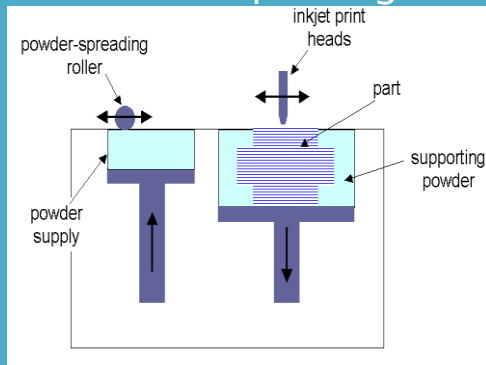


# Powder based systems

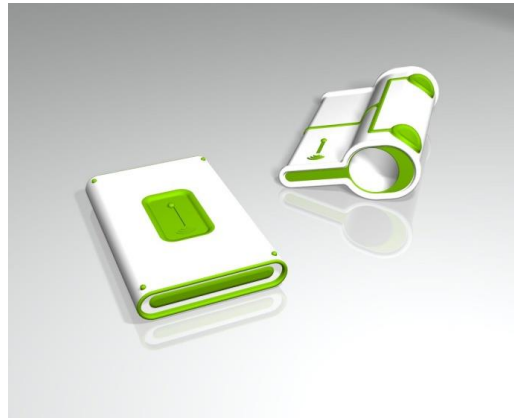
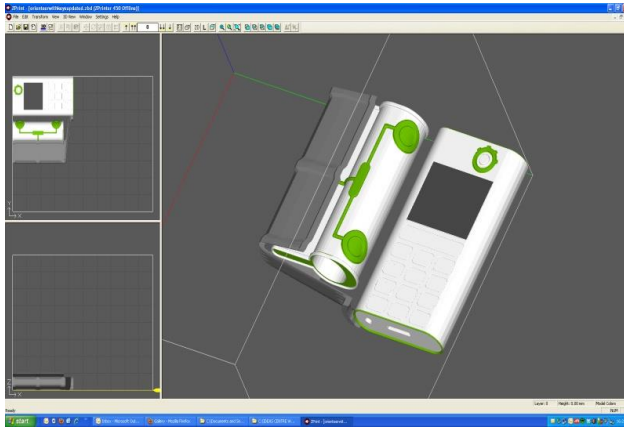
## Selective laser sintering/melting



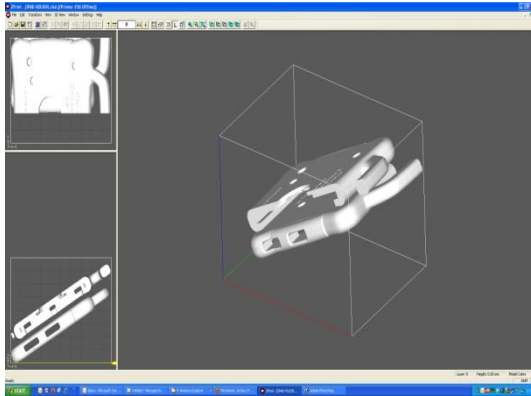
## Ink based 3d printing



# Powder based systems



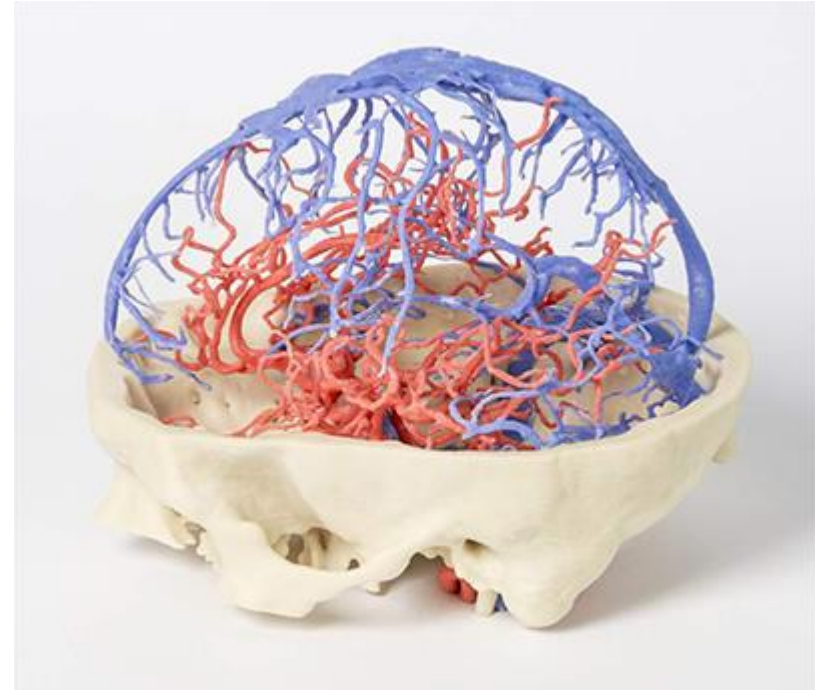
# Powder based systems



# Powder based systems

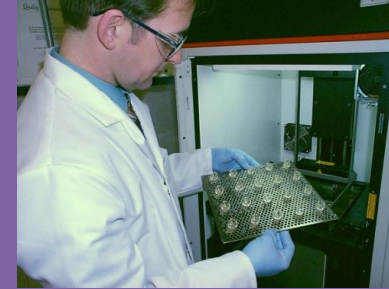
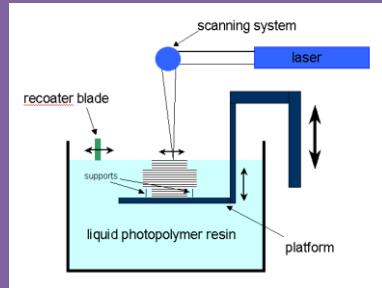


# Powder based systems



# Liquid based systems

## Stereolithography

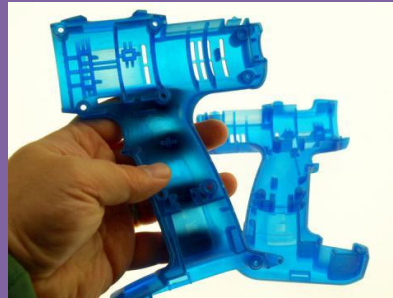
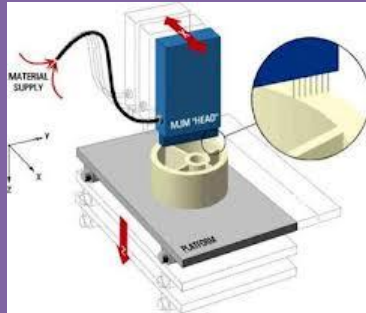


## DLP



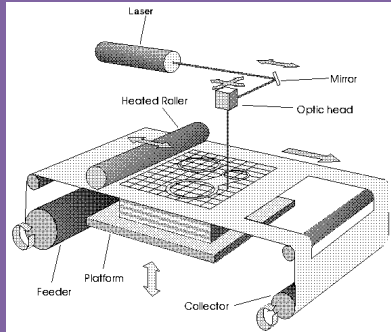
# Jetting based systems

## Multi jet Printing

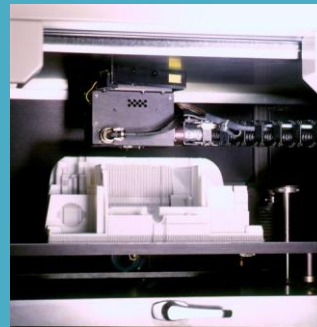
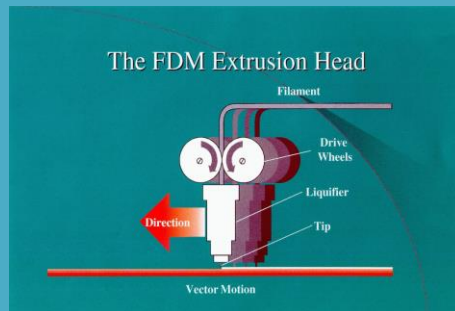


# Solid based systems

## Laminate object modelling



## FDM



# Solid based systems



# Solid based systems



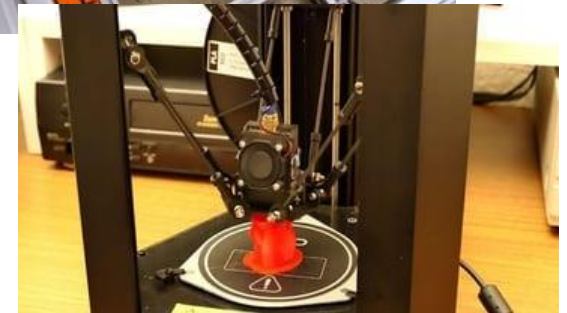
# Solid based systems



# Additive Manufacturing

## Desktop systems

- FDM / FFF – fuse deposition modelling/ fused filament fabrication
- Types – Delta, Cartesian systems



# Additive Manufacturing

## Desktop systems

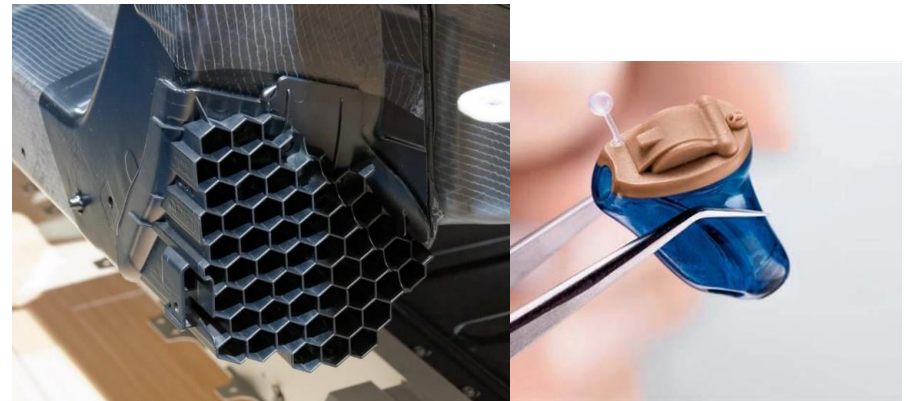
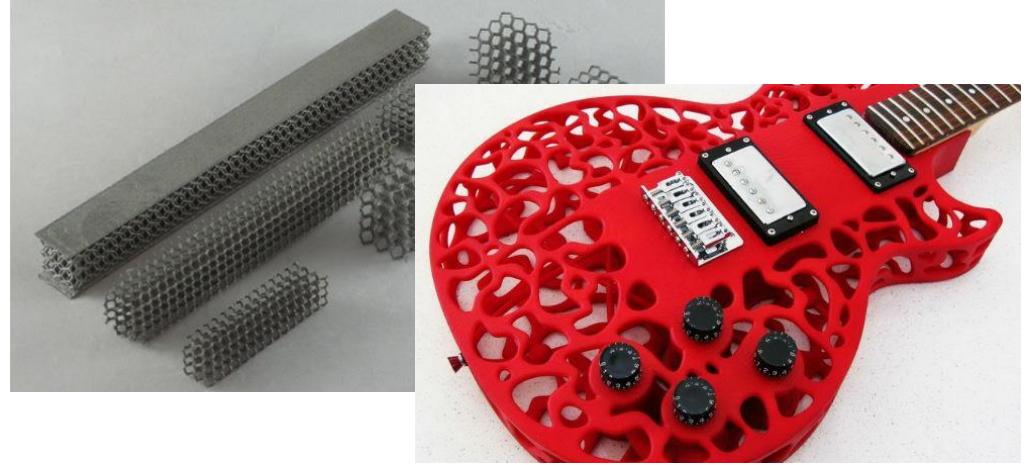
- SLA
- DLP
- Composite Printing



# Additive Manufacturing

## Why use 3D printing?

- No need for tooling, jigs and fixtures
- Reduced capital investment and inventory
- Simplified supply chain – reduces lead time
- Embedding materials – electronic encapsulation
- Geometric freedom – example : lattice structure developed for crumple zone on vehicles
- Bespoke products – example: hearing aids industry standard manufacture, implants replacements



# Additive Manufacturing

## Why do we use 3D Printing?

- Life cycle and sustainability
- reduces raw material, lighter weight components – example: honeycomb structure for aerospace industry saves fuel.
- Reduced energy over traditional processes – AM uses  $\frac{1}{4}$  of CO2 emissions compared to CNC
- Scalable – example “[Contour Crafting](#)”

# Additive Manufacturing

- Contamination of materials
- Consistency of machines
- Controlling production environment
- Reliability
- low volume high cost products
- Econolyst – Assessed over 200+ products in last 7 years–  
90% are not suitable

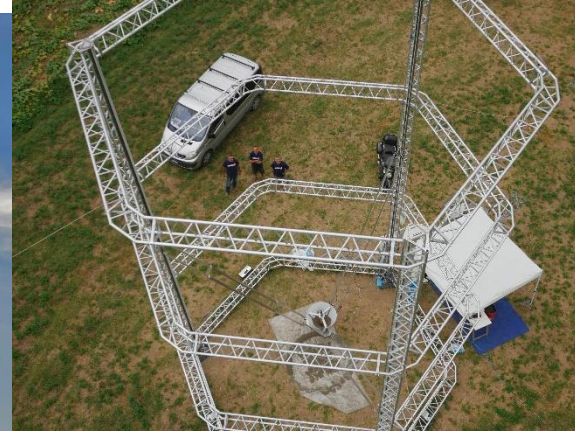
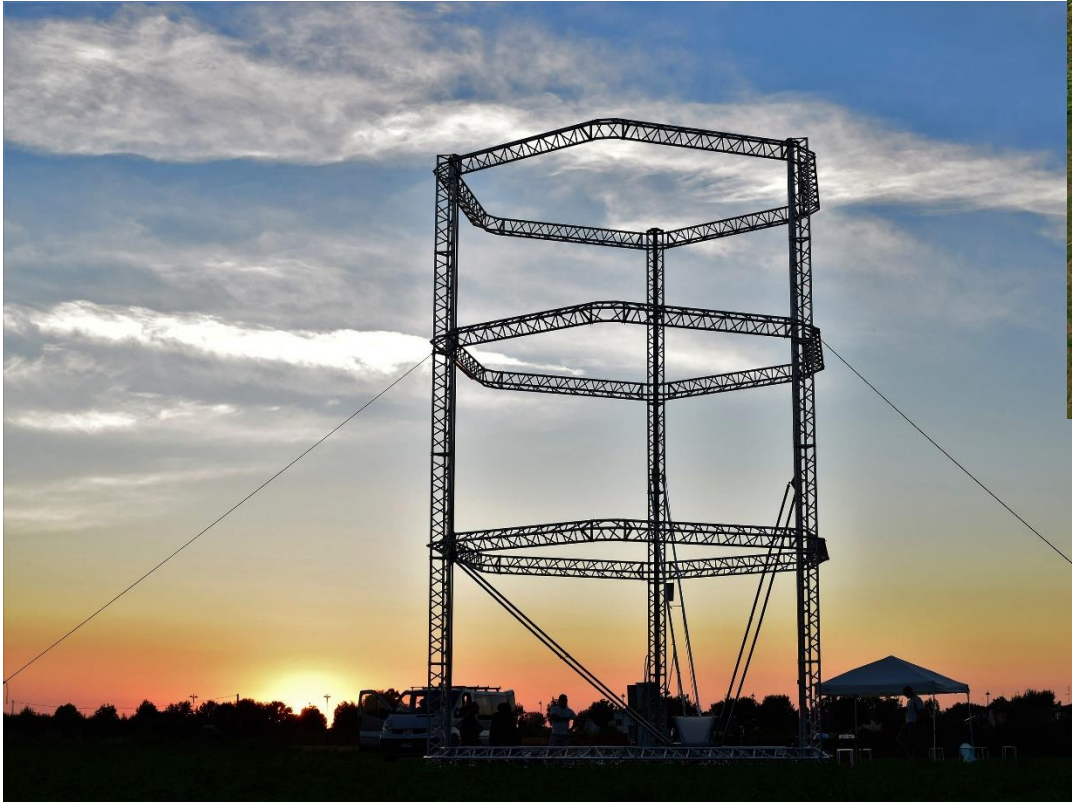
# Additive Manufacturing

- AM technology value 1.7 billion
- Only 8% of potential market
- 8.4 billion by 2020
- Growth of open source [printers](#)

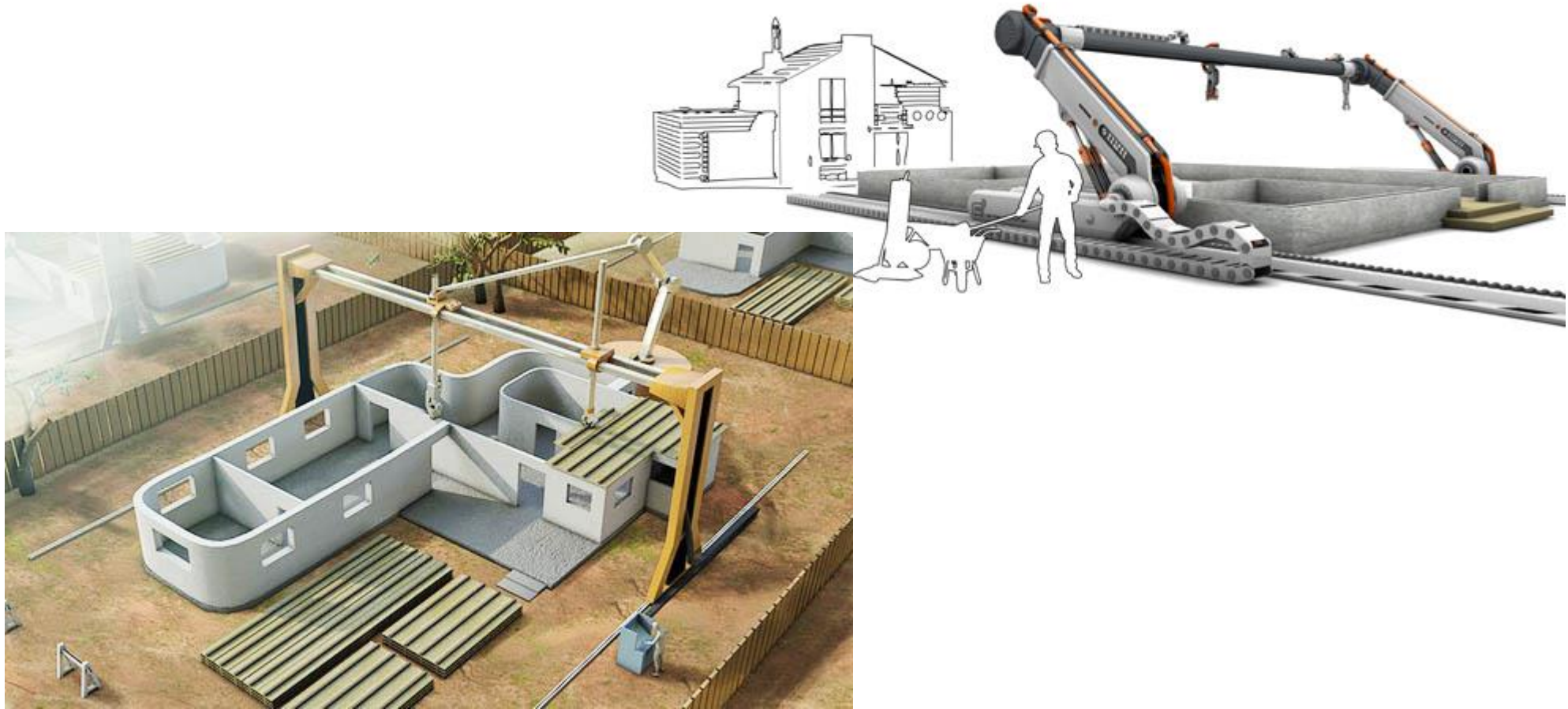
# Construction Industry



# Construction Industry



# Construction Industry



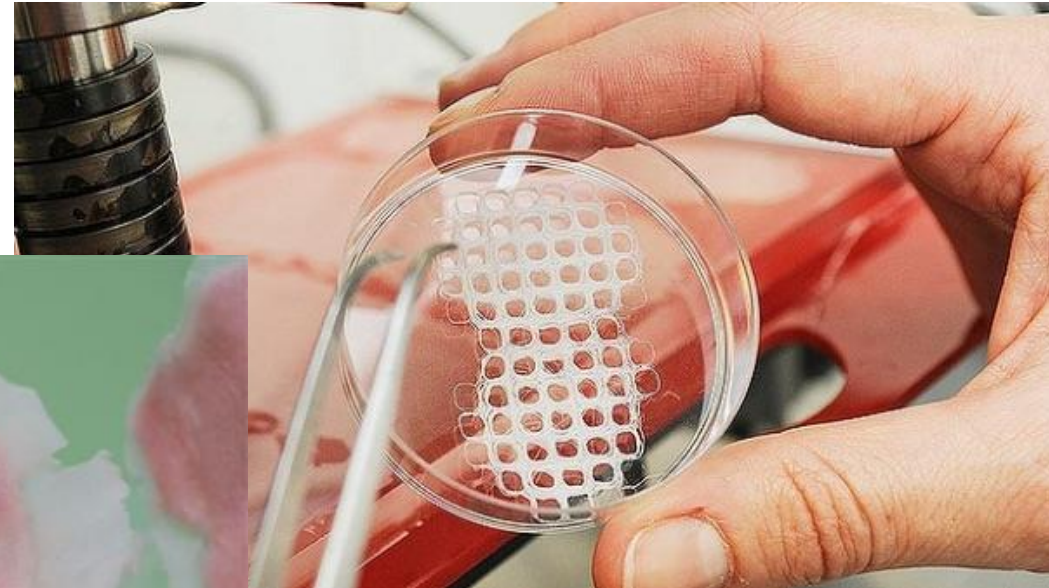
Prifysgol Cymru  
Y Drindod Dewi Sant  
University of Wales  
Trinity Saint David

**Swansea  
College of Art**  
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau  
Transforming Education; Transforming Lives*

# Life science Sector

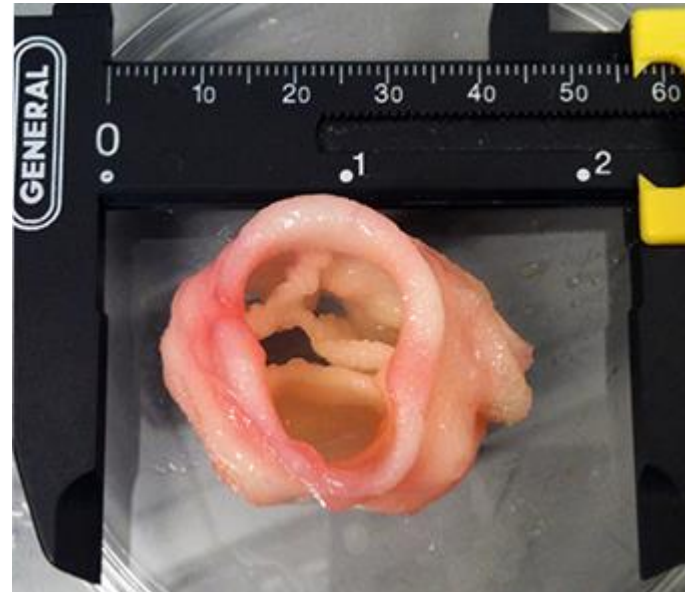
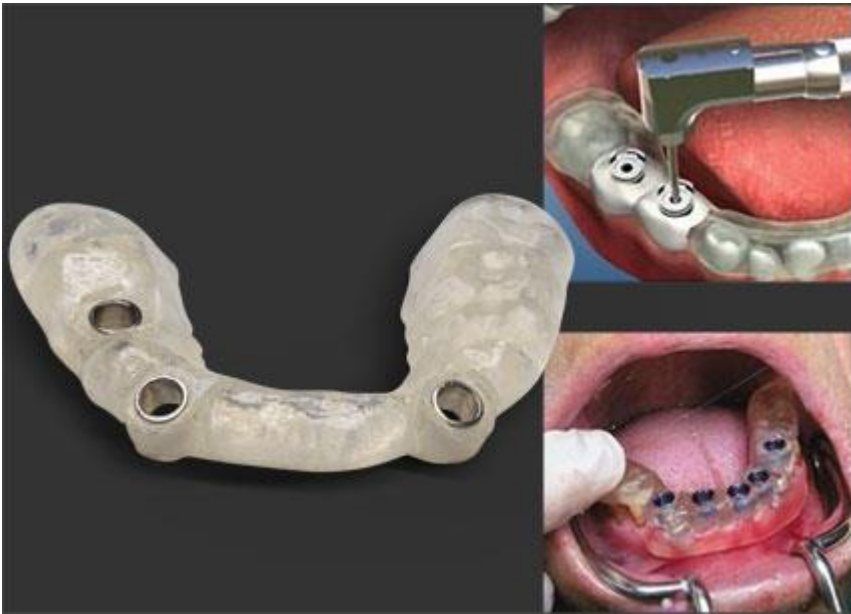
**\$1.82 billion** within less than 10 years.



# Life science sector



# Life science sector



# Life science sector



Prifysgol Cymru  
Y Drindod Dewi Sant  
University of Wales  
Trinity Saint David

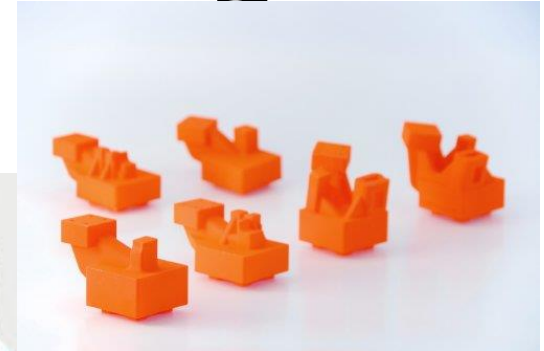
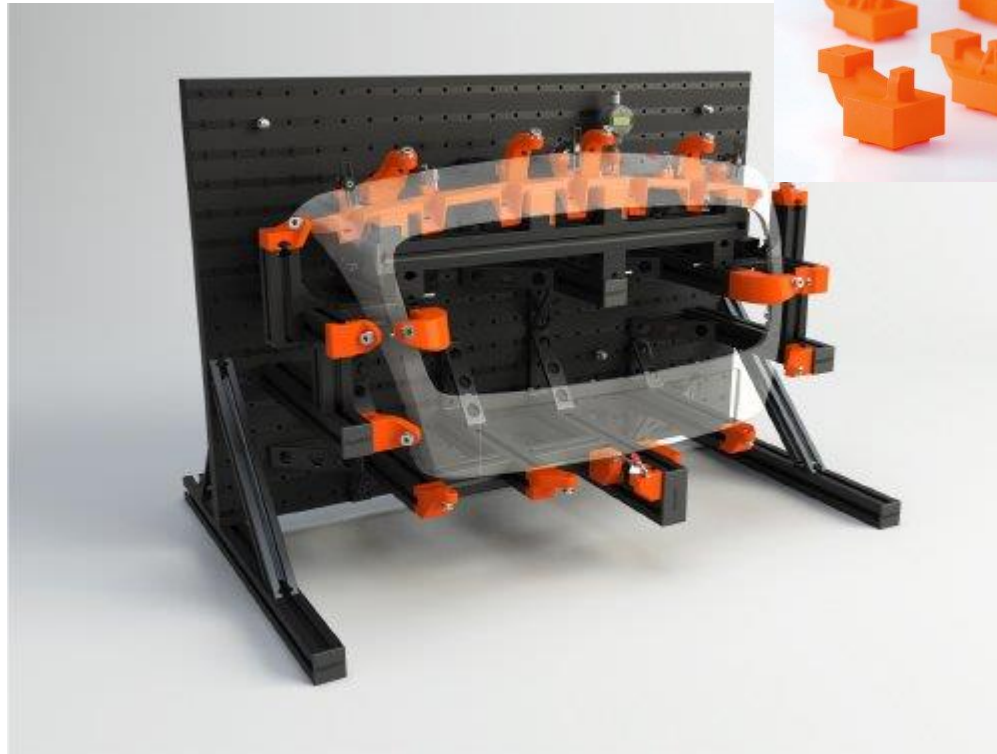
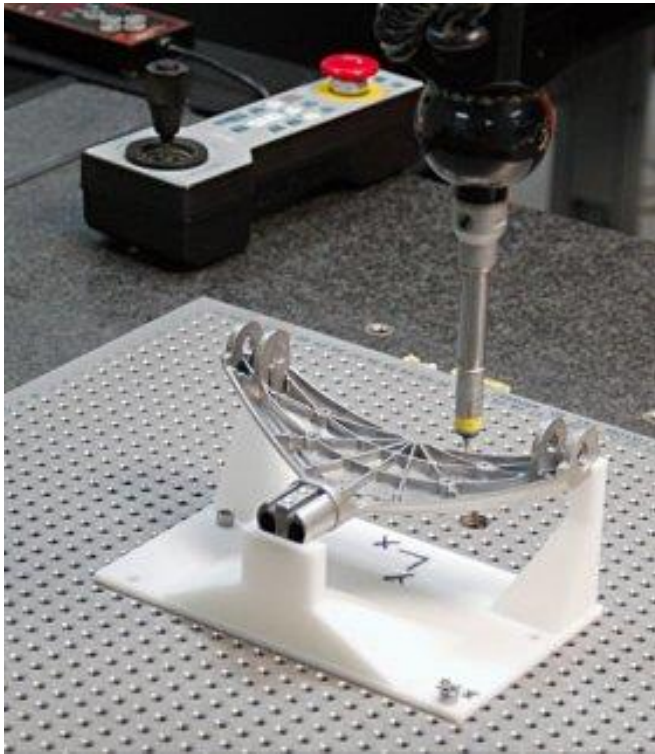
**Swansea  
College of Art**  
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau  
Transforming Education; Transforming Lives*

# Life science sector



# Traditional Manufacturing



# Traditional Manufacturing

|                         |                         |
|-------------------------|-------------------------|
| External suppliers      | Ultimaker 3D printers   |
| Cost per part€800       | Cost per part€21        |
| Project duration56 days | Project duration10 days |

Used during the positioning and screw assembly to prevent scratches/damage to the wheels. Without this protection, scrap costs can be huge.



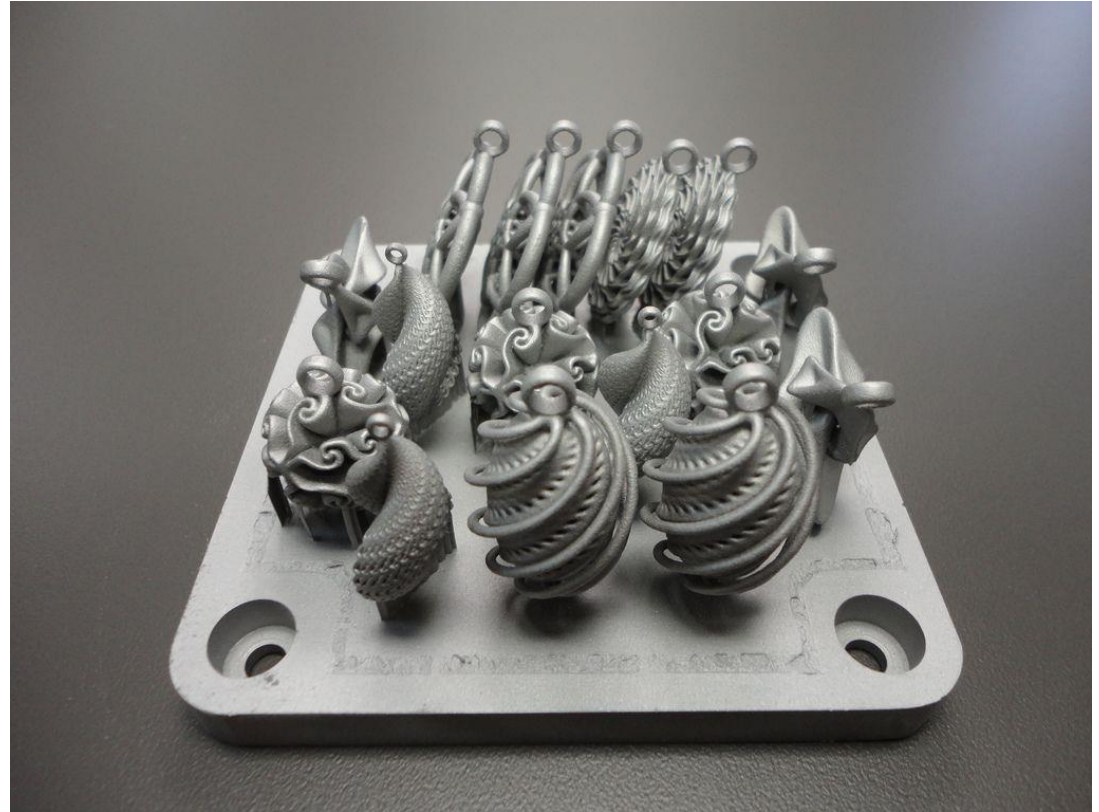
# Traditional Manufacturing

| External suppliers      | Ultimaker 3D printers  |
|-------------------------|------------------------|
| Cost per part€400       | Cost per part€10       |
| Project duration35 days | Project duration4 days |

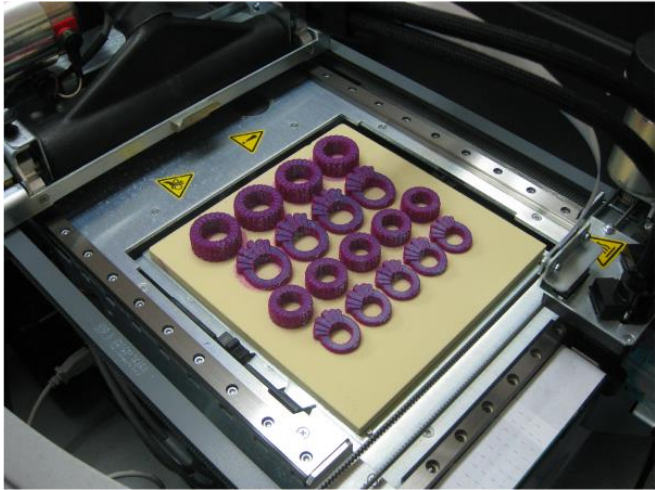
Ensures the correct positioning of the 2.0 TDI emblem, repeatedly and efficiently.



# Fashion Industry



# Fashion Industry



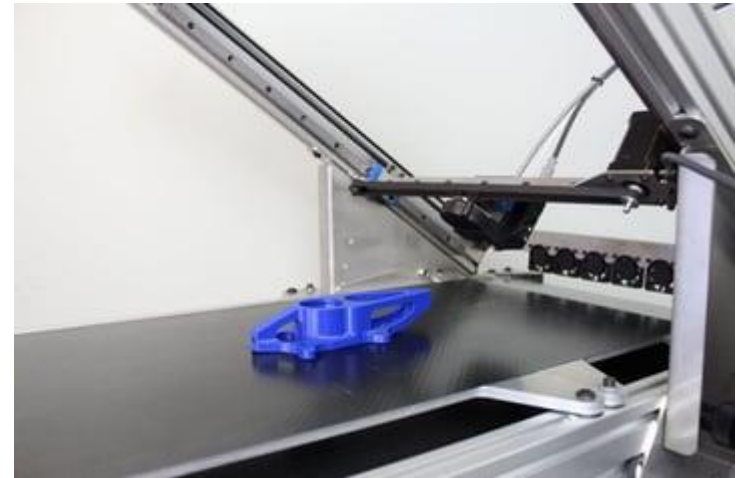
# Fashion Industry



# Additive Manufacturing

## Scaling up for production

- Printrbelt systems
- Robotic automation
- 3d printer farming
- Management software
- Dedicated software to optimise 3D Printing. – Generative design.



# Additive Manufacturing



Prifysgol Cymru  
Y Drindod Dewi Sant  
University of Wales  
Trinity Saint David

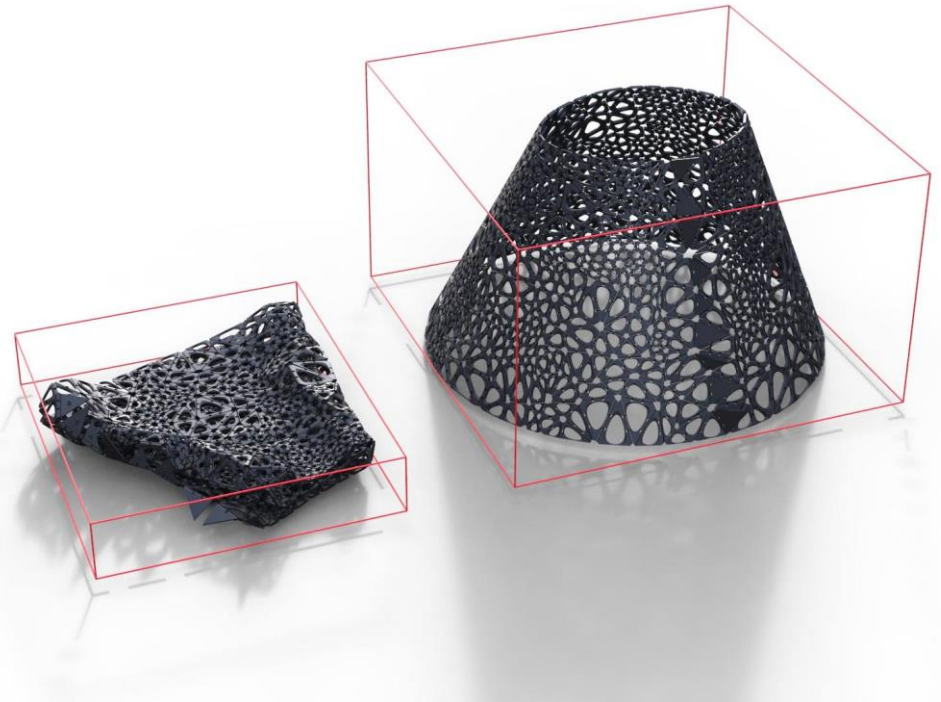
**Swansea  
College of Art**  
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau  
Transforming Education; Transforming Lives*

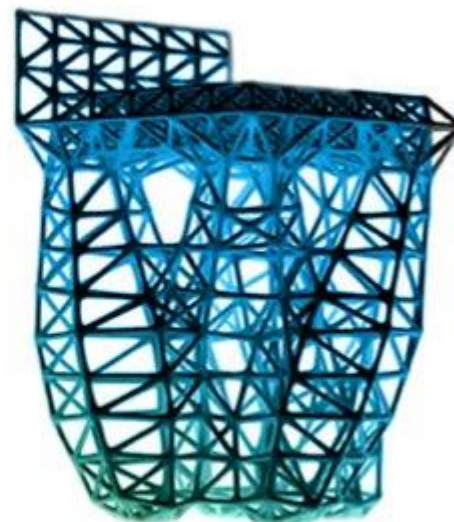
# FUTURE TECHNOLOGY

- SOFTWARE – GENERATIVE DESIGN
- MATERIALS RESEARCH – NEW PRINTABLE MATERIALS
- SPEED

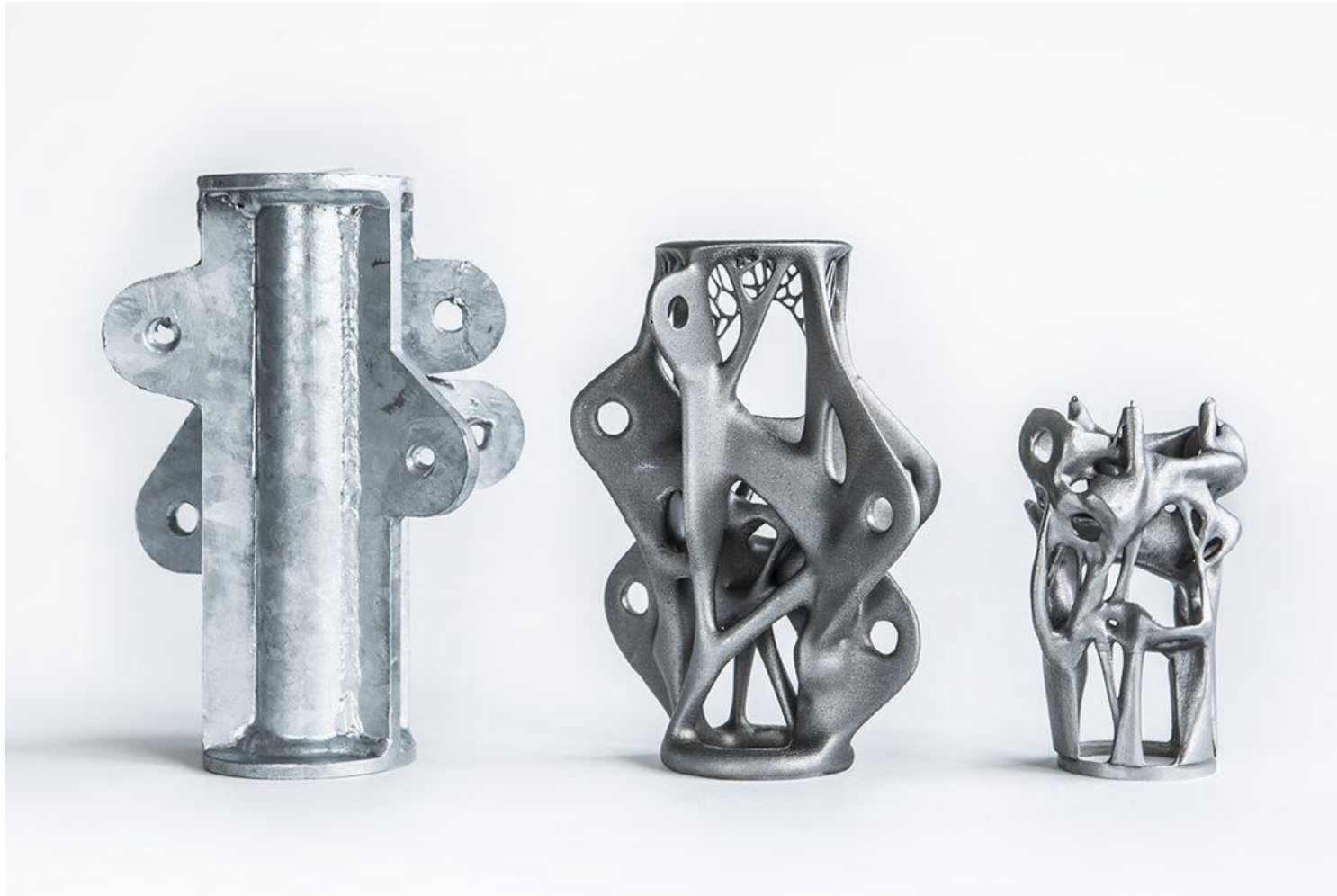
# 4D Printing



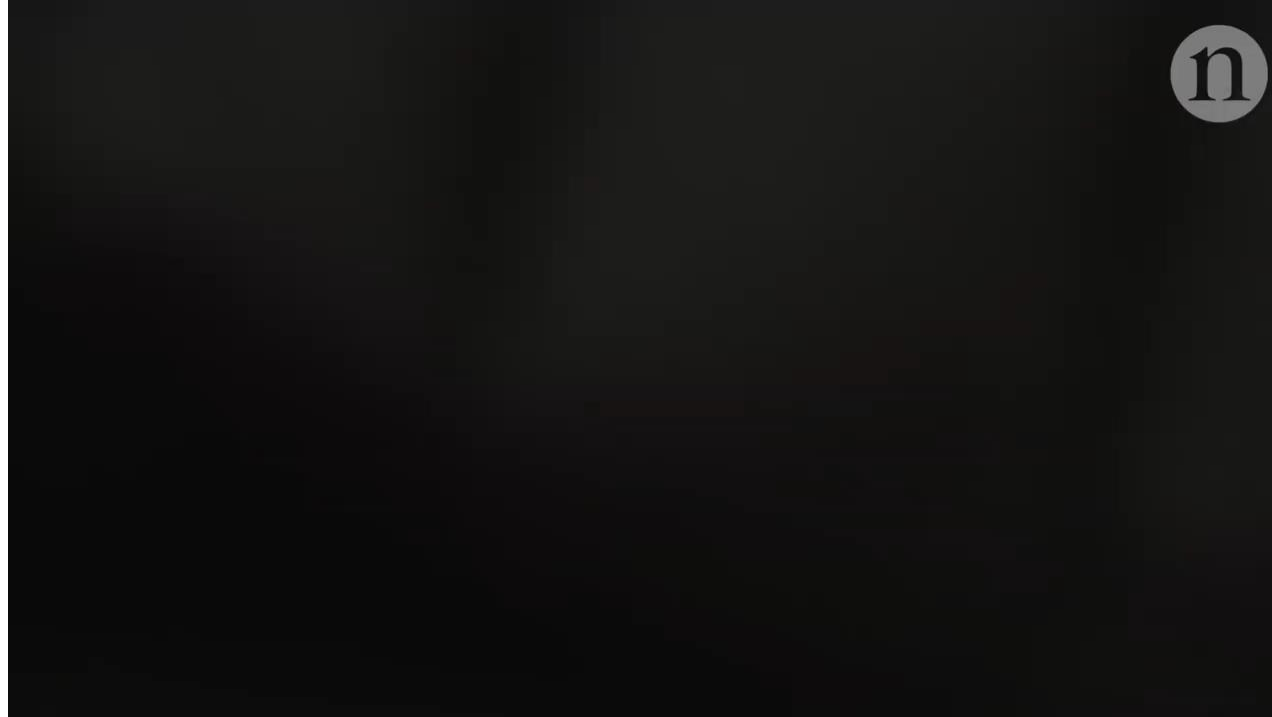
# Generative Design



# Generative Design



# Volumetric 3D Printing



# Useful links

<https://www.tctmagazine.com/>

[www.3ders.org](http://www.3ders.org)



# Thank You



**Swansea**  
**College of Art**  
Founded 1853

*Trawsnewid Addysg; Trawsnewid Bywydau*  
*Transforming Education; Transforming Lives*