NARLabs 國家實驗研究院

國家高速網路與計算中心

3D列印技術發展與趨勢

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3D列印與固力小組

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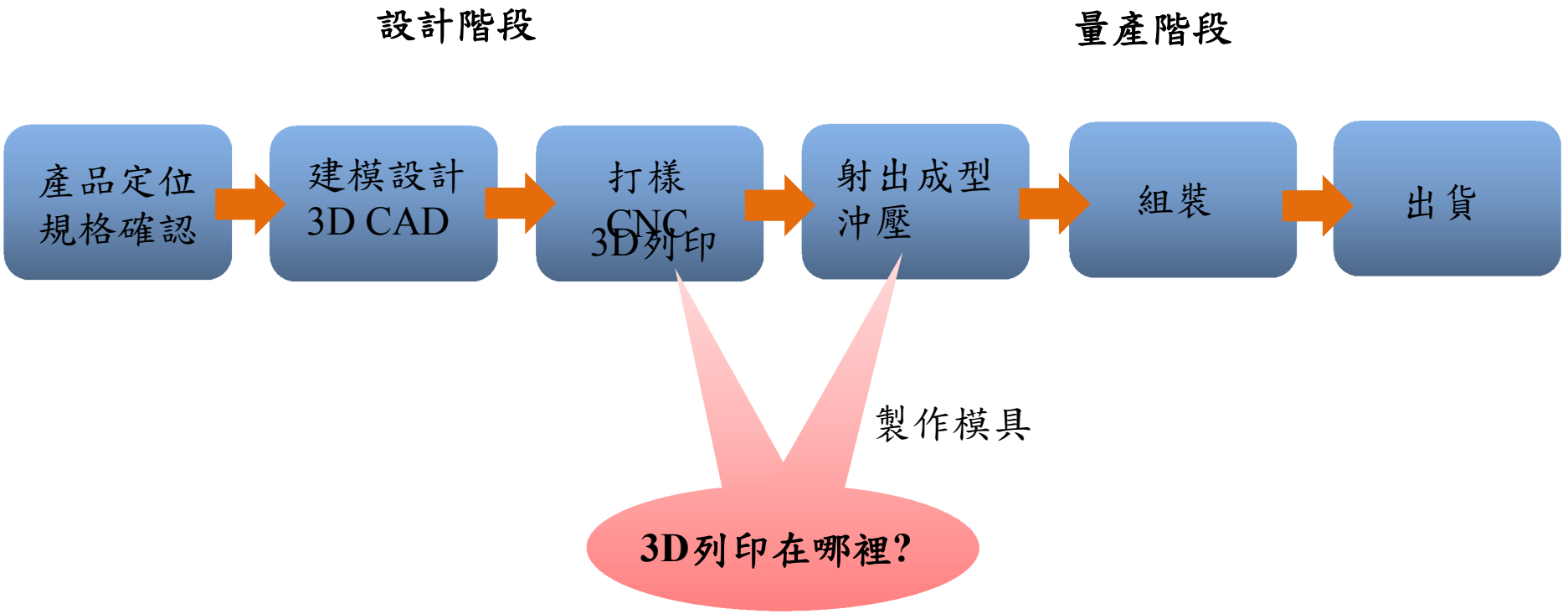
Outline

- 產品製造、3D列印的原理
- 3D列印應用
- 3D列印產品製作過程
- 3D列印的網路與實體資源
- 3D列印的商業模式
- 國網中心的研發、服務

產品的製造流程

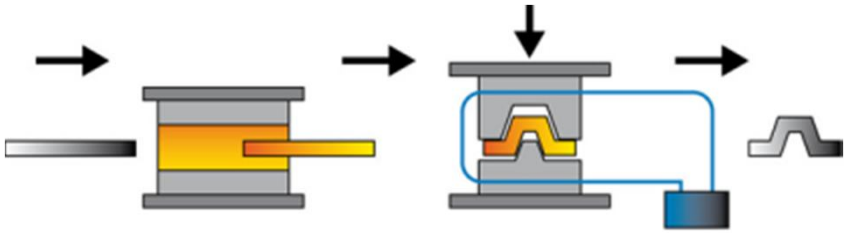

設計階段
量產階段
產品定位
規格確認
建模設計
3D CAD
打樣
CNC
3D列印
射出成型
沖壓
組裝
出貨
製作模具
3D列印在哪裡?

製造方法

CNC電腦數值加工(切削製造)

https://britehub.com/manufacturing/machining/5-axis-cnc-milling

沖壓

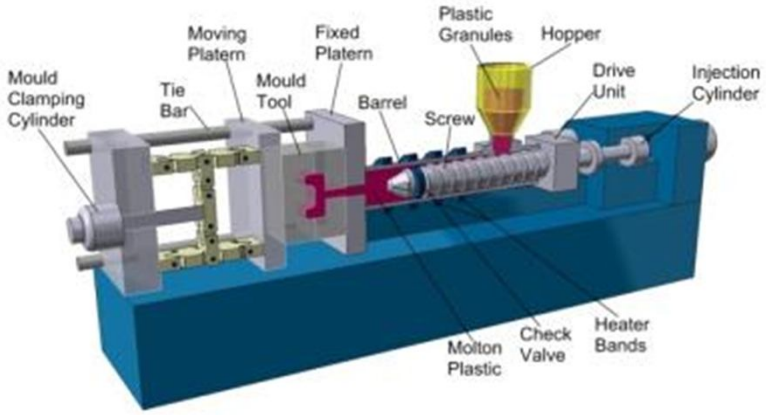


http://automotive.arcelormittal.com/europe/products/EN

3D列印、快速成型(積層製造)

https://gigaom.com/2014/01/14/why-2014-could-be-the-year-of-the-light-based-3d-printer/

射出成型、鑄造



http://www.rutlandplastics.co.uk/advice/moulding_machine.html

切削製造 V.S. 積層製造

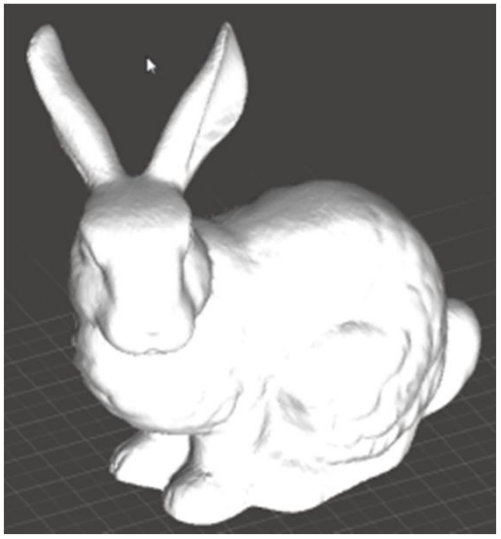
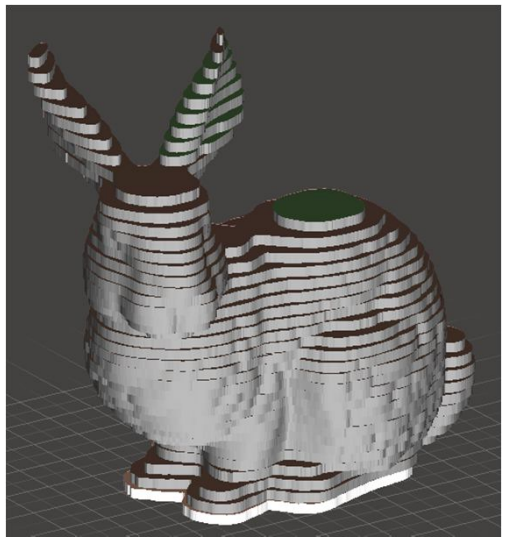
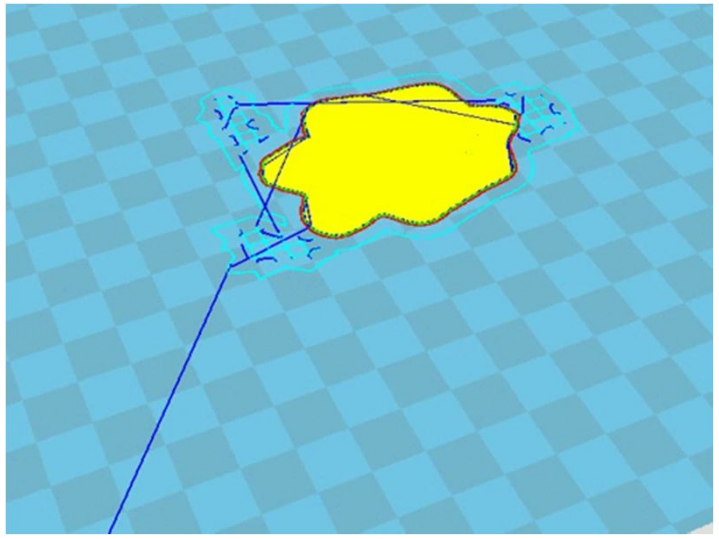
● Conventional Manufacturing (subtractive) process

● Additive Manufacturing Process

http://www.matse.psu.edu/research-topics/additive-manufacturing

3D列印的工作原理

- 將3D模型分割成數個切片，印表機將印製切片，並堆放在前一個切片上，切片堆疊後形成立體物件。
- 1983年，美國Charles Hull發表商用3D列印技術(Stereolithography, SLA)，也首次提出3D列印模型stl格式。
- 以前，3D列印稱為快速成型(Rapid Prototyping , RP)。
- 2009年，美國材料試驗協會正式命名積層製造(Additive Manufacturing, AM)。

3D列印之父 Charles Hull

Charles Hull在1983年發明了SLA (Stereolithography，液態樹脂固化或光固化) 3D列印技術，隨後於1984年申請美國專利，1986年獲得有史以來第一件結合電腦繪圖、固態雷射與樹脂固化技術的3D列印技術之專利憑證(US 4,575,330);同一年，他也在加州成立了業界知名的3D Systems公司，大力推動相關的業務。

Charles Hull最近在美國進入美國發明家名人堂(NIHOF)，同在名人在的有亨利福特和史提夫·賈伯斯。

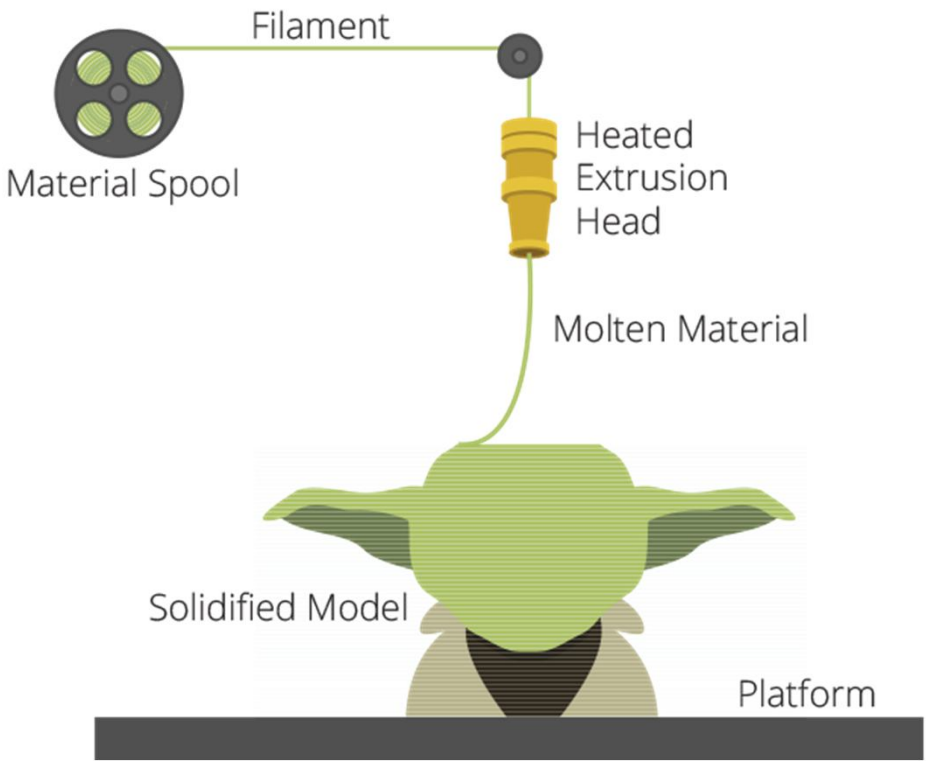
www.3done.cn/

https://www.youtube.com/watch?v=eyUPSYynywM

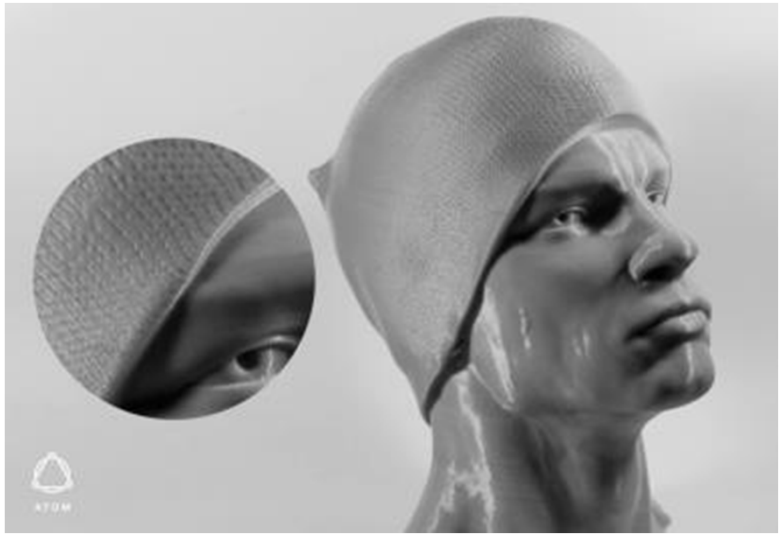
3D列印的製程種類

- 熔融沉積成型(Fused Deposition Modeling, FDM)
- 光固化立體造型 (Stereolithography, SLA)
- 選擇性雷射燒結 (Selective laser sintering, SLS)
- 噴墨式(Powder bed and inkjet head 3D printing,3DP)
- 分層實體製造（Laminated object manufacturing, LOM）
- 數位光處理(Digital Light Processing, DLP)
- 電子束熔化成型（Electron beam melting , EBM）

Fused Deposition Modeling (FDM)

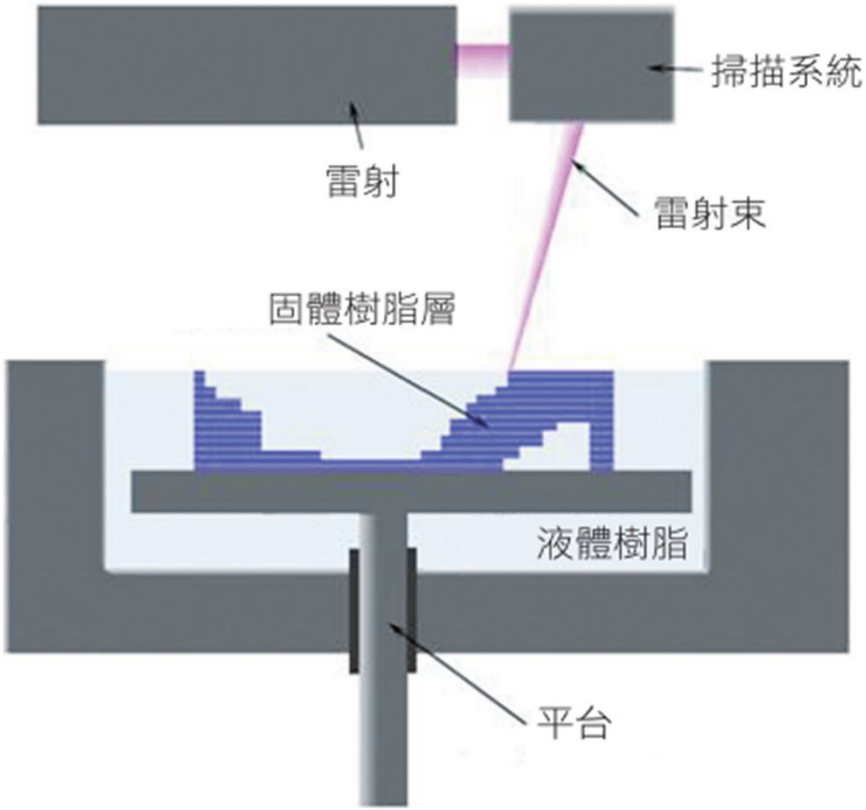


http://3dprintingindustry.com/3d-printing-basics-free-beginners-guide/processes/



http://personalfactory.tumblr.com/post/109444400017/atom-2-0-3d-printer-laser-engraver-specs

Stereolithography (SLA)



http://en.wikipedia.org/wiki/Stereolithography

http://pixshark.com/stereolithography.htm

http://www.designboom.com/technology/low-cost-stereolithography-3d-printer-by-formlabs/

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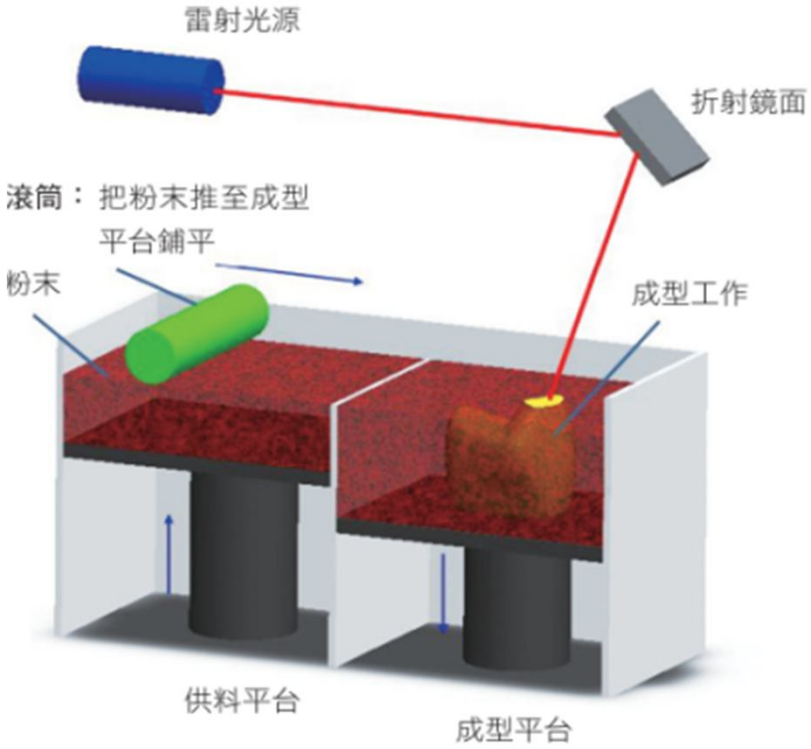
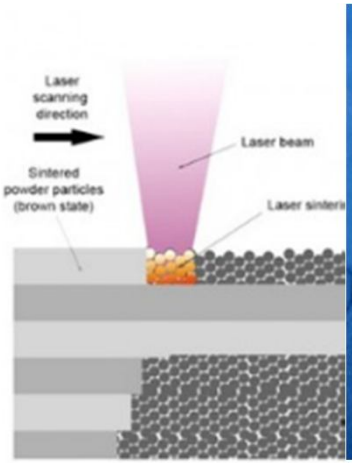
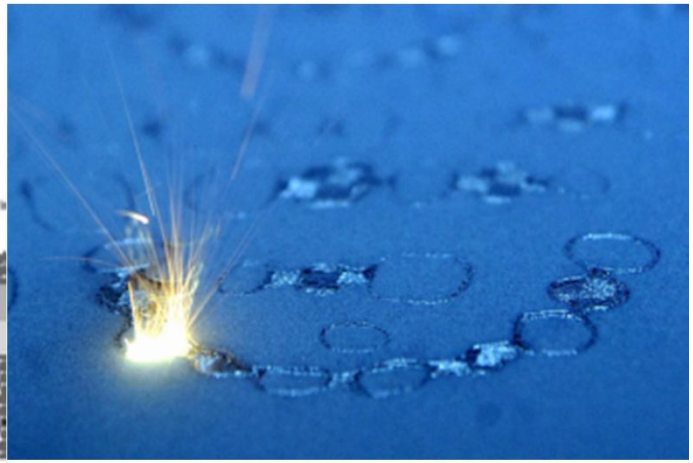
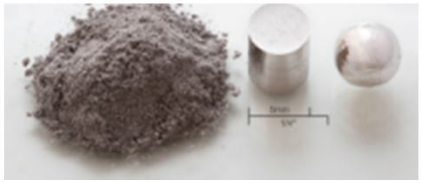
Selective laser sintering (SLS)



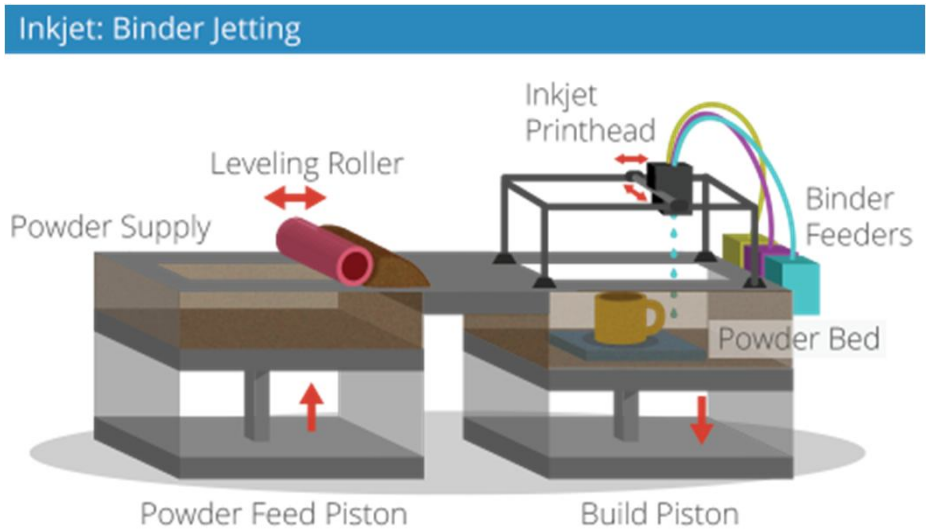






http://desiredcreations.com/Misc_MakerFaire09.htm

Powder bed and inkjet head 3D printing (3DP)



http://3dprintingindustry.com/3d-printing-basics-free-beginners-guide/processes/

http://www.3axis.us/zprinter-3d-printer.asp

http://www.senztech.cc/showpros.aspx?proid=109

3D列印平價化與普及化1

1. FDM技術專利2009年到期

United States Patent [19]

Crump

[11] **Patent Number: 5,121,329**

[45] **Date of Patent: Jun. 9, 1992**

[54] **APPARATUS AND METHOD FOR CREATING THREE-DIMENSIONAL OBJECTS**

[75] Inventor: **S. Scott Crump**, Minnetonka, Minn.

[73] Assignee: **Stratasys, Inc.**, Minneapolis, Minn.

[21] Appl. No.: **429,012**

[22] Filed: **Oct. 30, 1989**

[51] **Int. Cl.**[5] **G06F 15/46**

[52] **U.S. Cl.** **364/468**; 364/474.24; 364/477; 264/239; 264/25; 425/174.4

[58] **Field of Search** 364/472, 473, 477; 264/308, 113; 425/174.4; 427/8, 52; 164/94; 239/75, 82, 83, 84, 132

[56] **References Cited**

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3,749,149	7/1973	Paton et al.	164/94
4,071,944	2/1978	Chuss et al.	427/8
4,247,508	1/1981	Housholder	264/221
4,293,513	10/1981	Langley et al.	264/308
4,545,529	10/1985	Tropecano et al.	239/75
4,575,330	3/1986	Hull	364/473
4,595,816	6/1986	Hall et al.	364/477
4,665,492	5/1987	Masters	364/474.02
4,681,258	7/1987	Jenkins et al.	239/83
4,863,538	9/1989	Deckard .	
4,938,816	7/1990	Beaman et al. .	
4,944,817	7/1990	Bourell et al. .	

OTHER PUBLICATIONS

Asymtek Brochure, "Benchtop Automation" May 1988.

Primary Examiner—Joseph Ruggiero
Assistant Examiner—Patrick D. Muir
Attorney, Agent, or Firm—Moore & Hansen

[57] **ABSTRACT**

Apparatus incorporating a movable dispensing head provided with a supply of material which solidifies at a predetermined temperature, and a base member, which are moved relative to each other along "X," "Y," and "Z" axes in a predetermined pattern to create three-dimensional objects by building up material discharged from the dispensing head onto the base member at a controlled rate. The apparatus is preferably computer driven in a process utilizing computer aided design (CAD) and computer-aided (CAM) software to generate drive signals for controlled movement of the dispensing head and base member as material is being dispensed.

Three-dimensional objects may be produced by depositing repeated layers of solidifying material until the shape is formed. Any material, such as self-hardening waxes, thermoplastic resins, molten metals, two-part epoxies, foaming plastics, and glass, which adheres to the previous layer with an adequate bond upon solidification, may be utilized. Each layer base is defined by the previous layer, and each layer thickness is defined and closely controlled by the height at which the tip of the dispensing head is positioned above the preceding layer.

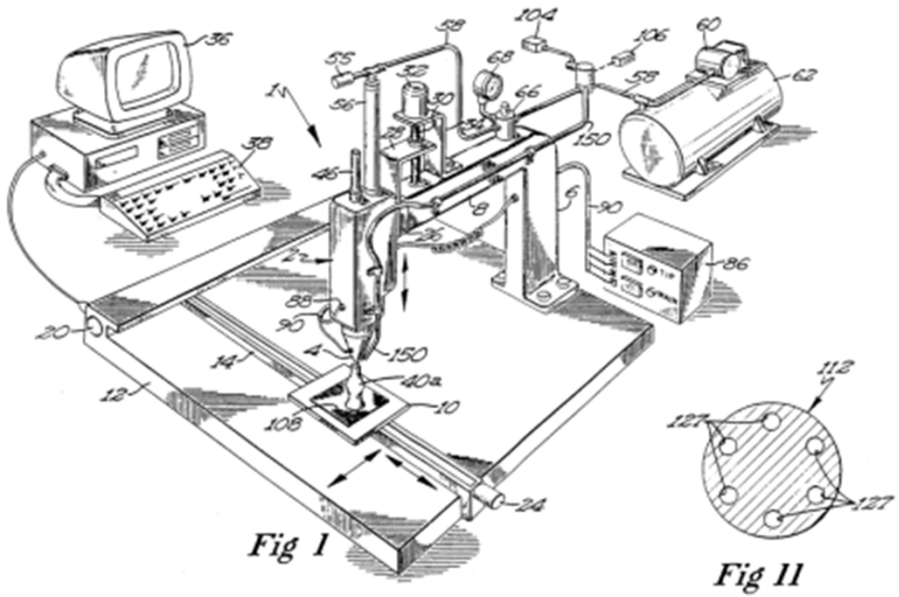


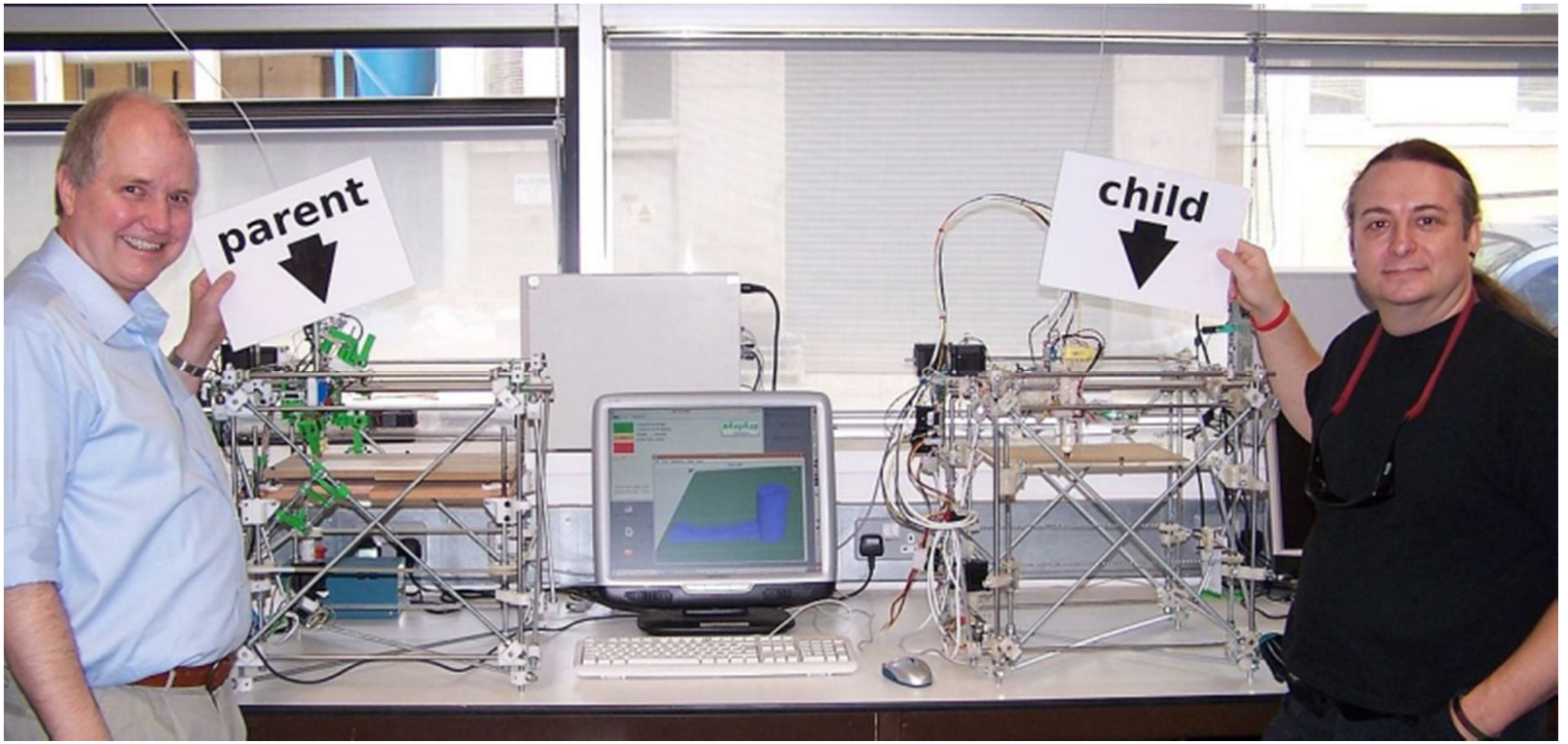
Fig 1

Fig 11

3D列印平價化與普及化2

2. 開源機器的釋放：RepRap(replicating rapid prototyper)

   RepRap網址：http://reprap.org/



Adrian Bowyer

http://zh.wikipedia.org/wiki/RepRap

3D列印平價化與普及化3

3. 美國政策主導

http://3dprint.com/6834/president-obama-zego-robotics/

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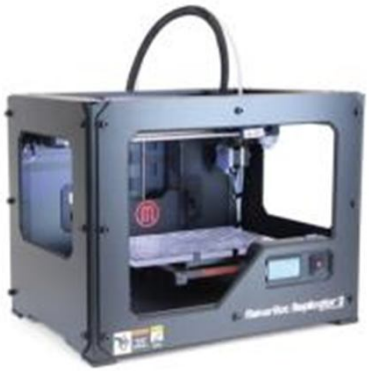
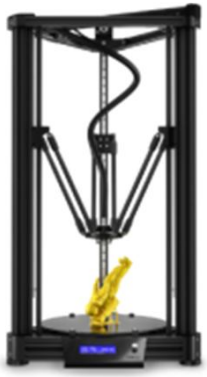
常見的桌上型3D印表機

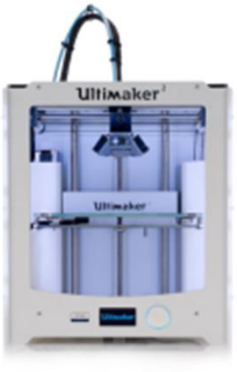
UP plus2



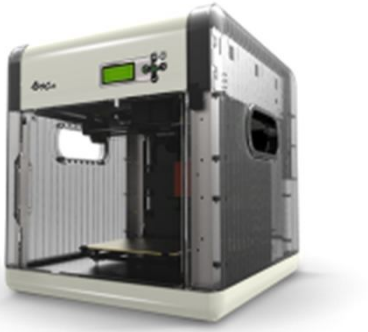
Makerbot Replicator 2



Atom 2.0



Ultimaker 2



XYZ Da Vinci 1.0A

Prusa i3

Form1+ (SLA)

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3D列印的優點1

	設計軟體	製造工具	特色
大量製造	AutoCad Solidworks Pro/E Rhino Catia	CNC 射出成型 鑄造 沖壓	高資本支出 專業人士操作 產品開發時間長 產品依市場導向 大量製造
個人製造	123D Design Tinkercad Meshmixer FreeCad Blender	桌上型3D印表機 桌上型雕刻機	低資本支出 業餘人士使用 產品開發時間短 自行主導產品 少量/客製化製造

3D列印的優點2

- 客製化、快速打樣
- 減少耗材成本、少量生產
- 可製造特殊造型，創意不受限

http://www.hoganas.com/en/Powder-Applications/Additive-Manufacturing/

3D列印應用-生活1

健身車的手機架

3D列印應用-生活2

線材架

擠牙膏器

3D列印應用-生活3

手機座

遮板

3D列印應用-藝術 文創1

http://lunglungdesign.blogspot.tw/2014/12/hiroaki-nishimura-stratum-vase.html#more

http://www.pichaus.com/design-3d-printing-diy-electrical-lamp-light-@bd4bdd34da25c2ce703deeabd71e178b/

3D列印應用-藝術 文創2

大洪水—諾亞方舟計畫，彭泓智，臺北市立美術館。

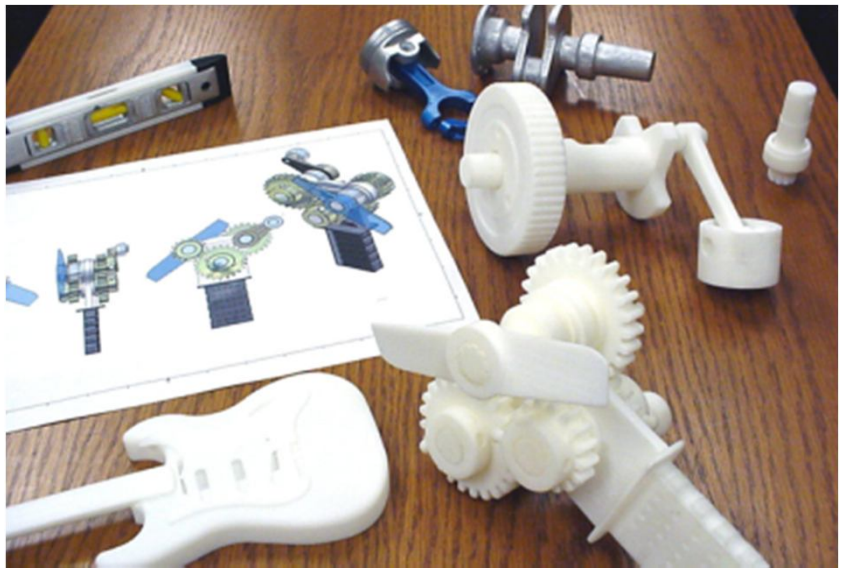
http://newsweek.shu.edu.tw/public/view.php?id=2296

3D列印應用-時尚

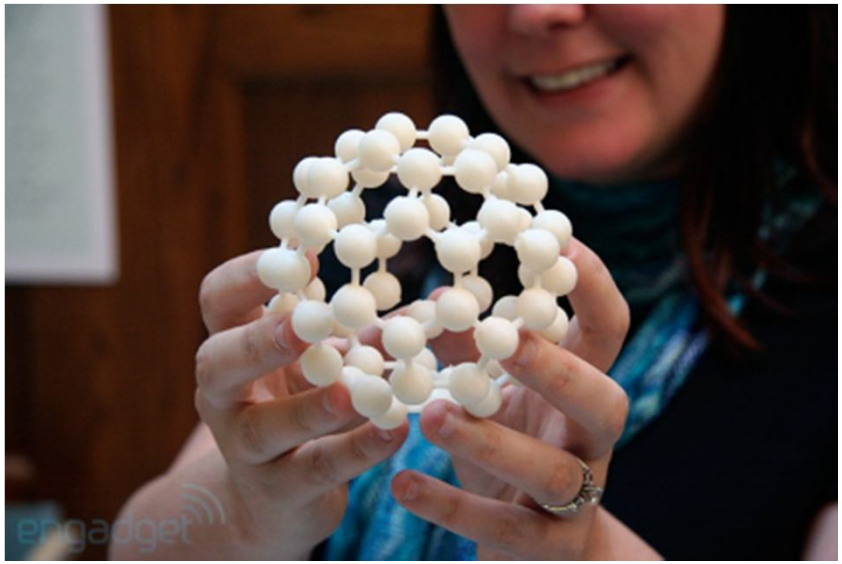
http://n-e-r-v-o-u-s.com/index.php

3D列印應用-教育1

3D列印應用-教育2



http://design-engine.com/new-more-affordable-3d-printers-in-development/



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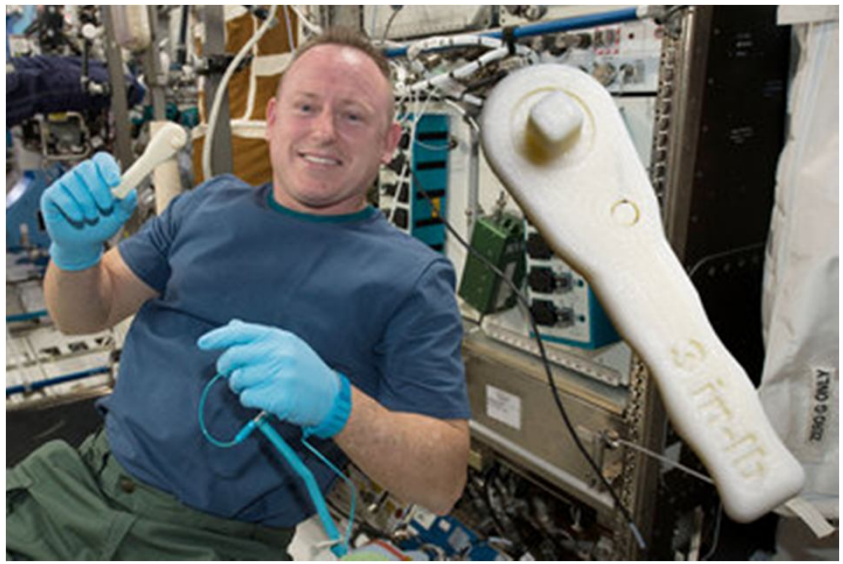
http://disrupt3d.com/2015/01/04/safe-3d-printing-pen-children/

3D列印應用-航太



http://www.space.com/28118-3d-printed-wrench-space-station.html

https://flightopportunities.nasa.gov/technologies/4/

3D列印應用-醫療

http://www.mymodernmet.com/profiles/blogs/william-root-exo-prosthetic-leg

http://disrupt3d.com/2013/04/02/how-a-3d-printer-gave-a-man-his-face-and-his-life-back/

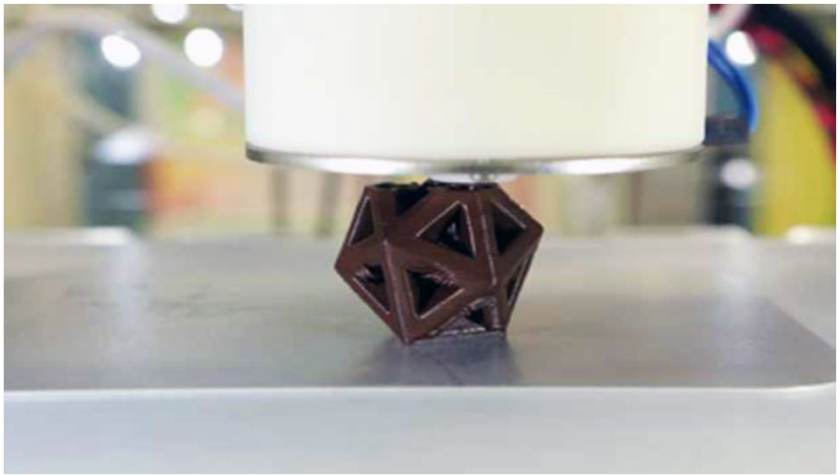
3D列印應用-建築

http://www.gizmag.com/custom-3d-printer-concrete-castle/33577/

http://thisdesignofmine.com/2014/04/24/3d-print-your-next-eco-friendly-home/

https://www.whiteclouds.com/3d-printing-buildings-scale-models

3D列印應用-飲食



http://3dprintingindustry.com/2015/01/06/hershey-3d-systems-unveil-new-cutting-edge-chocolate-3d-printer-ces/

http://homeli.co.uk/geometric-confectionary-3d-printed-sugar-cubes-by-the-sugar-lab/

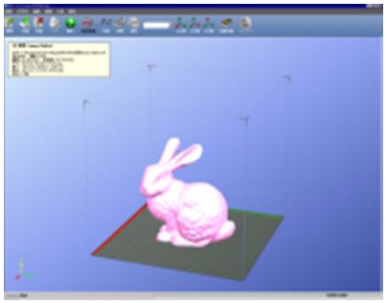
3D列印產品製作步驟

產生3D模型
建模軟體
3D掃描
轉檔stl格式

列印軟體
切片模型
設定列印格式

3D印表機
校正
熱機
列印

後處理
脫模
拆除支架

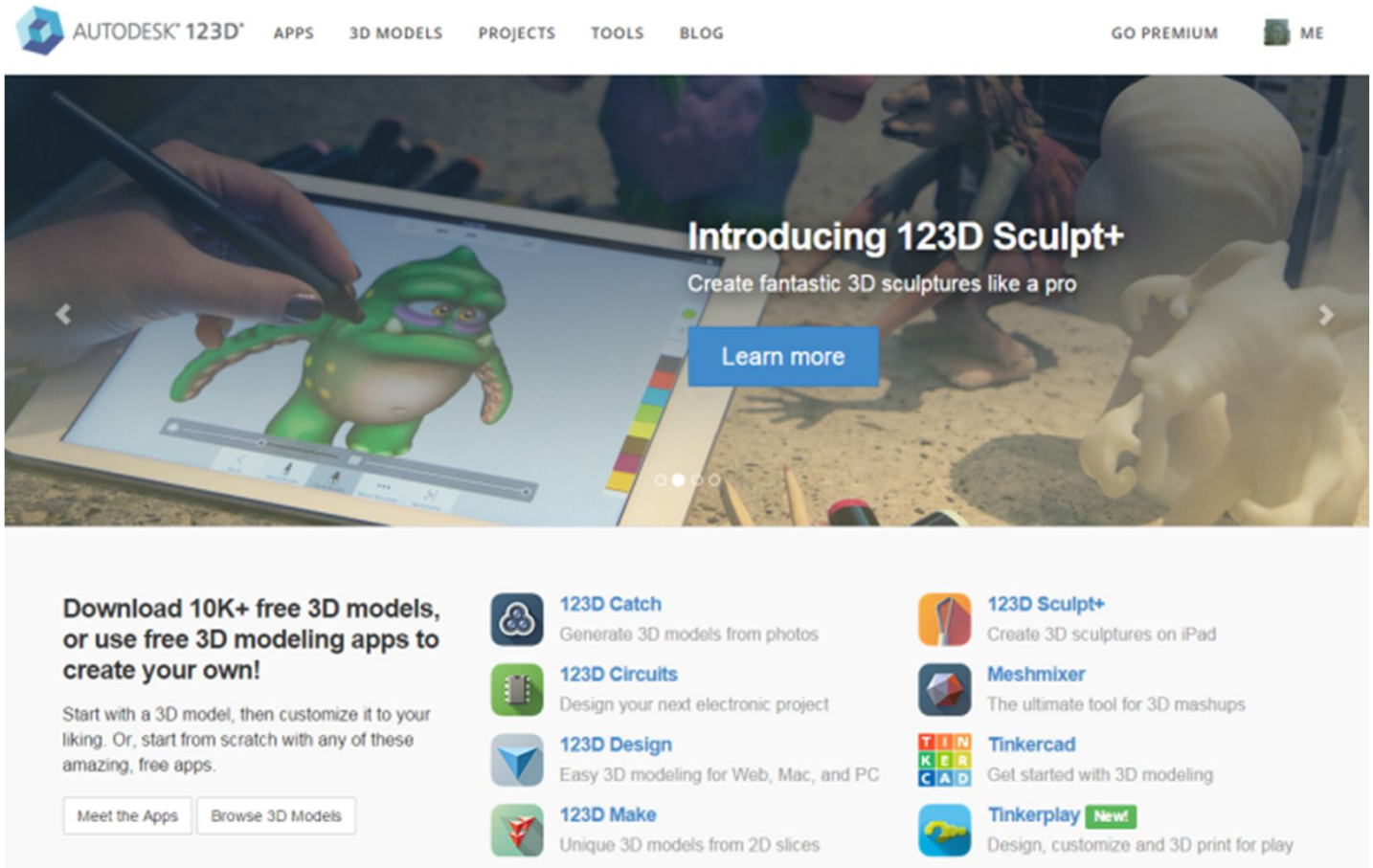


3D建模軟體

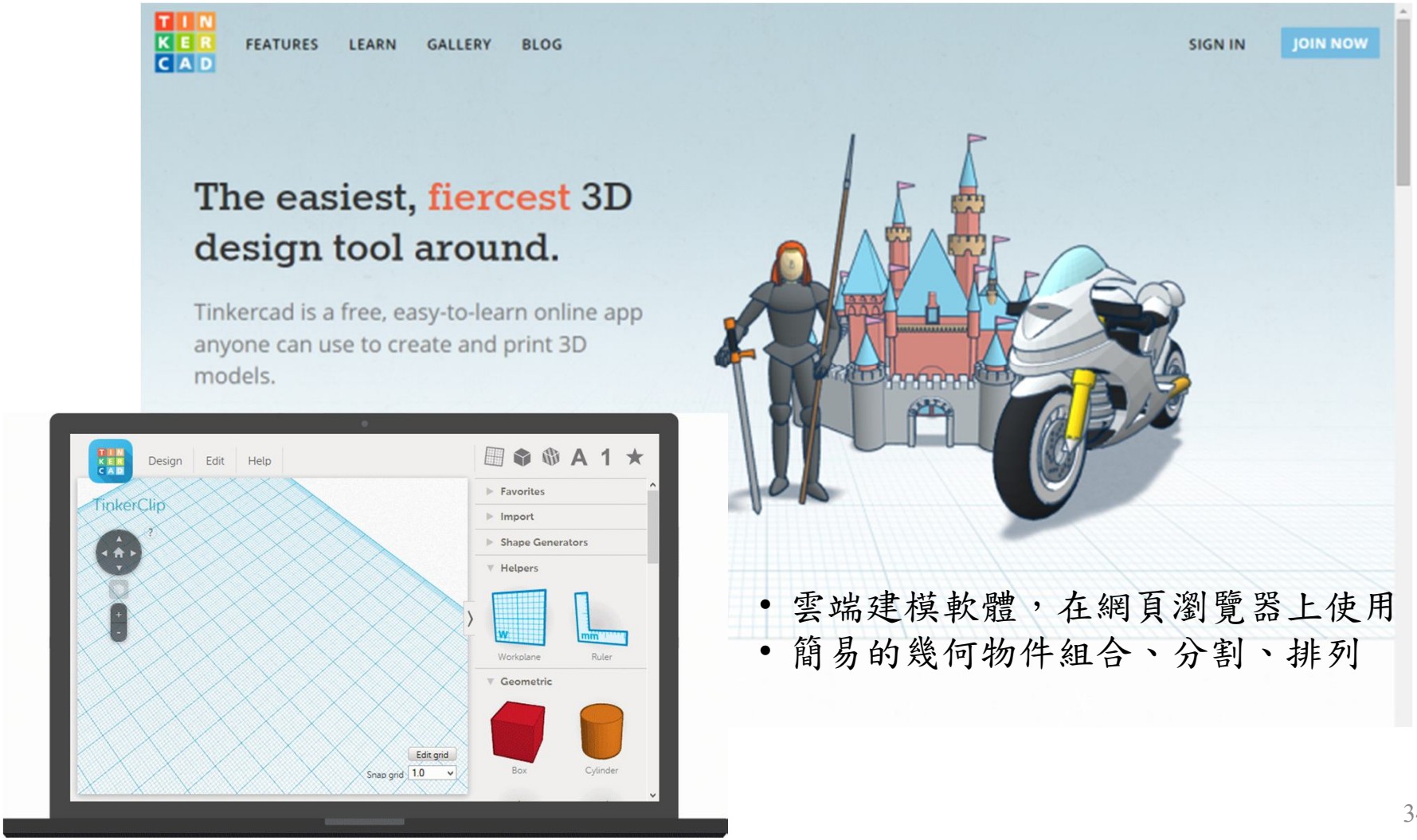
	免費	付費
工程CAD	Tinkercad 123D Design FreeCad DesignSpark Mechanical	SketchUp Solidworks Pro/E Rhinoceros Catia
造型CG	Blender 123d sculpt+	Maya 3ds Max Zblush
模型編修	Meshmixer Meshlab	Magics

開源建模平台

- Autodesk 123D (http://www.123dapp.com)



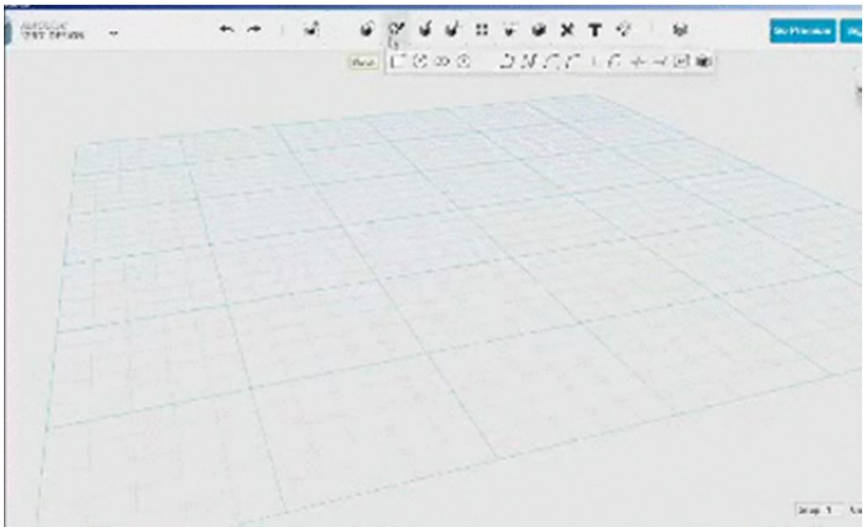
Tinkercad



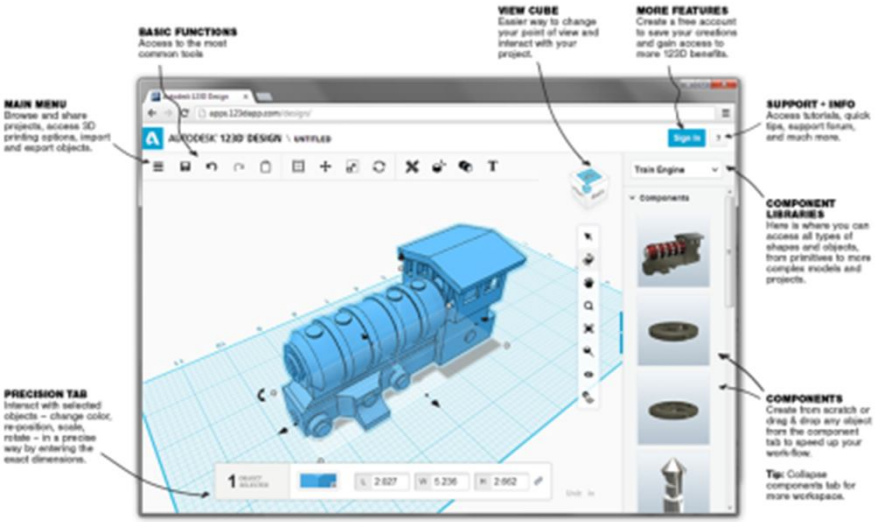
- 雲端建模軟體，在網頁瀏覽器上使用
- 簡易的幾何物件組合、分割、排列

123D design

- 最簡易的工業建模軟體
- 雲端存取檔案



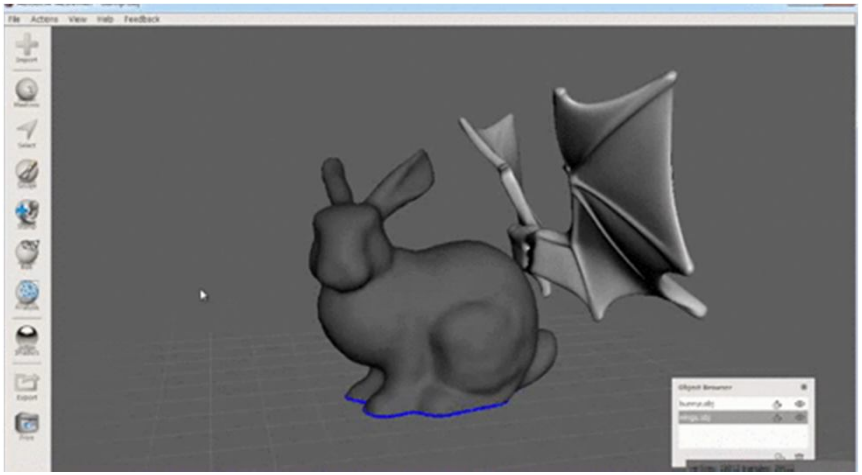
https://www.youtube.com/watch?v=_rH5mXvYLjQ



http://www.123dapp.com/howto/design

Meshmixer

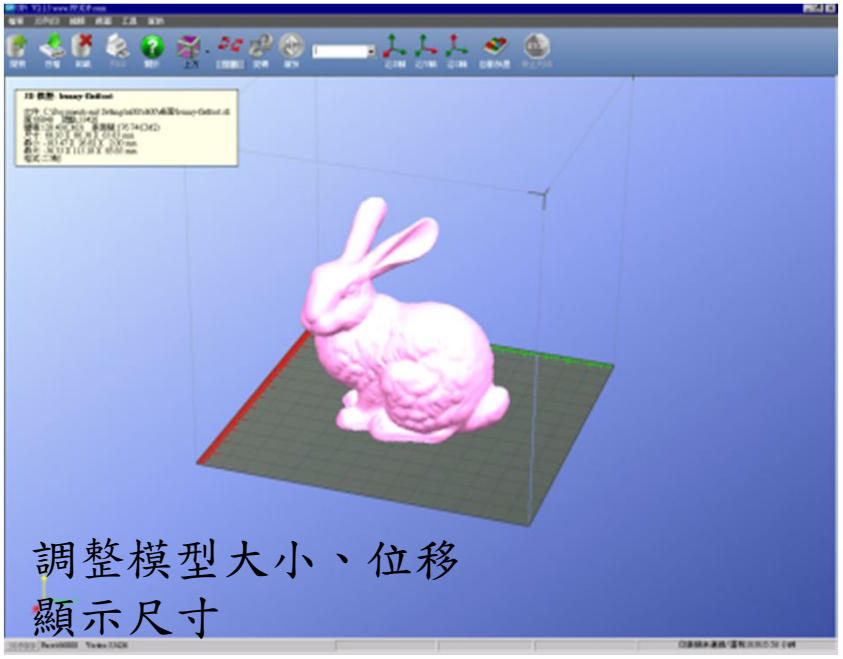
- 破面修補
- 支撐設計
- 表面設計
- 混合設計



https://www.youtube.com/watch?v=hxGaiHa40So

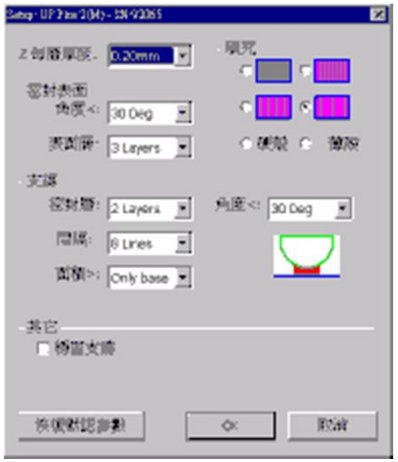
http://inplus.tw/archives/970

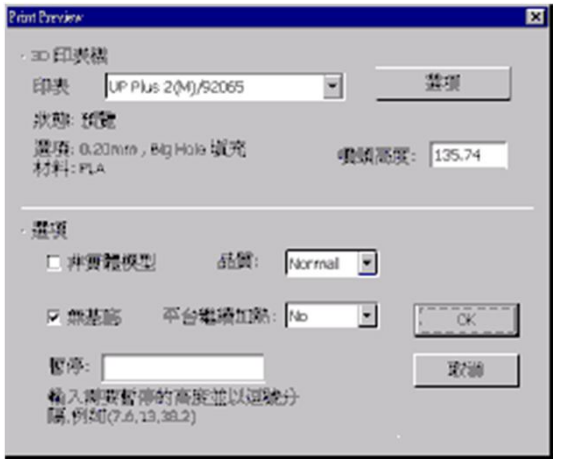
列印/切層軟體

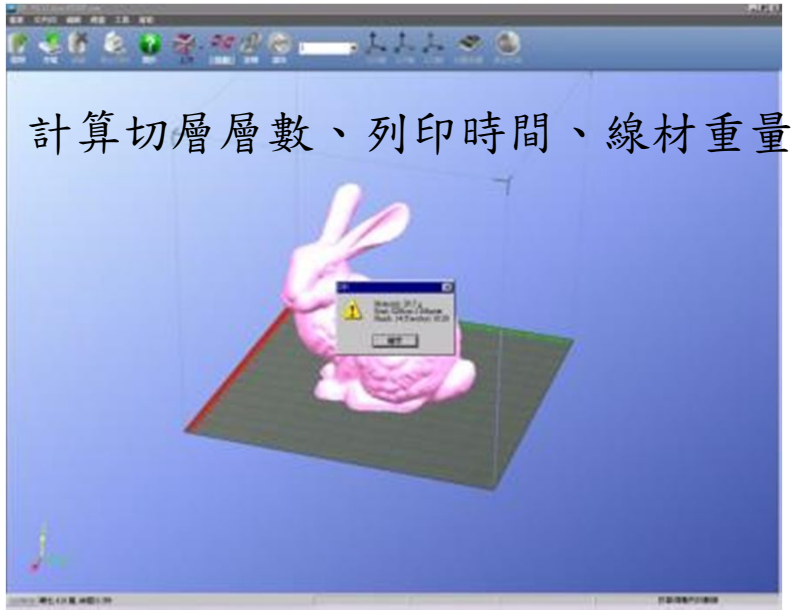


調整模型大小、位移
顯示尺寸

設定層厚、填充率、支撐角度、列印速度





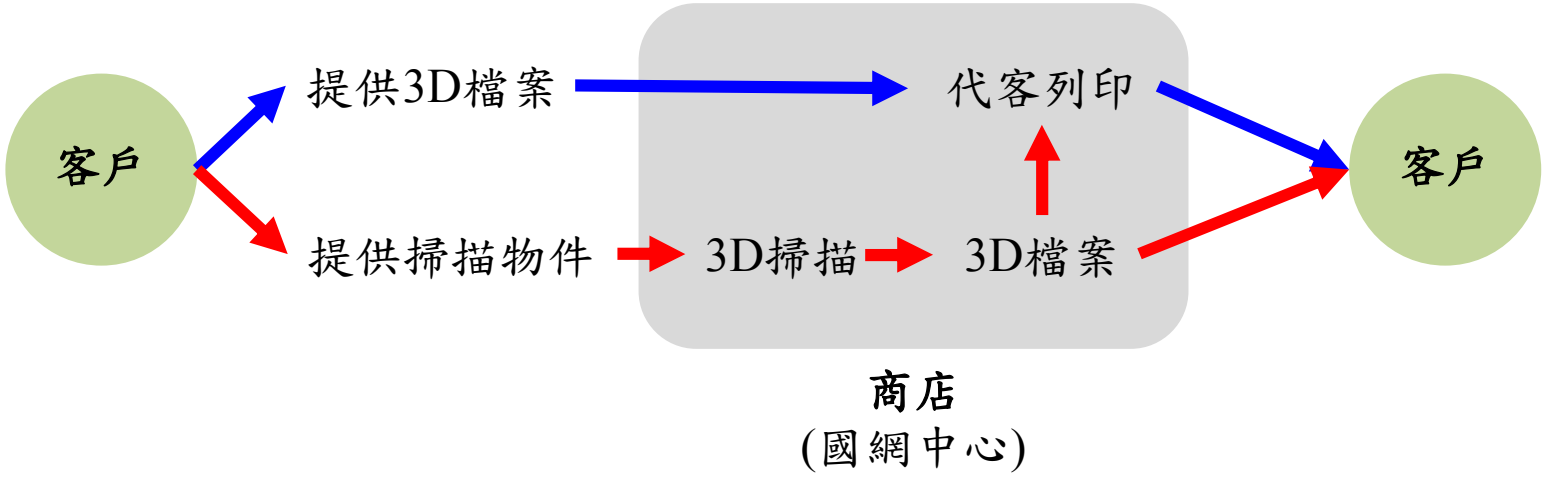


計算切層層數、列印時間、線材重量

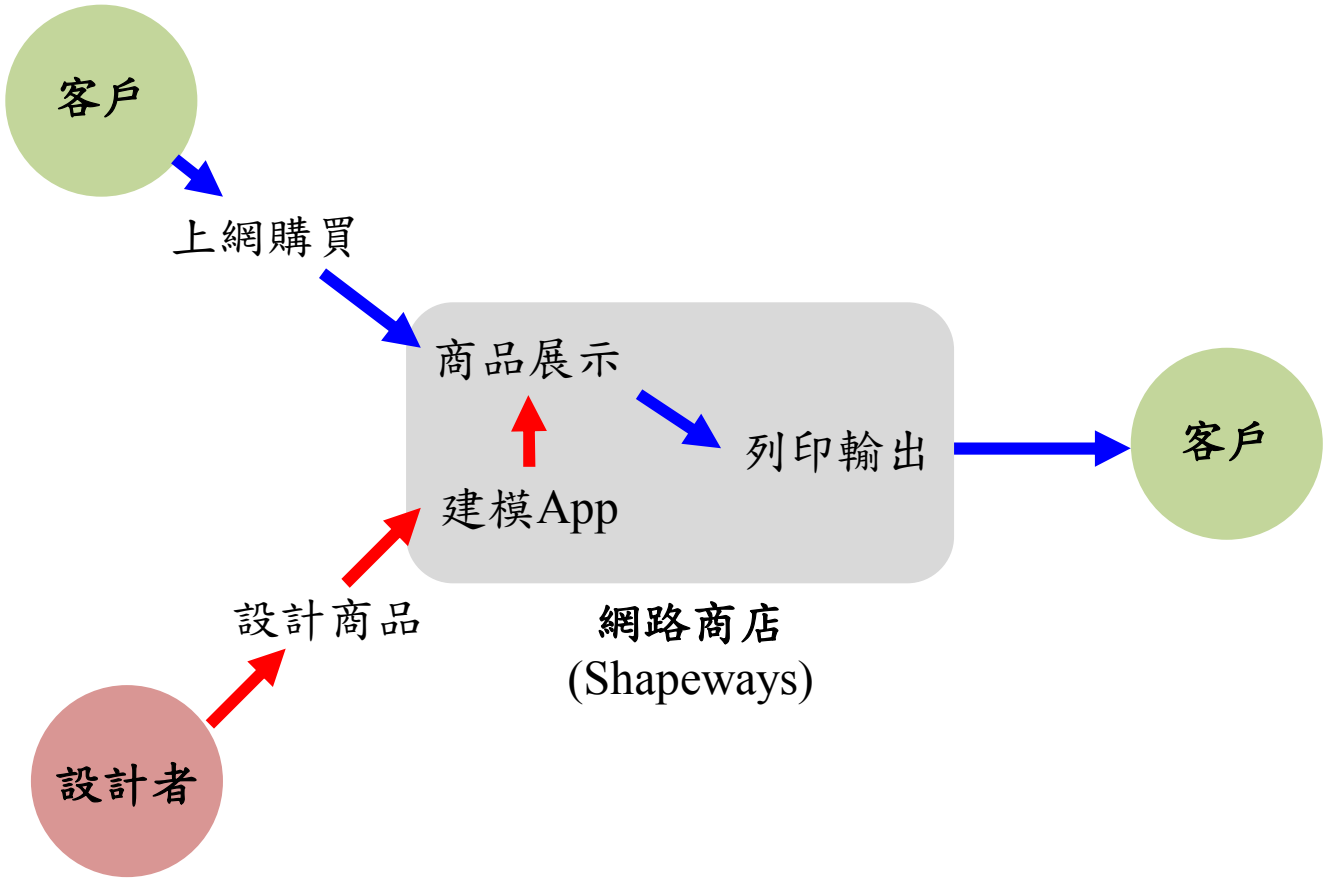
網路與實體資源

- 開源平台
  - Autodesk 123D
- 3D模型庫
  - Thingiverse, MyMiniFactory
- 輸出服務
  - Shapeways, Nervous System, Cubify
- 網路社群
  - 技術分享：朗朗設計, inplus 3D列印良品, 3D印表機DIY 建構筆記
  - 討論區：3D Printer 印表機討論交流| Facebook
  - 募資網站：嘖嘖, Kickstarter
- ◆ 實體資源
  - 自造者空間 Maker space, Fablab
  - 自造者博覽會 Maker Faire

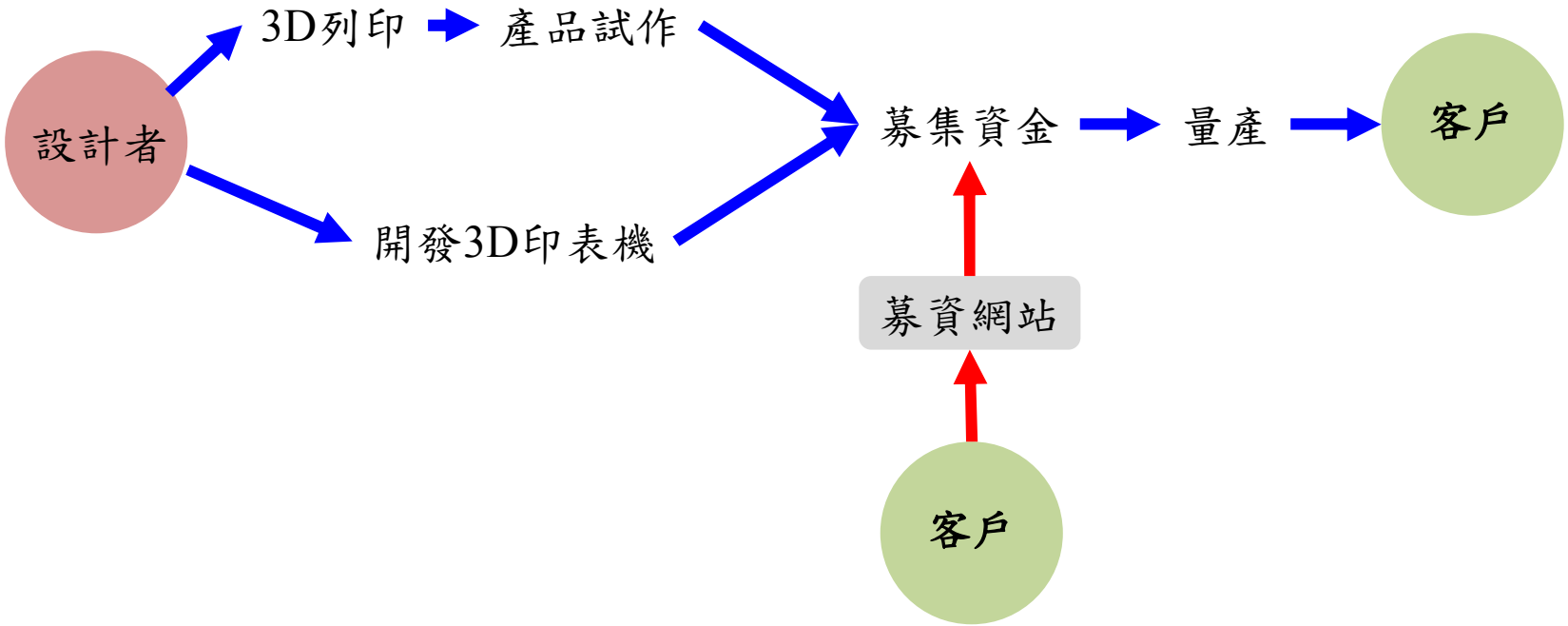
3D列印的商業模式1



3D列印的商業模式2



3D列印的商業模式3



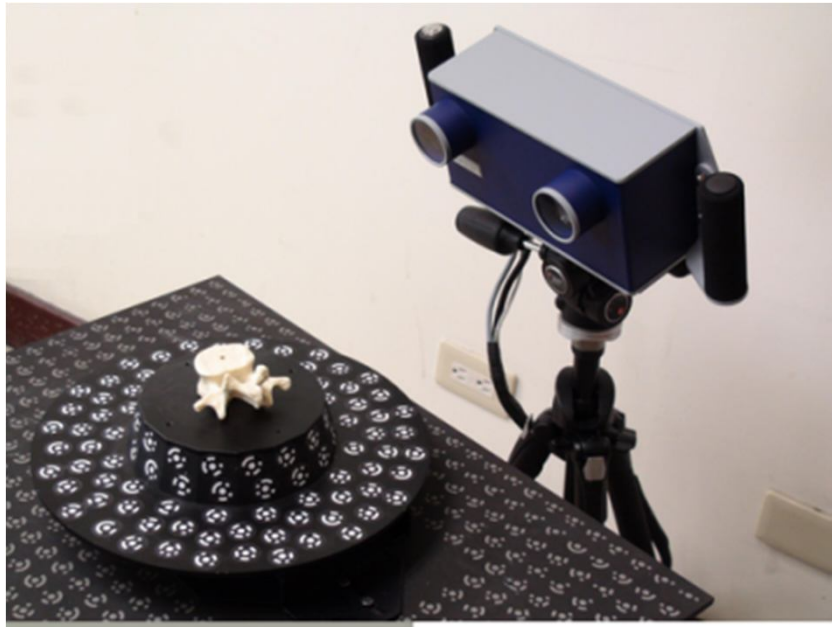
3D列印雲端服務網

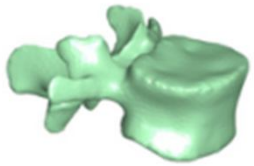
網址：https://ss.nchc.org.tw/3dp/index.php
關鍵字：3dp nchc

服務項目：

- 提供3D列印相關技術、訊息
- 3D掃描和代印服務
- 教育訓練服務
- 大型主機雲端建模服務
- 雷射燒結之微觀結構分析模擬
- 生醫材料與人工器官之力學模擬

3D掃描和代印服務

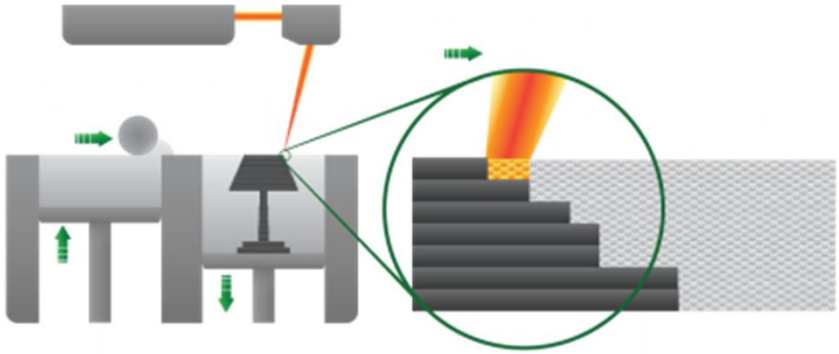




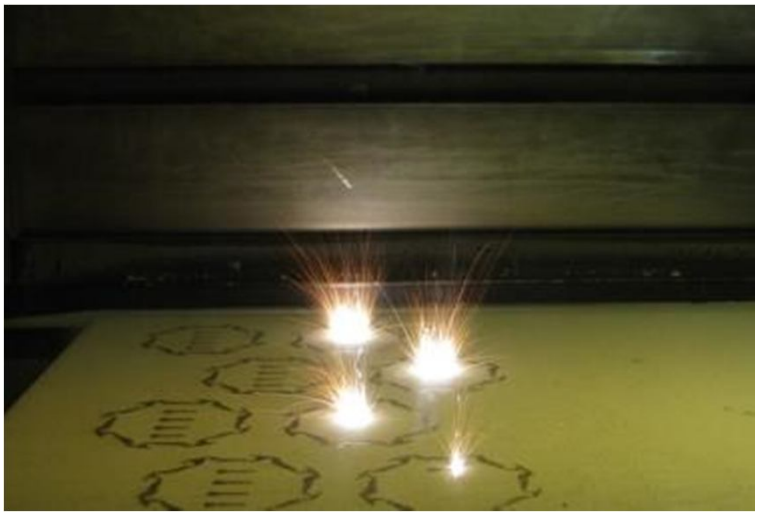
廠商 / 型號	3D Systems / CubeX Trio	PP3DP / UP plus 2
放置地點	新竹分部	台南分部
列印製程	FDM (熔融沈積，Fused Deposition Modeling)	
材料(目前供應)	PLA	ABS、PLA
噴頭數	3	1
最大列印尺寸 (w) x (l) x (h)	單噴頭275 x 265 x 240mm 三噴頭185 x 265 x 240mm	140 x 140 x 135mm
列印層厚	0.25mm(實際最小層厚)	最小0.15 mm 最大0.40 mm
公差設計	軸件應縮0.5-0.8mm 孔件應增0.5-1mm	軸件應縮0.1-0.2mm 孔件應增0.1-0.3mm
列印顏色	紅、藍、綠	ABS：白、黑、黃、紅、藍、綠 PLA：天藍、草綠、半透明

教育訓練服務

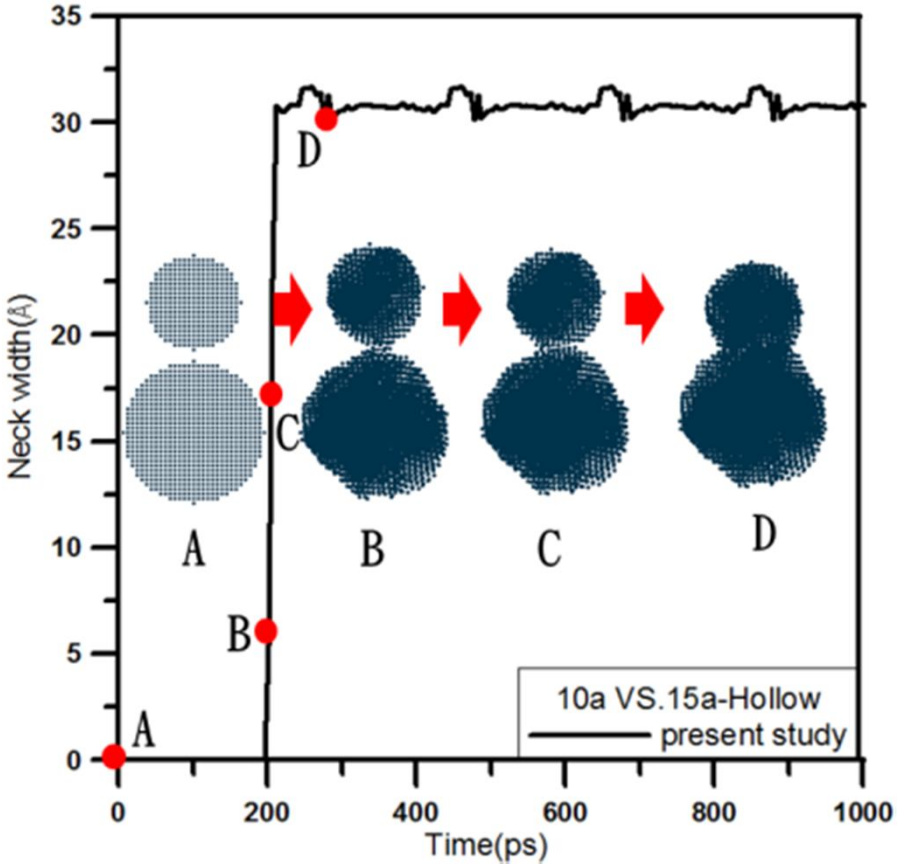
雷射燒結之微觀結構分析模擬



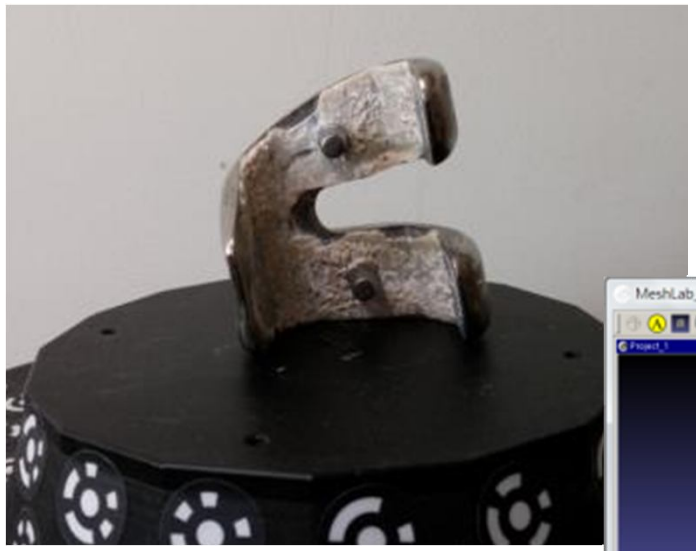
http://rapidprototypingservicescanada.com/selective-laser-sintering-sls.php



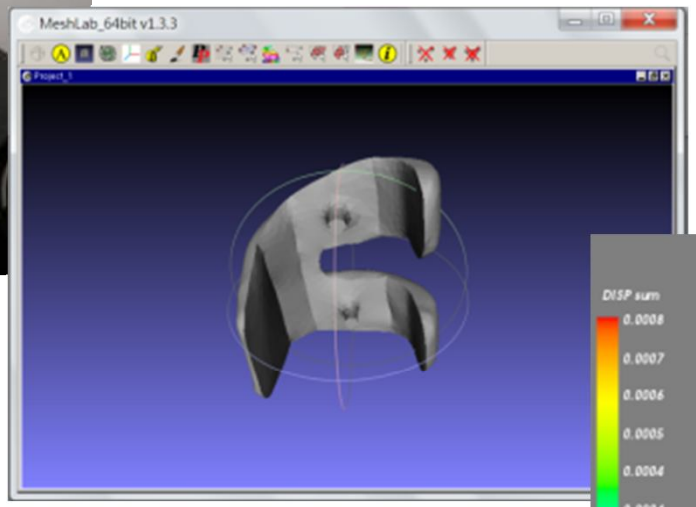
http://www.harbec.com/capabilities/rapid-prototyping/



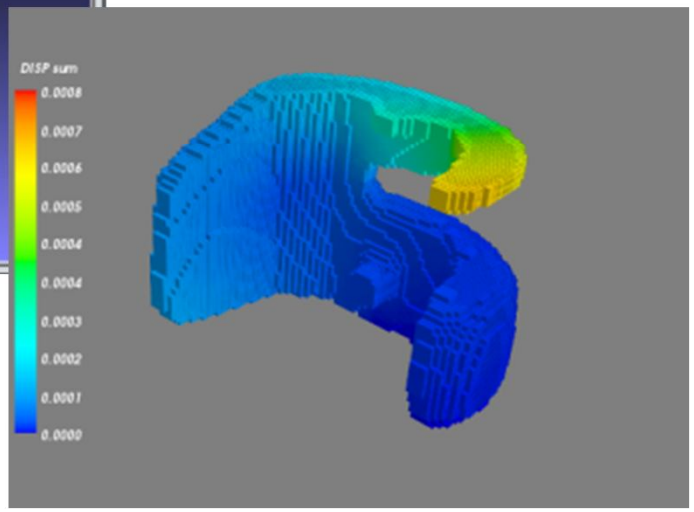
生醫材料與人工器官之力學模擬



實體掃描

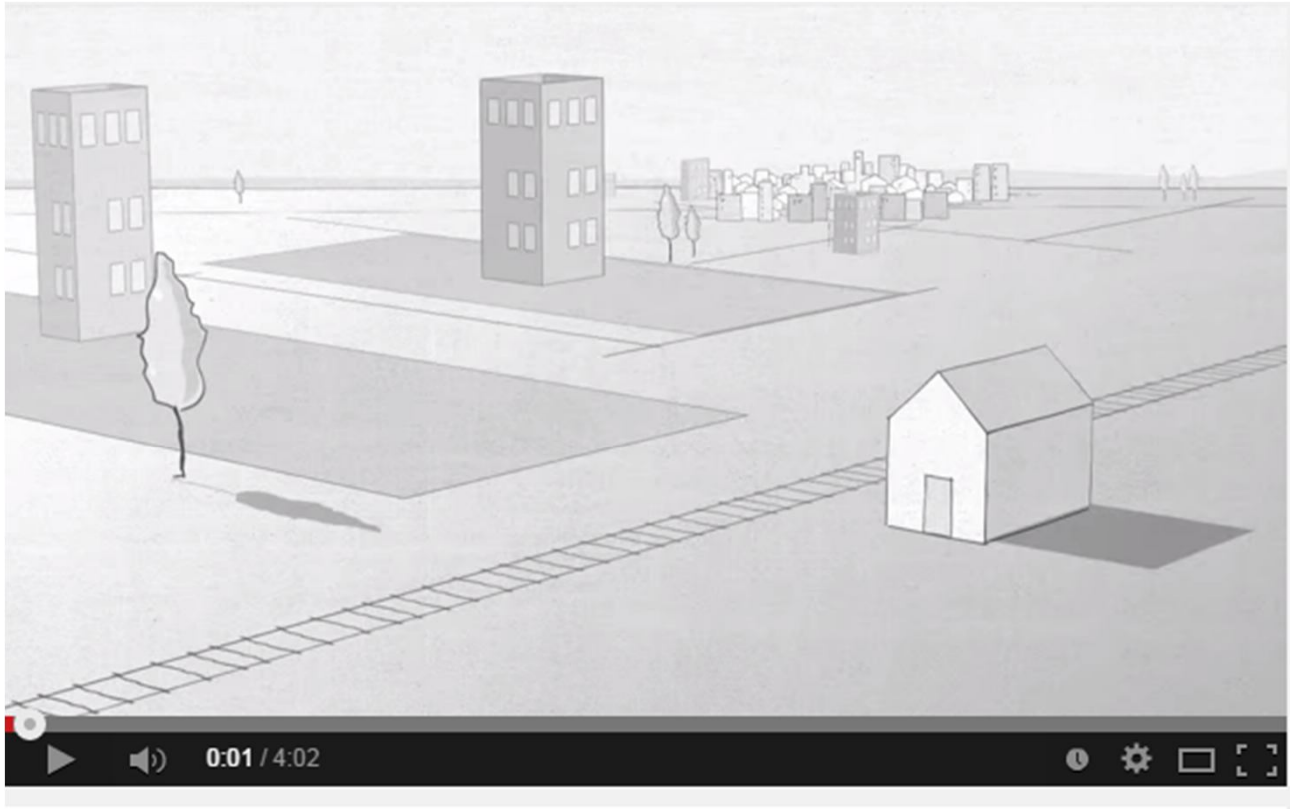


3D數位模型



力學模擬

3D列印的未來趨勢



Full Printed

http://youtu.be/NiOKDOnJ3VE

NARLabs

感謝聆聽

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