CUC2016
CARNet Users Conference

Digitalno proizvodnja

Digital fabrication

mr.sc. Roberto Vdović, dia
Morana Pap, dia

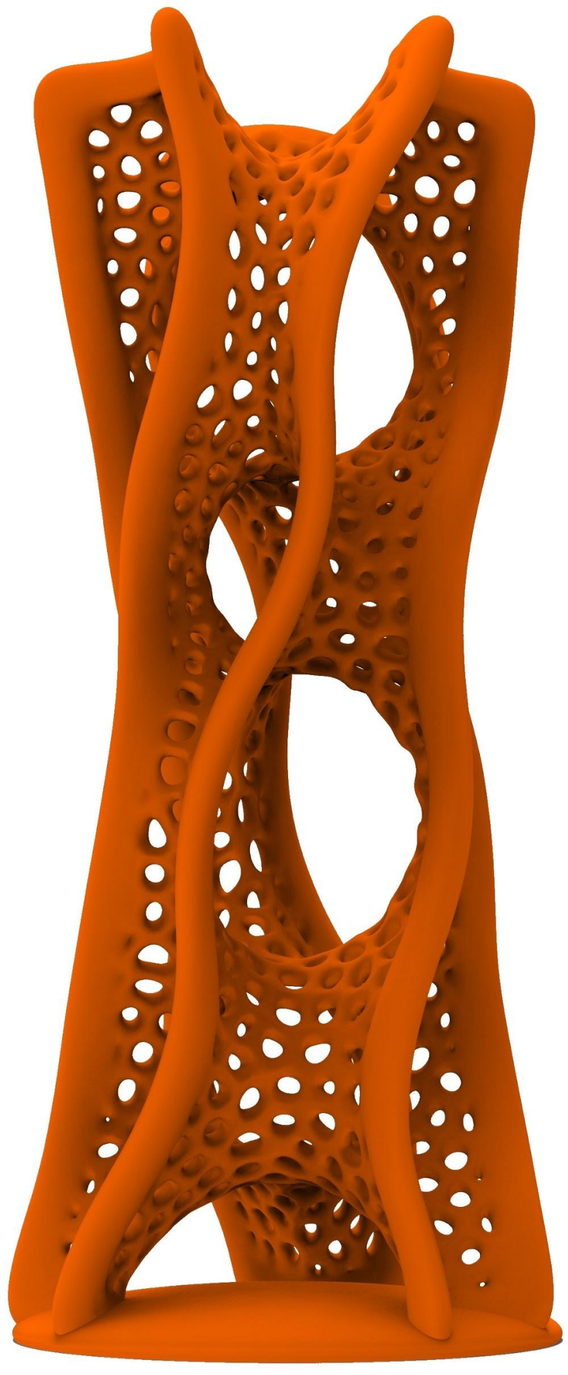
Rovinj, 10 / 11/ 2016

Af

FabLab
udruga za promicanje
digitalne fabrikacije

Digitalna proizvodnja

CUC2016
CARNet Users Conference



- Počeci digitalne proizvodnje
- Definicije i pojmovi
- Područja primjene
- Zašto sada?
- Postupak izrade
- Primjeri iz prakse
- Gdje smo i kamo idemo…

Af Sveučilište u Zagrebu
Arhitektonski fakultet

FabLab
udruga za promicanje
digitalne fabrikacije

Razvoj 3D ispisa

prvo glodalo spojeno na računalo CNC (M.I.T.)

prvi uređaj za 3D ispis (Chuck Hull)

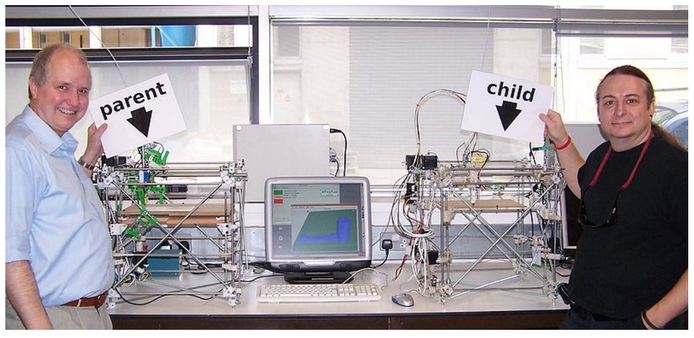
patentirana stereolitografija SLA, UV laser (Chuck Hull)

Laser sintering SLS metale (Carl Deckard)

prvi komercijalni uređaj (3D Systems)

RepRap projekt FDM > FFF (Adrian Bowyer)

prvog 3D ispisanog predmeta



RepRap projekt

2005. prof. Adrian Bowyer
RepRap projekt

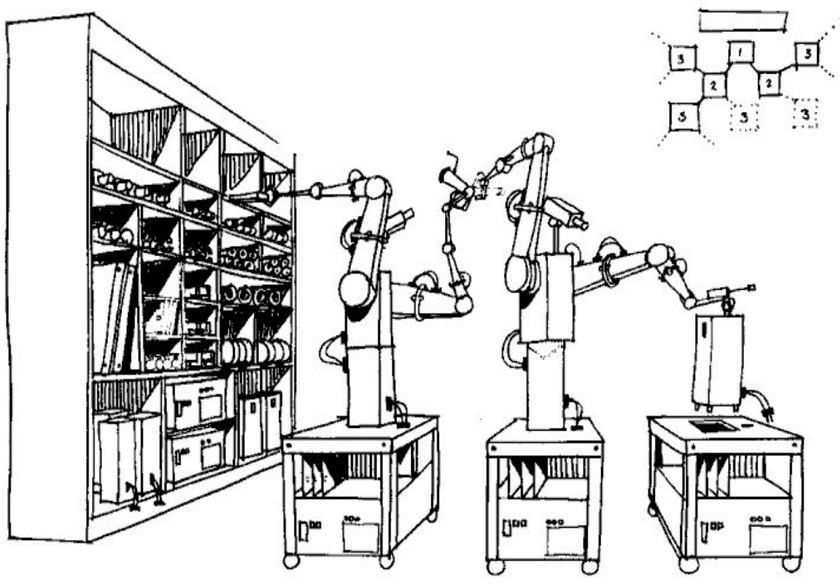
> Darwin, 2007. > Mendel, 2009. > Huxley, 2010. > Prusa Mendel, 2010. > ProMendel, 2011. > MendelMax, 2011.

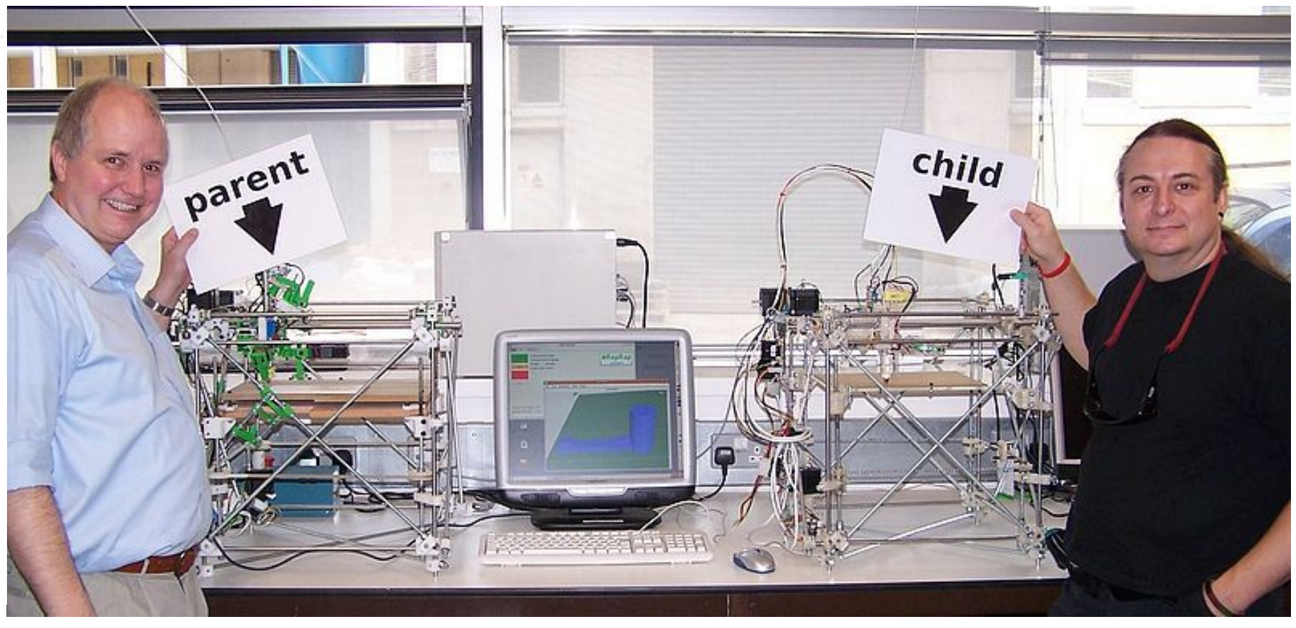
naziv po poznatim biolozima, jer ”poanta RepRapa je repliciranje i evolucija”

RepRap (kratica za Replicating Rapid Prototyper) varijantu (*Fused Filament Fabrication, FFF*) proizvodnje dodavanjem. Sa idejom otvorenog dizajna, sav dizajn proizvoda u projektu postavljen je pod licencom slobodnog softvera:

RepRap je o samoumnožavajući stroj, slobodno dostupan za dobrobit svima.

https://www.youtube.com/watch?v=-mHwRgiTeB4



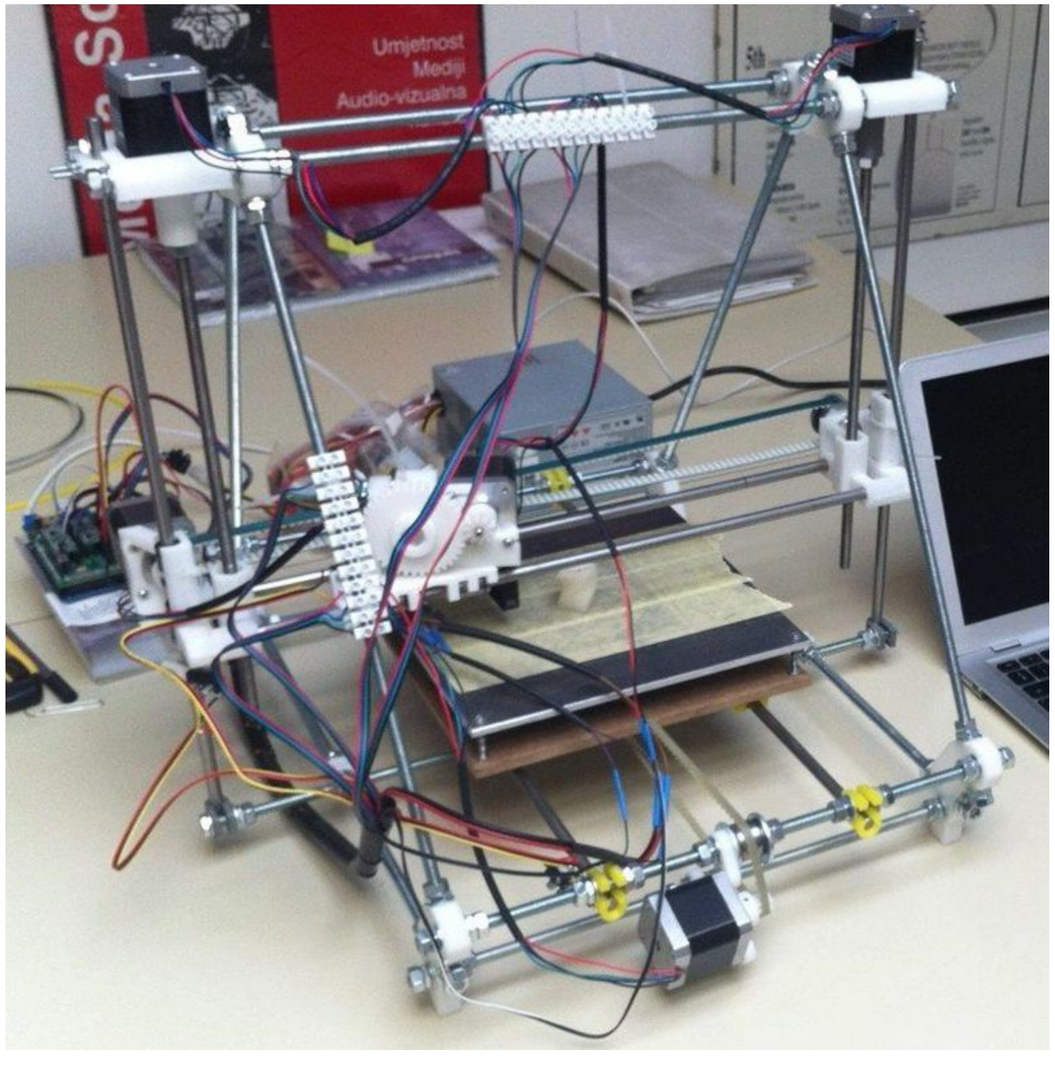


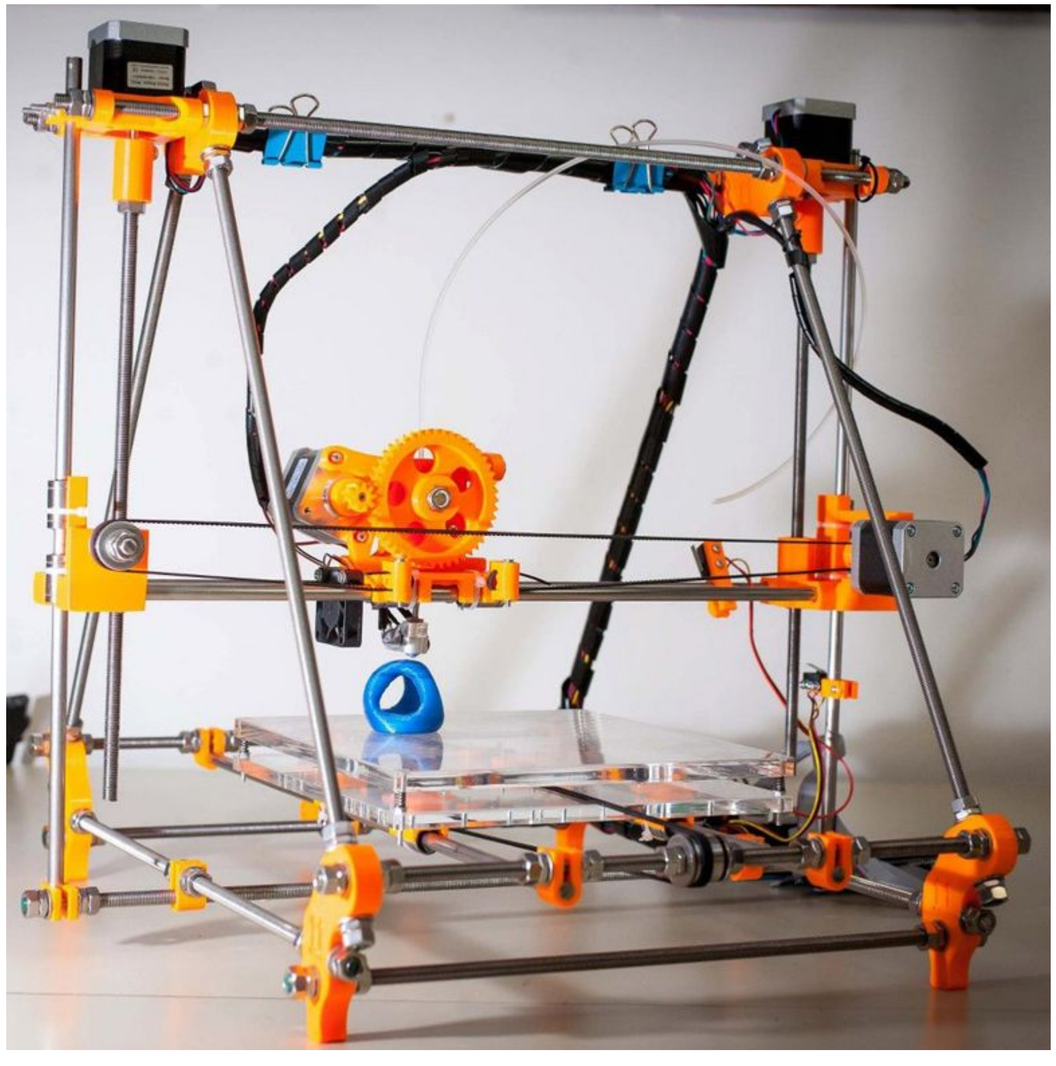
Adrian Bowyer @ PopTech 2007

https://www.youtube.com/watch?v=-mHwRgiTeB4

Digitalna proizvodnja

RepRap at Af - Prusa i2 2010/11.



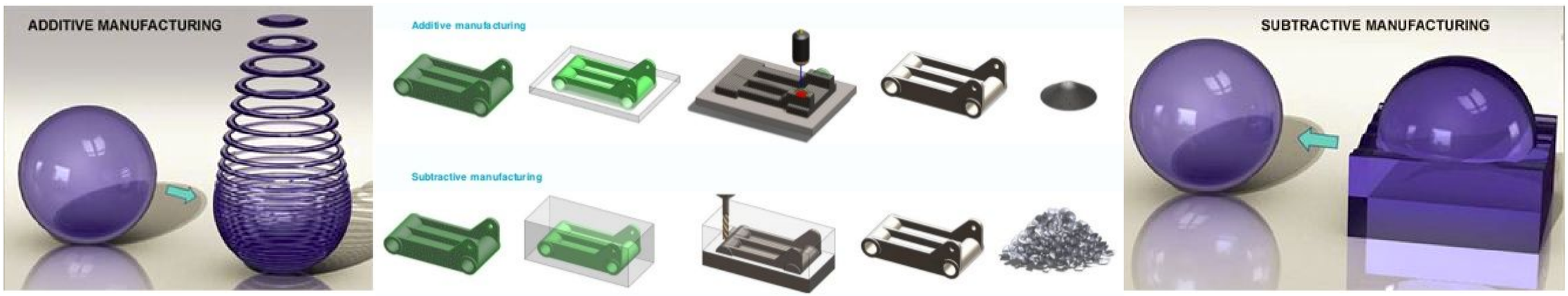


Terminologija

Digitalna proizvodnja | *Digital Fabrication*
Digital modeling and fabrication is a process that joins design with the Construction / Production through the use of 3D modeling software and ***additive and subtractive manufacturing processes****.*

Aditivne tehnologije | *Additive manufacturing*
3D printing (or additive manufacturing, AM) is any of various processes used to make a three-dimensional object. In 3D printing, additive processes are used, in which successive layers of material are laid down under computer control.

additive** vs. **subtractive



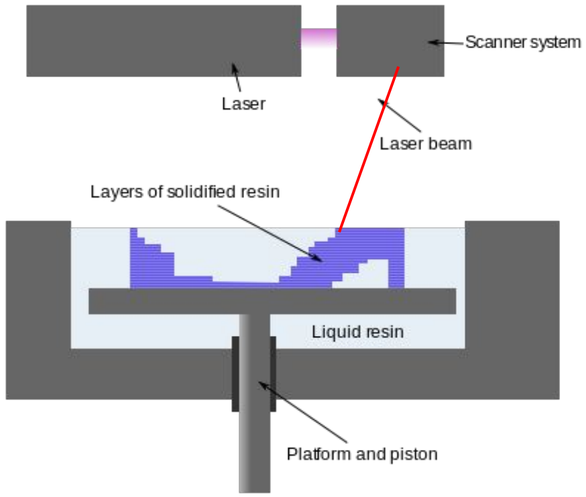
Aditivne tehnologije danas

Processes	Materials
Selective laser sintering (SLS)	Thermoplastics, metals & ceramic powd.
Direct metal laser sintering (DMLS)	Almost any alloy metal
Electron beam melting (EBM)	Titanium alloys
Powder bed and inkjet head 3d print	Plaster, Colored Plaster
Plaster-based 3D printing (PP)	Plaster, Colored Plaster
Fused deposition modeling (FDM)	Thermoplast.
Fused Filament Fabrication (FFF)	PLA, ABS
Melted and Extrusion Modeling (MEM)	Metal wire, plastic filament
Laminated object manufacturing (LOM)	Paper, foil, plastic film
Selective Heat Sintering (SHS)	Thermoplastic powder
Stereolithography (SLA)	Photopolymer
Digital Light Processing (DLP)	Liquid resin

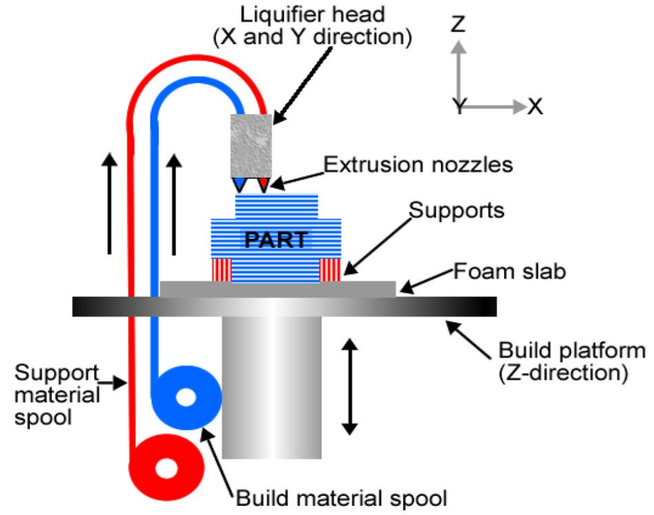
Digitalna proizvodnja

Aditivne tehnologije proizvodnje

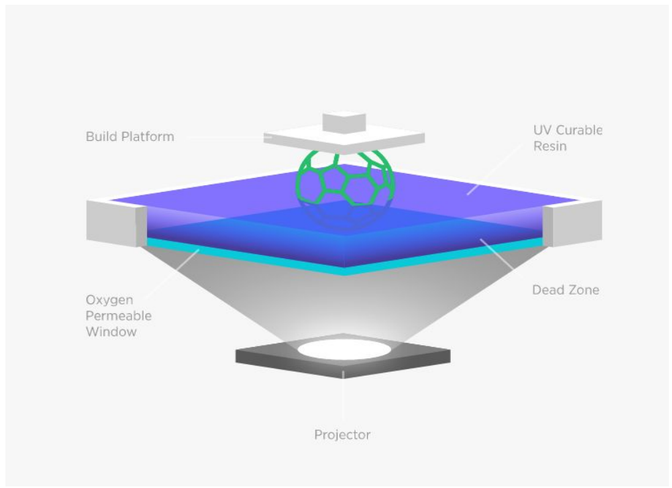
SLA



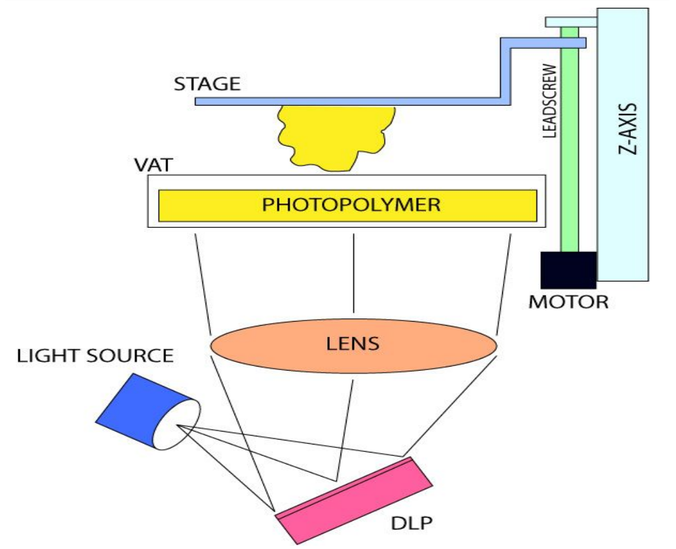
FDM / FFF



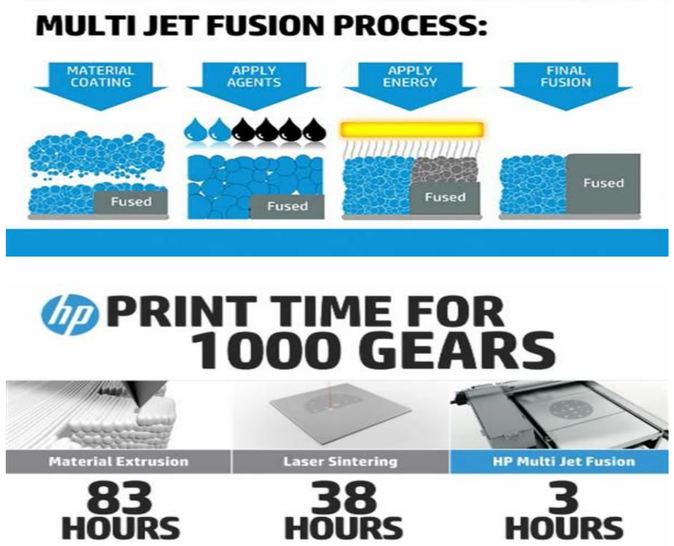
CLIP

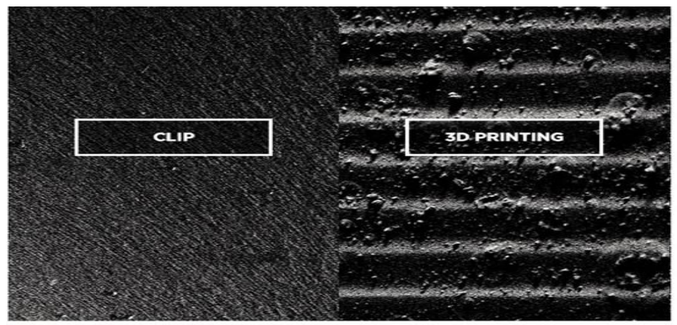


DLP

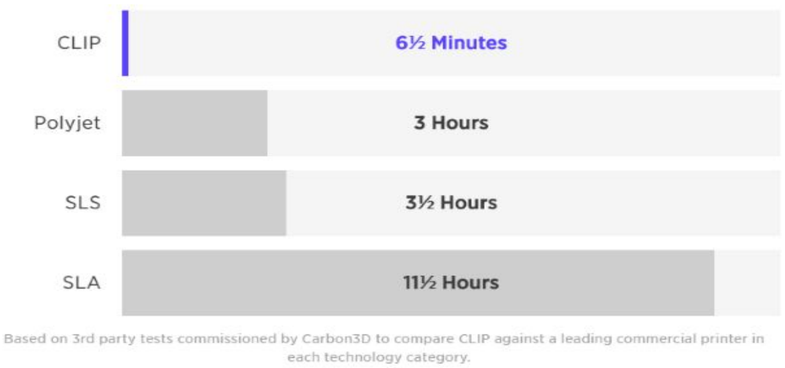


MULTI JET





* Photos from electron microscope at 130x. ⟵ 100µ ⟶



Based on 3rd party tests commissioned by Carbon3D to compare CLIP against a leading commercial printer in each technology category.

Af Sveučilište u Zagrebu
Arhitektonski fakultet

FabLab
udruga za promicanje
digitalne fabrikacije

Materijali za stolne FDM 3D printere

Materijali / Filamenti

PLA (polylactide / polylactic acid) is a biodegradable thermoplastic aliphatic polyester derived from renewable resources, such as corn starch, tapioca roots, chips or starch, or sugarcane. In 2010, PLA had the second highest consumption volume of any bioplastic of the world. Melted at 180-220C

ABS (Acrylonitrile Butadiene Styrene), thermoplastic polymer, produce fumes of poisonous acrylonitrile which is irritating, ABS should not be used in medical implants. Melted at 230-250C.

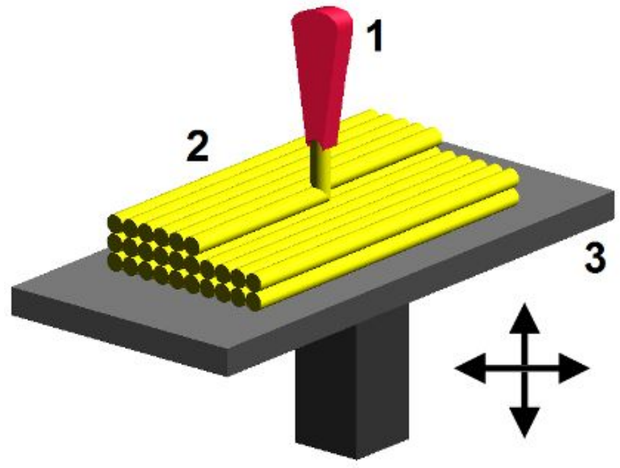
Nylon
HIPS - High Impact Polystyrene
PVA - Polyvinylalkohol, water-soluble for support
Porolay - porose material
Moldlay - permanent casting and investment casting

LayWoo - PLA + wooden dust
LayBrick - PLA + clay dust
FlexPLA - PLA + silicon/rubber
CarbonFil

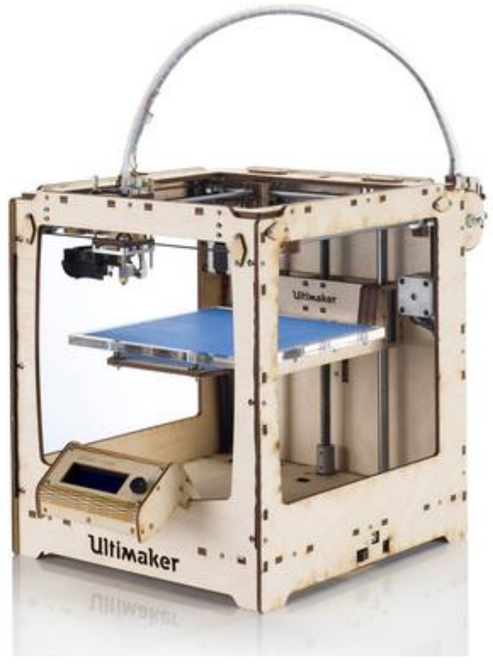
CooperFil **BronzeFil**

FDM postupak kod stolnih 3D printera

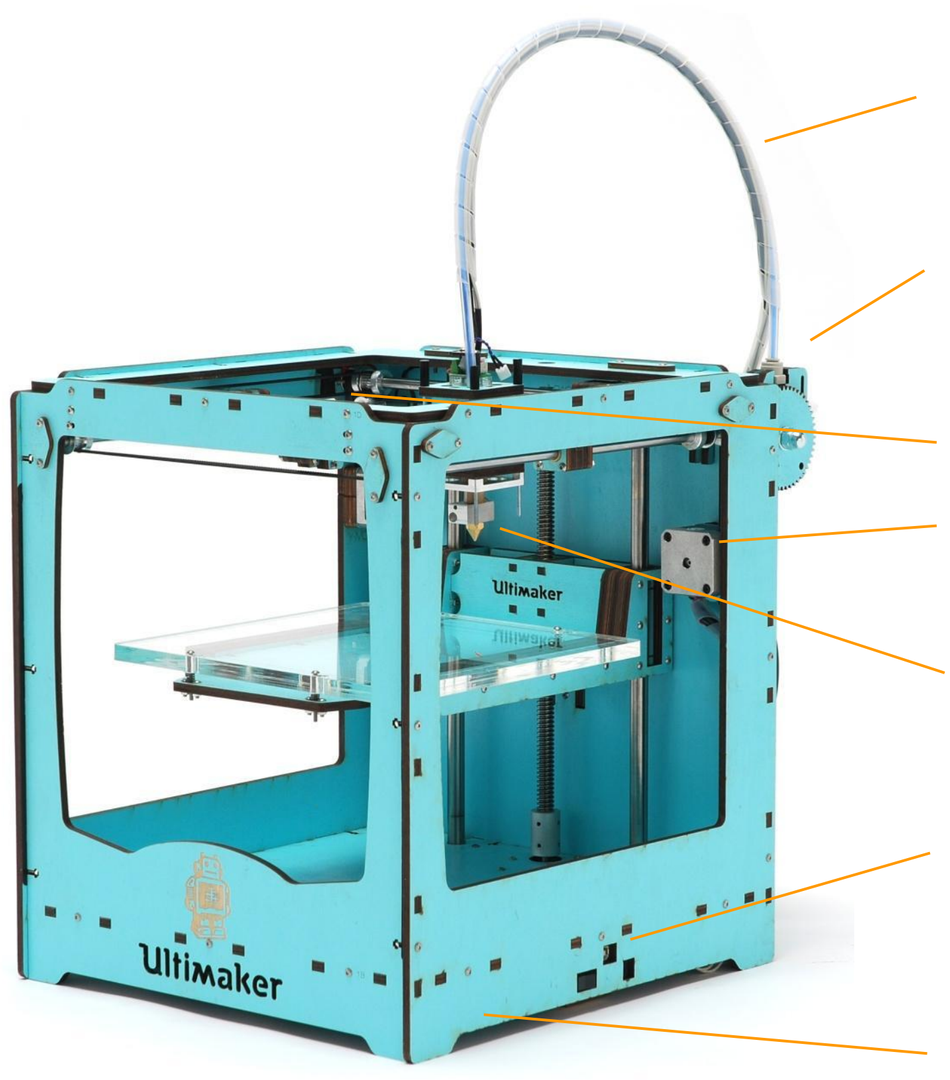
Polaganje rastopljenog materijala
- FDM (fused deposition modeling)
- FFF (fused filament fabrication)



> RepRap & Delta
> MakerBot (USA)
> Ultimaker (EU)



Opis FDM 3D printera



- **Boweden tube**, transfer filament from extruder to head
- **filament feeder**, 3mm ili 1.75mm

- **endstops**
- **stepper motors** for X, Y and Z move

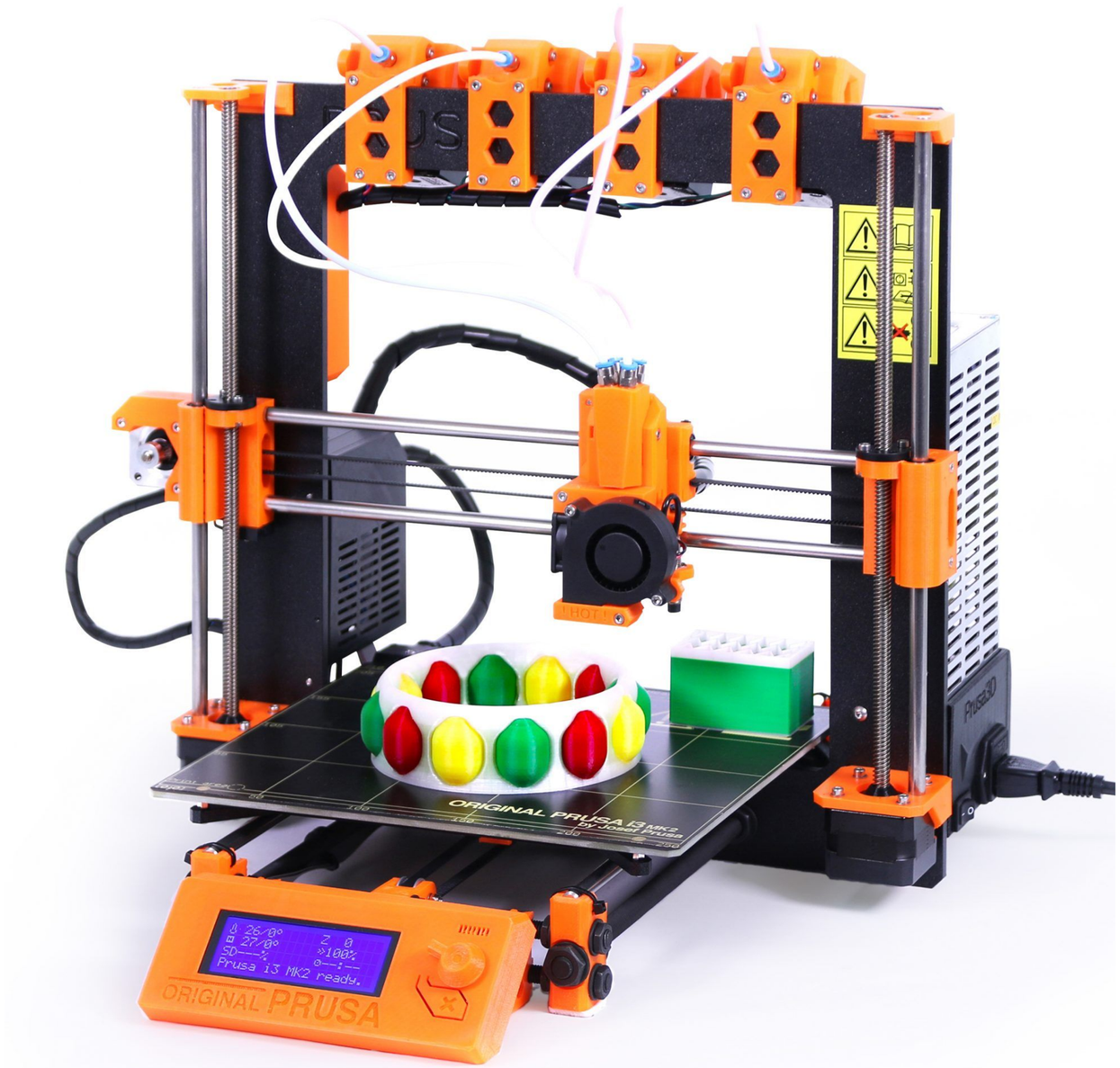
- **hotend**, melt filament (185-230+) and push to 0.3-0.5mm nozzle
- **electronics** Arduino or RaspberryPi

- **case** and construction

Digitalna proizvodnja

Delta

Prusa MK2



Proces 3D ispisa - 3D model u računalu (1)

1a. **3D modeliranje**

- komercijalni
- open source i besplatni
- u “oblaku”

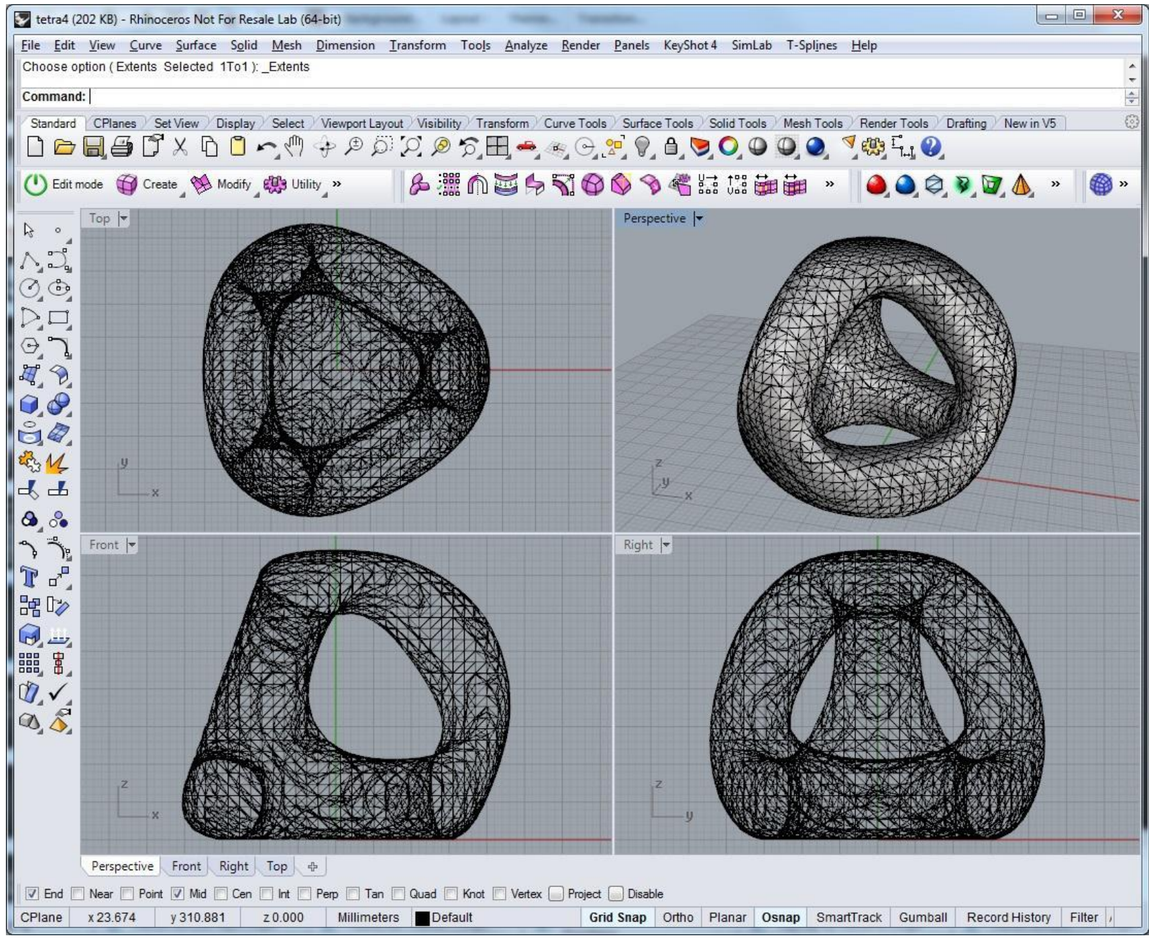
1b. **3D skeniranje**

- structural light
- sensors (IR, laser, …)
- photomodeling

1c. **Preuzimanje sa Interneta**

- Thingiverse
- Youmagine

...



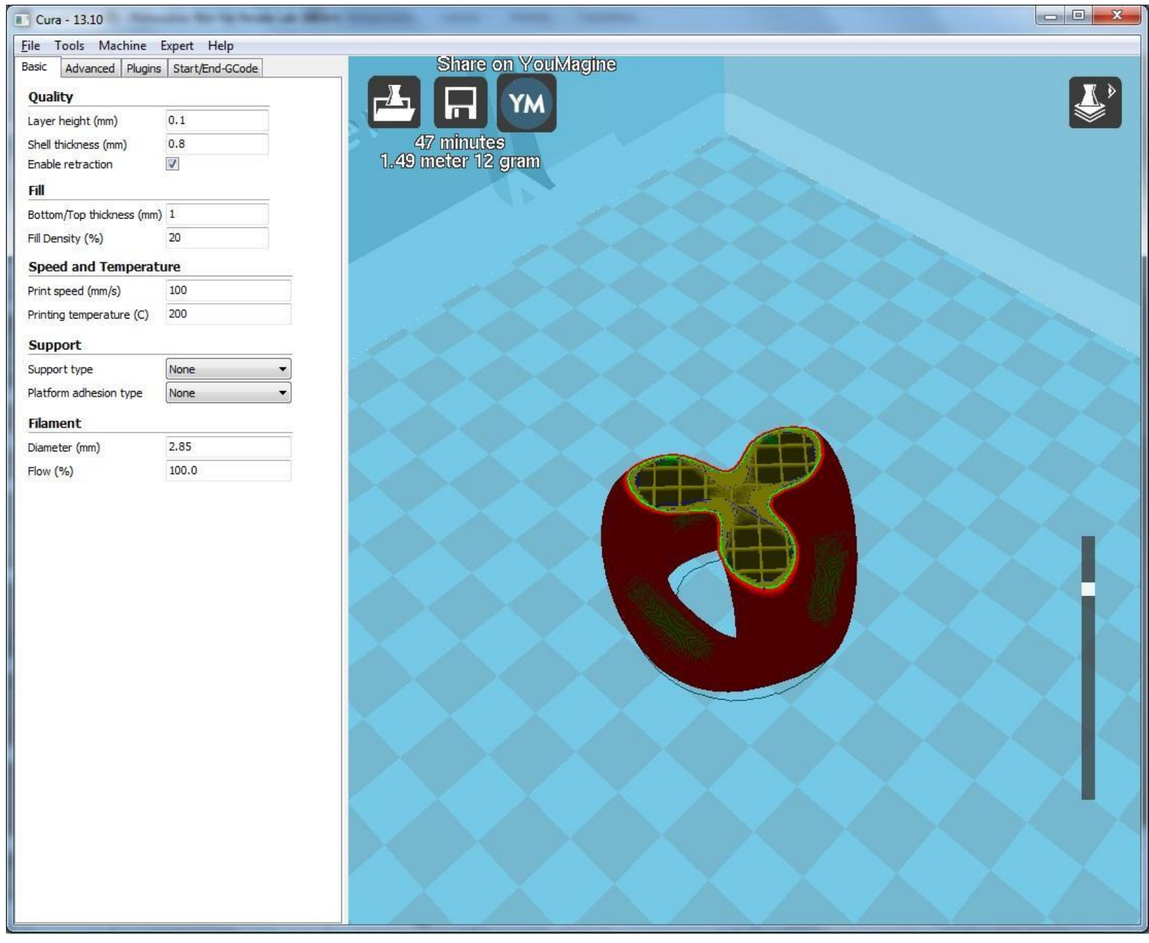
2. Pohrana u STL formatu

Proces 3D ispisa - priprema za 3D printer (2)

3. Podrška za slicing kontrolu printera

- open source (Cura, Pronterface, ...)
- komercijalni (NetFab, ...)

- prilagodba ispisa
  - preciznost
  - brzina
  - temperatura
  - količina ispuna
  - debljina ljuska
  - support!
  - ...

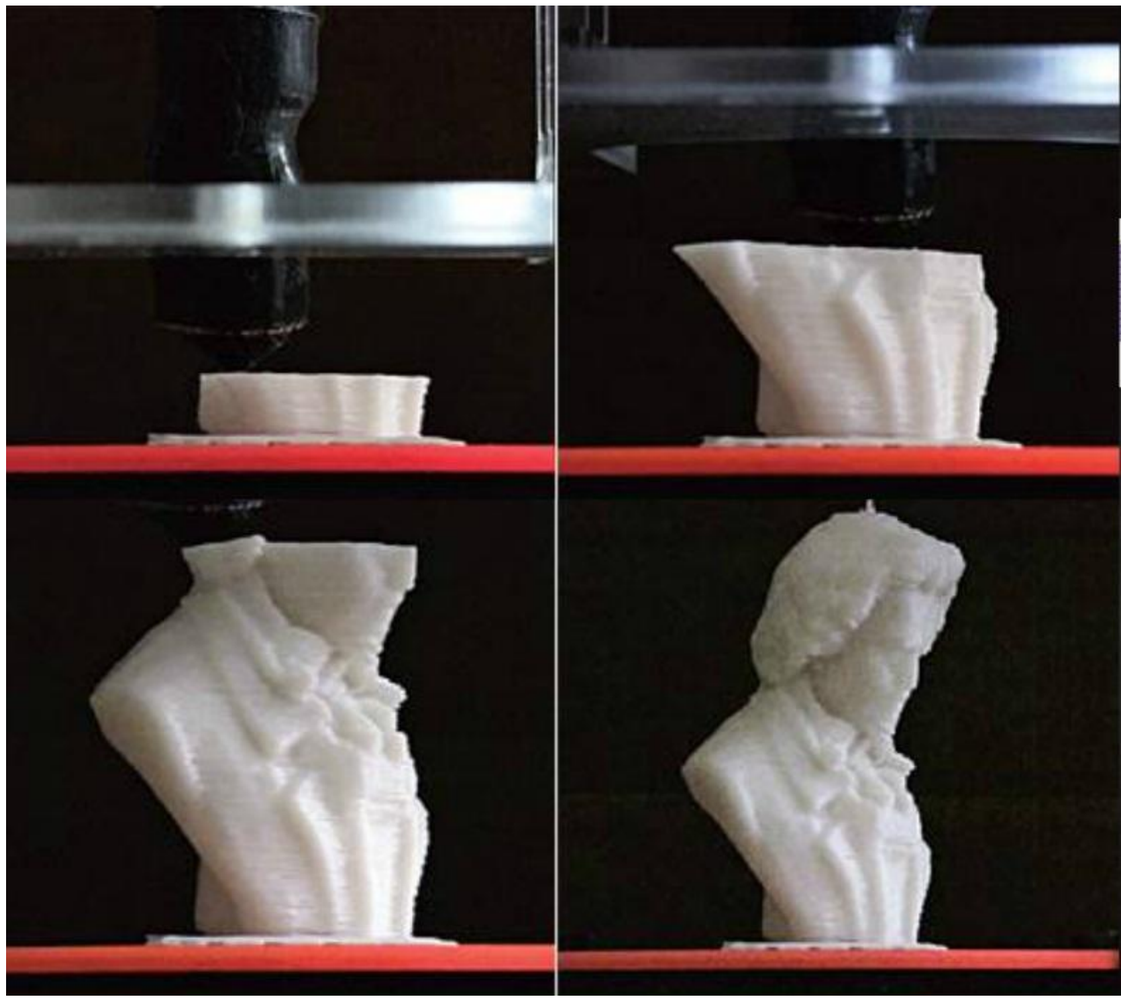


4. Pohrana u gcode formatu

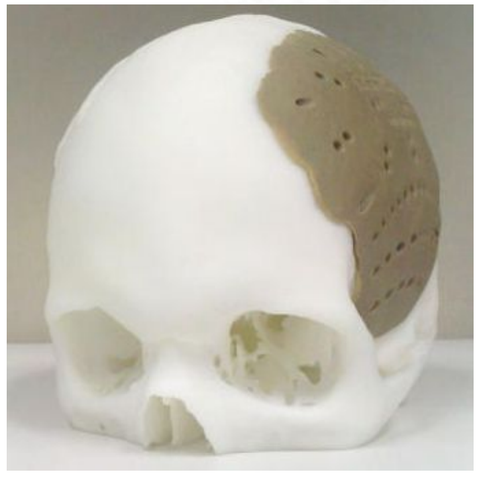
Proces 3D ispisa - 3D ispis na uređaju (3)

5. gcode podaci

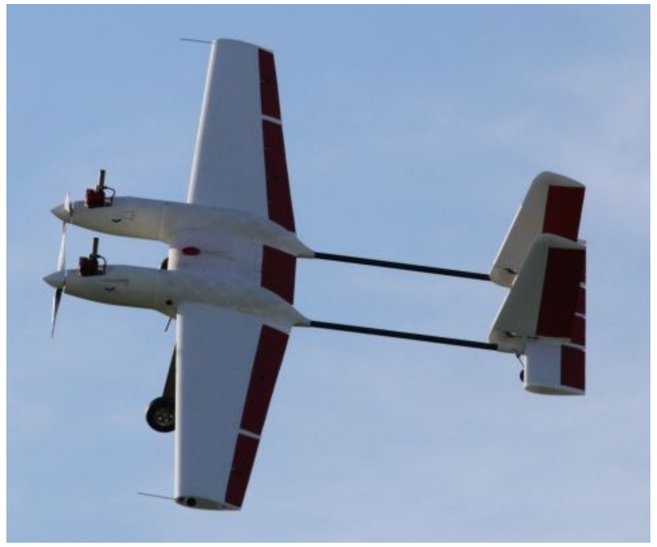
- control code uređaja
- putanje i opis 3D modela

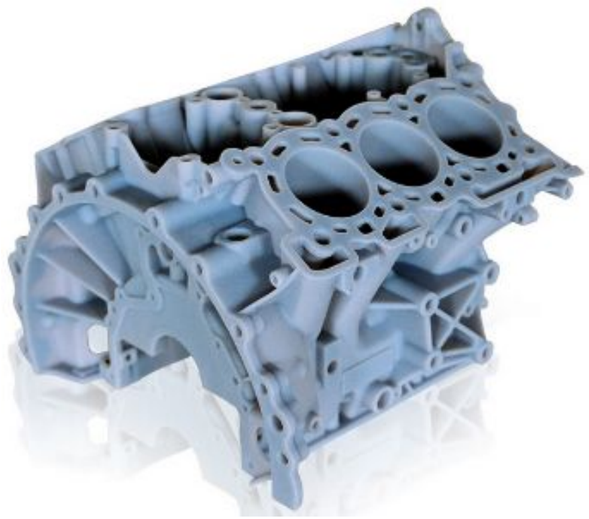


Primjena 3D ispisa



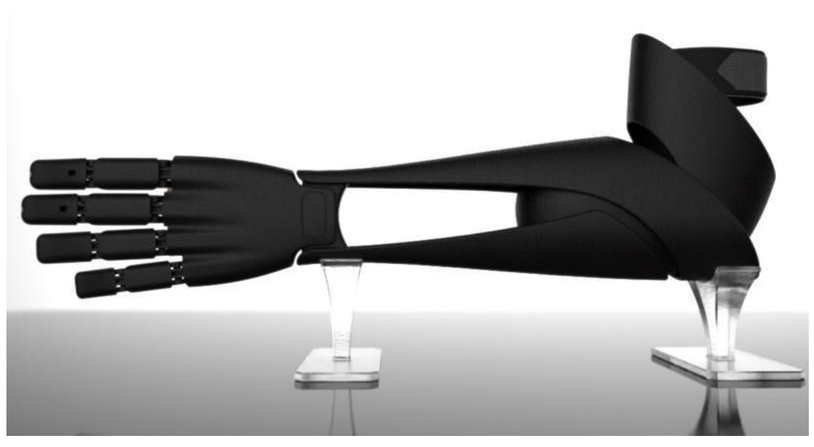
Primjena u automobilskoj i avio industriji





Digitalna proizvodnja

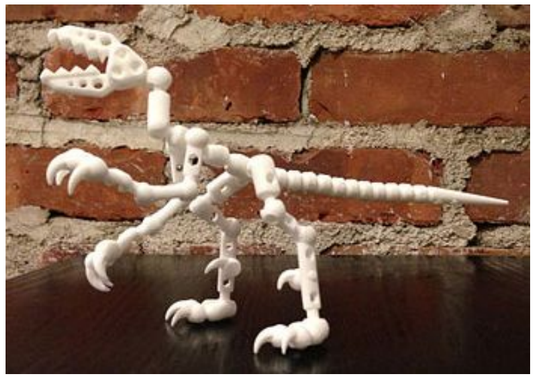
Primjena u medicini

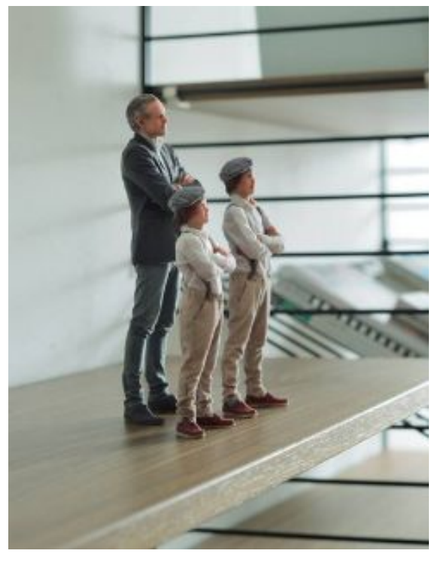


Af Sveučilište u Zagrebu
Arhitektonski fakultet

FabLab
udruga za promicanje
digitalne fabrikacije

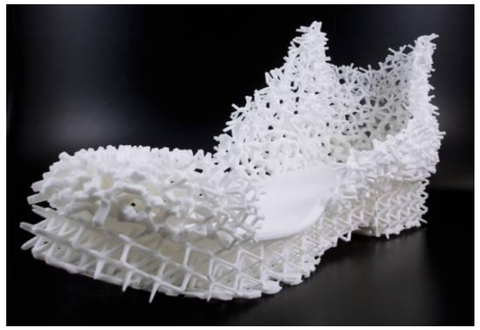
Primjena u industriji igračaka i zabave





Primjena u izradi nakita

Primjena u industriji mode



Digitalna proizvodnja

Ukusni kolačići iz 3D printera

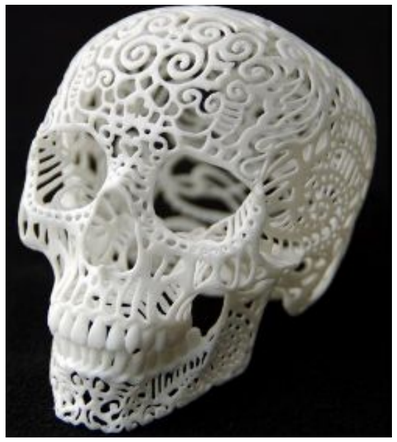
Sveučilište u Zagrebu
Arhitektonski fakultet

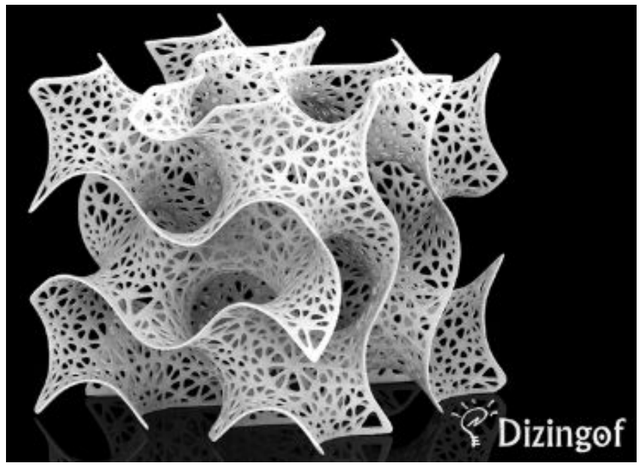
FabLab
udruga za promicanje
digitalne fabrikacije

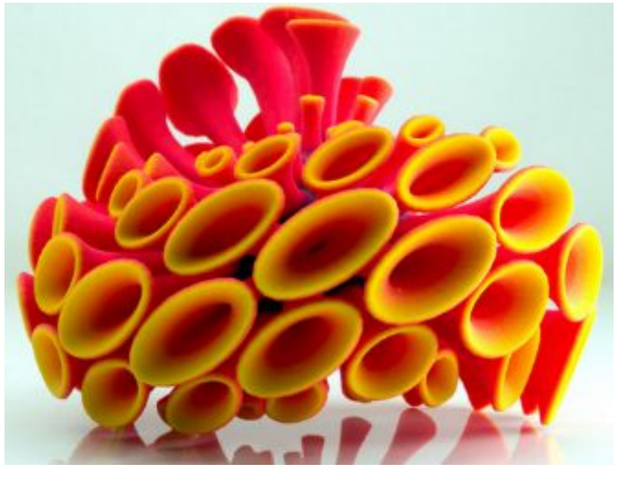
Primjena u prehrambenoj industriji

Digitalna proizvodnja

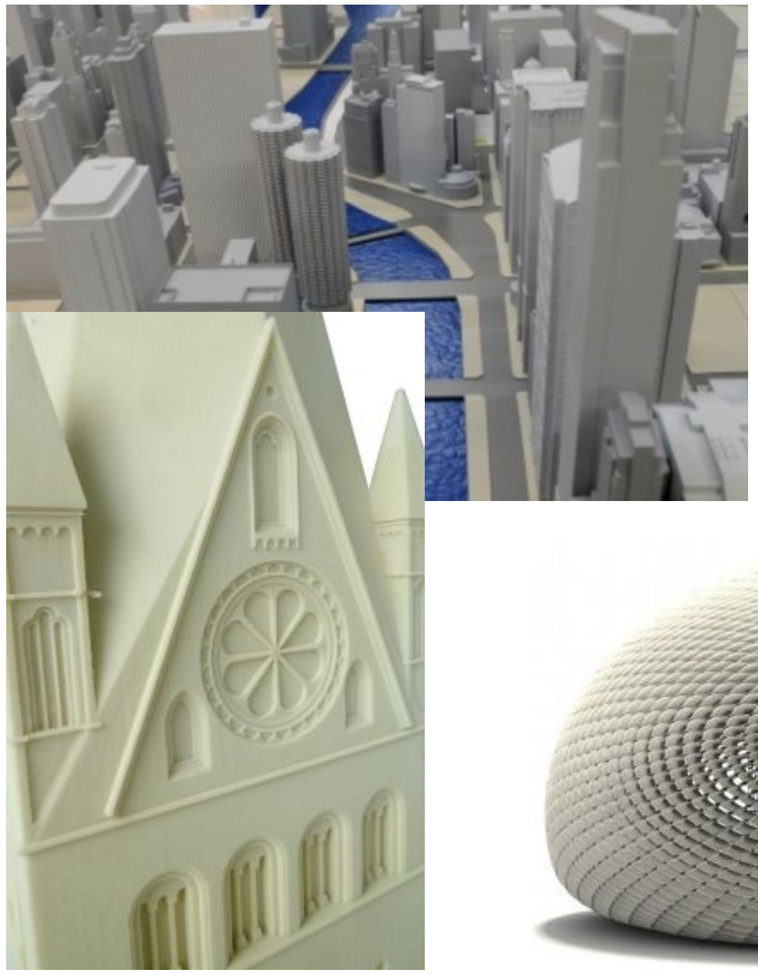
Primjena u umjetnosti i dizajnu

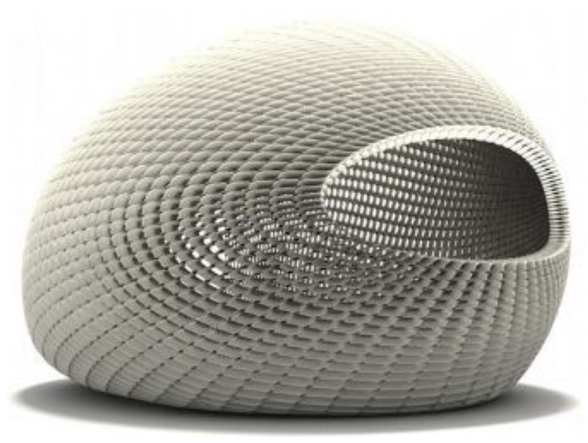






Primjena u arhitekturi i graditeljstvu





Digitalna proizvodnja

Ispis većeg formata

Af Sveučilište u Zagrebu Arhitektonski fakultet

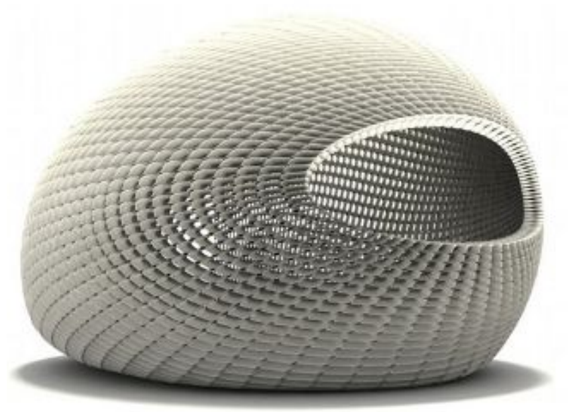
FabLab udruga za promicanje digitalne fabrikacije

Primjena u izradi novih konstrukcija

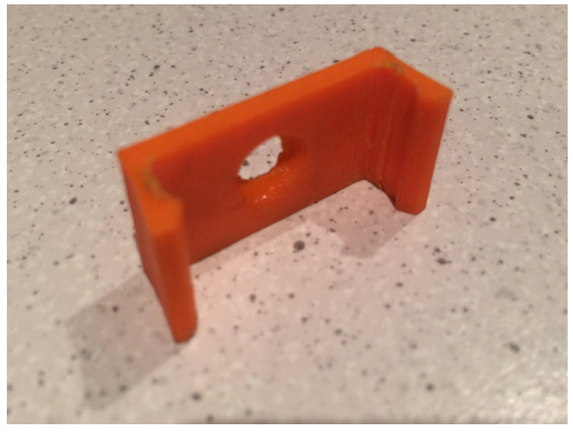
Projekti lokalne zajednice i suradnje

Pomoć pri realizaciji zanimljivih projekata:

- **Project EGG > projectegg.org**
  - jedan od najvećih objekata ispisan u 3D pomoću stolnih printera, 3x4x5m
  - ukupno 4760 različitih opeka koje 3D zajednica printa diljem cijelog svijeta
  - prvu opeku iz 3D zajednice isprintala Manufaktura28, Samobor



- **eNable The Future**
  - izrada proteza
- **FabLab@School**
  - korištenje u školama
- **FabLab@Road**
  - mobilni FabLab

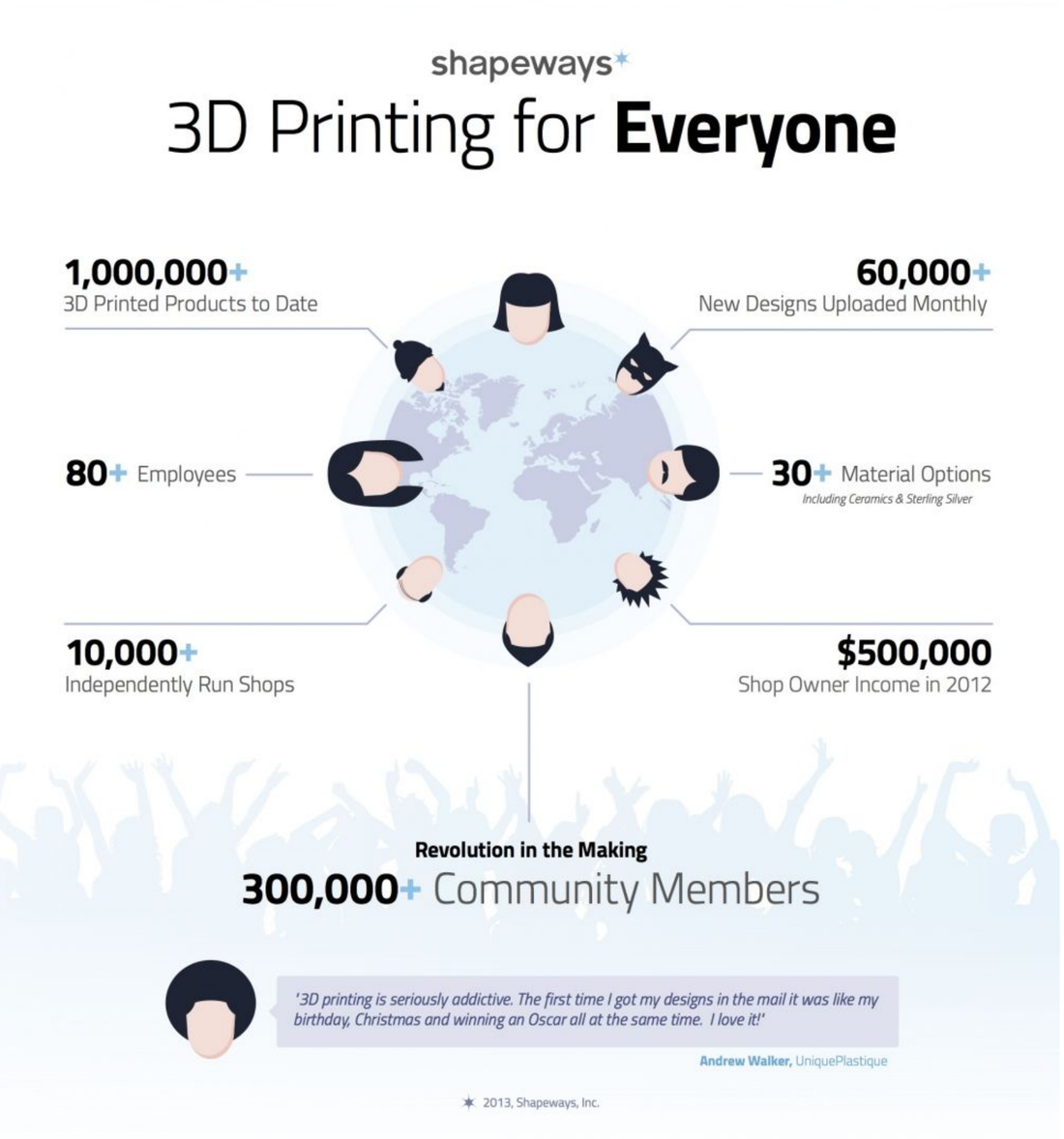


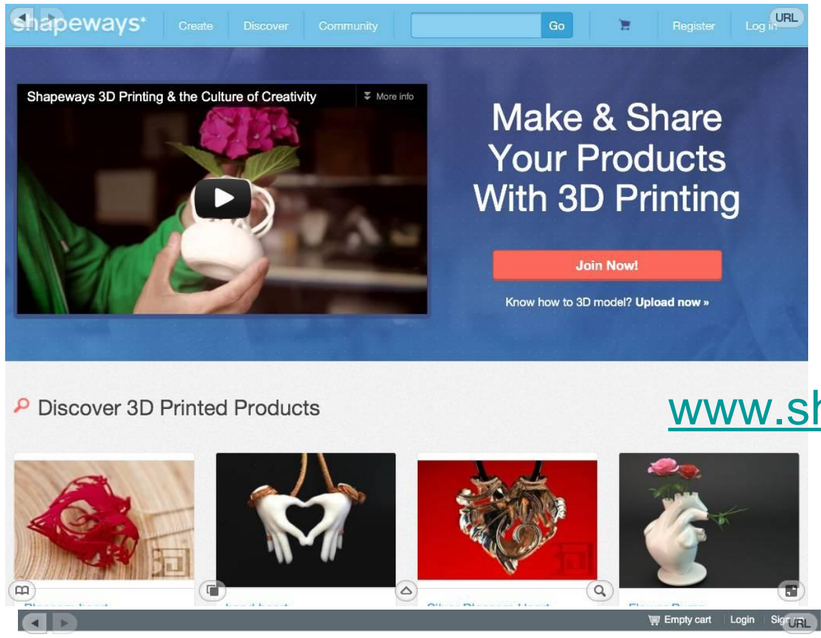
Digitalna proizvodnja

Iz crteža u predmet

Digitalna proizvodnja

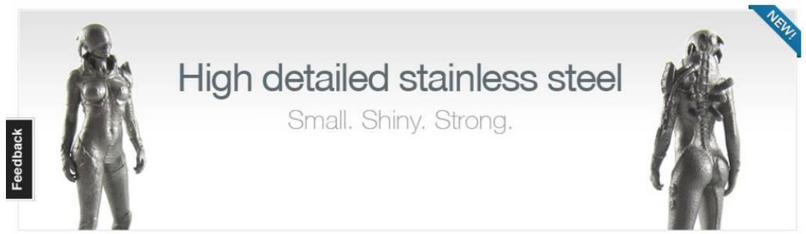
Digitalne tvornice



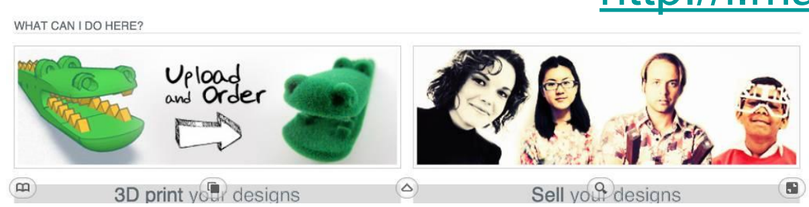


www.shapeways.com
NL > USA

www.sculteo.com
FR



http://i.materialise.com/
BE

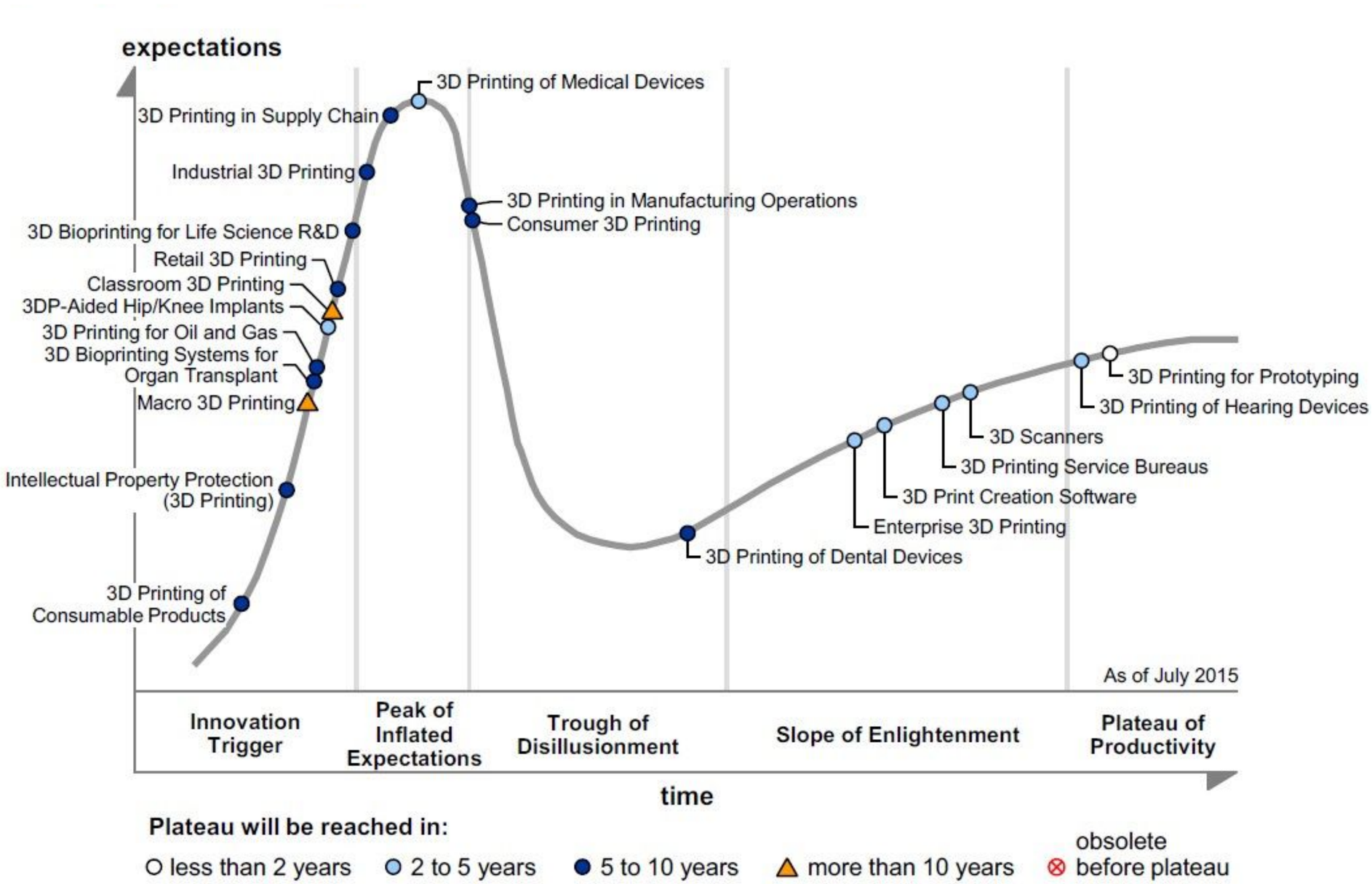


Af Sveučilište u Zagrebu
Arhitektonski fakultet

FabLab
udruga za promicanje
digitalne fabrikacije

Digitalna proizvodnja

3D printing Hype Cycle, Gartner, 2015



Source: Gartner (July 2015)

Na pragu nove industrijske revolucije

Prva industrijska revolucija (1750-1850)
-mehanizacijom
-parni stroj
-čeličane

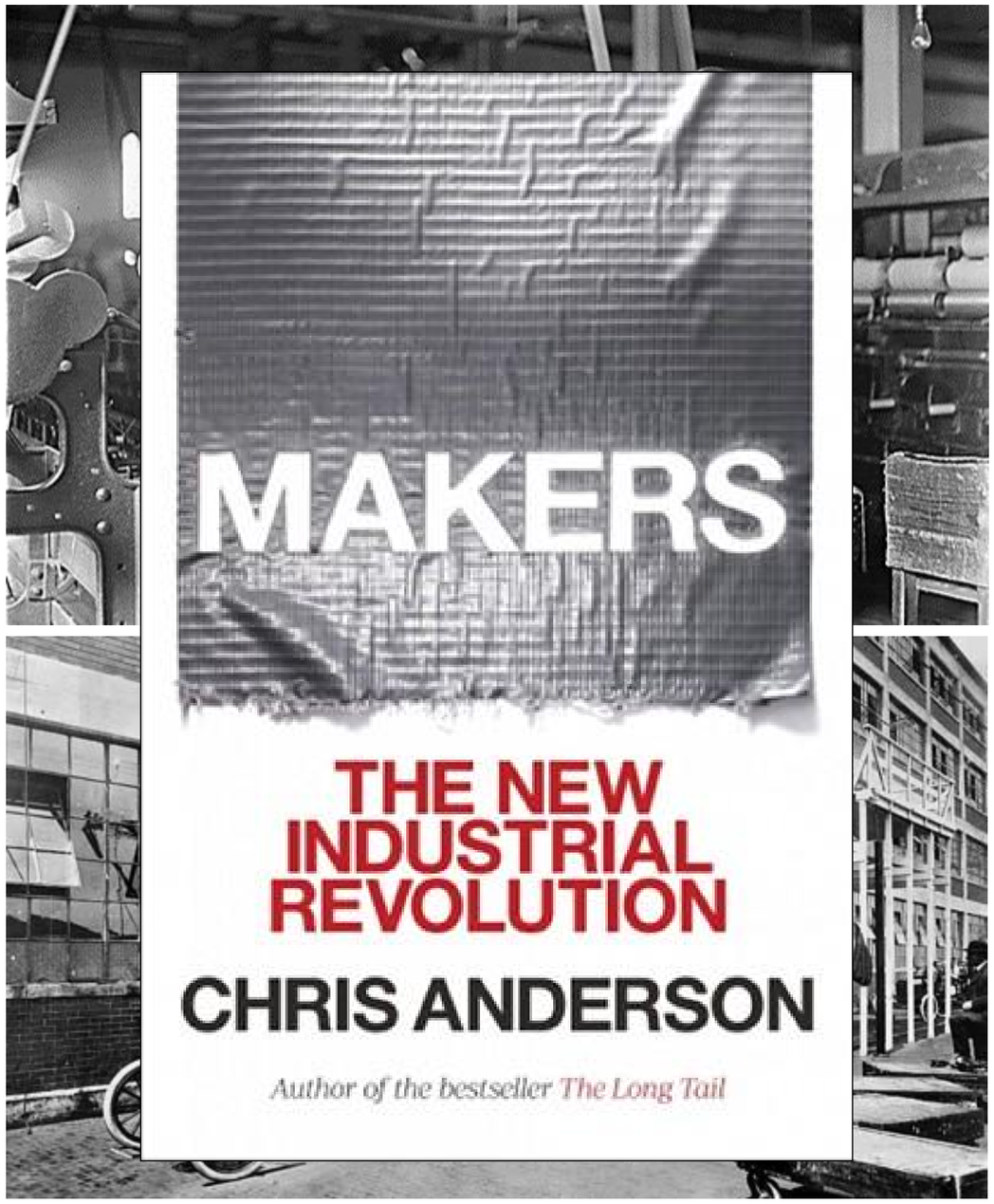
Tvornica je rođena!

Druga industrijska revolucija (1870-1950)
-pokretne proizvodne linije
-Henry Ford, početak 20. st.

Početak masovne proizvodnje!

Prve dvije industrijske revolucije učinile su ljude bogatijima i više urbanima.

Nova (4.) industrijska revolucija je u tijeku. **Proizvodnja postaje digitalna**, a to bi moglo promijeniti ne samo posao, već imati i šire posljedice na suvremeno društvo.



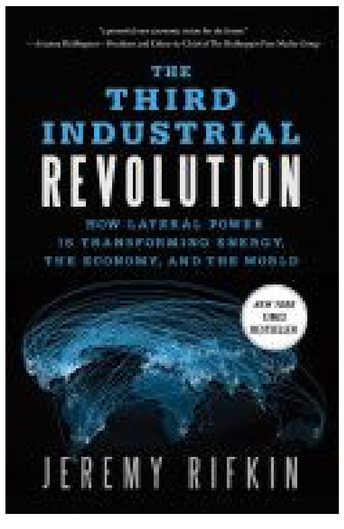
Digitalna proizvodnja

Tko posjeduje budućnost

Makerbot founder, Bre Pettis >

Ping Fu, http://news.bbc.co.uk/2/hi/programmes/hardtalk/9788066.stm

*… She founded the company Geomagic which is revolutionising the manufacturing process in the digital age using 3D printing. She says the technology "**is as big as steam engines... as big as the Internet**".*



Jeremy Rifkins, http://thethirdindustrialrevolution.com/

"...While the Third Industrial Revolution (TIR) economy allows millions of people to produce their own virtual information and energy, a new digital manufacturing revolution now opens up the possibility of following suit in the production of durable goods. In the new era, everyone can potentially be their own manufacturer as well as their own internet site and power company. The process is called 3D printing."

Af Sveučilište u Zagrebu Arhitektonski fakultet

FabLab udruga za promicanje digitalne fabrikacije

Digitalna proizvodnja

CUC2016
CARNet Users Conference

Pitanja i odgovori

Roberto Vdović
roberto.vdovic@fablab.hr

Morana Pap
morana.pap@fablab.hr

FabLab.HR
info@fablab.hr

Af Sveučilište u Zagrebu Arhitektonski fakultet

FabLab
udruga za promicanje digitalne fabrikacije

Digitalna proizvodnja

Sveučilište u Zagrebu
Arhitektonski fakultet
University of Zagreb
Faculty of Architecture

Kačićeva 26, pp 9, 10000 Zagreb
Hrvatska | Croatia
Tel. centrala: +385 (0) 1 4639 222
Fax: +385 (0) 1 4828 079

4. otvoreni dani 3D ispisa 2016

4th 3D Printing Open Days 2016

Organizator: Arhitektonski fakultet Sveučilišta u Zagrebu i udruga FabLab

Organizer: *Faculty of Architecture University of Zagreb & FabLab Croatia*

Tema 2016: **(R)Evolucija učenja**

Topic 2016: ***Education (R)Evolution***

Datum održavanj

Dates

Mjesto o

Venue: *...rsity of Zagreb, Kačićeva 26, Zagreb*

... Aula / ground floor

18. i 19. studeni 2016.
Arhitektonski fakultet
Sveučilišta u Zagrebu

Sadržaj: Projekti osnovne i srednje škole, inovatori, poduzetnici, FabLab članovi

Content: *Elementary and Secondary schools projects, Inovators, SME, FabLab members*

Svi su dobrodošli, a događanje je beslatno za sve učesnike!
All are welcome and the event is free for all participants!

FabLab, udruga za promicanje digitalne fabrikacije / *association for the promotion of digital fabrication*
Roberto Vdović, predsjednik / *president* | Morana Pap, tajnik / secretary
www.fablab.hr | info@fablab.hr

Sveučilište u Zagrebu
Arhitektonski fakultet

FabLab
udruga za promicanje
digitalne fabrikacije