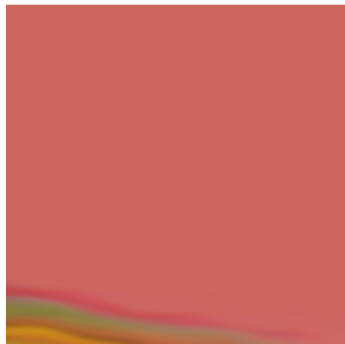
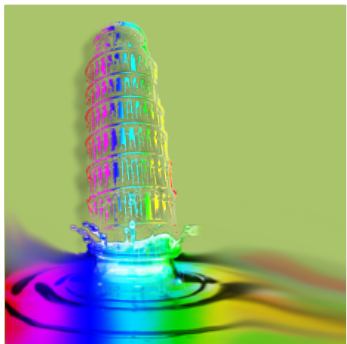
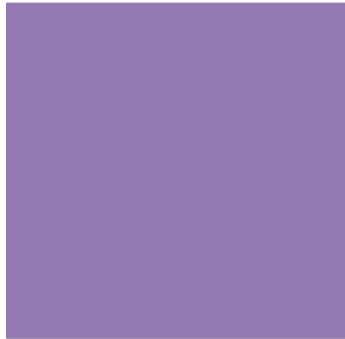


# Micro e Nano Sistemi

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G. Vozzi





# Contatti



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- Gianni Orsi
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# Siti internet di riferimento



- <http://www.centropiaggio.unipi.it/course/micro-e-nanosistemi.html>
- <http://dionisio.centropiaggio.unipi.it/gvozzi/default.aspx>
- <http://dionisio.centropiaggio.unipi.it/cdemaria/default.aspx>



# Programma preliminare del corso



- Microfabbricazione 2D
- Microfabbricazione 3D e tecnologie di prototipazione rapida
- Analisi Multifisica agli elementi finiti



# Presequisiti

- Analisi Matematica
- Fisica
- Chimica
- Scienze dei Materiali





# Modalità d'esame



- Una domanda per ogni parte del corso
- Tesina teorico-pratica su un argomento del corso:
  - Analisi dello stato di sforzo indotto da un raffreddamento non omogeneo
  - Sintesi di un controllore di temperatura
  - Analisi fluidodinamica di estrusori
  - ...



# Ricevimento

- Prenotazione tramite e-mail (Vozzi, De Maria o Orsi) a seconda del particolare argomento da trattare
- Il ricevimento è sospeso durante la settimana d'esame





# Materiale didattico

- Slide ed appunti forniti dal docente
- Libri di riferimento:
  - Madou, Fundamentals of Microfabrication, CRC Press
  - Gebhardt, Rapid Prototyping, Hanser Verlag



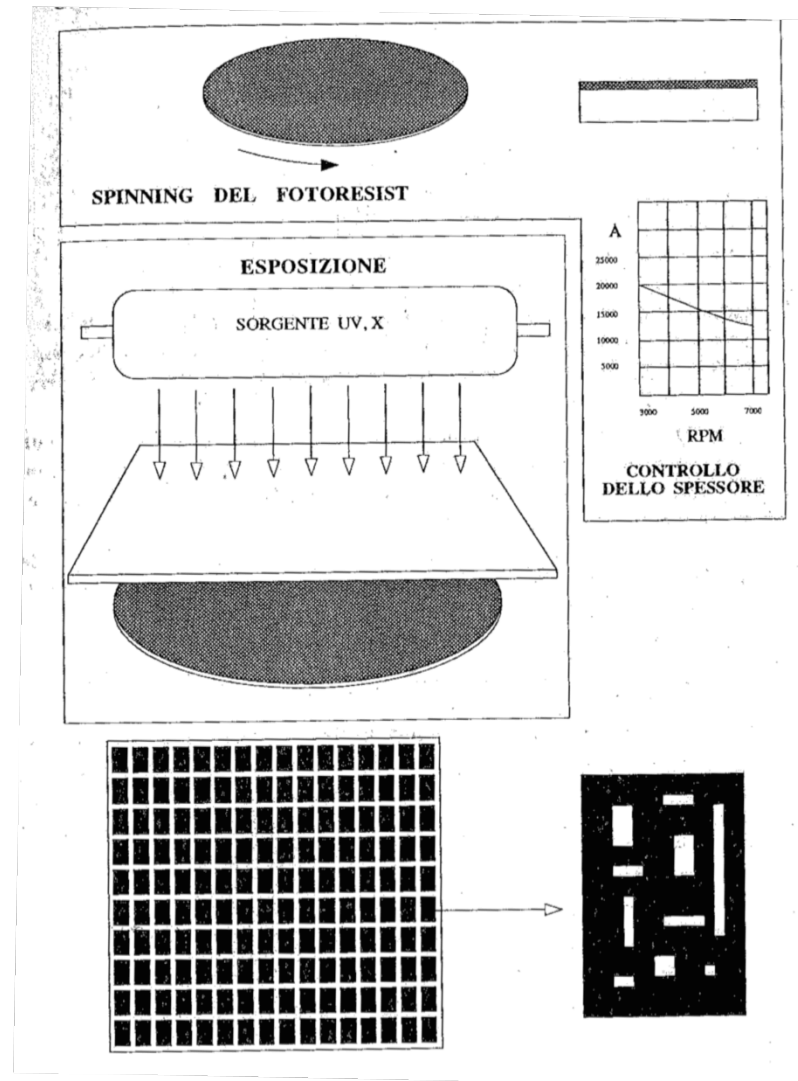


# **MICROFABBRICAZIONE 2D**

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# Litografia

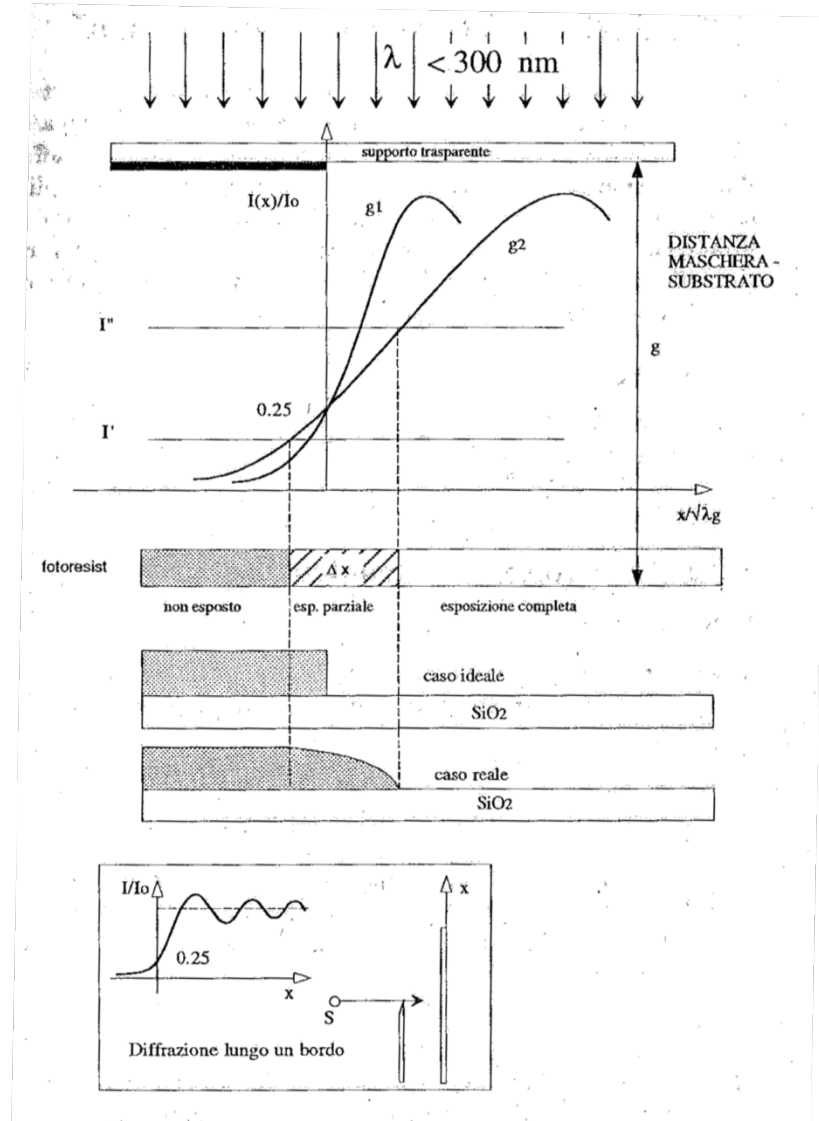
- Dalle proprietà del silicio alla fabbricazione di circuiti integrati





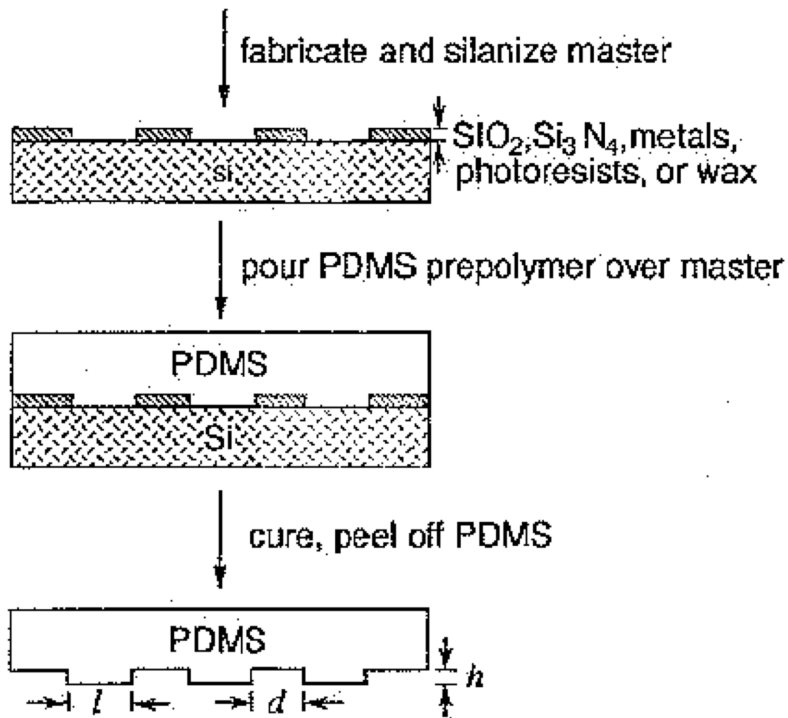
# Litografia

- Dalle proprietà del silicio alla fabbricazione di circuiti integrati





# Soft-litografia



# **MICROFABBRICAZIONE 3D**

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3D  
fabrication

Additive

Subtractive

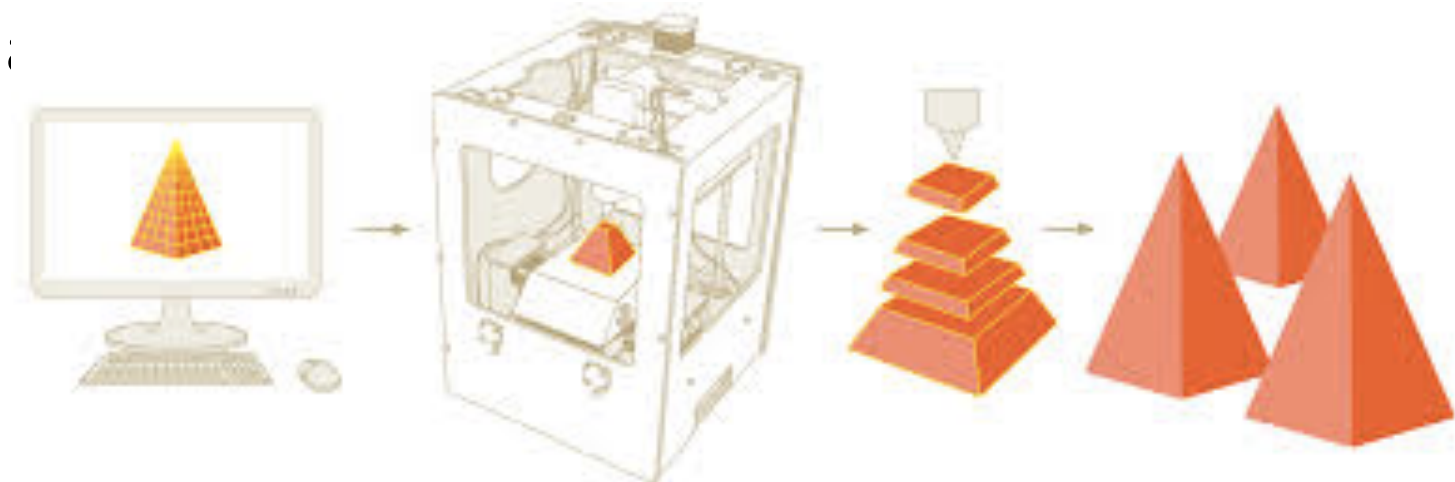




# 3D printing

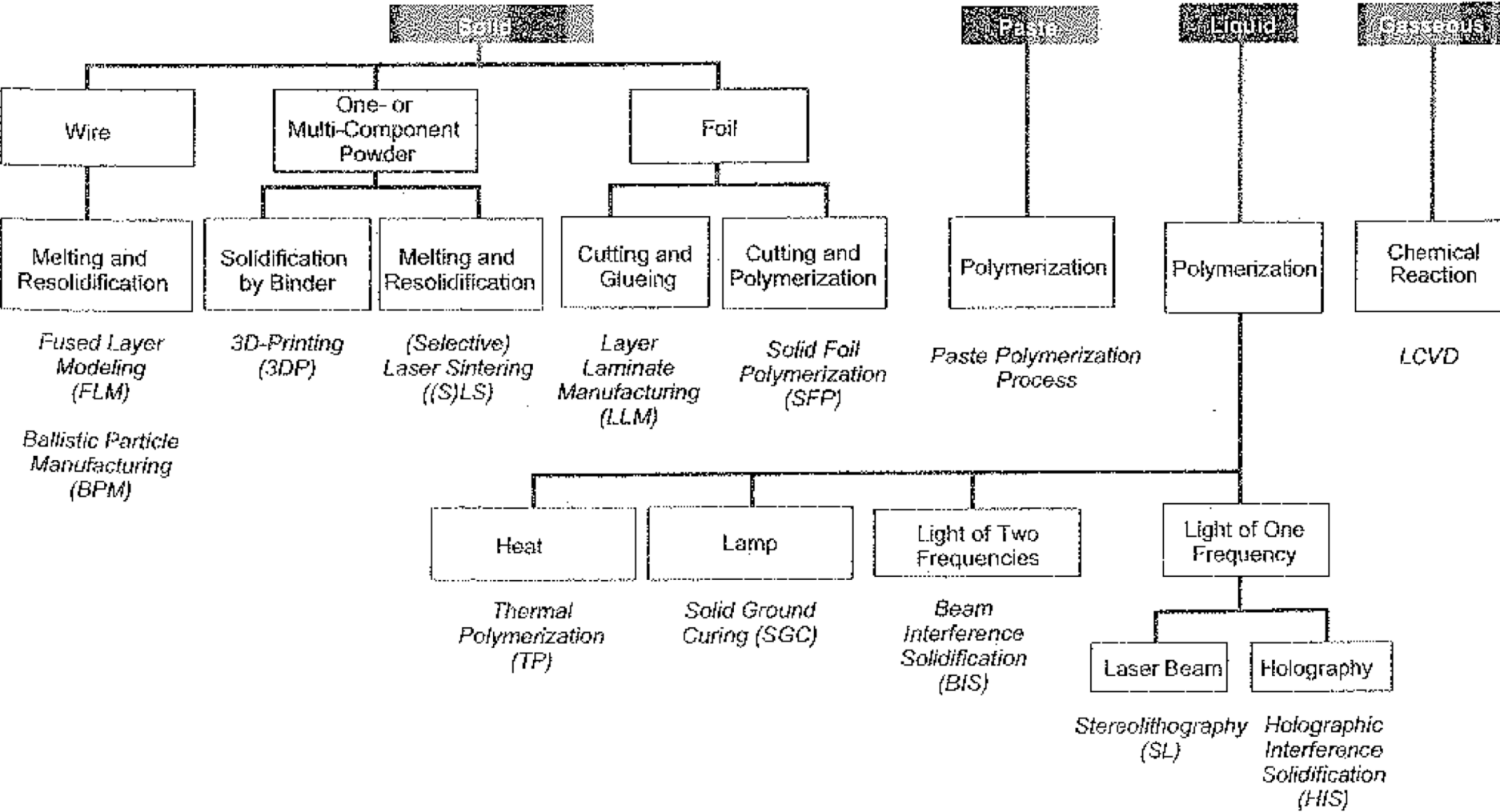


- 3D printing (or Additive Manufacturing) is a process of making a three-dimensional solid object of virtually any shape from a digital model.
- 3D printing is achieved using an additive process, where successive layers of material





# Additive manufacturing world



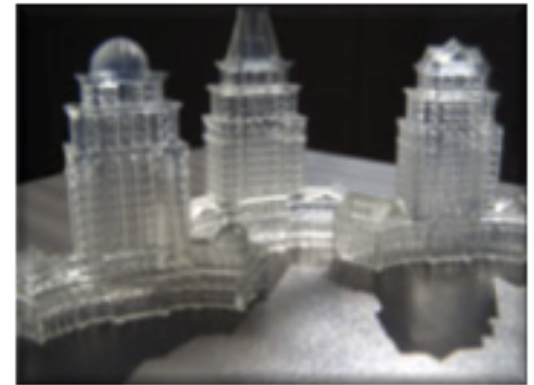
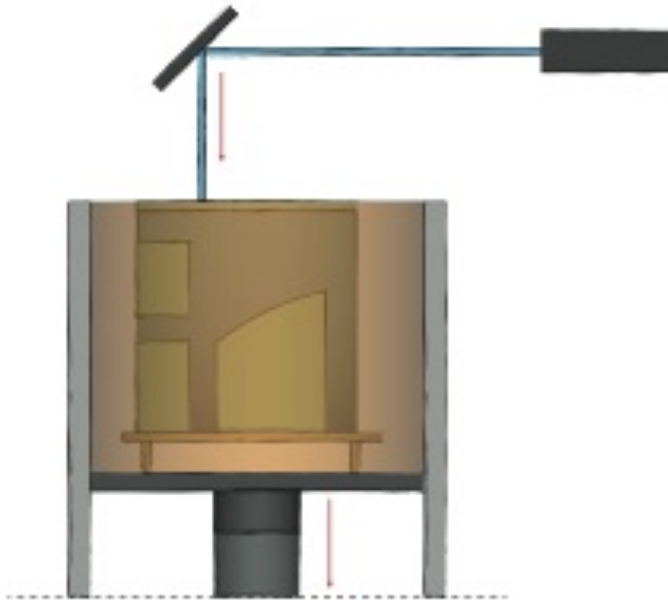


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# Available technologies



- Solidification of liquid materials
  - Photo-polymerization process

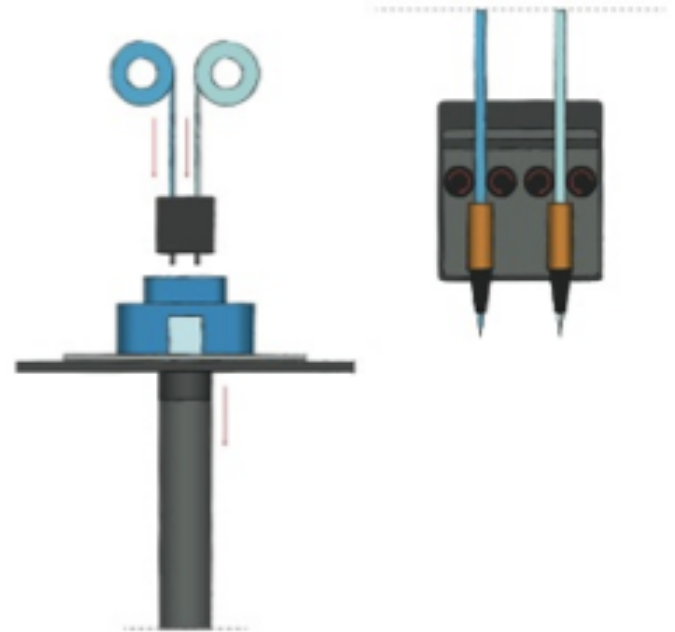




# Available technologies



- Generation from the solid phase:
  - incipiently or completely melted solid materials, powder, or powder mixtures:
    - Extrusion (FDM),
    - Ballistic and
    - Sintering processes





# Available technologies



- Generation from the solid phase:
  - incipiently or completely melted solid materials, powder, or powder mixtures:
    - Extrusion (FDM),
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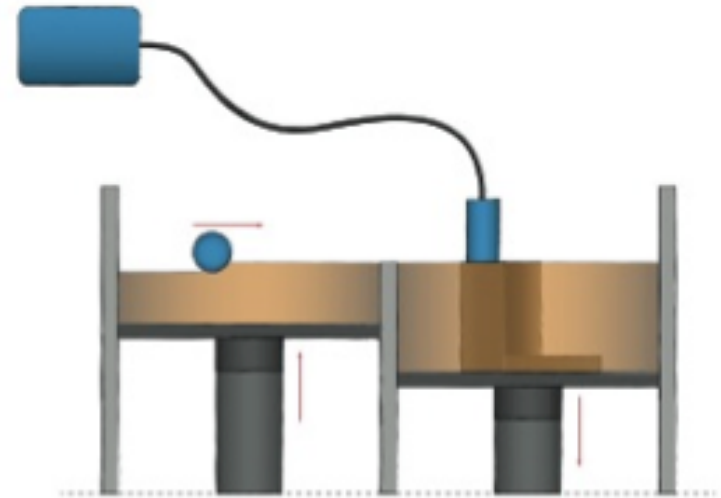


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# Available technologies

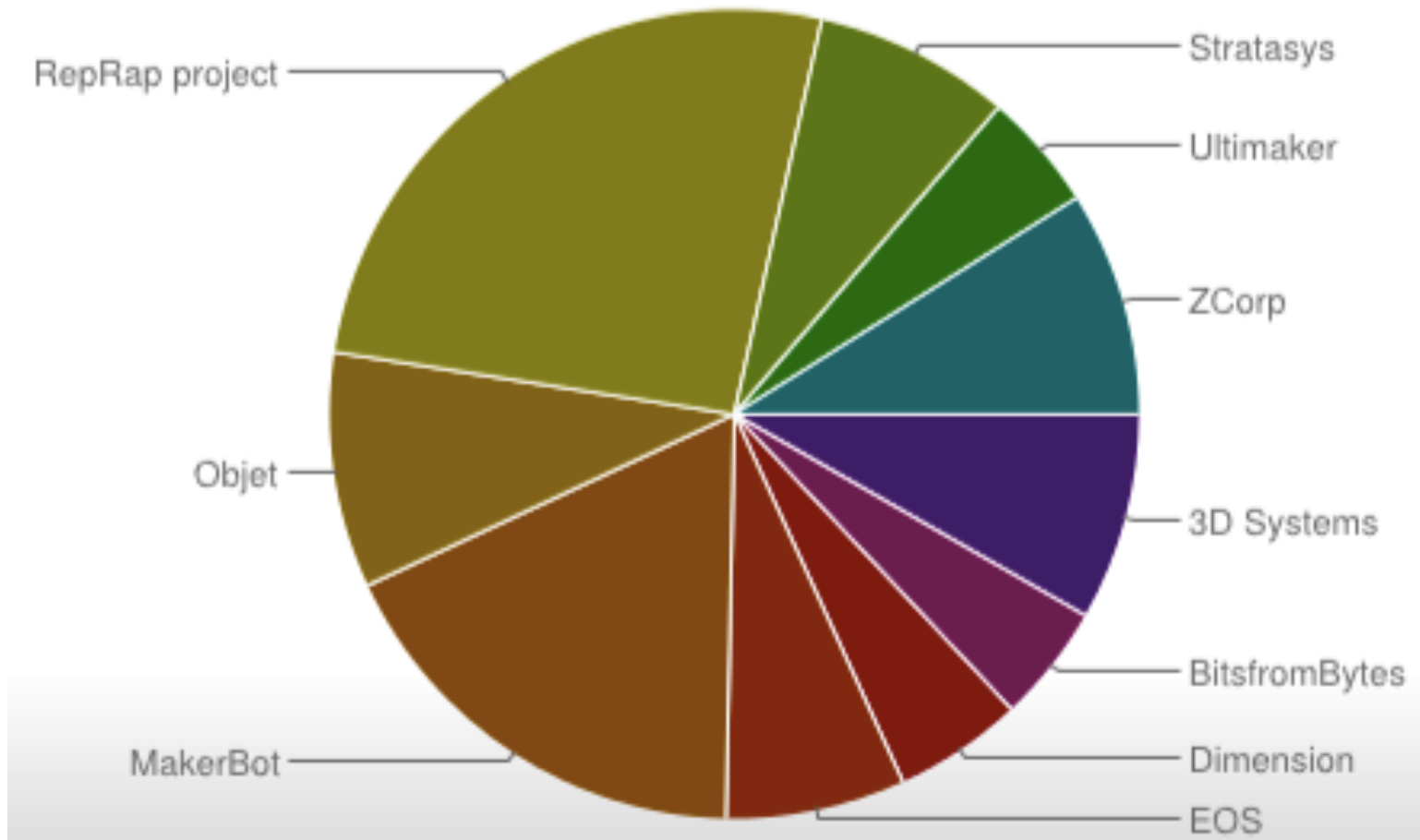


- Generation from the solid phase:
  - Conglutination of granules or powders by additional binders
    - 3D inkjet printer



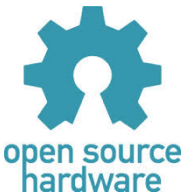
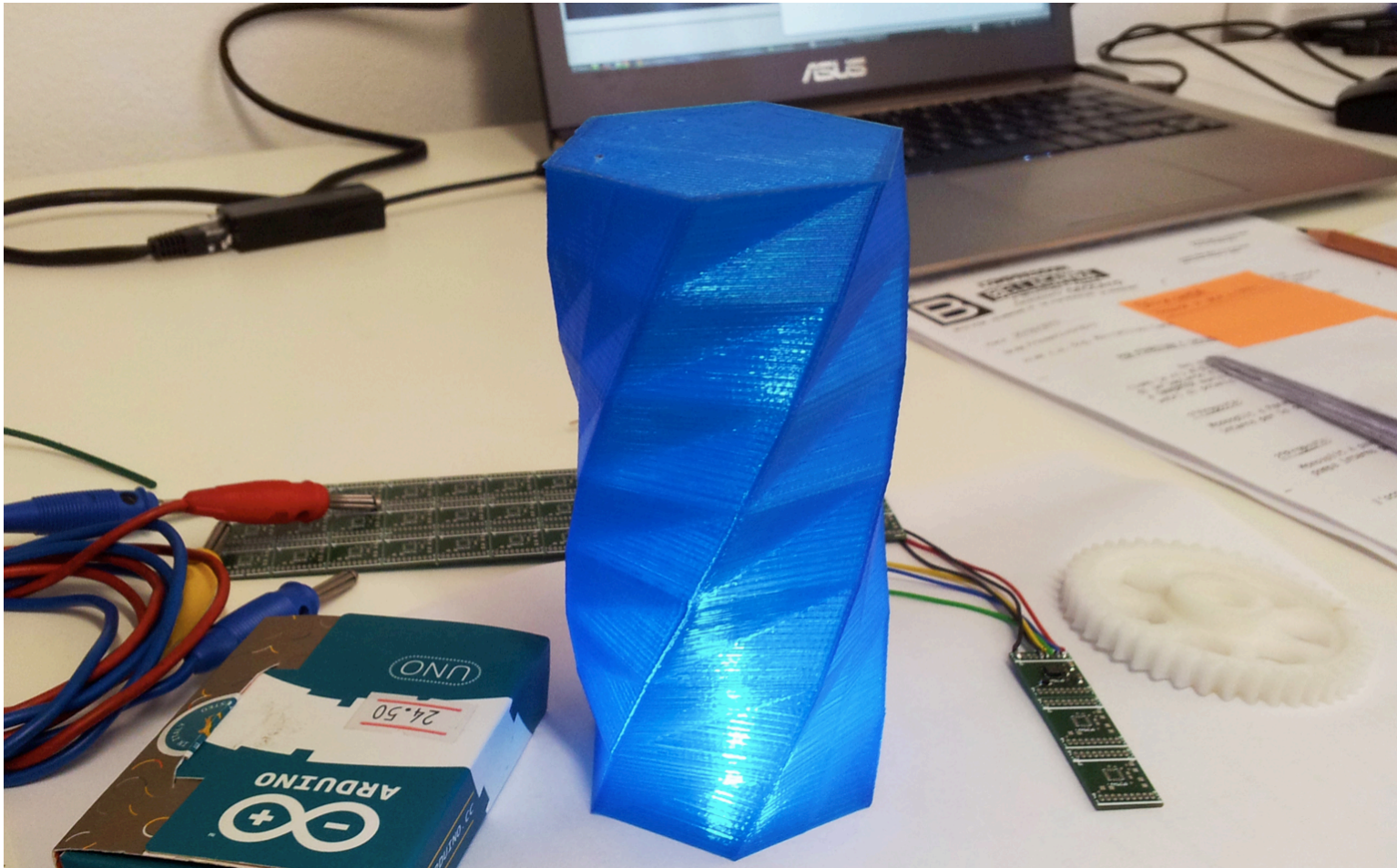
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# 3D printer as a whole



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# The RepRap Project

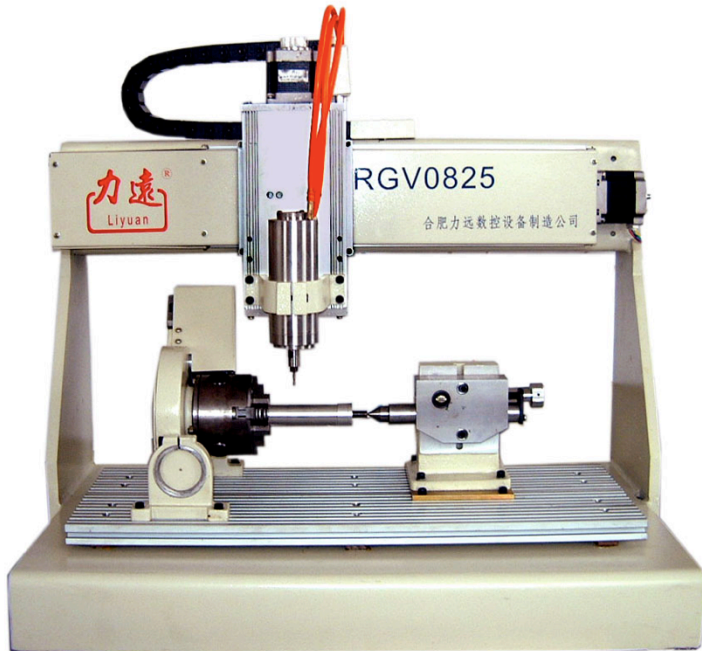
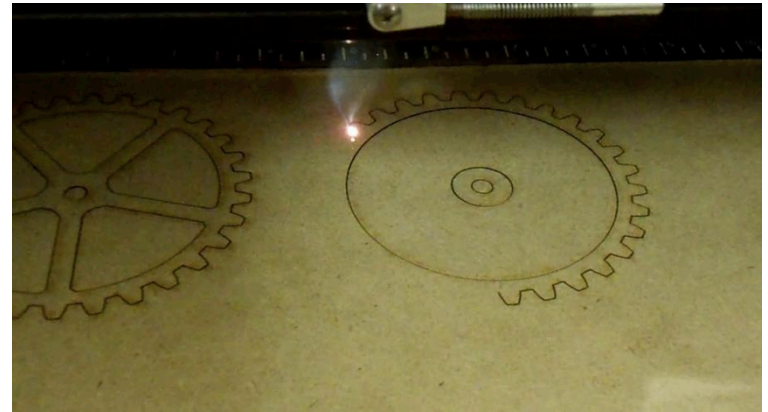


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# Other fabrication technologies

- Subtractive technologies

- Laser cutter
- CNC milling machines



# **ANALISI MULTIFISICA AGLI ELEMENTI FINITI**





# Analisi agli elementi finiti

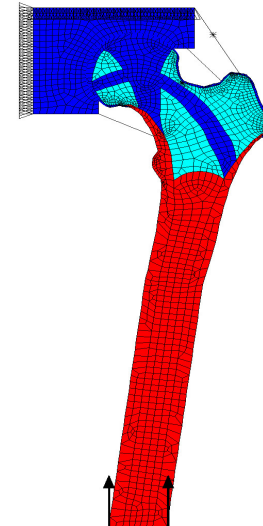
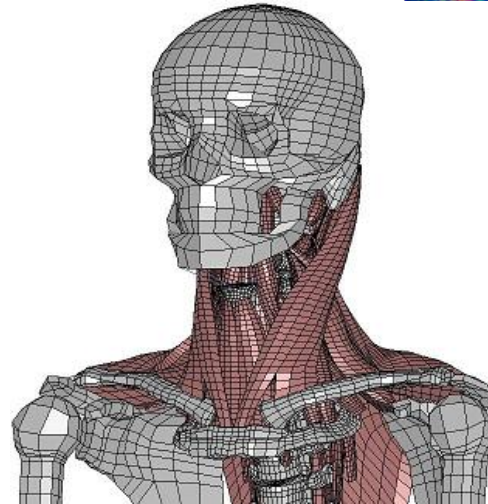
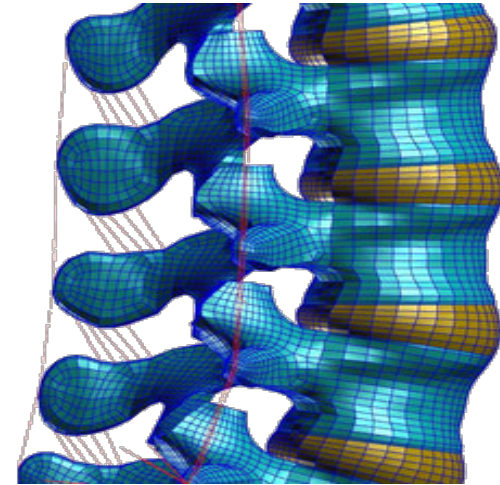


- Metodo per la risoluzione **numerica** di una equazione differenziale, sia essa alle derivate totali o parziali
- Più precisamente si tratta di un metodo per approssimare una equazione differenziale con un sistema di equazioni algebriche



# Analisi agli elementi finiti

- Elementi
- Nodi
- Funzioni Forma
- Gradi di libertà





# Comsol Multiphysics

