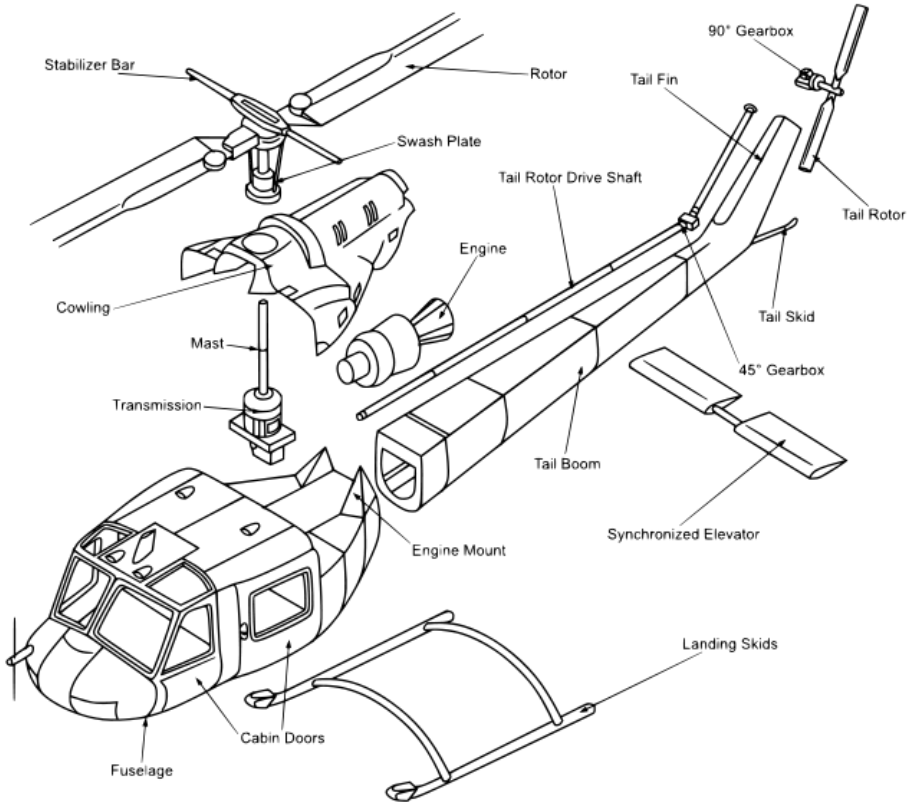
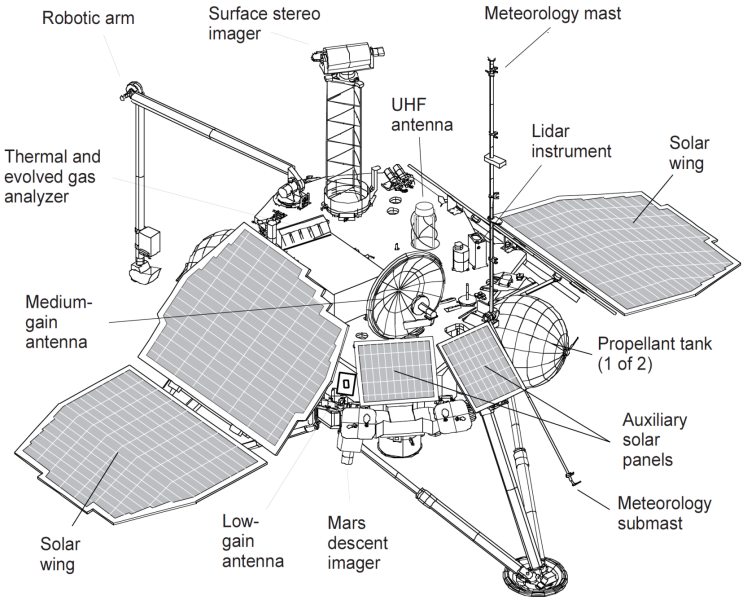
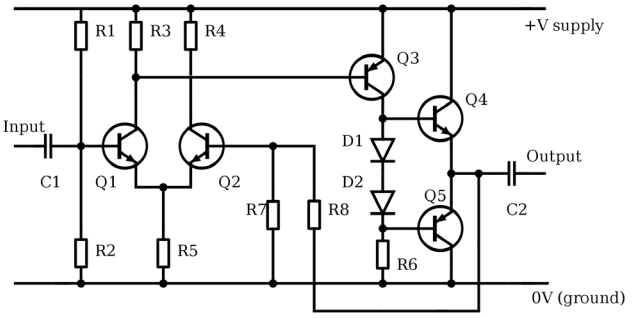


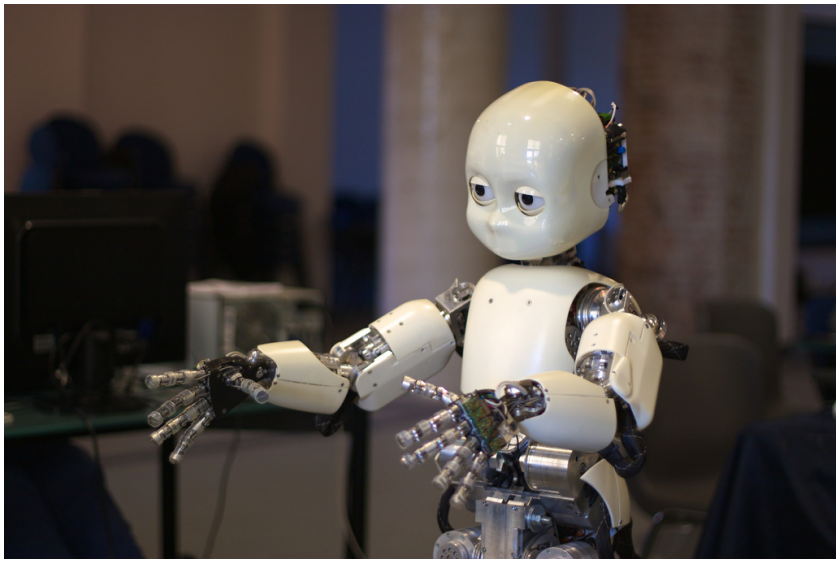


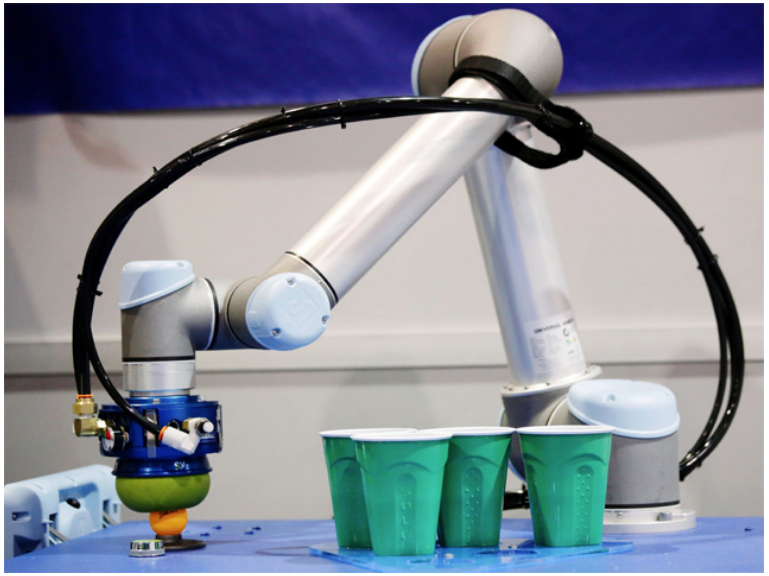
Lecture 1 – The design process and 3D modelling

Andrés Faíña (anfv@itu.dk)



Product design





Product design

Analyze current situation

Design requirements, find specifications of your product:

- Discuss it with “clients/users”
- Find operational environment
- Target cost

Preliminary design (high-level design): analysis different approaches

- Outputs: Type and size of motors, lights?
- Interface: Type and location of sensors?
- Mechanisms: Type?
- Power: Autonomy?
- Size?

Detailed design

Design for manufacturability

Production planning

Example

Vending machine?

Interface: Keypad and screen or a button for each product?

Mechanism: One drive motor and motorised clutch or a motor for each product?

Outputs: DC motors, stepper motors, electromagnets?

Power: Connected to power grid, powered by solar cells?

Size: 1 or 2 meter high, number of products to sell?

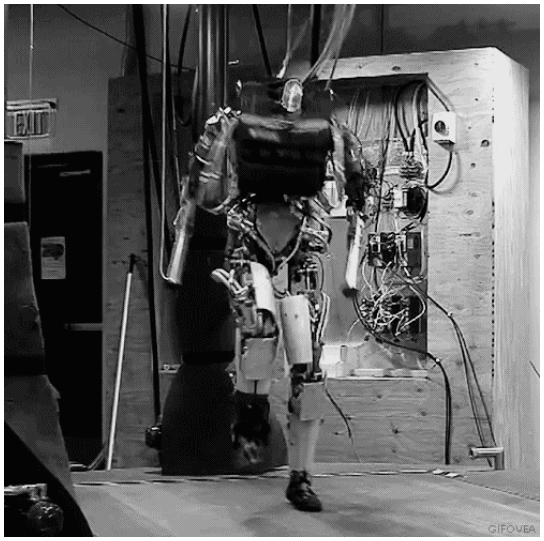
Designing a machine

Multiple solutions are possible

Some of them are better than others

Usually, there is no optimal solution

Trade of advantages and disadvantages



Petman

Passive Walker

Big dog

Theo Jansen

Cost of a modification

During preliminary design:
Very cheap (1,000$)

During detail design:
Cheap (10,000$)

During testing:
Medium (100,000$)

During process planning:
Expensive (1,000,000$)

During production:
Very expensive (10,000,000$)

Exercise - Design a product

Task: Design a robot to follow a line and grasp an object at the end of the line.

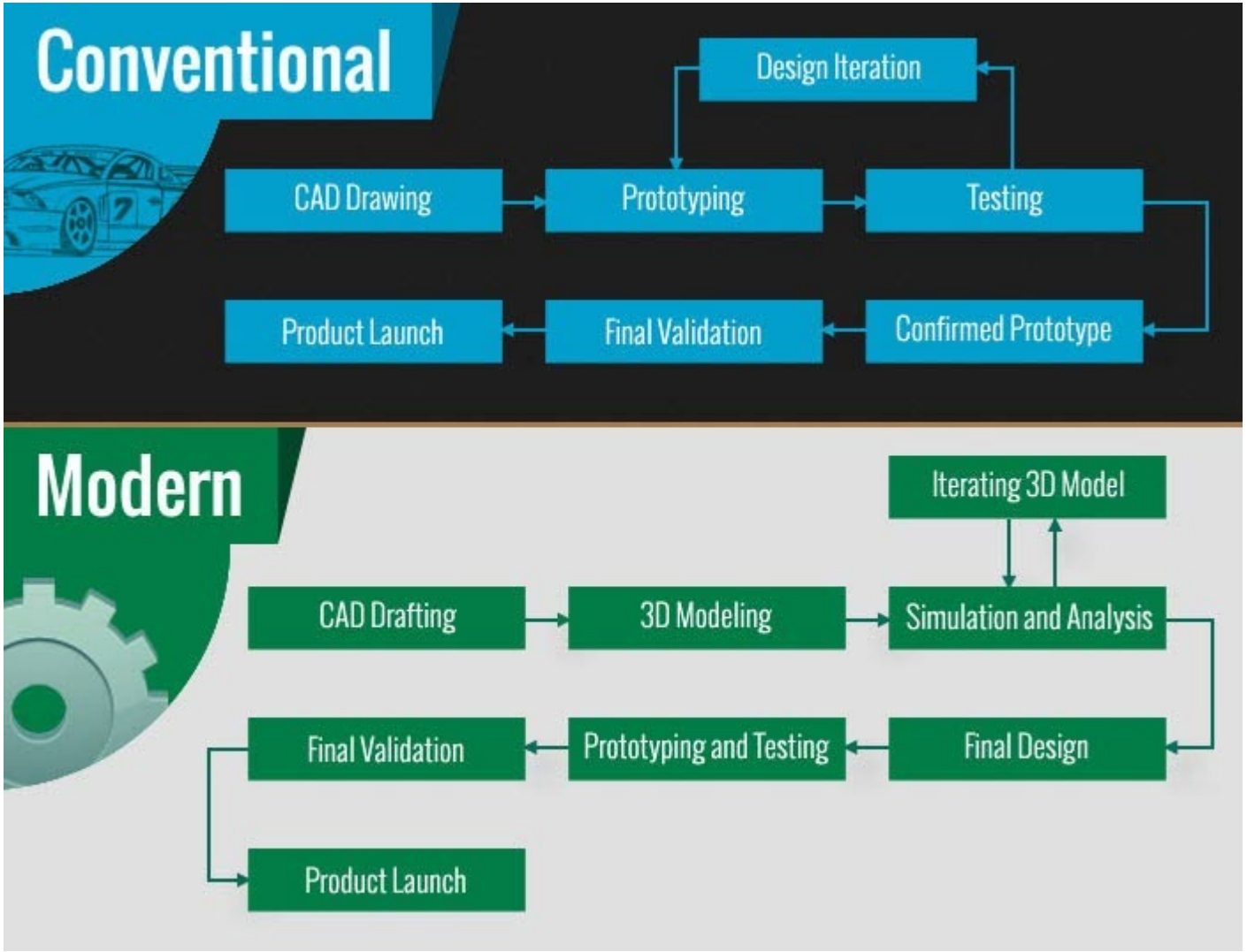
Groups of 2 persons

Define:

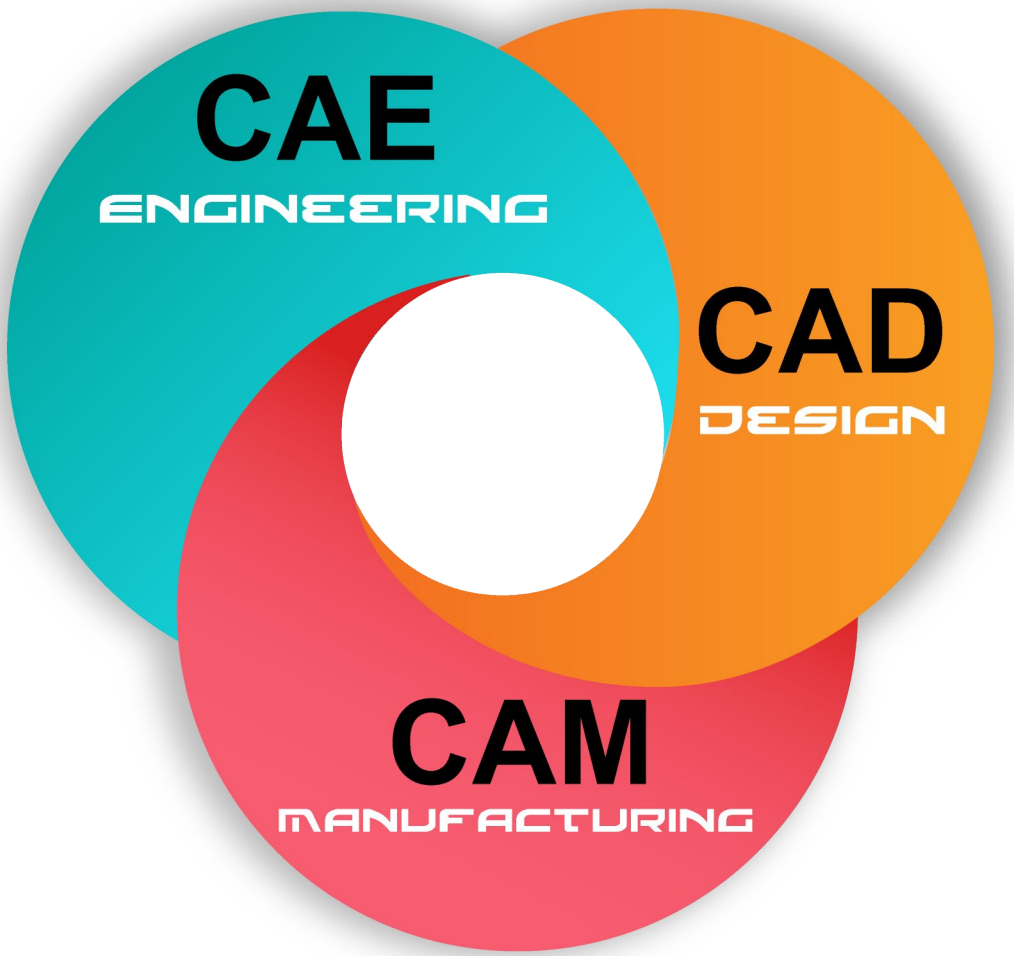
- Requirements
- Outputs: Type and size of motors, lights?
- Interface: Type and location of sensors?
- Mechanisms: Type?
- Power: Autonomy?
- Size?

Try to draw a sketch of your solution!

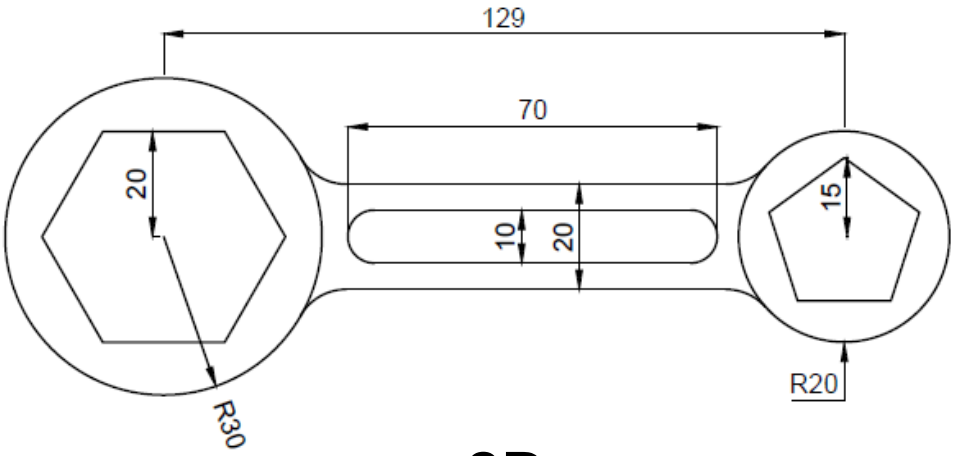
Product design



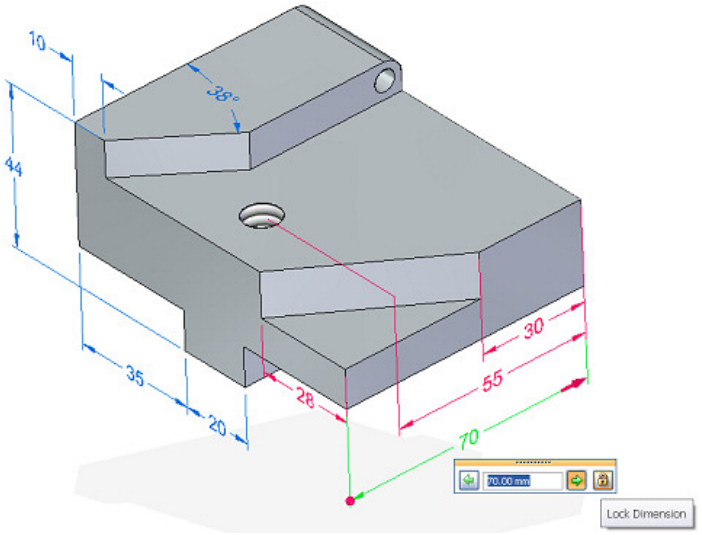
CAD / CAM / CAE



Computer Aided Design



2D

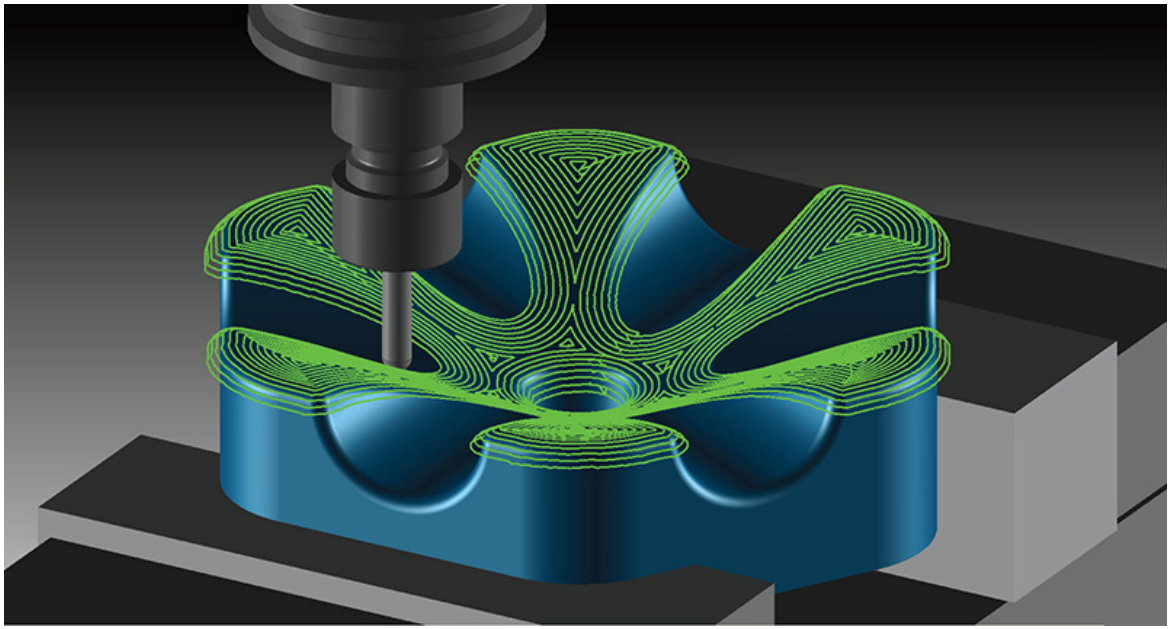


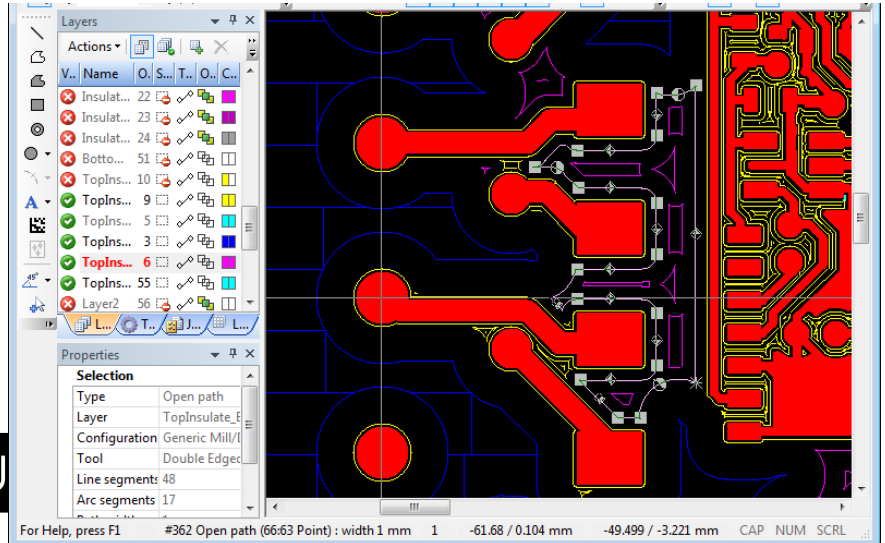
3D

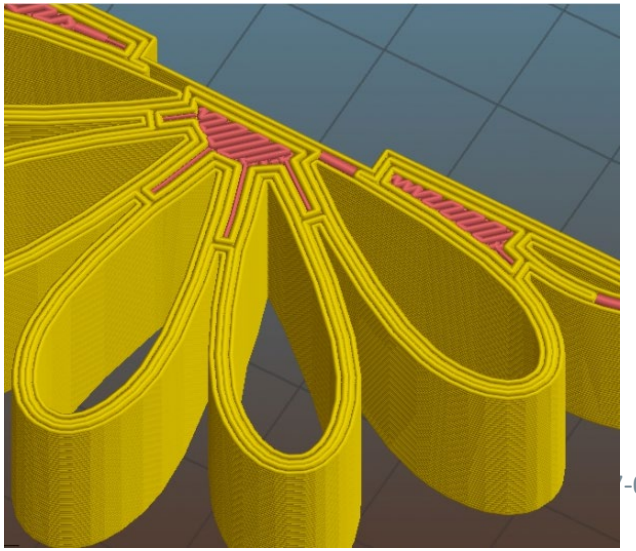
Parametric models:

You can always edit the model through parameters!

Computer Aided Manufacturing

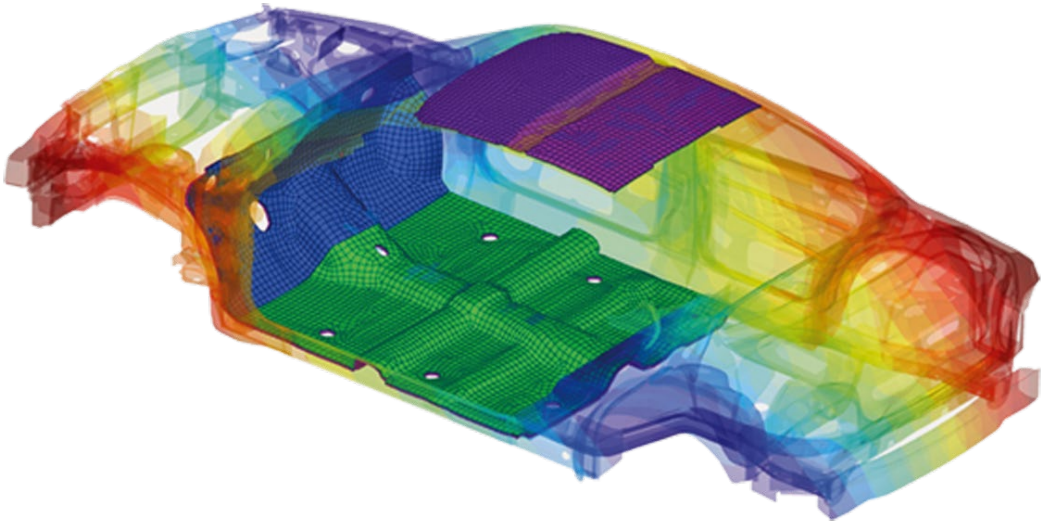




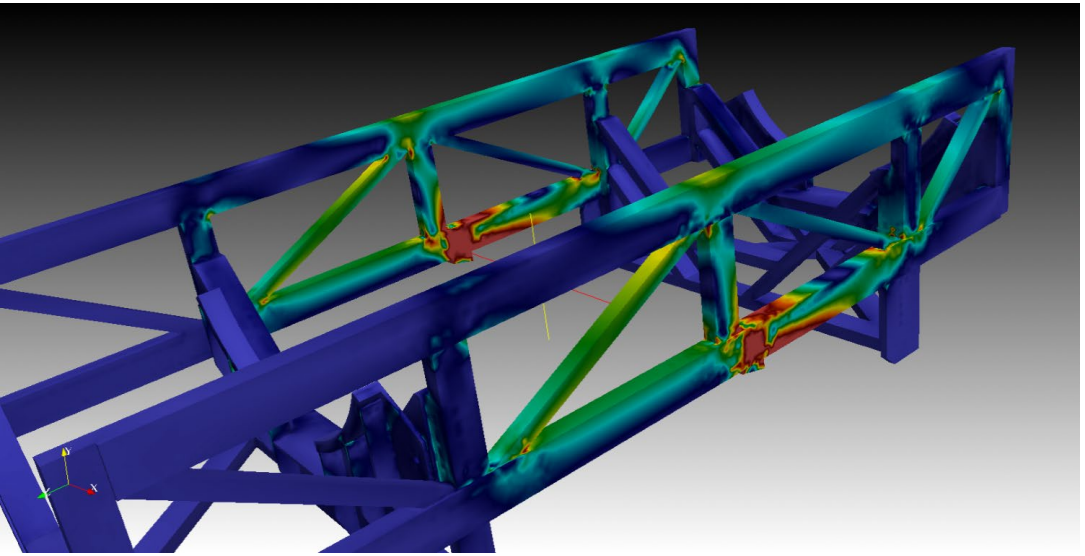


Computer Aided Engineering

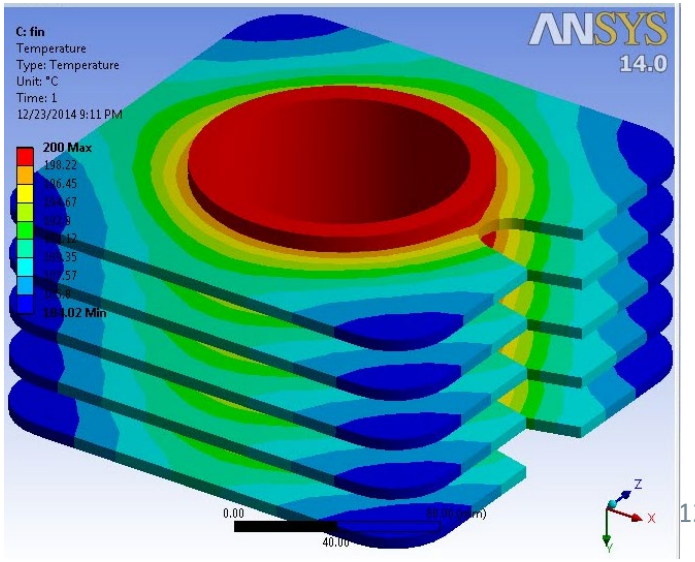
Vibrations and noise



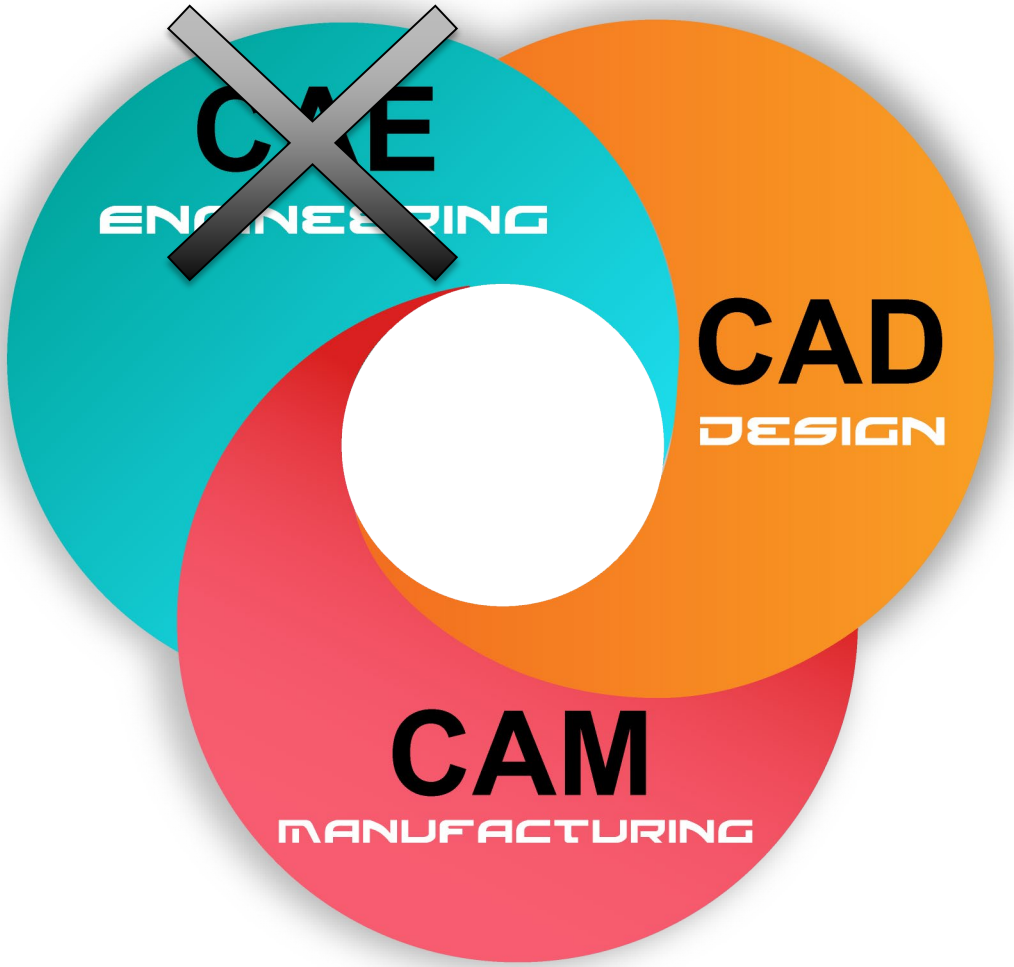
Mechanical Stress



Temperature



CAD / CAM / CAE in this course



CAD/CAE/CAM programs

Open Source:

- Openscad (script based)
- FreeCAD (without assemblies)
- Blender (not parametric)
- …

Freeware:

- Onshape (web browser)
- Autodesk Fusion A360
- …

Commercial software:

- SolidWorks ($$)
- Catia ($$$$)
- NX ($$$$)
- …

CAD/CAE/CAM programs, table

	OS	Open Source	3D models	Assembly	Drawings	CAM	Sheet metal	CAE
Fusion 360	Win Mac	No	Yes	Yes	Yes	Yes	Yes	Yes
Onshape	All	No	Yes	Yes	Yes	No	Yes	No
FreeCad	All	Yes	Yes	No*	Yes	Yes	No*	Yes
OpenScad	All	Yes	Yes	No*	No	No	No	No

Let´s design something in OpenSCAD

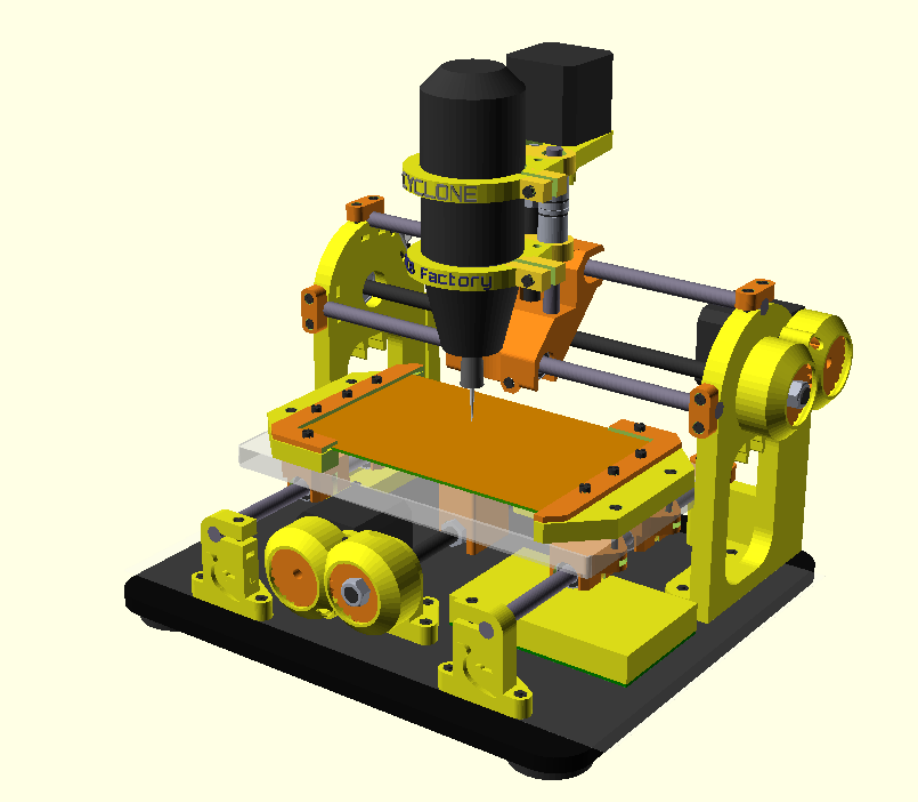
Change to OpenSCAD (Google Chrome):

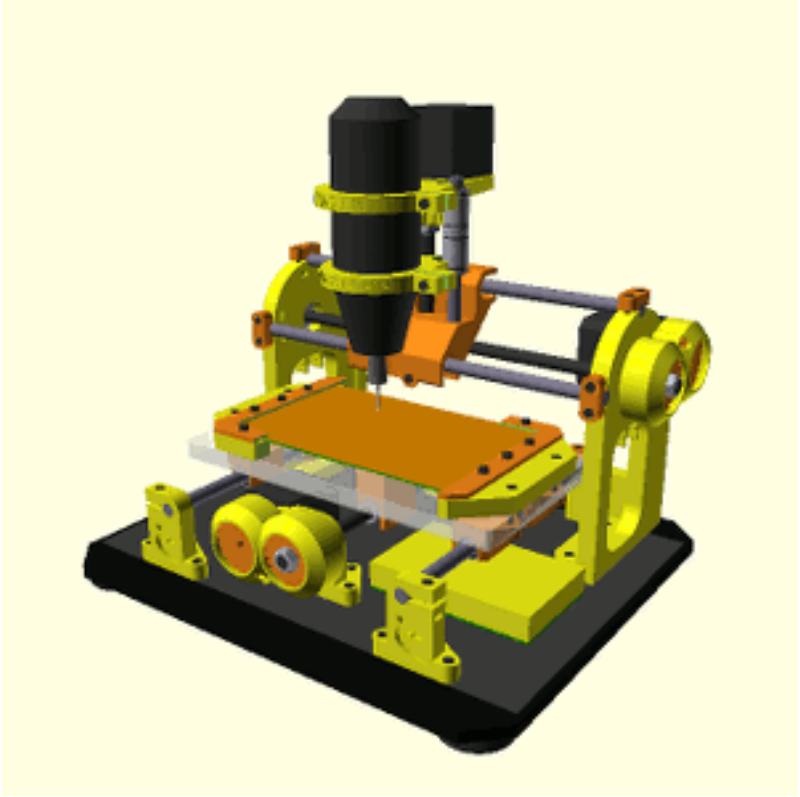
http://openscad.net/

Cheatsheet:

http://www.openscad.org/cheatsheet/

An example made in OpenScad





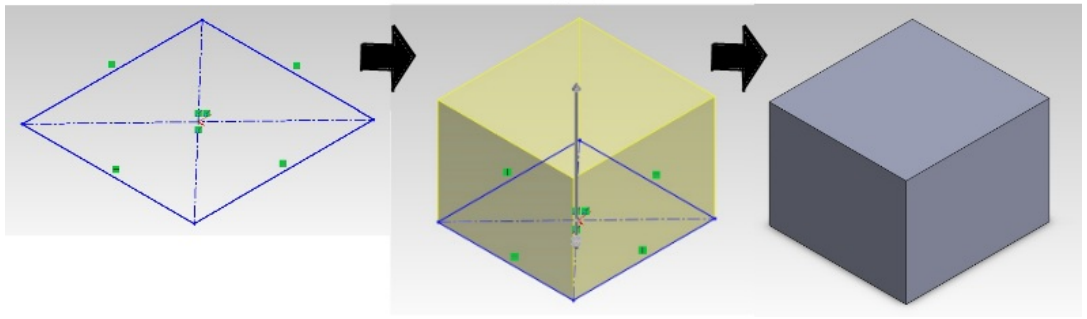
Cyclone-PCB-Factory:
https://github.com/carlosgs/Cyclone-PCB-Factory/

3D modelling (CAD)

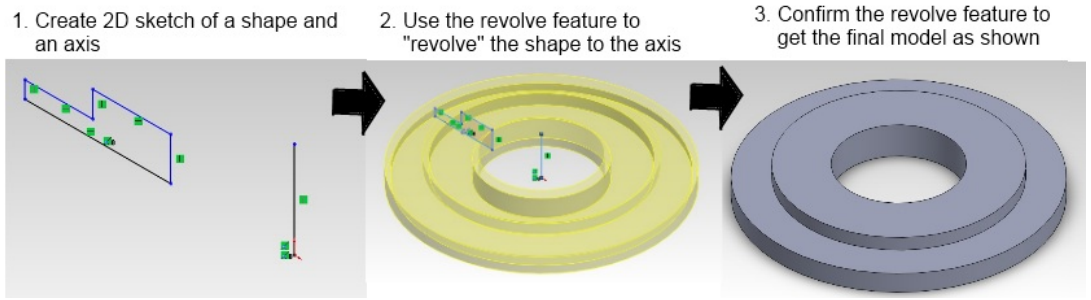
Basic operations:

- Extrusions
- Revolutions
- Mirror
- Linear/Circular pattern
- Chamfer
- Round

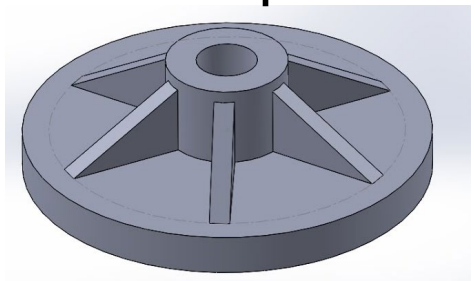
Extrude



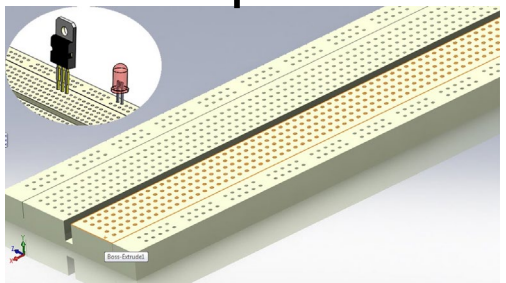
Revolve



Circular pattern



Linear pattern



Workflow (traditional CAD programs)

Operations to create a geometry:

- Select a plane or face (2D) to sketch
- Sketch: draw a profile or a contour
- Revolve or extrude the profile or contour:
  - Choose starting and end points

Symmetry/Mirror operations:

- Select a plane (3D)
- Choose a operation to mirror

Chamfer/Round:

- Select a edge
- Round: Select a radius
- Chamfer: Select angle and distance

Let´s design something

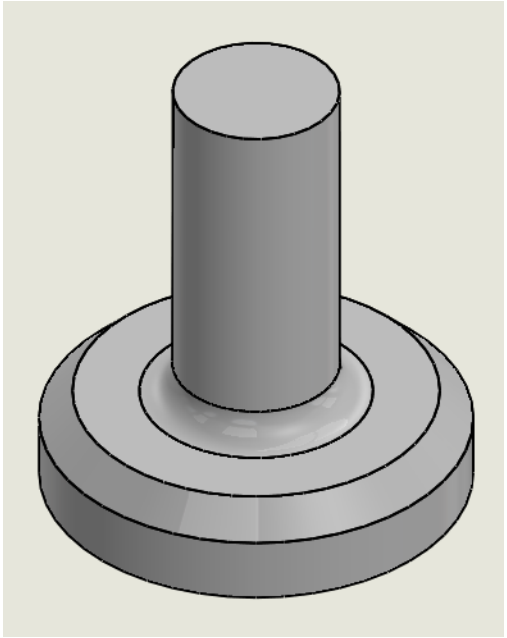
Change to Fusion 360!

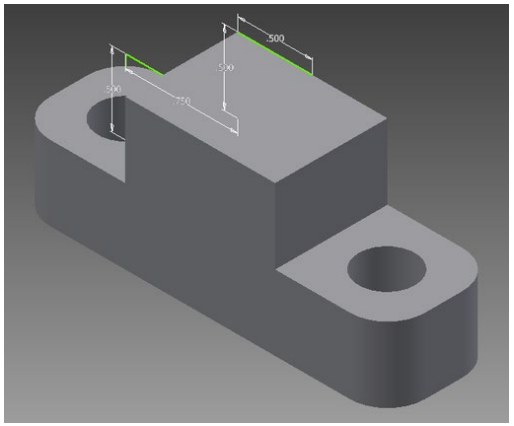
Some tips

What is the best way to design your part?

Extrusions or revolutions?
Can you use symmetry?
Can you use circular or linear patterns?

Practice, practice and practice!





Today´s plan and MA

Model at least two physical products that we will use to build a line follower robot:

- A motor (dc or stepper)
- Arduino Uno
- Small breadboard
- Battery holder

Ready?

Let´s design!

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