

FABO ACADEMY X - CHINA

MACHINE DESIGN

MECHANICAL COMPONENTS

Principles: materials, fasteners, framing, drive.

Mechanisms: gears, belts, pulleys.

Drive device: stepper motors, servo motors



PRINCIPLES

Material: Plywood

- High flexibility.
- Can be easily cut, drilled, glued.
- Low resistance to abrasion.
- Can be laser-cut

Used for: Framing, connecting plates, boxes.



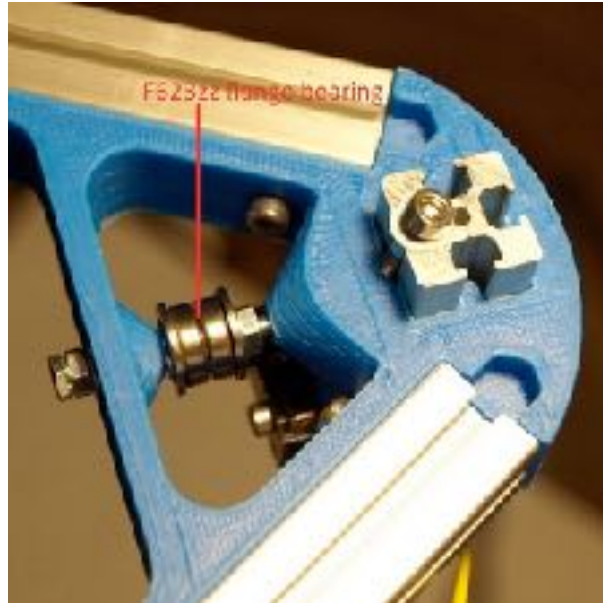
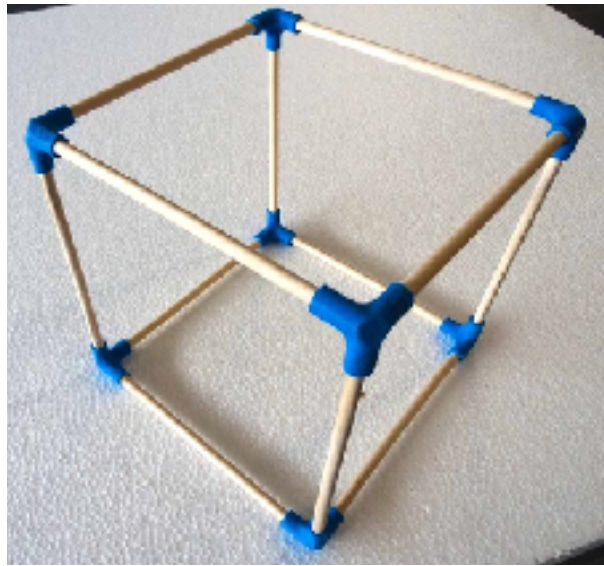
PRINCIPLES

Material: Acrylic

- Good flexibility.
- Can be easily drilled.
- Good resistance to abrasion.
- Can only be laser-cut.
- Can stand good stress, but cracks easily when stress is concentrated in one single point

Used for: Framing, connecting plates, boxes, small rigid components.





PRINCIPLES

Material: PLA

- 3D Printed in many shapes.
- Can be easily cut, drilled.
- Low resistance to abrasion.
- Basic strenght and flexibility.

Used for: joints, connectors, small details, complex shapes (smaller than 5 or 6 cm).



PRINCIPLES

Material: Metal

- High strength and flexibility.
- Can be cut and drilled with appropriate tools.
- High resistance to abrasion.
- Aluminum is light weight.

Used for: Framing, screws, nuts, linear guide, pulleys, bearings.



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PRINCIPLES

Fasteners

Anything used to connect two parts permanently or temporarily.

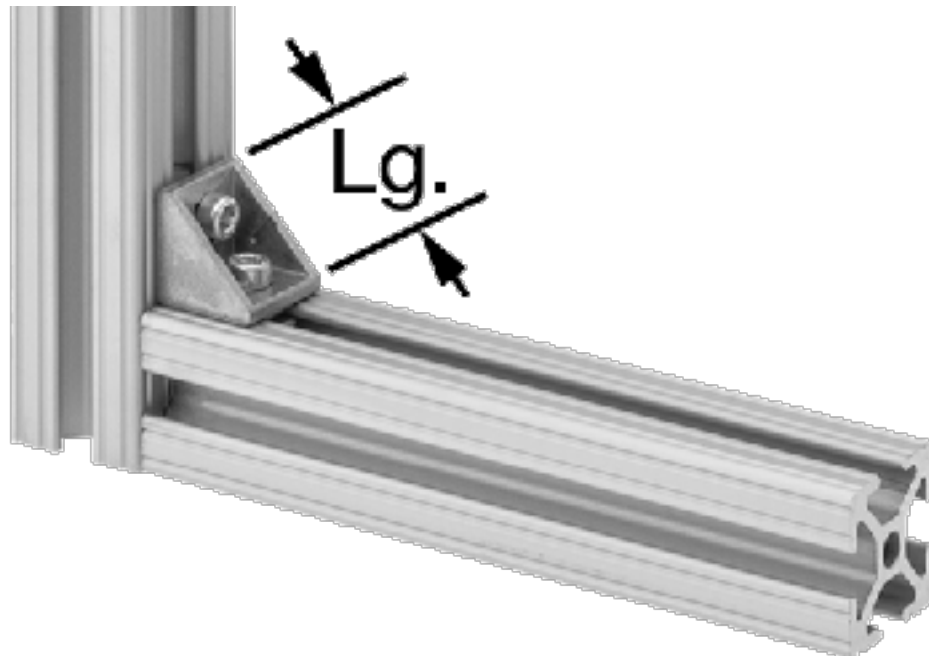
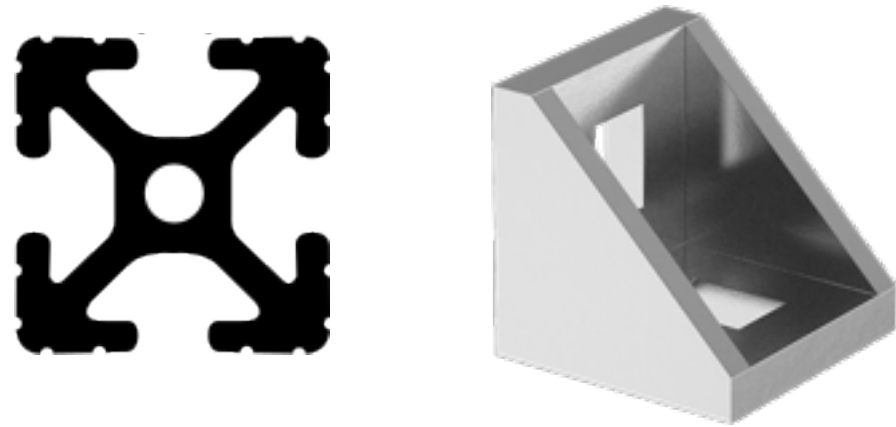
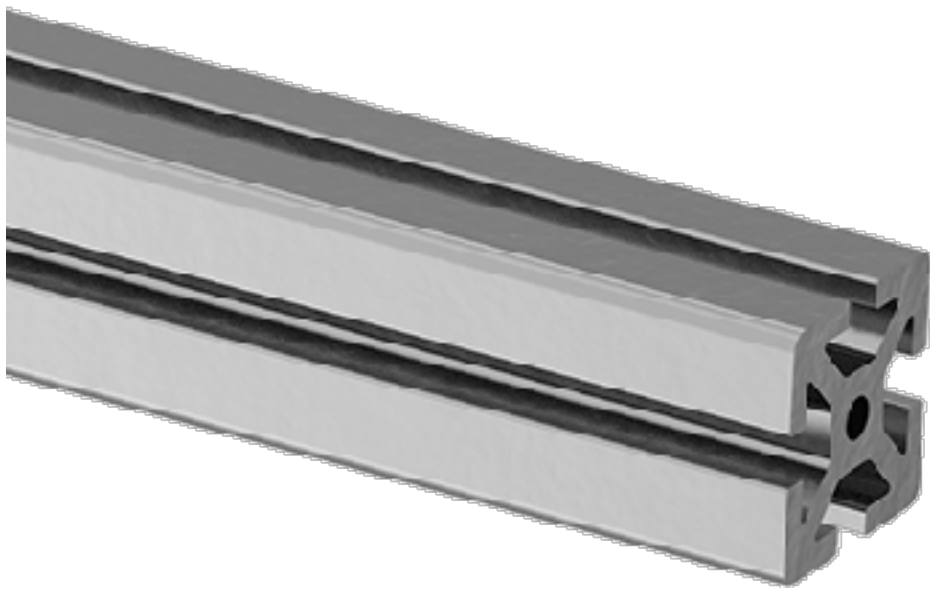


- Screws and Nuts, steel.
- T-Nuts.
- Cable ties / zip-ties, plastic.
- Glue is used only when there is no need of disassembling the parts.

PRINCIPLES

Framing

The frame of a machine can be assembled with special modular rails and connectors.



Aluminum: strong, lightweight.
Modular: can be assembled in many configuration.
T-Slots: can be connected in many ways to many parts.

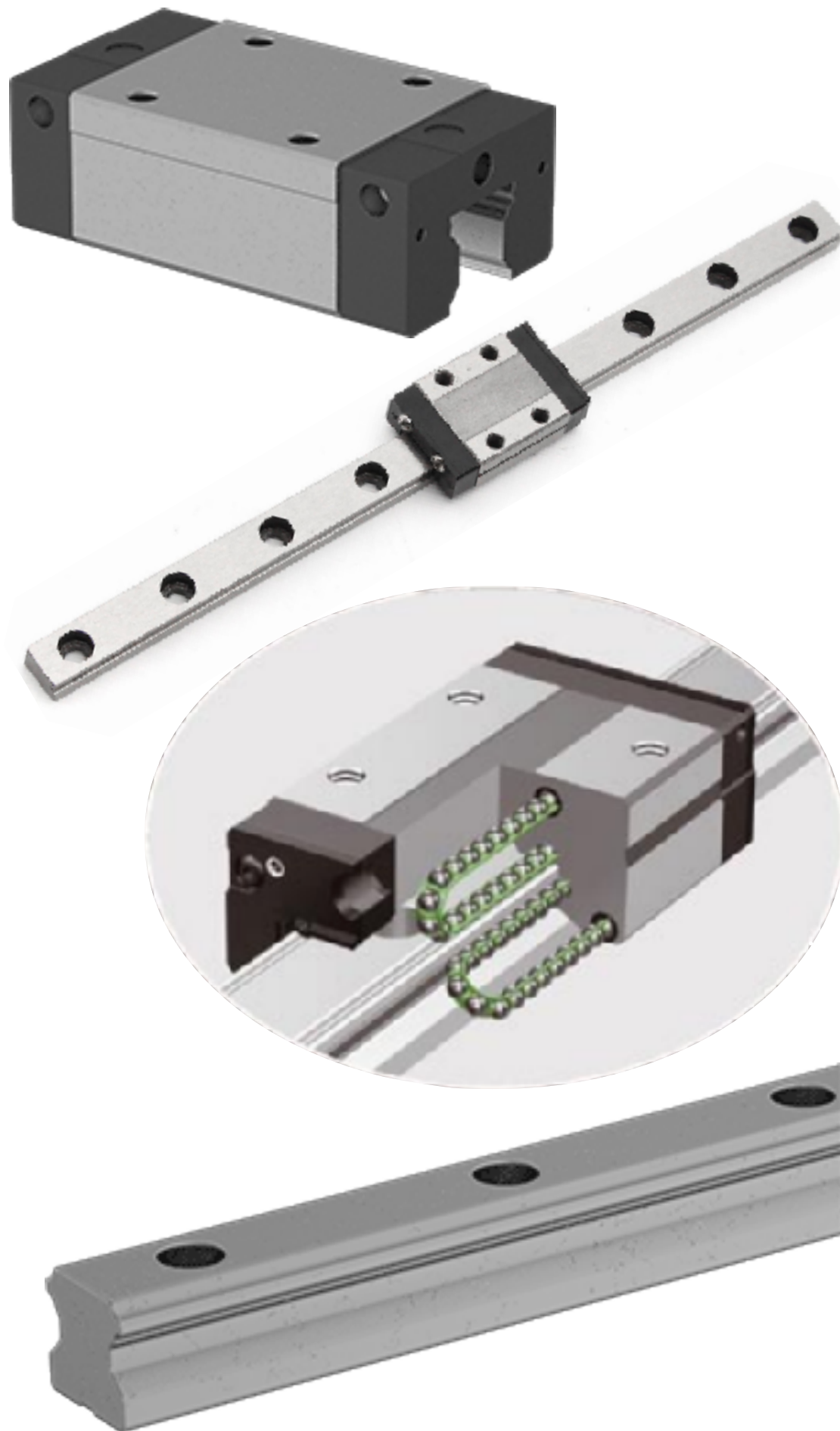
Can be cut to length with a Miter Saw

PRINCIPLES

Drive

Any component used to allow linear and rotatory movements of a machine.

- Linear guide, a steel rail with a sliding block, allows smooth linear movements.
- The sliding block act as a ball bearing
- Caution: when the block is removed from the rail, the steel sphere might get lost.

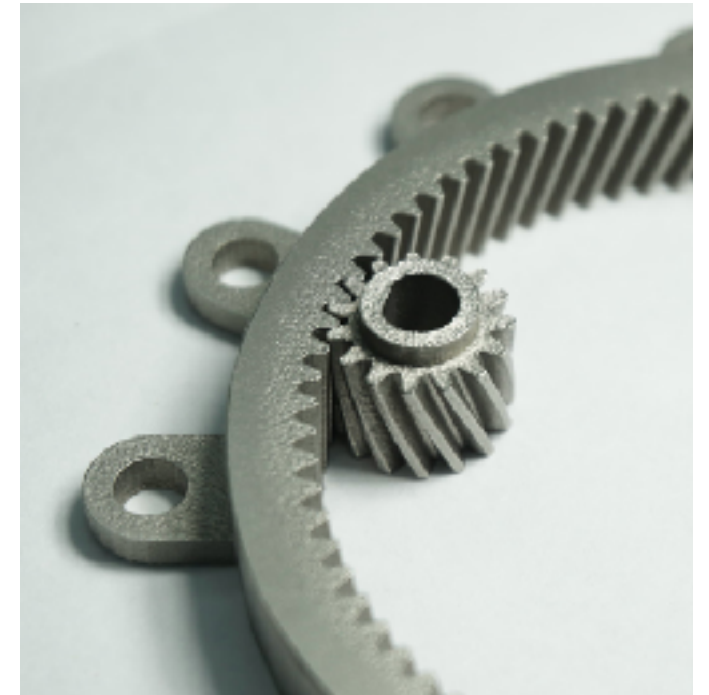
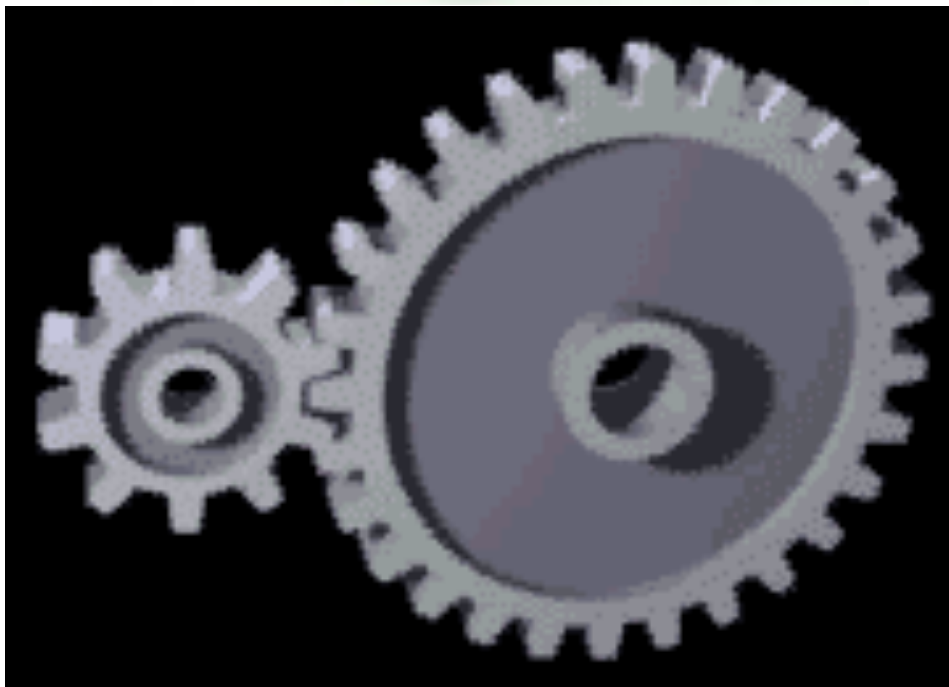


MECHANISM

Gears

A gear have teeth which mesh with another toothed part to transmit torque.

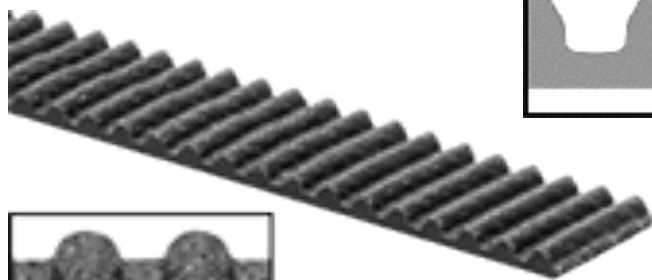
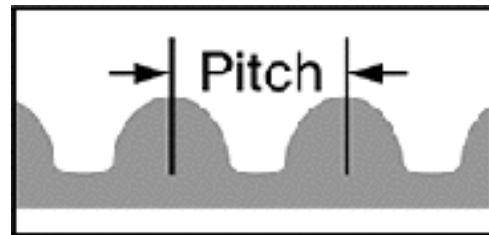
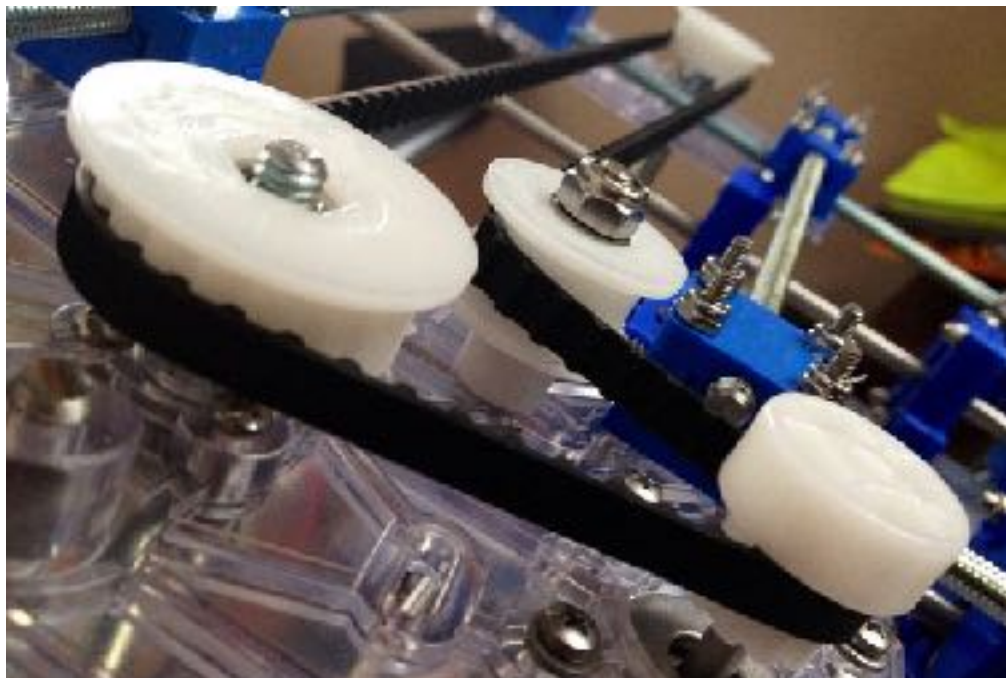
- Geared devices can change the speed, torque, and direction of a power source and can create a mechanical advantage, through their gear ratio.
- A gear can mesh with a linear toothed part, called a rack, producing translation instead of rotation.



MECHANISM

Timing Belt

They have teeth that fit into a matching toothed pulley, they have no slippage, run at constant speed, and therefore they are used to transfer very high precision motion at a specific rate.

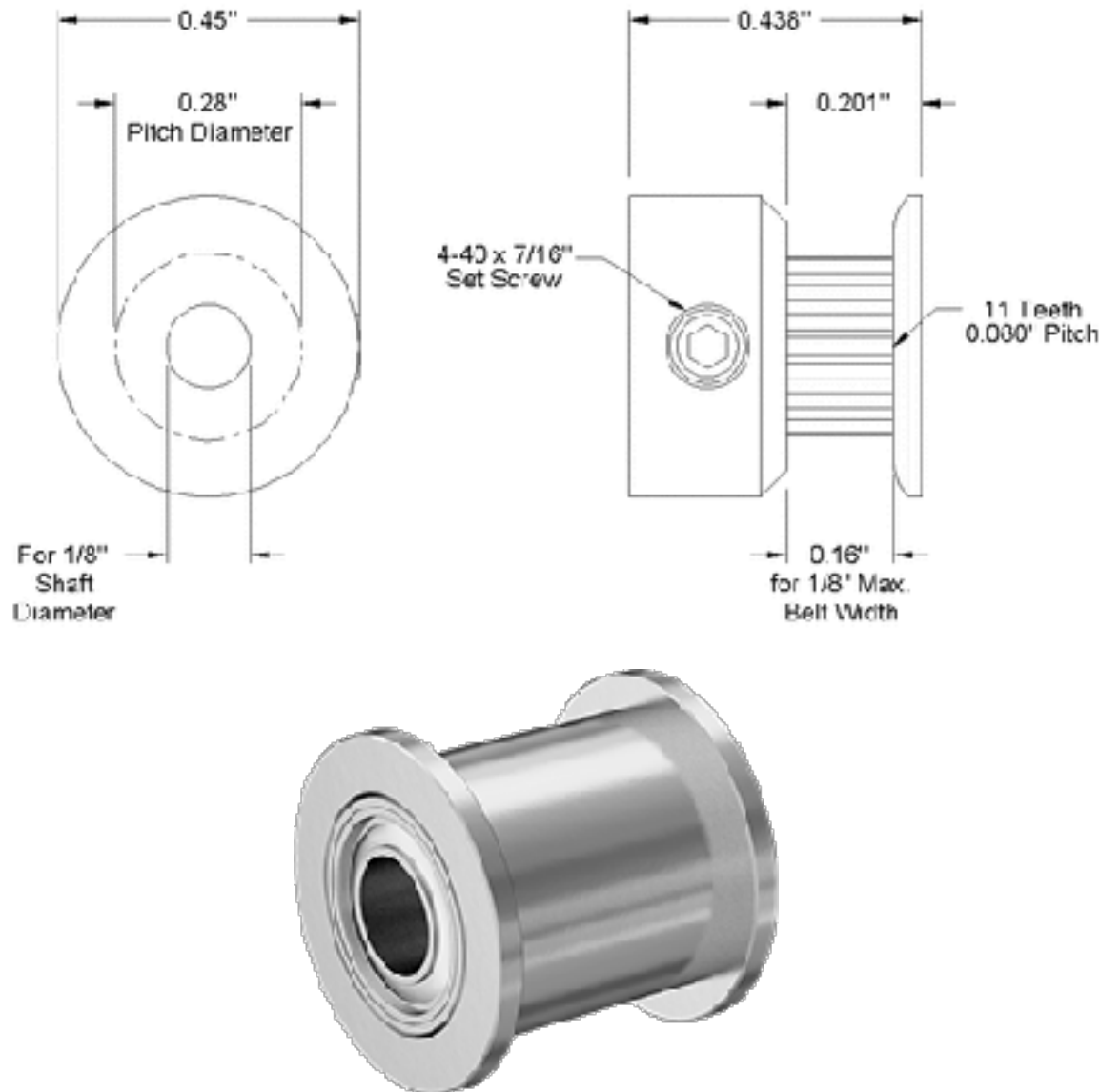


- The pitch between two tooth determine the size of the belt and it has to match the rate of the pulley.
- Timing belts need to be well tensioned: too tight will make the motion difficult, too loose will let the tooth slip.

MECHANISM

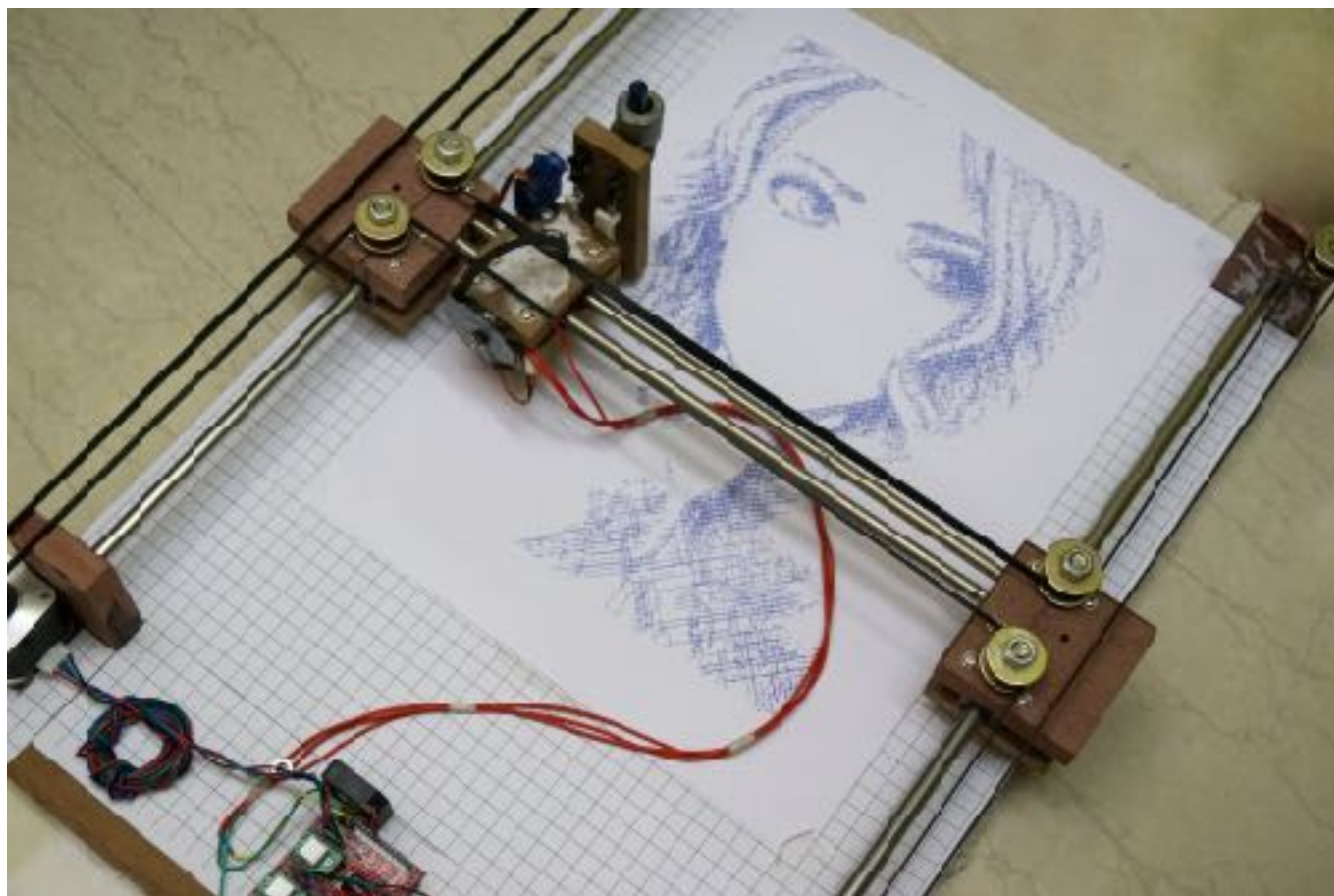
Pulley

A component used to allow rotatory movements of a machine. Can be toothed or smooth, fixed or free rotating.

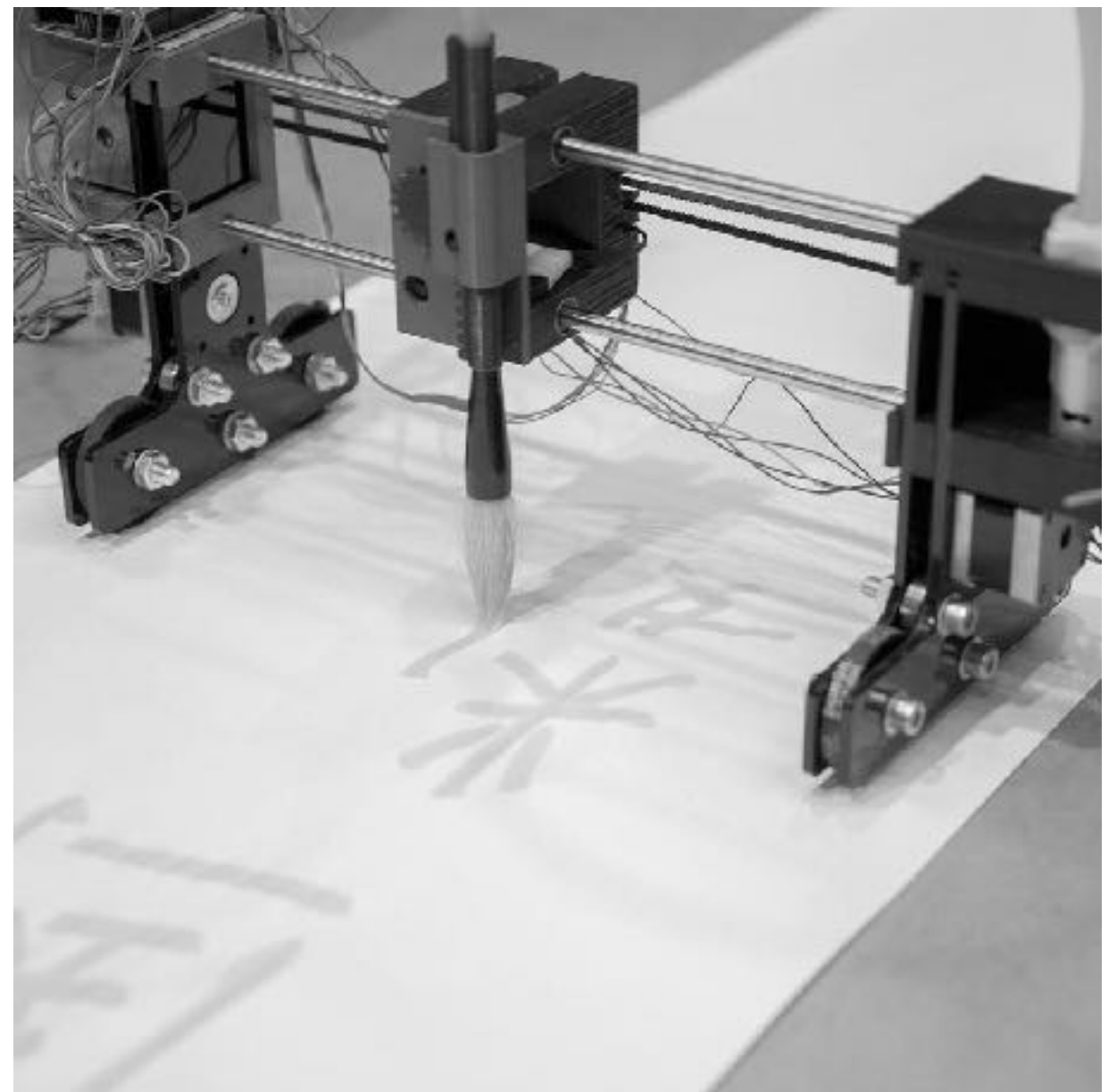
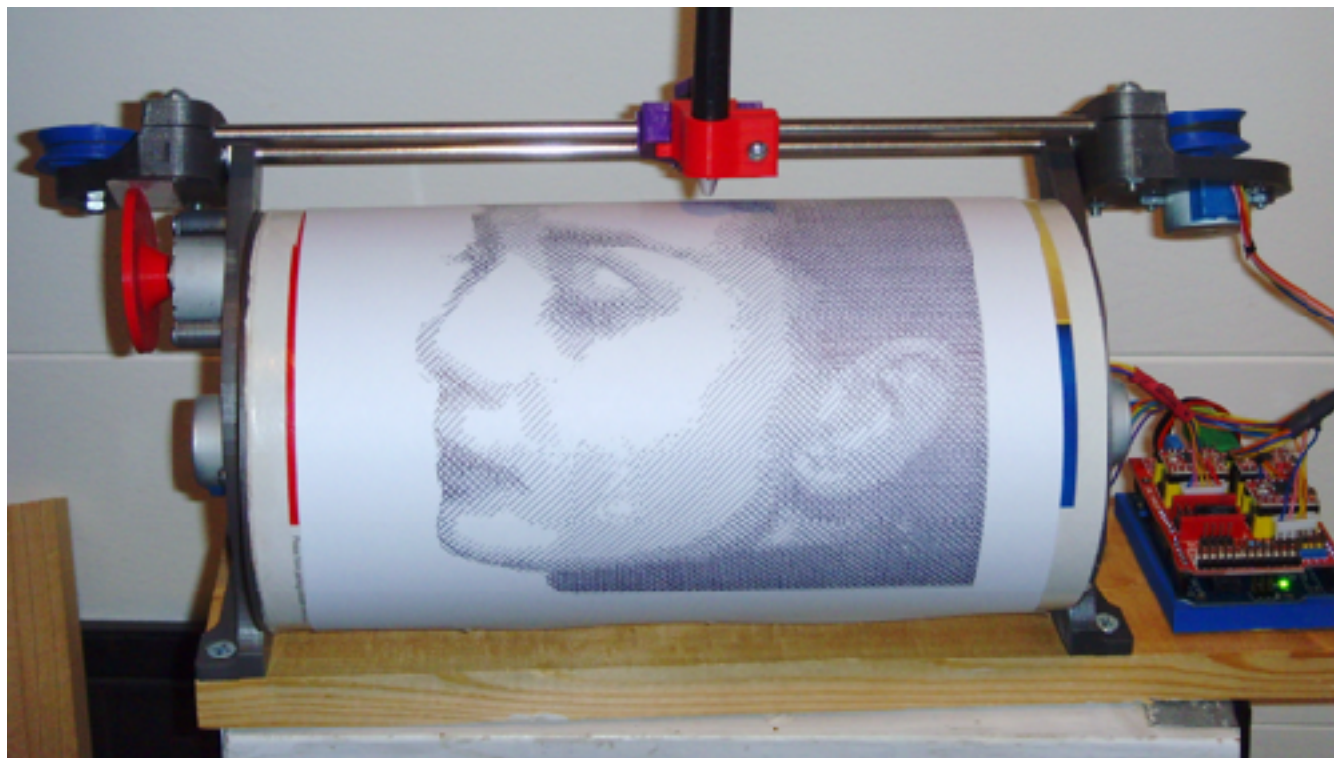


- Toothed: knowing the diameter and the number of teeth, the linear movement of each rotation can be determined.
- Fixed: the pulley has a ring with a set screw to hold it against the motor shaft.
- A smooth pulley is flanged a ball bearings that allows free rotation of the belt.

MACHINES CONFIGURATIONS

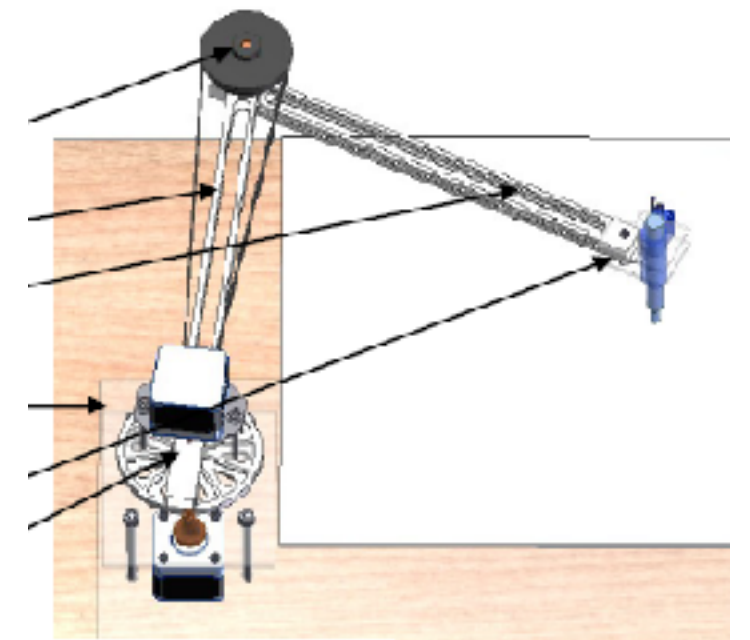
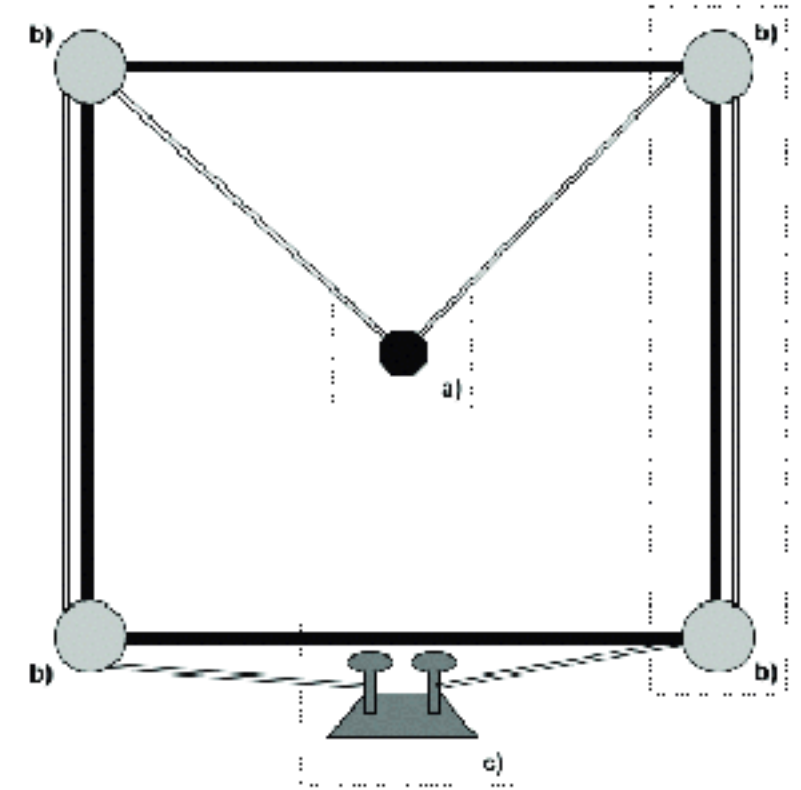
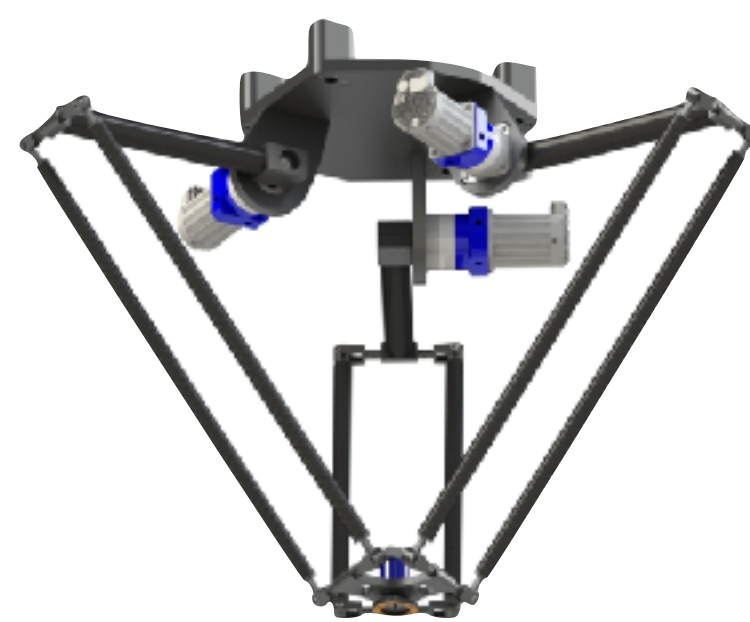
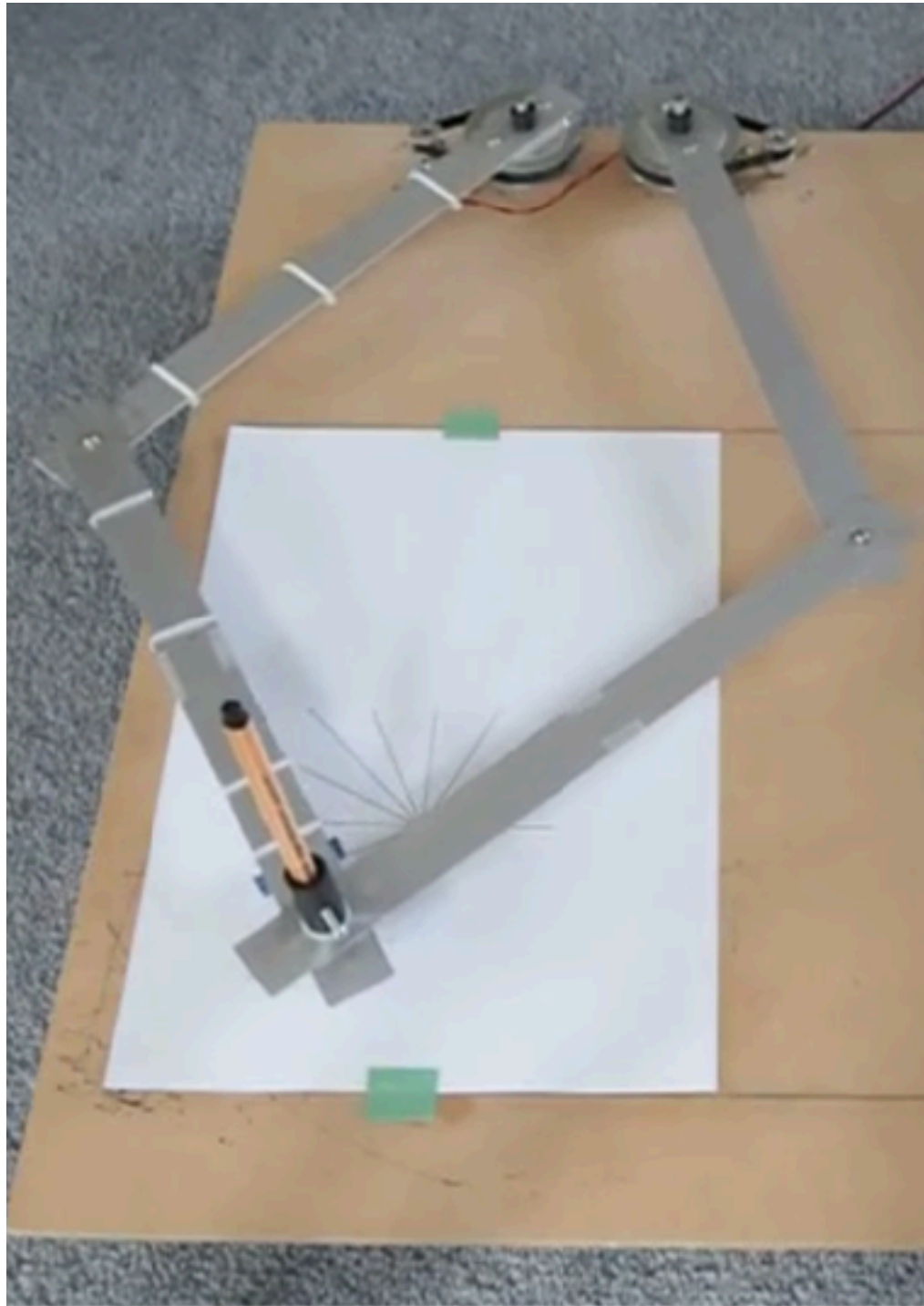


Cartesian: X and Y are linear axis



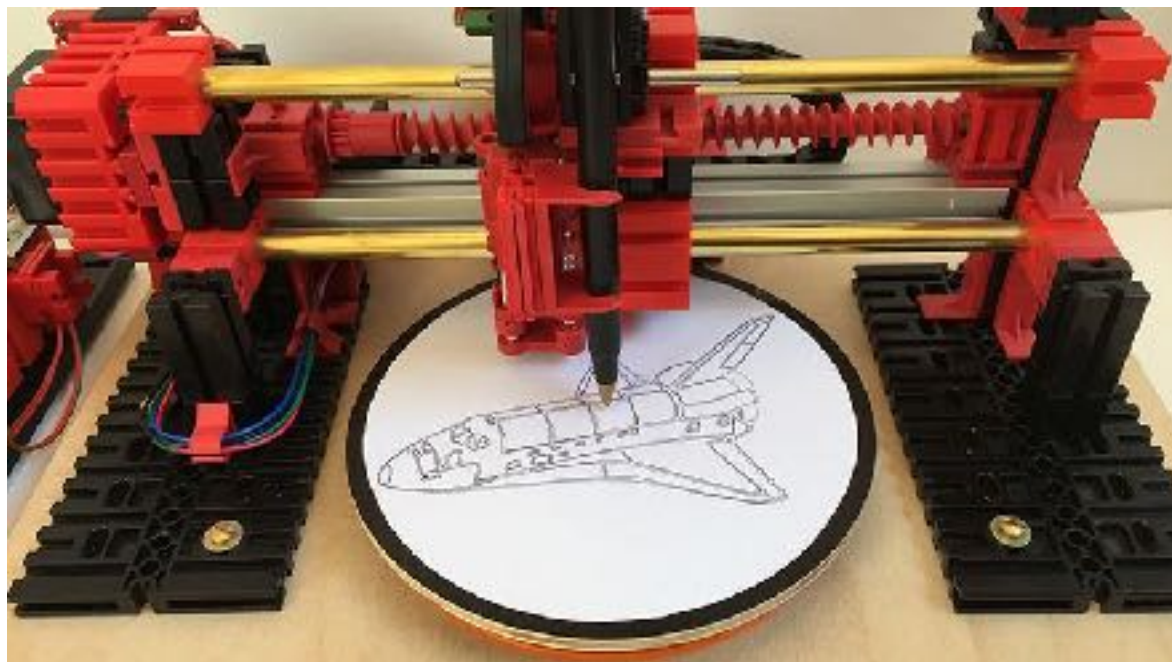
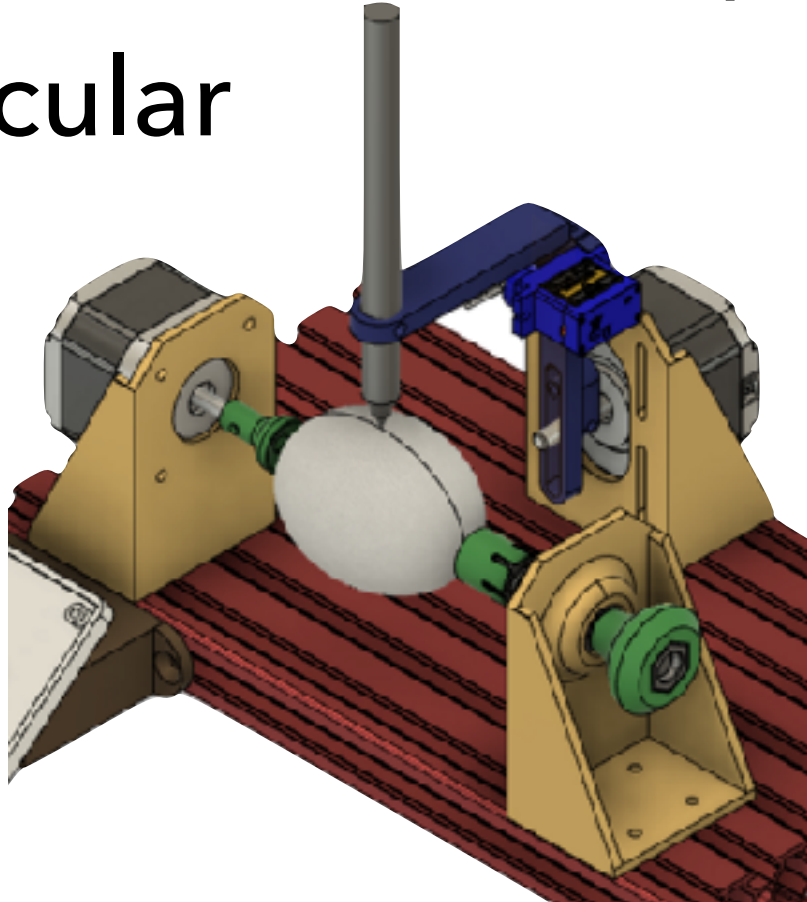
MACHINES CONFIGURATIONS

Panthograph and Delta: uses polar coordinates.

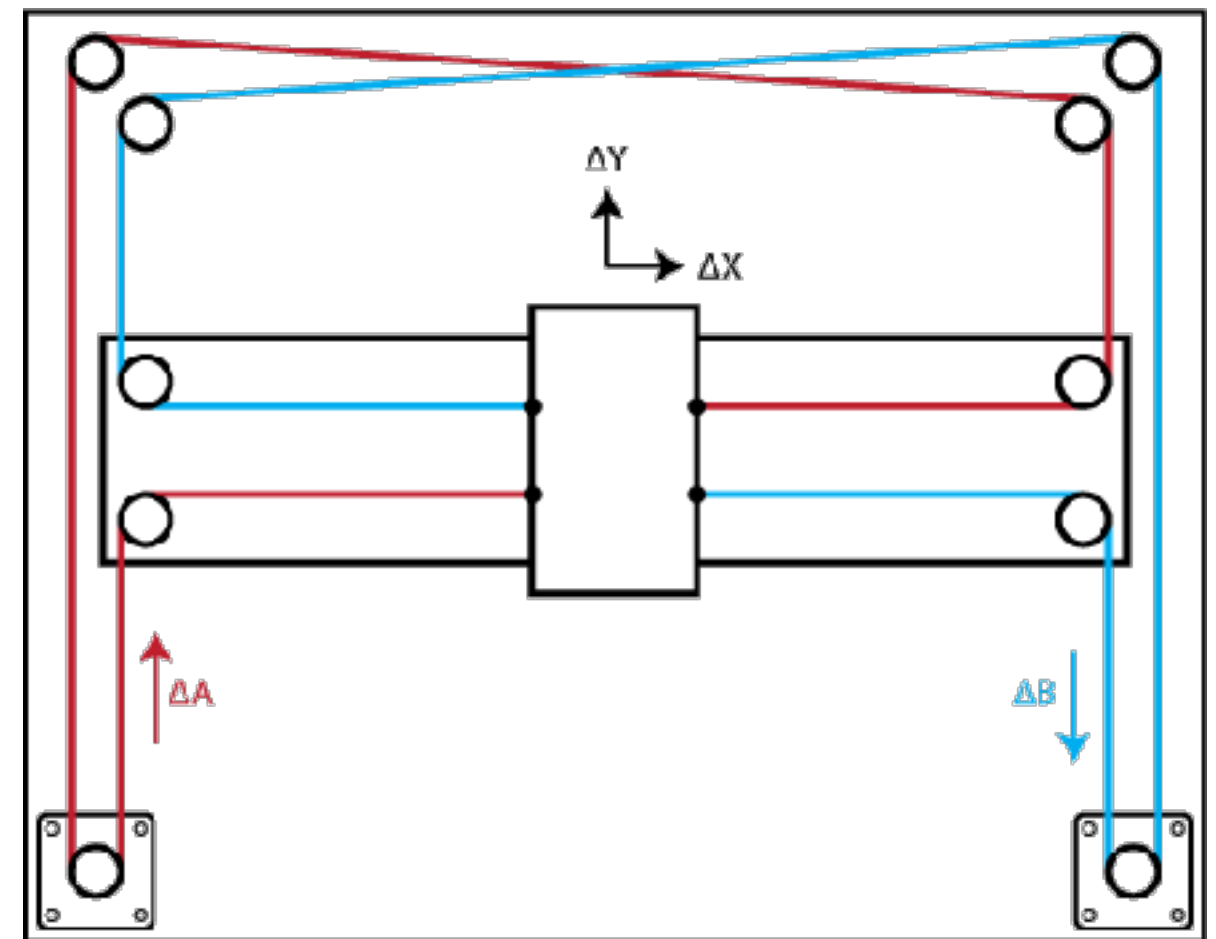


MACHINES CONFIGURATIONS

Other: one linear axis,
one circular
axis



Other: "Core XY"



Equations of Motion:

$$\Delta X = \frac{1}{2}(\Delta A + \Delta B), \quad \Delta Y = \frac{1}{2}(\Delta A - \Delta B)$$

$$\Delta A = \Delta X + \Delta Y, \quad \Delta B = \Delta X - \Delta Y$$

DESIGN OUR OWN MACHINE

MATERIAL LIST

Make a list of materials, components and parts needed.