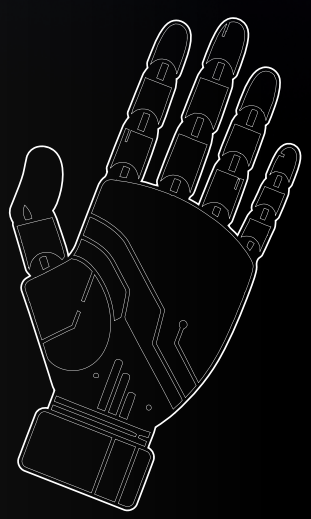
Selecting the Right Actuation Method; Electric, Pneumatic, or Hydraulic?

Selecting an actuation method means trading force density, control precision, and system complexity. Hydraulics deliver the highest force density, electric systems offer greater precision and lower maintenance, and pneumatics prioritize speed and simplicity.

Electric Actuation



Motor and electromechanical actuators driven by electrical power.

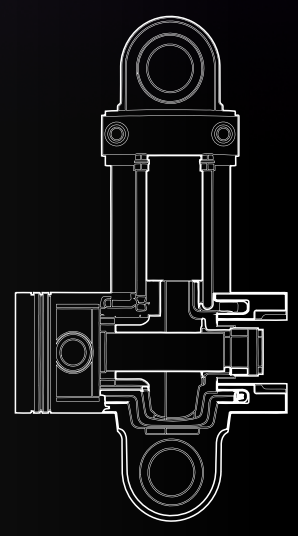
BEST WHEN

- Precision and repeatability matter most
- Weight is an important system constraint
- Clean, low-maintenance operation is a priority

TRADEOFF

Trades precise control and lower maintenance for lower maximum force density.

Hydraulic Actuation



Pressurized fluid driving cylinders or hydraulic motors.

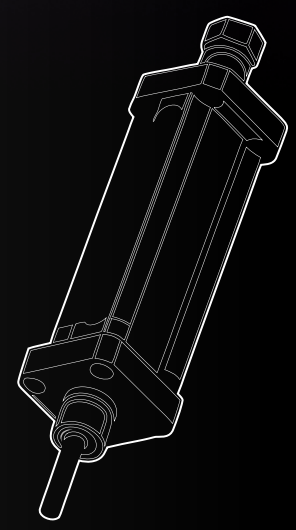
BEST WHEN

- High force is needed in a compact package
- The work is heavy and load-bearing
- Hydraulic power already exists, or the force justifies it

TRADEOFF

Trades maximum force density for higher maintenance and system complexity.

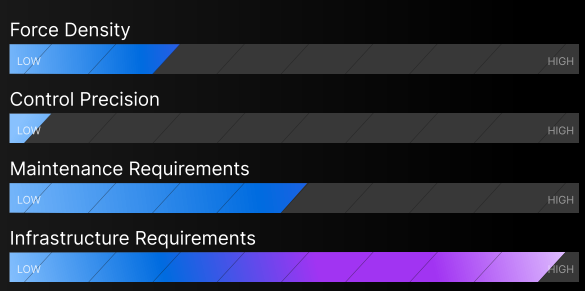
Pneumatic Actuation



Compressed air driving cylinders or rotary actuators.

BEST WHEN

- Motion is simple, fast, and repetitive
- Compressed air is already available
- Cost and simplicity matter more than precise control



TRADEOFF

Trades fast, simple motion for lower precision and energy efficiency.

Actuation Method Selection for Real-World Applications

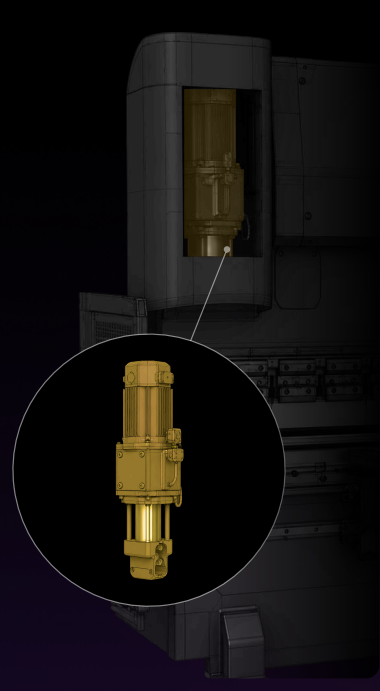
Cobot End Effectors

WHEN THE DEFAULT CHANGES

Pneumatic grippers were the standard: cheap, simple, and easy to run off shop air. Higher-torque motors and linear electric actuators changed that.

DECISION

Electric for many light- to medium-duty grippers due to sufficient force and lower maintenance. Pneumatics remain common for heavier payloads, especially where compressed air is already available.



Press Brakes

WHEN FORCE SETS THE FLOOR

Both hydraulic and pneumatic press brakes bend sheet metal. Force requirement, machine size, and safety decide which one.

DECISION

Pneumatic for lighter-duty work where cost and simplicity are primary constraints. Hydraulic when force requirements climb or high-pressure compressed air adds risk.