

**Motion Control**

Wikipedia defines Motion control as follows: “***Motion control*** *is a sub-field of* [*automation*](https://en.wikipedia.org/wiki/Automation)*, in which the position or velocity of machines are controlled using some type of device such as a* [*hydraulic pump*](https://en.wikipedia.org/wiki/Hydraulic_pump)*,* [*linear actuator*](https://en.wikipedia.org/wiki/Linear_actuator)*, or* [*electric motor*](https://en.wikipedia.org/wiki/Electric_motor)*, generally a* [*servo*](https://en.wikipedia.org/wiki/Servomechanism)*”*

The word 'pneumatic' isn't mentioned in the first instance. So has the main publication on pneumatics, *I Quaderni dell’Aria Compressa*, and the company Metal Work, with 'pneumatic' in its logo, got it right? Indeed they're very closely related, and let's see why.

A **pneumatic cylinder**, which implements movement between retracted rod and extended rod positions, is the most basic example of motion control, I’d say the base unit. They resolve a widespread and frequent problem - implementing movement between two positions with a speed that can be controlled and a force that can be limited, and braking control obtained via pneumatic shock absorbers. It wouldn't be wrong to say that 95% of cases with movement requirements can be solved with the conventional, reliable, cheap and simple pneumatic cylinder. The position reached can be checked by a similarly conventional, cheap and simple magnetic sensor. Anybody who produces pneumatic components can sleep soundly in bed at night.

If a third intermediate position needs to be checked, pneumatics provides simple solutions - multi-stage cylinders or the insertion of an intermediate mechanical stop. Stopping in an intermediate position and relying on the compressed air, via a closed centre valve for example, can only work if the stopping position is very rough and there are no external loads.

**Pneumatic actuators** were developed to check speed and stop with good precision in programmable positions, and they include dedicated drive mechanisms, proportioning valves to check pressure and/or capacity, and linear position transducers. Decent results are obtained in certain applications, but in our opinion the difficulties, limitations and cost of these solutions can't be justified. As the term suggests, compressed air can be compressed, and this makes control more complicated and unstable. This isn't the case with oil, which can't be compressed, so there have always been hydraulic actuators characterised by the possibility of releasing very high forces in small spaces. Pneumatic actuators have to contend with a technological competitor - the electric actuator. The pneumatic actuator loses out on comparison, except in particular applications (e.g. where the use of electricity is not permitted).

If on the other hand it is NOT necessary to control movement and only rod position needs to be known, there are valid solutions around at the moment. Metal Work provides linear **position transducers** that sense the position of a standard cylinder magnet and which are secured to the sensor slot directly. Their great advantage is that they can be used with standard cylinders. There are also solutions that involve the transducer being incorporated within the cylinder, but the disadvantage is that the cylinder is more specific and a fault in the cylinder or sensor would require the whole unit to be replaced. It is not possible to have models with a feed-through rod, the reading cannot be limited to just one section of the range of motion. Conversely, transducers fitted to the outside of standard cylinders can be used on different cylinder types, for example compact and mini-cylinders, and also rotating actuators and grippers.

Electric actuators are the right solution for motion control when it is necessary to position accurately at unspecified values, and control speed and/or acceleration ramps. Both technologies i.e. pneumatic actuators and electric actuators, have come together in what are commonly known as **electric cylinders**. These are electric actuators housed in structures that have the shape of a cylinder. For example, Metal Work has the Elektro ISO15552 series - these seem like cylinders with dimensions in accordance with ISO standards, but in reality an internal recirculating ball screw mechanism transforms the rotation of the motor propelling the rod. This range has diameters from 32 to 100 mm. In practice the diameter is not in itself significant because, size being equal, an electric cylinder can deliver much higher thrust than the pneumatic equivalent. For example, a 32 ø cylinder fed at 6 bar develops a force of approximately 470 N. The Elektro 32 ø brushless 400W motor can deliver a constant 2800 N. The Elektro 100 ø can deliver 15000 N compared with 4600 N from the corresponding pneumatic model.

Various types of motor control can be used for electric cylinders, such as brushless, stepper and DC motors. It's impossible to say beforehand that one solution is better than another, it all depends on the application. It is important to select and scale the cylinder, motor and drive mechanism correctly to avoid unexpected issues at the time of commissioning. It doesn't pay to use a sledge hammer to crack a nut - it can be expensive and cause damage. The support of sales technicians is fundamental for making the right choice. Metal Work has a trained team of specialists in the main countries in Europe who not only have **Easy Elektro**®, powerful calculation and test software, but who have also acquired experience in the various applications and can benefit from a bank of information shared between colleagues.

There are no electric cylinders comparable with traditional pneumatic cylinders with a piston rod but there are models comparable with **cylinders without a piston rod**. These have an aluminium sleeve and a carriage that runs along the sleeve groove. The transformation of the rotation of the motor shaft in linear movement can typically take place in two ways - in the case of reduced speeds and high forces the recirculating ball screw mechanism is used; for higher speeds a toothed belt with pulley is used. The sleeve can also accommodate the load support and runner system internally or externally, which may be a sliding mechanism or have ball recirculating runners.

As illustrated, motion control applications, be they pneumatic or electric, can use a large variety of construction and technical solutions. What seems increasingly clear is that one technology doesn't have the edge over the other, they are equally valid, and the user can always choose the most appropriate option. Metal Work has set up an exhibition to illustrate this **complementarity** visually and via model representation. This is displayed at trade fairs and has been eloquently named 'illuminated path', consisting of a path between two rows of actuators, with pneumatic actuators on the right and the equivalent electric actuators opposite on the left. Here it is possible to see the pneumatic round cylinder opposite the Elektro Round DC model, powered by a simple DC motor. The pneumatic ISO15552 cylinders are opposite the Elektro ISO15552, the rodless STD series is opposite the Elektro Rodless with ball screw, and so the list goes on. At the end of the path is the LEPK series pneumatic Pick & Place model, with two orthogonal 90° movements placed opposite the equivalent Elektro SHEK model.

Starting to use electric cylinders **isn't easy** for many people, and basically requires skill in programming and managing drive mechanisms. This is a real obstacle for companies that do not have specific expertise in electric automation. An additional stumbling block is that every type of motor has its own drive mechanism with management differences. Furthermore, cycles, changes and sequences are managed via PLCs, but not all machines have a PLC, raising another issue for those who do not want to be involved in programming a PLC to operate a cylinder. Metal Work has developed an electronic device known as **Motion** to address this problem, which aims to simplify motor drive management as much as possible. Motion's main objective, the most basic requirement, was as follows: anyone using an electric cylinder must be able to have the same ability as when using a pneumatic cylinder controlled by an electronically-controlled valve and monitored by no more than two magnetic sensors. The following was another requirement: it must be possible to interface Motion with any other drive mechanism with any power rating, be it brushless or stepper motors, so that one device which is easy to manage and relatively cheap works for all applications. The product which transpired after years of research and testing meets these requirements, and it can also manage more complex applications and more sophisticated programs if necessary, making it a programmer for all seasons!

Giorgio Guzzoni

Product Manager at Metal Work S.p.A.

Fig. 1 *transducer*

Metal Work's LTS series position transducer - secured in the slot for standard cylinder sensors, makes it possible to know the exact position of the piston/rod. Can be secured to various standard cylinder types in addition to rotating actuators and grippers.

Fig. 2 *electric cylinders*

Metal Work's electric cylinders include small round models, ISO15552 models, rodless screw models and toothed belt models.

Fig. 3 *illuminated path*

The sequence of cylinders demonstrates how each pneumatic actuator corresponds to an electric model via a model representation. To the left are the following pneumatic cylinder models: round, ISO15552 ø 32 and ø 100, rodless, rodless for heavy loads, pick & place. The equivalent electrically-operated models are to the right.

Fig. 4 *Motion*

This Metal Work device, known as Motion, makes it possible to programme electric actuators with ease. It is designed for anyone not familiar with managing drive mechanisms and PLCs. It can be connected to any drive mechanism with brushless or stepper motors of any power rating.