The 4 Fundamentals
of Industrial Automation

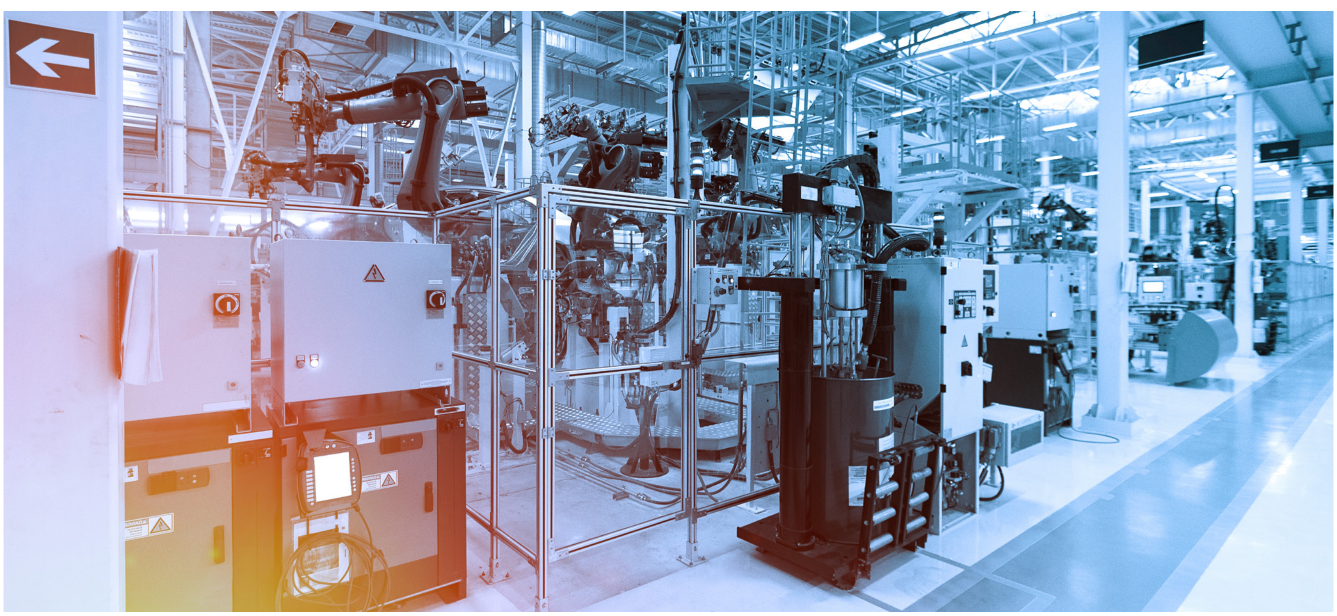
Manufacturers need to stay competitive in a global marketplace. Customer demand drives every aspect of production: from product quality and manufacturing efficiency, to delivery time and stock availability.

To help with these demands, more manufacturers are turning to industrial automation and innovative smart manufacturing systems. To achieve full IIOT (Industrial Internet of Things), industrial automation first needs to be addressed.

What is Industrial Automation?

Industrial automation is the use of control systems and sophisticated equipment in a production environment. This includes robots, various sensors, and computers; performing tasks that were previously done manually. These systems will operate without significant human intervention or oversight, improving the quality and repeatability of repetitive operations.

Automated platforms share many key elements, each with their own criteria for success. Here's the run-down of the 4 fundamentals, with the biggest element first.



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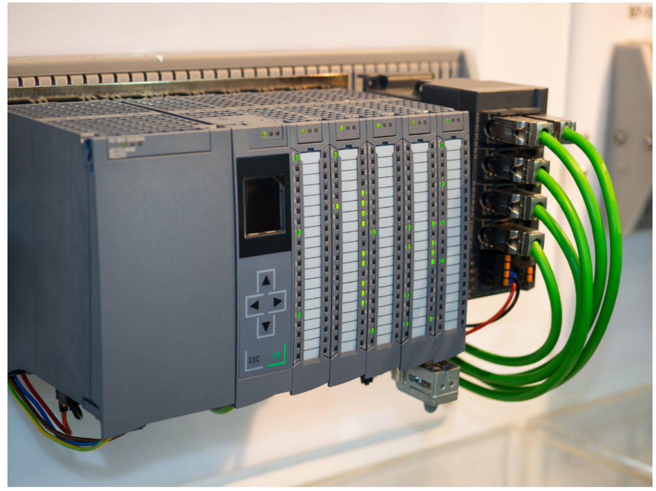
1 – The Programmable Logic Controller (PLC)



The PLC is a digital processor, controlling any automated equipment by constantly monitoring input lines from sensor devices, and providing the action command to react to these specific input signals.

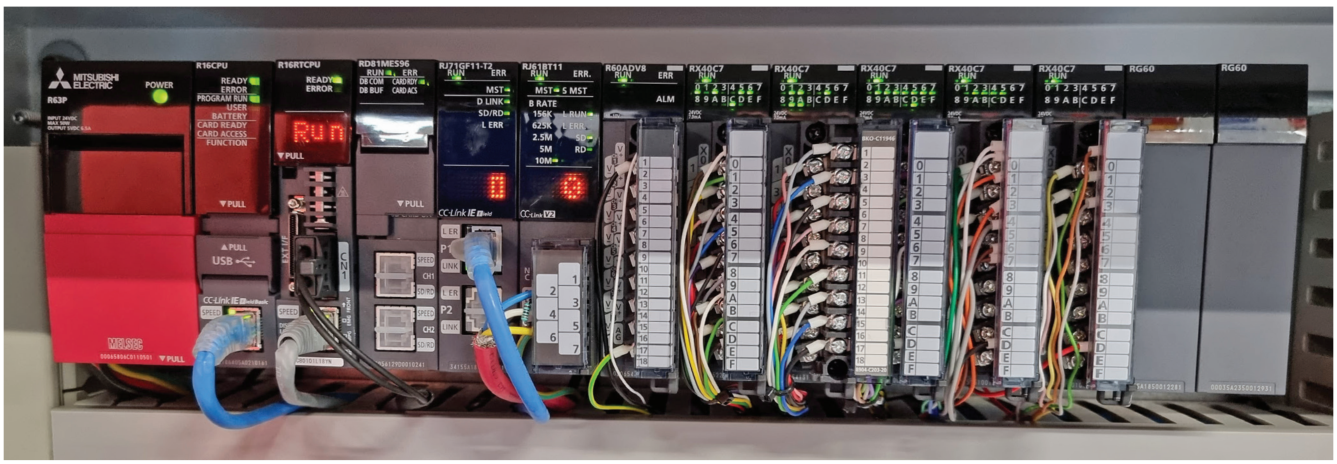
PLCs can handle multiple I/O arrangements. They can withstand a range of temperatures, electrical noises, vibrations, and impacts. Integrating a PLC into any production line or mechanical process is highly beneficial. Operation processes are easily changed or replicated, and important situational information and statistics are collated and communicated.

PLCs have been a main component of machine control for many years, but the level of sophistication is on the rise thanks to Industry 4.0 and IIOT (Industrial Internet of Things).

We can split the PLC into its own fundamental elements for a more detailed analysis:

- **Central Processing Unit (CPU) or Embedded Computer:** A microprocessor-based computer brain, often on a single board. It executes the control programs after reading and processing the input signals, then sends out applicable response commands on output channels.
- **Input/ Output section:** I/O modules act as the real-time data interface between the machine interfaces and the CPU. It is mainly a data transfer system, but may also do some initial data conversion into signals that can be recognized by the CPU (for input) or the machine interfaces (for output).
- **Programming device:** This is often a separate device, like a PC or similar terminal, using Human/Machine Interface software (HMI). The CPU is connected to this device through a communication link. Being able to re-program PLCs through an interface makes them very flexible, and eliminates the need for re-wiring or adding additional hardware for each new logical configuration. The devices can also control multiple complex systems at the same time, making them cost-effective.

- **Gateway interface:** Enables communication with other processor-based devices, or for remote troubleshooting. The data transfer might be via a field bus or by IP-based protocols, such as: simple serial (RS-232 or 485), ModBus, Profibus, Ethernet, Profinet, CanOpen, etc. Most of these standardized protocols were invented and implemented by specific manufacturers (Siemens, Alan Bradley, Omron, Beckhoff, etc.) so this will need considering at installation.
- Power supply: All the elements of the PLC will need a power supply to function – separate ones will be required for any remote PLC devices. Uninterruptible Power Supplies (UPS) may be required for continuous operation or areas with poor electricity supply.



Automation on the Harwin assembly line: Power supply, PLC, communications and input modules

PLCs typically come in two formats – compact and modular. Compact PLCs are a standalone device containing all the necessary devices. Modular PLCs start with a main module, and additional expansion modules can be fitted for more functions, upgrades or larger installations.

It is important to consider the impact of the local environment on the PLC at installation, such as vibration, shock, dust and electro-magnetic interference (EMI). For minimal protection, PLCs are securely mounted into a metal cabinet with a seal rated to IP21. At external or contaminated locations, a higher IP rated seal is recommended to prevent dust and water damage. Temperature issues can be addressed with basic cooling functions or a fully temperature-controlled enclosure. The metal enclosure will also shield against EMI. Further shielding inside the cabinet may also be required if other EM transmission sources are mounted in the same panel. This could include inverters, switching power supplies and variable speed drives.

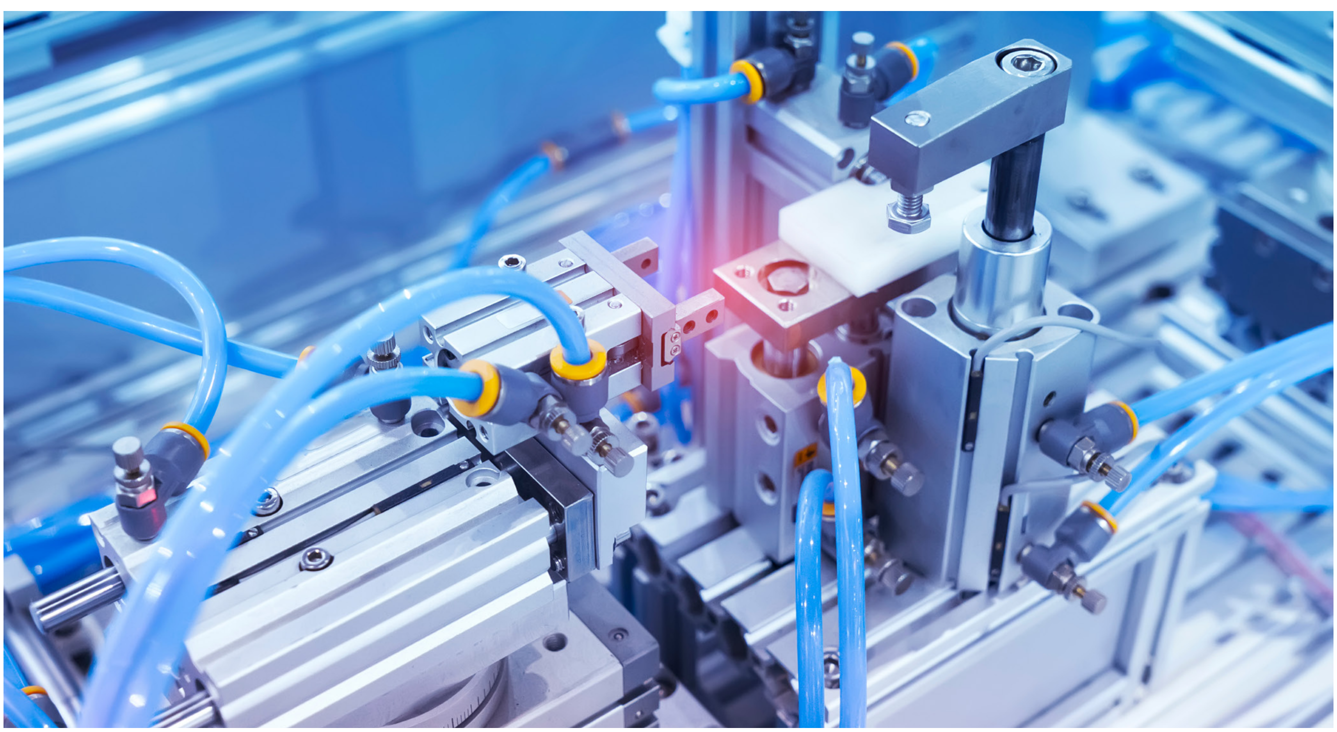
2 – Input/Output devices

Input device: a device used to provide data and control signals to an information processing system (IPS) such as a PLC (via its I/O system) or other control mechanism. A commonly used name is field sensor. Examples include:

- Human interaction devices – switches and push buttons, keyboards, touch screens
- Sensing devices – proximity sensors, photoelectric sensors, ultrasonic sensors
- Mechanically-activated switches – limit switches, vacuum switches, temperature switches, level switches, pressure switches

Output device: a device used to act on the results of data processing carried out by an IPS, translating the processing back into an action required by the automated machinery under control. A commonly used name is actuator. Examples include:

- Mechanical movement – pneumatic or hydraulic cylinders, magnetic valves, motor starters, control relays, pumps, fans
- Visual or Auditory feedback - horns and alarms, stack lights
- System feedback – electronic alerts via messaging systems



As these devices are in the same location as the automated operation under control, it will experience the same environment as the automated process but also factors resulting from the process itself. Temperatures could be very high or very low, vibration and other mechanical stresses may be present. Contaminants such as water, mist, oil spray, UV light, sparks, etc. could surround the device. Pay careful consideration to the operating conditions, and if the device itself does not come with adequate protection then additional defense is needed.

3 – Safety automation – safety devices

As a factory becomes more automated, it is vital we protect the humans working in these spaces. Devices are necessary to prevent operators, technicians and maintenance specialists from any harm when operating or troubleshooting machines. A safety-first policy is the right policy in the automated arena.

Many safety devices are designed to halt the automated device as quickly as possible once a human presence is detected. Mechanical devices such as door switches are mounted on handles or hinges of safety cages or screens, and they halt the process inside as soon as the cage is opened. These are often employed when a visible physical barrier is already necessary to protect from debris flying around, marking pedestrian areas between workspaces.

Optoelectronic sensors such as light curtains or laser scanners use invisible laser light to detect foreign objects in proximity to the machine. These are great on production lines that don't need a physical barrier, and access is required often.

Other safety devices might include gas or fire detection, with sound warnings or extraction/suppression systems.

4 – Robotics

Robotics used in industrial automation are an evolution of the automated machinery, designed to closer mimic the flexibility of a human operator. Most industrial robots are based on a single arm, with 6-axis movement:

Axis 1 - Rotates robot (at the base of the robot)

Axis 2 - Forward / back extension of robot's lower arm

Axis 3 - Raises / lowers robot's upper arm

Axis 4 - Rotates robot's upper arm (wrist roll)

Axis 5 - Raises / lowers wrist of robot's arm

Axis 6 - Rotates wrist of the robot's arm

These robot arms can be under the control of higher-level systems, but often have their own control package for standalone operation.

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Robot arms are very flexible machines that can substitute and replicate human actions in very dangerous and harsh environments. They are often seen in welding, painting, plastic and metal forming, and feeding hammering machines. Their flexibility means they can be programmed with many different tasks, and moved around a factory as the capacity requires – sometimes a new program is the only change required.

The latest addition to robotic automation is the cobot – a robot arm designed to work within the same space as a human. The arm will typically have coverings or padding so there are no sharp edges. It will have many sensors to halt or reverse motion when it encounters any other object, as that object might be a human.

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