Principles of PLC and its Application

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The first PLC was developed by a group of engineers at General Motors in 1968, when the company were looking for an alternative to replace complex relay control systems.
Definition of a PLC:

A Programmable Logic Controller, or PLC for short, is simply a special computer device used for industrial control systems. They are used in many industries such as oil refineries, manufacturing lines, conveyor systems and so on. Wherever there is a need to control devices the PLC provides a flexible way to "soft wire" the components together.
The new control system had to meet the following requirements:

• Simple programming
• Program changes without system intervention (no internal rewiring)
• Smaller, cheaper and more reliable than corresponding relay control systems
• Simple, low cost maintenance
A Simple Example

Consider something as simple as a switch that turns on a light. In this system with a flick of the switch the light would turn on or off. Beyond that though there is no more control. If your boss came along and said I want that light to turn on thirty seconds after the switch has been flipped, then you would need to buy a timer and do some rewiring. So it is time, labor and money for any little change.
A PLC Saves the Day

Now consider the same device with a PLC in the middle. The switch is fed as an input into the PLC and the light is controlled by a PLC output. Implementing a delay in this system is easy since all that needs to be changed is the program in the PLC to use a delay timer.

This is a rather simple example but in a larger system with many switches and lights (and a host of other devices) all interacting with each other this kind of flexibility is not only nice but imperative.
How PLCs Work:

A programmable logic controller is a specialized computer used to control machines and processes. It therefore shares common terms with typical PCs like central processing unit, memory, software and communications. Unlike a personal computer though the PLC is designed to survive in a rugged industrial atmosphere and to be very flexible in how it interfaces with inputs and outputs to the real world.
Main Units and Structure of a PLC

A PLC consists of the following main parts:

- CPU (Central processing unit)
- Input modules
- Output modules
- Power supply unit and the Rack
- Programming device

**CPU:** CPU or the Central Processing Unit is the heart of the PLC system. It executes the control instructions of the control logic program. It also communicates with other devices, which can include I/O Devices, Programming Devices, computers, Networks, and even other PLCs and also performs diagnostics tasks. The CPU reads input data from various sensing devices, executes the user program from memory and sends appropriate output commands to control devices.
The CPU consists of a microprocessor, memory chip and other integrated circuits to control logic, monitoring and communications. The CPU has different operating modes. In *programming mode* it *accepts* the downloaded logic from a PC. The CPU is then placed in *run mode* so that it can execute the program and operate the process.
**Input modules:** They are used for *interfacing* between input devices (such as start and stop push buttons, sensors, limited switch, selector switch) and microprocessor. The input devices which are in the field or remote locations are hard-wired to terminals on the input modules. Input modules accept signals from the machine or process devices and convert them to lower signals, such as 5VDC which are sent to the controller for processing. The input module also protects the processor from bs in input signal voltages or currents.

**Output modules:** Output devices which are located in the field or remote locations such as small motor, motor starters, solenoid valve, and indicator lights are hard wired to the output modules. The output interface modules *convert* the controller or processor signals into external signals which are used to control the output devices.
**Power Supply Module**: This module provides the direct current (DC) power source required to produce low-level voltage used by processor and I/O modules. Depending on the PLC manufacturer, the power supply can either be housed in the CPU unit or may be mounted a separately mounted unit.
The rack is the component that holds everything together. Depending on the needs of the control system it can be ordered in different sizes to hold more modules. Like a human spine the rack has a backplane at the rear which allows the cards to communicate with the CPU. The power supply plugs into the rack as well and supplies a regulated DC power to other modules that plug into the rack. The most popular power supplies work with 120 VAC or 24 VDC sources.
What Languages Are Used To Program PLCs:
The earlier PLCs used *simple ladder logic*, similar to electrical schematic diagrams, for setting up the logic and sequence. The electricians were able to trace out circuit problems with schematic diagrams using ladder logic. This program notation was chosen to reduce training demands for the existing technicians. While Ladder Logic is the most commonly used PLC programming language, it is not the only one. The following are some of the commonly used languages used to program a PLC:

Ladder Diagram (LD): The traditional ladder logic is a graphical programming language. Though initially it used simple contacts that simulated the opening and closing of relays, later it expanded to include counters, timers, shift registers, and math operations.

Statement List (STL): A high level text language that uses structured programming. It follows a structured syntax and supports a wide range of standard functions and operators.
example: Tank Used to Mix Two Liquids

Diagram: Motor connected to solenoids A, B, and C with a float switch (FS). Timer set for 1 minute.
A tank is used to mix two liquids. The control circuit operates as follows:
1. When the start button is pressed, solenoids A and B energize. This permits the two liquids to begin filling the tank.
2. When the tank is filled, the float switch trips. This de-energizes solenoids A and B and starts the motor used to mix the liquids together.
3. The motor is permitted to run for one minute. After one minute has elapsed, the motor turns off and solenoid C energizes to drain the tank.
4. When the tank is empty, the float switch de-energizes solenoid C.
5. A stop button can be used to stop the process at any point.
6. If the motor becomes overloaded, the action of the entire circuit will stop.
7. Once the circuit has been energized it will continue to operate until it is manually stopped.
Example: Entry/Exit Control of the Underground Car Park

- The entry/exit of the underground car park is a single path passage which needs the traffic lights to control the cars. Red lights prohibit cars entering or leaving while green lights allow cars to enter or leave.
- When a car enters the passage from the entry of the ground floor, the red lights both on the ground floor and the basement will be ON, and the green lights will be OFF. Any car entering or leaving is prohibited during the process till the car passes through the passage completely. When the passage is clear, the green lights will be ON again and allow other cars entering from the ground floor or the basement.
- Similarly, when a car leaves the basement and enters the passage, any other car entering or leaving is prohibited till the car passes from the passage to the ground completely.
- When PLC runs, the initial setting of traffic lights will be green lights ON and red lights OFF.
Red Light  Green Light

Entry/Exit of the Ground Floor

Singal Lane Passage

Entry/Exit of the Basement
THANK YOU
FOR YOUR ATTENTION