ECT
Engineering College of Technology.

The Impact of Industrial Automation Case-Study

Dr. Abdu Shaalan
Industrial Automation programme leader

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UKPRN: 10089771

About ECT

Engineering College of Technology.

We are dedicated to ensuring that you receive a world-class education and gain skills that you can immediately apply in the workforce.

World-Class Accredited Education

ECT is OfS registered and accredited, meeting the Office for Students' requirements for course quality, academic standards, student support and student protection.

Engineering Specialists

ECT - affiliated to the well-established Engineering Institute of Technology (EIT) - is an engineering education specialist. ECT delivers professional certificates, bachelor's and master's degrees.

Lecturers and Instructors

Our teachers are subject specialists with industry experience and the requisite academic qualifications. The online platform allows ECT to source them from a large, global pool of expertise.

Industry-Driven Programs

Our programs are designed by industry experts, ensuring you graduate with cutting-edge skills that are valued by employers. Our program content remains current with rapidly changing technology and industry developments.

Unique Delivery Model

We deliver our programs via a unique delivery methodology that makes use of live and interactive webinars, an international pool of expert lecturers, dedicated learning support officers, hands-on workshops and state-of-the-art remote labs connected to real equipment, and simulation software.

Introduction - Presenter

Dr. Abdu Shaalan

Dr. Abdu Shaalan is a PhD holder in the fields of Industrial Automation and Advanced Maintenance practices from the University of Sunderland.

He is a research enthusiast and has held multiple research projects over the years, including a research fellowship with the nursing school, several KTP projects with local manufacturers, and was recently awarded a Teaching Fellowship in AI in Education.

Abdu's research focus is on Industrial Automation and Advanced Maintenance practices in the advances of Industry 4.0 technologies.

Teaching-wise, Abdu held multiple programme lead positions ranging from Undergraduate and Postgraduate levels.

Abdu values the link between teaching, research, and industry through research-led education that bridges the gap between academia and industry, ensuring graduates are ready for industry upon graduation.

Currently a programme leader for Undergraduate and Postgraduate Industrial Automation programmes at ECT, he ensures students are supported and provided with high value education that competes with world class education.

Agenda

Industrial revolutions
How production lines operated
What is a PLC
Inputs
Outputs
What is hydraulic press
Case Study
Developed control system
Impact of developed system on PUWER

Industrial revolutions

- The transition from hand production methods to the use of machines started at the 17th century and kept developing till the current time.
- The Manufacturing sector had Four main revolutions that changed the industry dramatically.

1st Revolution (1780's – 1870's)

The first use of steam as main power source

2nd Revolution (1870's – 1960's)

- Started from Britain- Germany and the US
- The use of Electricity and Fossil fuel in industry
- The beginning of production lines
- Mass production
- Development in Steel and Rail production

How production lines operated

A typical relay Control Panel could have hundreds of relays

How production lines operated

Think about modern factories, and how many motors and ON/OFF power switches you would need to control just one machine. Then add on all the control relays you need and what you get is… a logistical nightmare.

All these relays had to be hardwired in a very specific order for the machine to work properly, and if one relay had an issue, the system as a whole would not work.

Troubleshooting would take hours, and because coils would fail and contacts would wear out.

These machines had to follow a strict maintenance schedule and they took up a lot of space. Then what if you wanted to change something? You would basically have to redo the entire system. It soon became clear that there were problems installing and maintaining these large relay control systems.

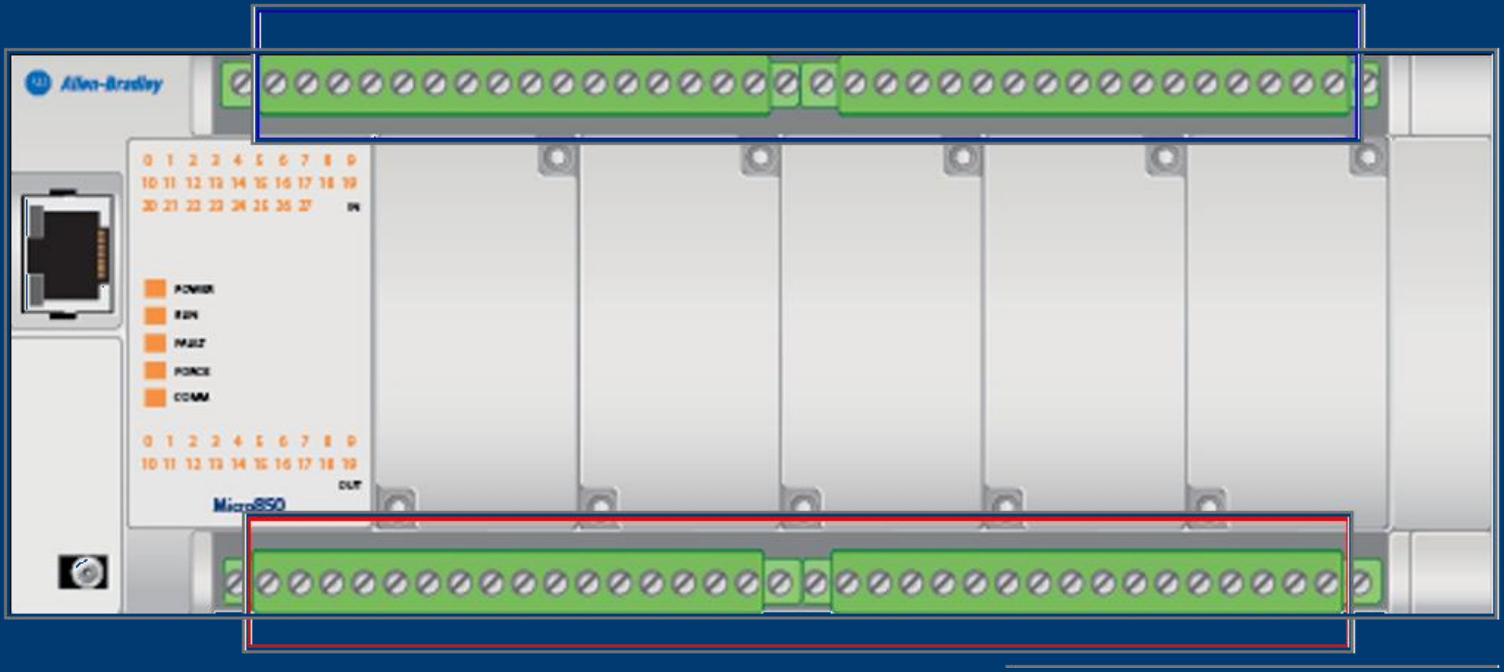
Third Industrial Revolution (1960's – early 2000's)

- The first Introduction of the Automation systems
- The use of computers
- Manipulators and Robotic arms

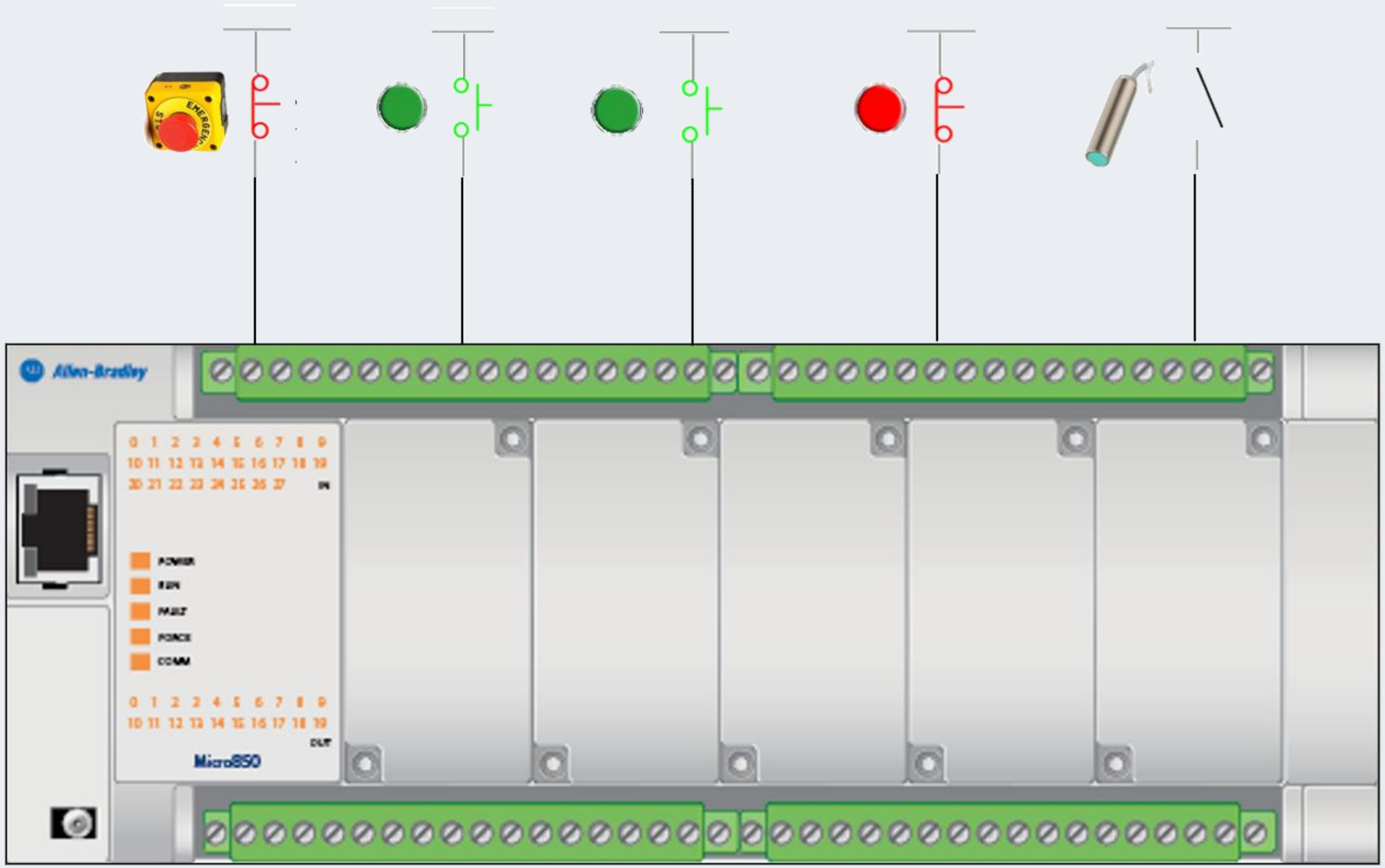
What is a PLC

Intelligent device that operates based on a preprogrammed logic to control Inputs and Outputs.

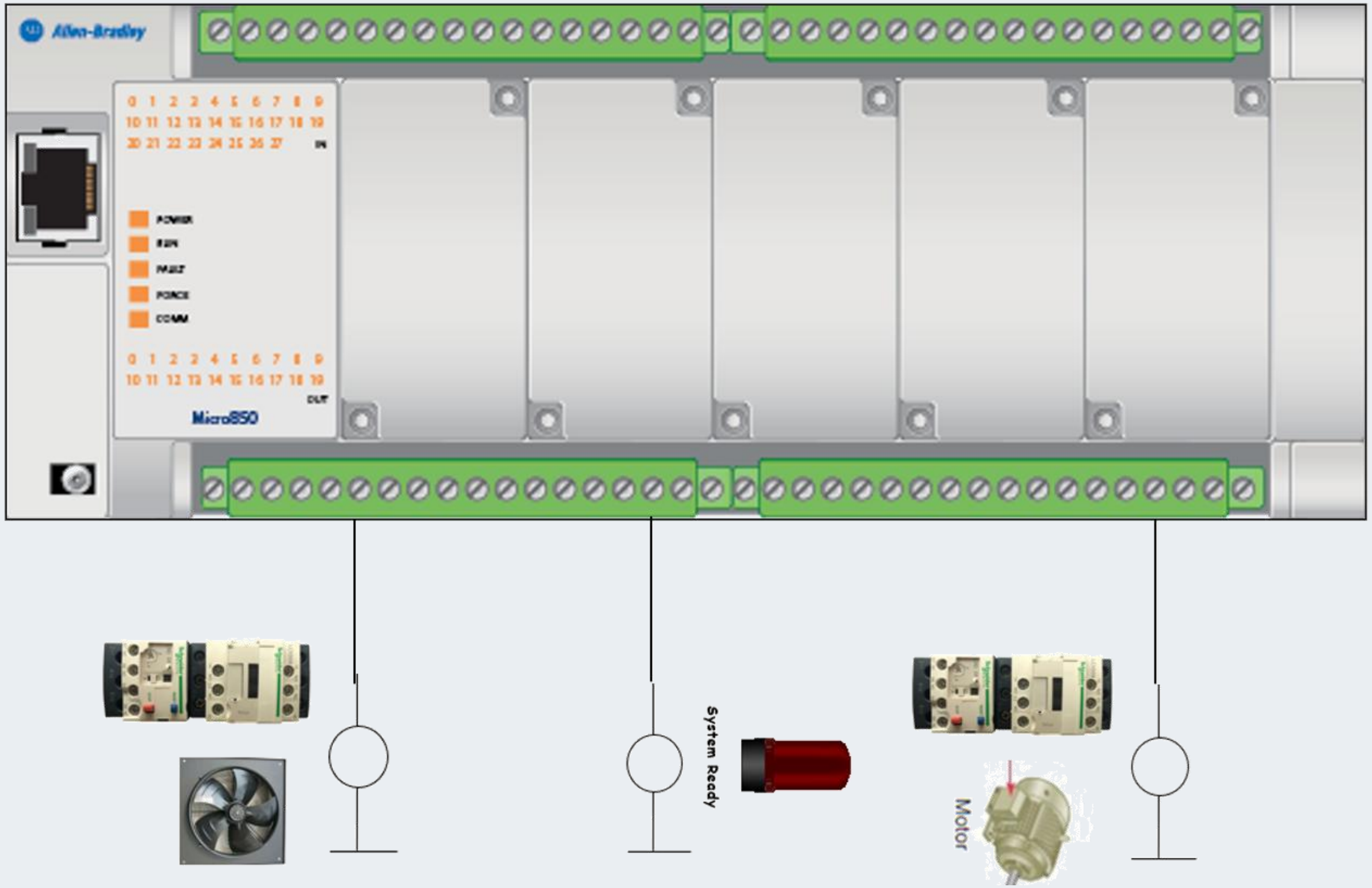
It has designated connections to inputs and outputs to interact with field devices.



Inputs



Outputs


Allen-Bradley
POWER
RUN
FAULT
FORCE
COMM
Micro850
System Ready
Motor

What is hydraulic press

- A hydraulic press is a machine that uses pressurised fluid, typically hydraulic oil, to generate and transmit compressive force through a piston-cylinder arrangement.
- It converts fluid pressure into controlled mechanical work, governed by Pascal's Law, whereby pressure applied at one point is transmitted equally throughout the fluid
- Common operations include forming, stamping, forging, punching, blanking, and press-fit assembly across manufacturing sectors.
- They come in different sizes and powers.

Hydraulic presses generational evolution

1st generation

Manually operated, mechanical valve control, basic pressure relief, entirely operator-dependent with no automated sequencing

2nd generation

Electro-hydraulic systems introducing relay logic, limit switches, and solenoid valves, enabling semi-automated and repeatable press cycles

3rd generation

PLC-based control with proportional and servo valves, closed-loop pressure and position feedback, significantly improving process precision and consistency

4th generation

Smart, network-connected presses integrating real-time condition monitoring, servo-hydraulic drives, HMI interfaces, and data-driven predictive maintenance capabilities

Our case-study

2nd generation hydraulic press with operations deficiencies.

Improvement stages

Stage 1: Investigation

- Machine studied across four domains: mechanical, electrical, hydraulic, and control
- Mechanical: chassis inspection for cracks, ram condition and motion, associated components
- Electrical: motors, pumps, fans, sensors and switches — specifications, integrity, and wiring requirements
- Hydraulic: fluid condition, directional control valves (DCVs), fluid lines, and operation sequence
- Control: automation requirements scoped from actuator and sensory device perspectives
- Overall parts quality assessed to confirm machine is within safe operating condition

Stage 2: Guard system design

- Safety-first approach integrated into automation planning from the outset
- Pneumatic-operated, PLC-controlled guard door designed to physically isolate the press during operation
- Eliminates human intervention risk during active press cycles
- Pneumatic position detector mounted inside the cylinder provides continuous open/closed feedback to the PLC

Improvement stages

Stage 3: Requirements identification

- Electrical components selected to deliver appropriate power ratings for each press component
- PLC and HMI selected for machine monitoring and control
- OPC-UA communication protocol adopted to enable future integration with wider systems or software

Stage 4: Monitoring tools

- Existing pressure and temperature sensors retained but enhanced with additional sensing devices
- Extra temperature and detection sensors added to the main motor and surrounding area
- Pressure and temperature deviations used as early warning indicators of abnormal behaviour
- Early detection approach aimed at preventing failures before they escalate
- Guard door status integrated into HMI monitoring for continuous security feedback

Improvement stages

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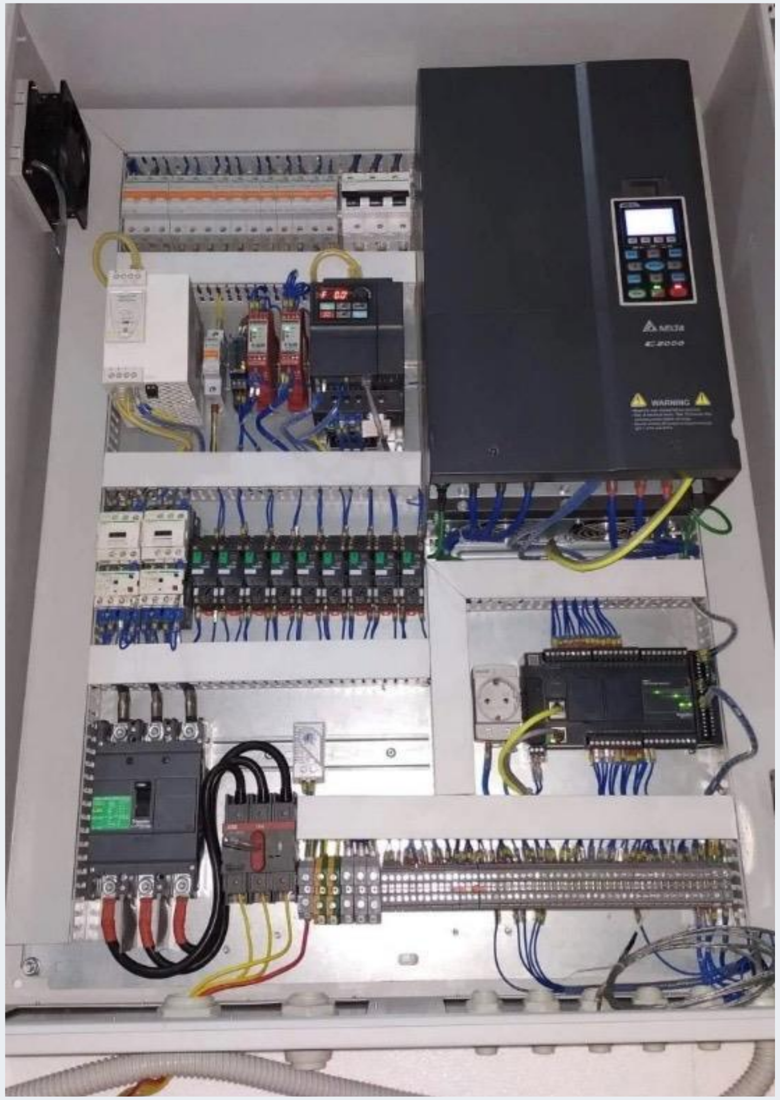
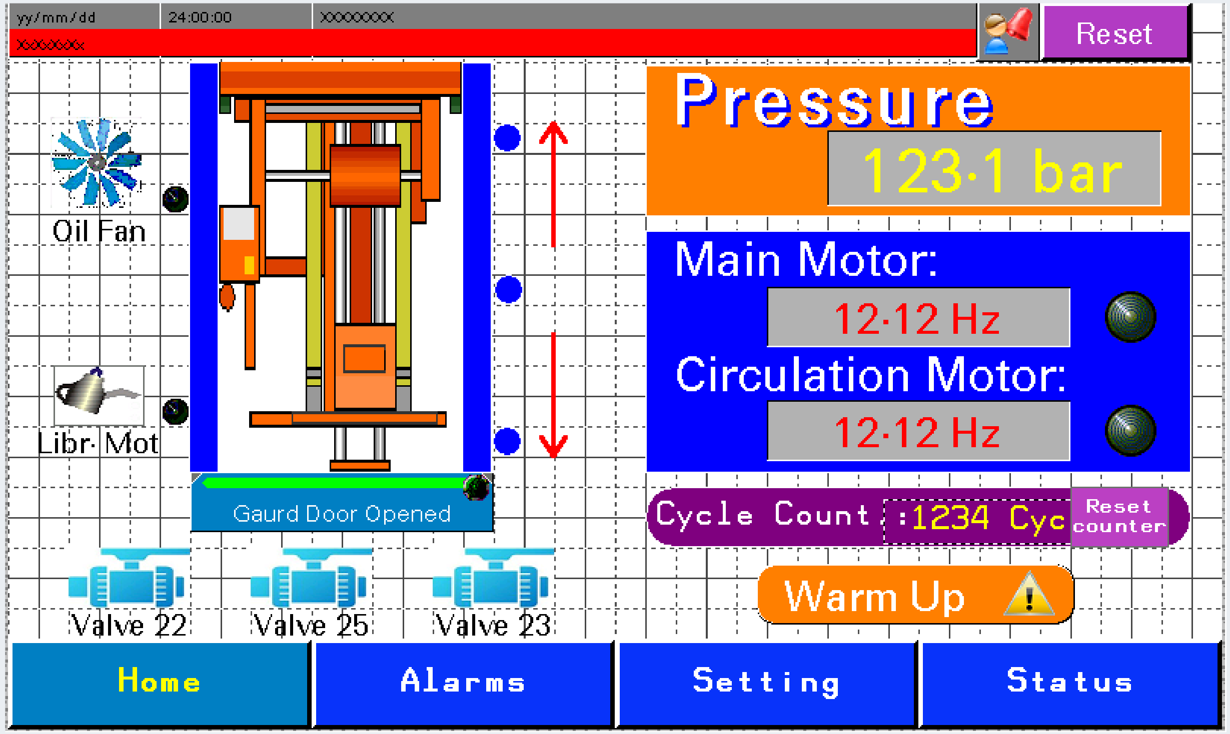
Stage 5: Programming

- PLC and HMI programmed using Ladder Logic Diagram (LLD) language
- Program governs machine self-control and monitoring without requiring human intervention
- Operation sequence defined by controlling actuators and motors based on real-time sensor inputs
- HMI screen presents a virtual representation of the press, displaying:
  - Hydraulic fluid pressure and temperature
  - Guard system and safety measure statuses
  - Adjustable thresholds for monitored parameters

Developed control system



Developed control system


yy/mm/dd
24:00:00
XXXXXXXX
Reset
Pressure
123.1 bar
Oil Fan
Libr. Mot
Main Motor:
12.12 Hz
Circulation Motor:
12.12 Hz
Gaurd Door Opened
Cycle Count :1234 Cyc
Reset counter
Warm Up
Valve 22
Valve 25
Valve 23
Home
Alarms
Setting
Status

PUWER: Provision and Use of Work Equipment Regulations 1998

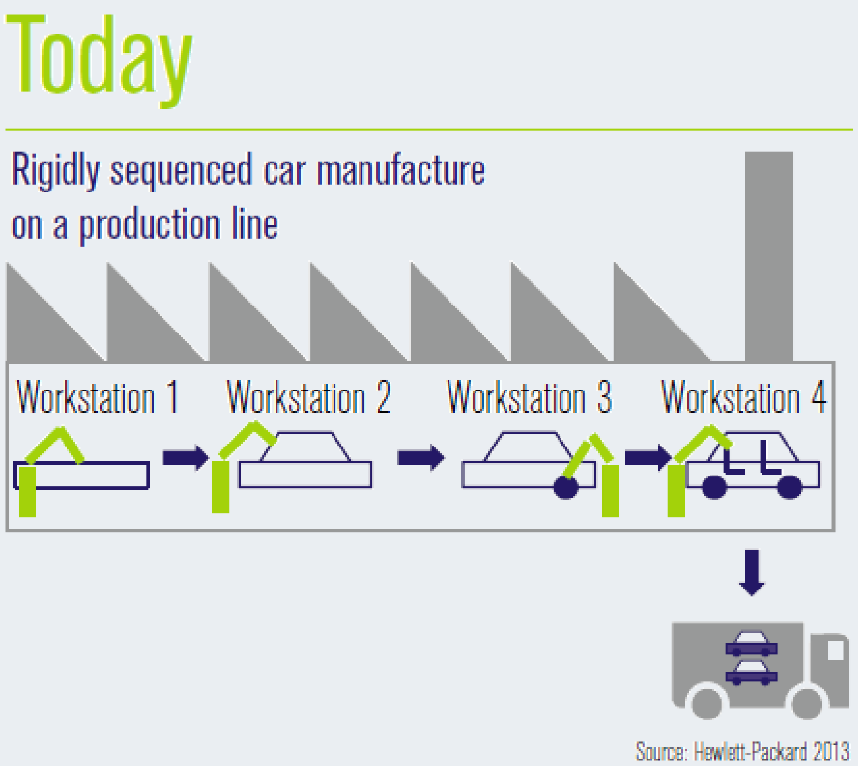
What PUWER requires

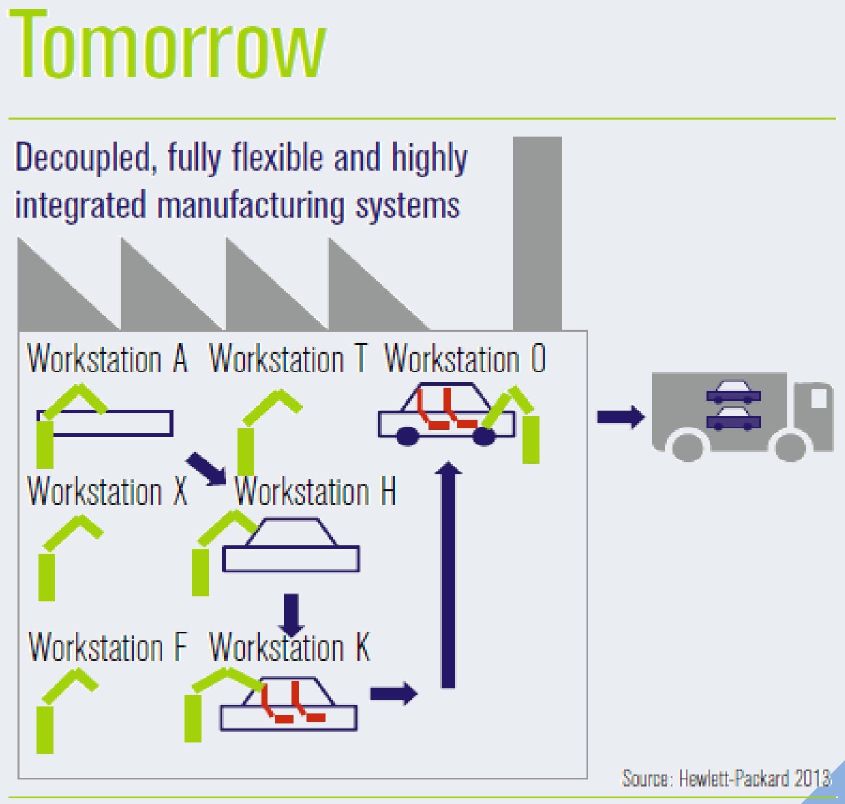
- All work equipment must be suitable for its intended use and operating conditions.
- Equipment must be maintained in a safe and efficient working state with up-to-date maintenance records.
- Inspection and examination must be carried out at appropriate intervals by a competent person.
- Adequate controls must be provided including start, stop, and emergency stop functions.
- Equipment must be fitted with appropriate guarding to prevent access to dangerous parts.
- Operators and maintenance staff must receive sufficient information, instruction, and training.

Impact of developed system on PUWER

- PLC-controlled guard door physically isolates the press during operation, directly satisfying the guarding requirement.
- Automated emergency stop and interlock logic embedded in the PLC program ensures compliant control architecture.
- OPC-UA enabled data logging provides auditable records of machine operation, supporting inspection and maintenance documentation requirements.
- Continuous sensor monitoring of pressure, temperature, and guard door status ensures deviations are detected and acted upon promptly.
- HMI screen gives operators real-time visibility of machine condition, reducing reliance on manual checks.
- Adjustable alarm thresholds allow maintenance teams to define and evidence safe operating limits
- Knowledge transfer programme ensures operators and maintainers are competent to work safely with the upgraded system.

What is next


Today
Rigidly sequenced car manufacture
on a production line
Workstation 1
Workstation 2
Workstation 3
Workstation 4
Source: Hewlett-Packard 2013


Tomorrow
Decoupled, fully flexible and highly
integrated manufacturing systems
Workstation A
Workstation T
Workstation O
Workstation X
Workstation H
Workstation F
Workstation K
Source: Hewlett-Packard 2013

Thank You!

Upcoming Courses

Engineering College of Technology (ECT) *UK-Recognised Qualifications*	Start Date
Bachelor of Engineering (Honours) in Industrial Automation	September 2026, February 2026
Bachelor of Engineering (Honours) in Electrical Engineering	September 2026, February 2026
Master of Science (Power System Analysis and Renewable Integration)	June 2026, October 2026
Master of Science (Industrial Automation and Instrumentation Control)	June 2026, October 2026

Contact Us:

Website
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Courses
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Head Office
Whittle Way, Stevenage SG1 2FS,
United Kingdom

Phone
Inside UK: 0203 582 1389
Outside UK: +44 203 582 1389