

The Impact of Industrial Automation Case-Study

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Dr. Abdu Shaalan
Industrial Automation programme leader



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Event Conduct



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- Follow the chair/moderator's directions.
- Do not share illegal, abusive or extremist content.
- Recording is not permitted unless authorised.
- Breaches may result in remove and referral under ECT policies.

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.

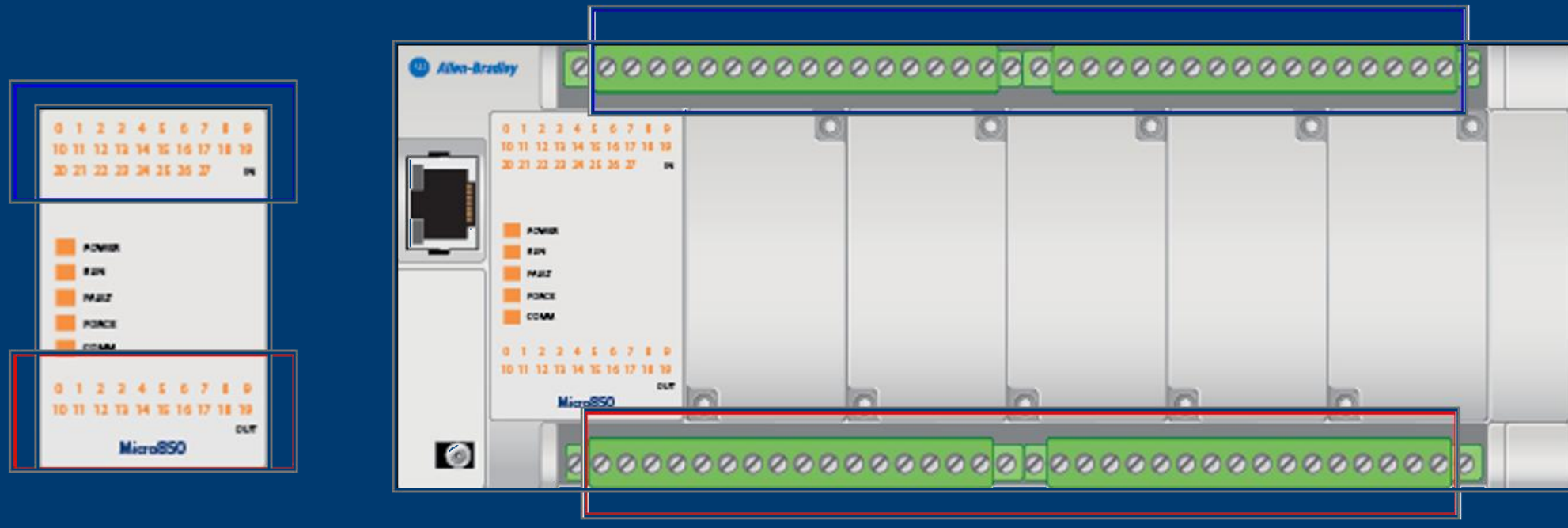
Third Industrial Revolution (1960's – early 2000's)

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

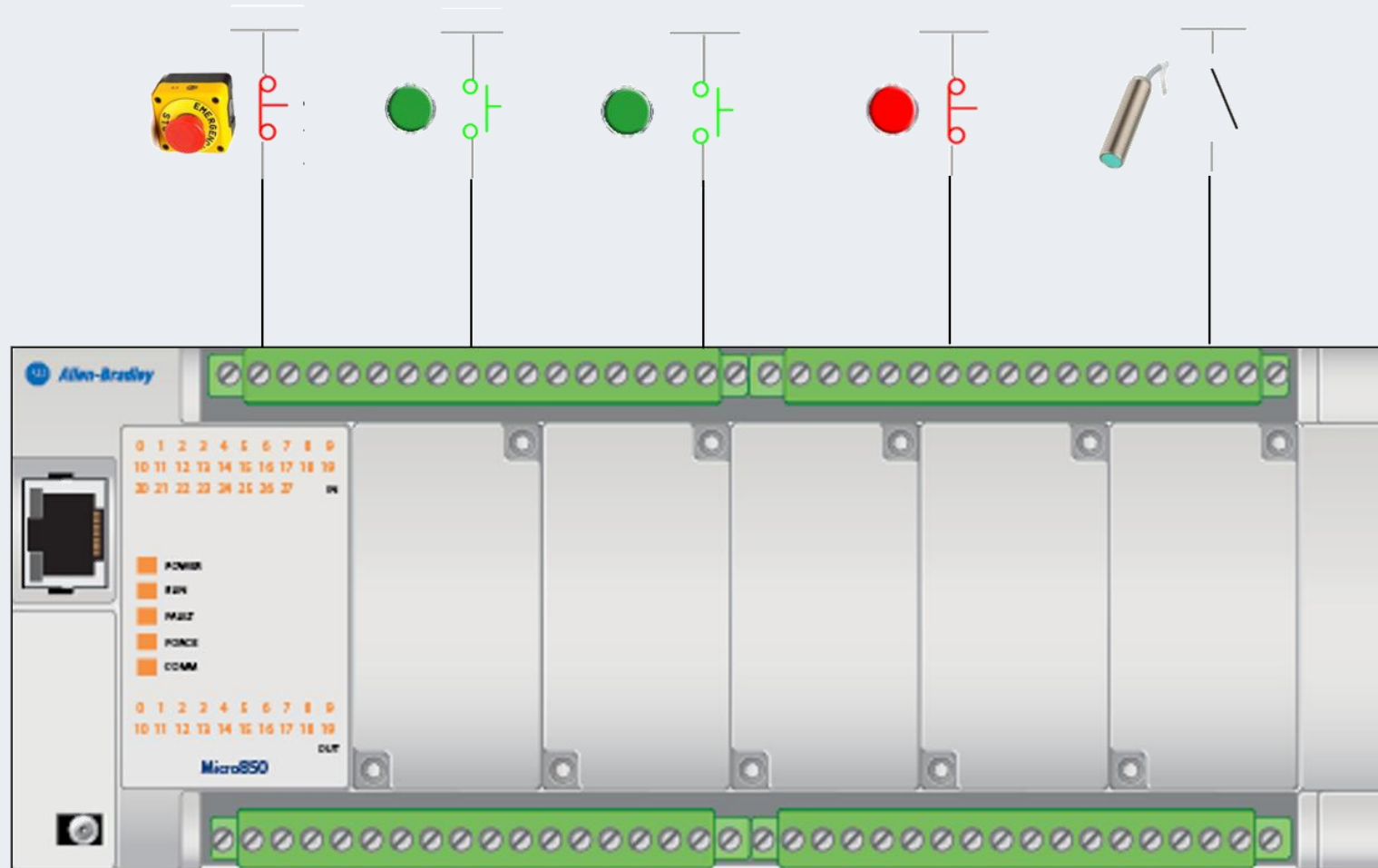


What is a PLC

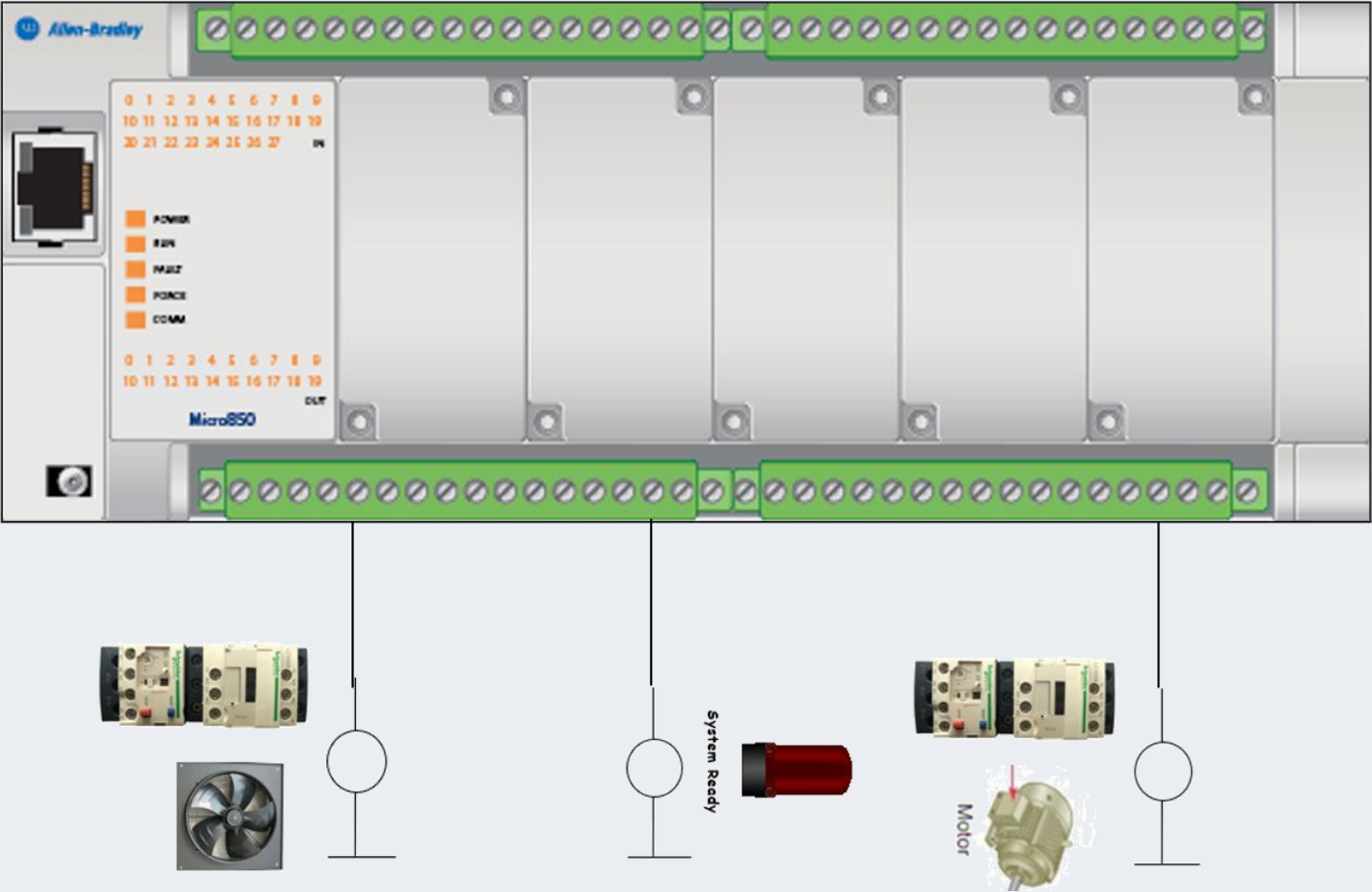
Intelligent device that operates based on a preprogrammed logic to control Inputs and Outputs.
It has designated connections to inputs and outputs to interact with field devices.



Inputs



Outputs



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

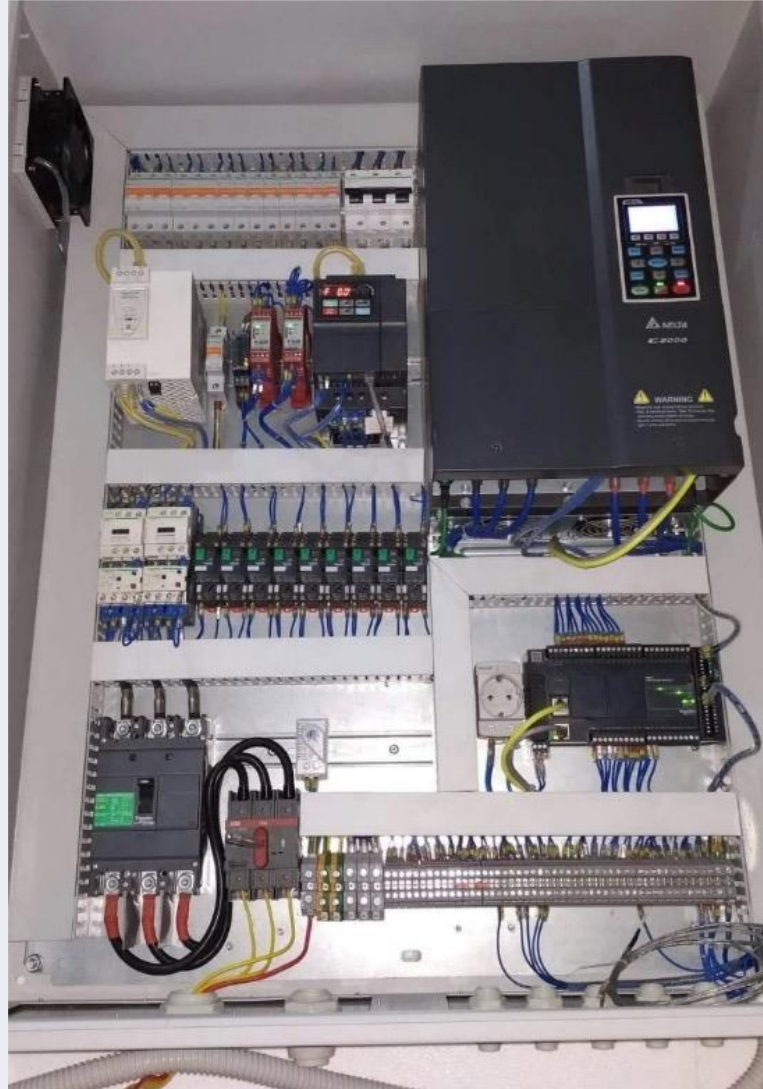
- Existing pressure and temperature sensors retained but enhanced with additional sensing devices
- Extra temperature and detection sensors added to the main motor and surrounding area
- Pressure and temperature deviations used as early warning indicators of abnormal behaviour
- Early detection approach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

Improvement stages

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



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.

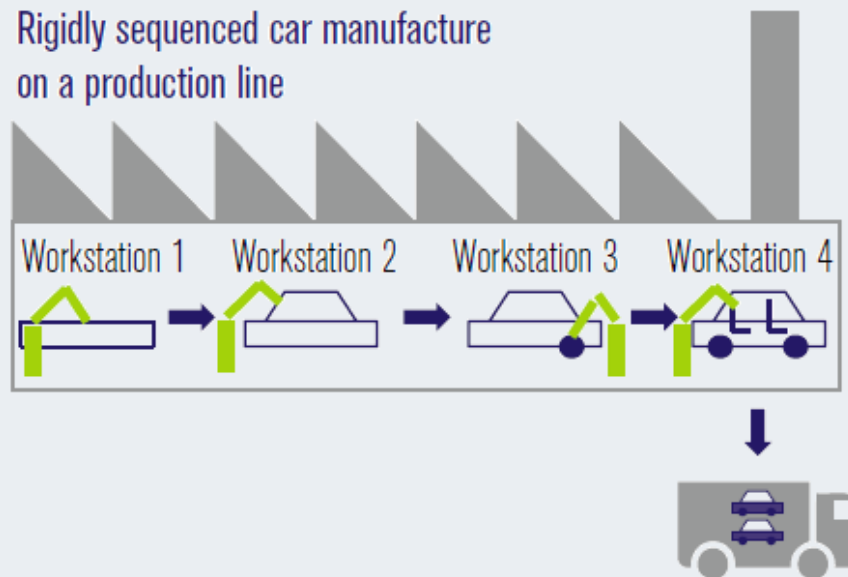
Impact of developed system on PUWER

- 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

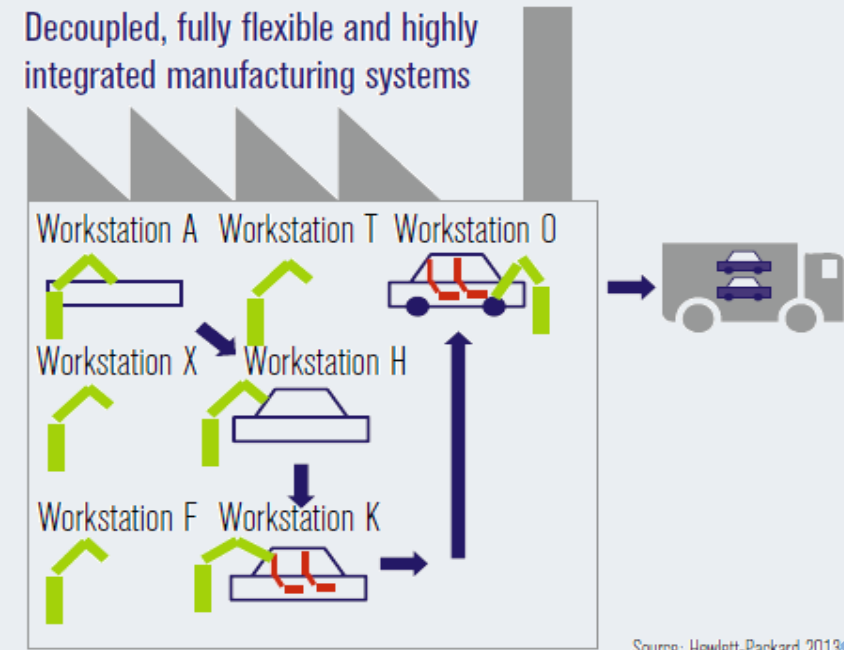


Source: Hewlett-Packard 2013



Tomorrow

Decoupled, fully flexible and highly integrated manufacturing systems



Source: Hewlett-Packard 2013

Thank You!

Upcoming Programmes

Engineering College of Technology (ECT) <i>UK-Recognised Qualifications</i>	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

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