QUEEN'S
UNIVERSITY
BELFAST

ESTᴰ 1845

A Trans-National Smart Manufacturing Education Hub

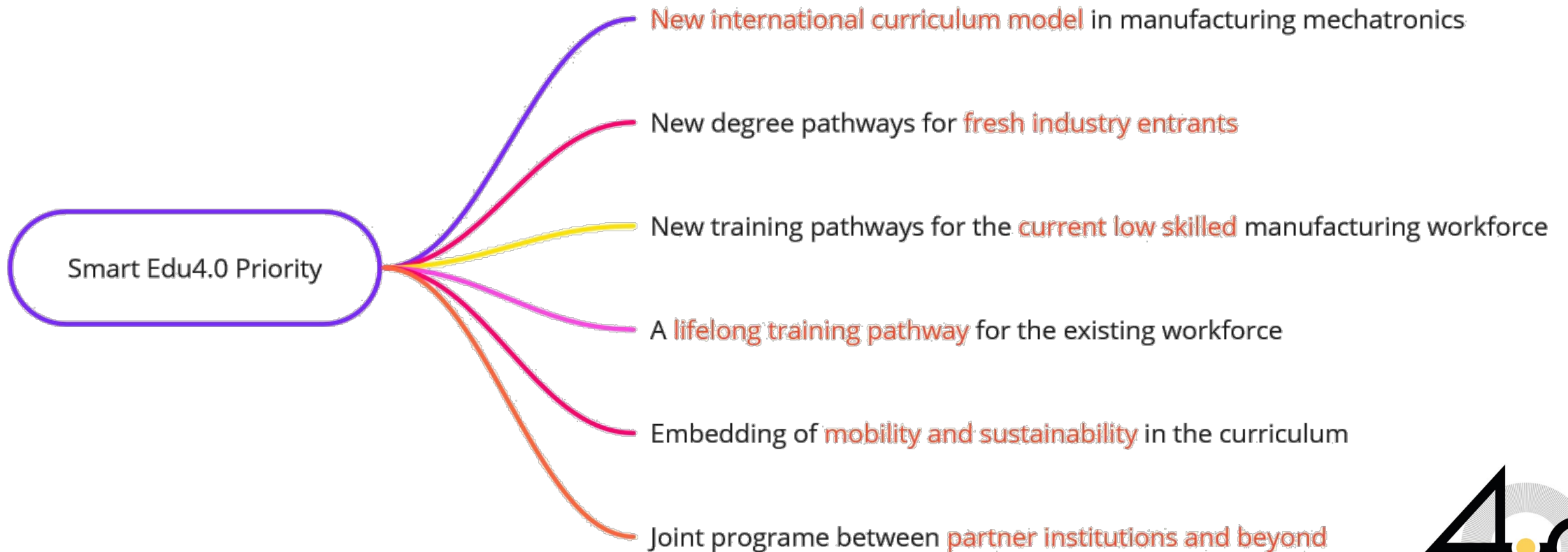Project Partners

https://smartedu40.eu/
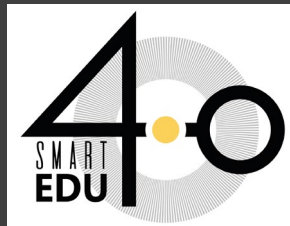
Outline
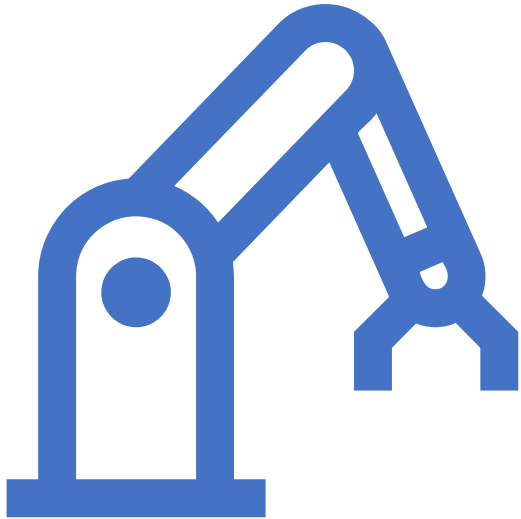
1. Smart-Edu4.0 Priority

2. Competitor Analysis

3. Course Overview

4. Module Overview

5. Industry 4.0 and Gaps for Mechatronic and Manufacturing

6. Smart Sensor Skill and Augmented Reality for Industry 4.0

Smart-Edu4.0 Priority

- To <u>review</u>, <u>investigate</u> and <u>develop solutions</u> for ==***managing skills gaps***== in the general manufacturing sector as we transition to factories of the future and Industry 4.0 related smart manufacturing.

Smart Edu4.0 Priority

- New international curriculum model in manufacturing mechatronics
- New degree pathways for fresh industry entrants
- New training pathways for the current low skilled manufacturing workforce
- A lifelong training pathway for the existing workforce
- Embedding of mobility and sustainability in the curriculum
- Joint programe between partner institutions and beyond

Intellectual Outputs (IO)

IO5: Delivered Output

📚 **Output title:** Market Research Report for Industry 4.0 Related UG, PG and Training Programmes
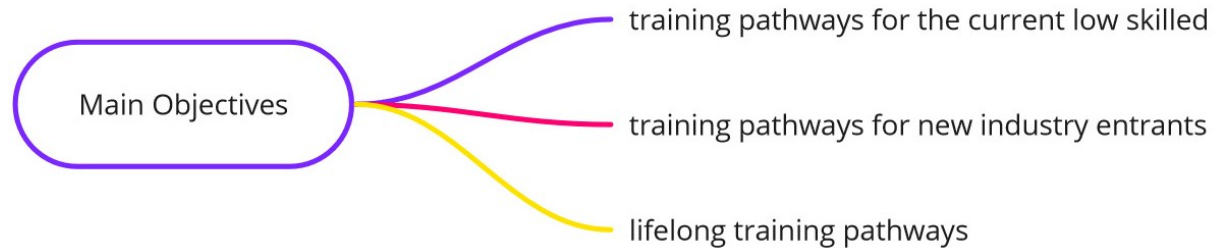
IO1: QUB

🎯 **Curriculum Design for an undergraduate programme in Manufacturing Mechatronics.**

IO6: QUB
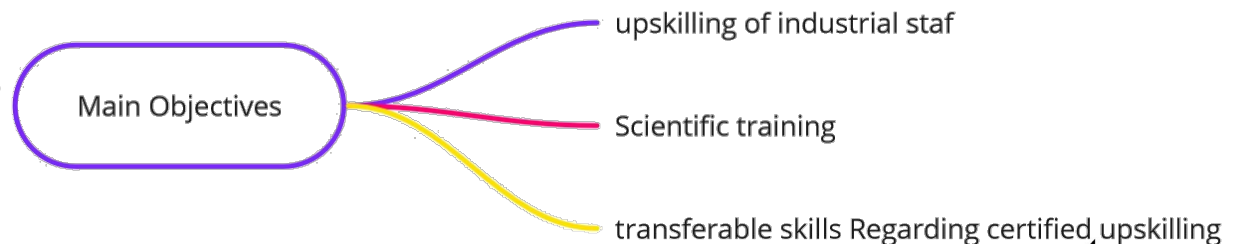❑ **Curriculum Design for a Joint Postgraduate Degree in Manufacturing Mechatronics**

IO2: SERC
❑ **Vocational/higher education pathway**

Main Objectives
- training pathways for the current low skilled
- training pathways for new industry entrants
- lifelong training pathways

IO3: UoL
❑ **New CPD (Continuous Program Development) programmes**
❑ **UG and PGT Programmes**

Main Objectives
- upskilling of industrial staf
- Scientific training
- transferable skills Regarding certified upskilling

IO4: NTUA (Delivered Sustainability and Mobility Reports)
❑ **Embedding mobility and sustainability across all programmes**
❑ **Curriculum design in Industrial IoT**

Competitor Analysis

Analysis based on Market Insight

Undergraduate:

UK universities	46
Russell Group	11
Mechatronic	13
Robotic	10
Joint UG programme in Robotics and Mechatronics	6

Postgraduate:

UK universities	35
Russell Group	12
Mechatronic	11
Robotic	10
Joint PG programme in Robotics and Mechatronics	1

UK universities- 8 Russell Group

Analysis- BEng/MEng entrants for Robotics / Mechatronics

			Number of Entrants
1	University of Manchester	BEng / MEng Mechatronics And Robotics	47
2	University of Sheffield	BEng / MEng Mechatronics And Robotics	70
3	University of Leeds	BEng / MEng Mechatronics	72
4	University of Liverpool	BEng / MEng Mechatronics And Robotics	25
5	University of Glasgow	BEng / MEng Mechatronic	29
6	University of Birmingham	BEng / MEng Mechatronics And Robotics	16
7	Queen Mary University of London	BEng / MEng Mechatronics And Robotics	14
8	University of Southampton	BEng / MEng Mechatronics And Robotics	11

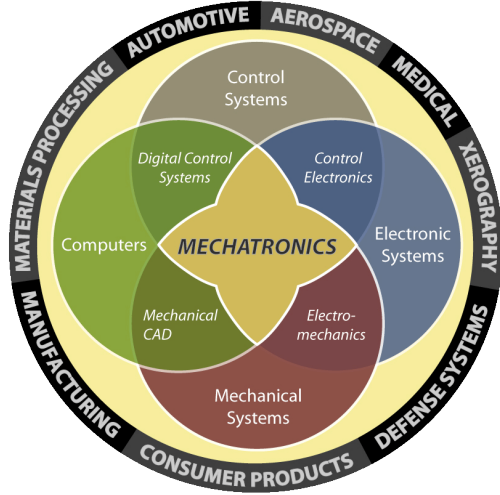❑ Mean value about 36 students/programme

From 2021 to 2022 analysis

UK universities intake – 8 Russell Group
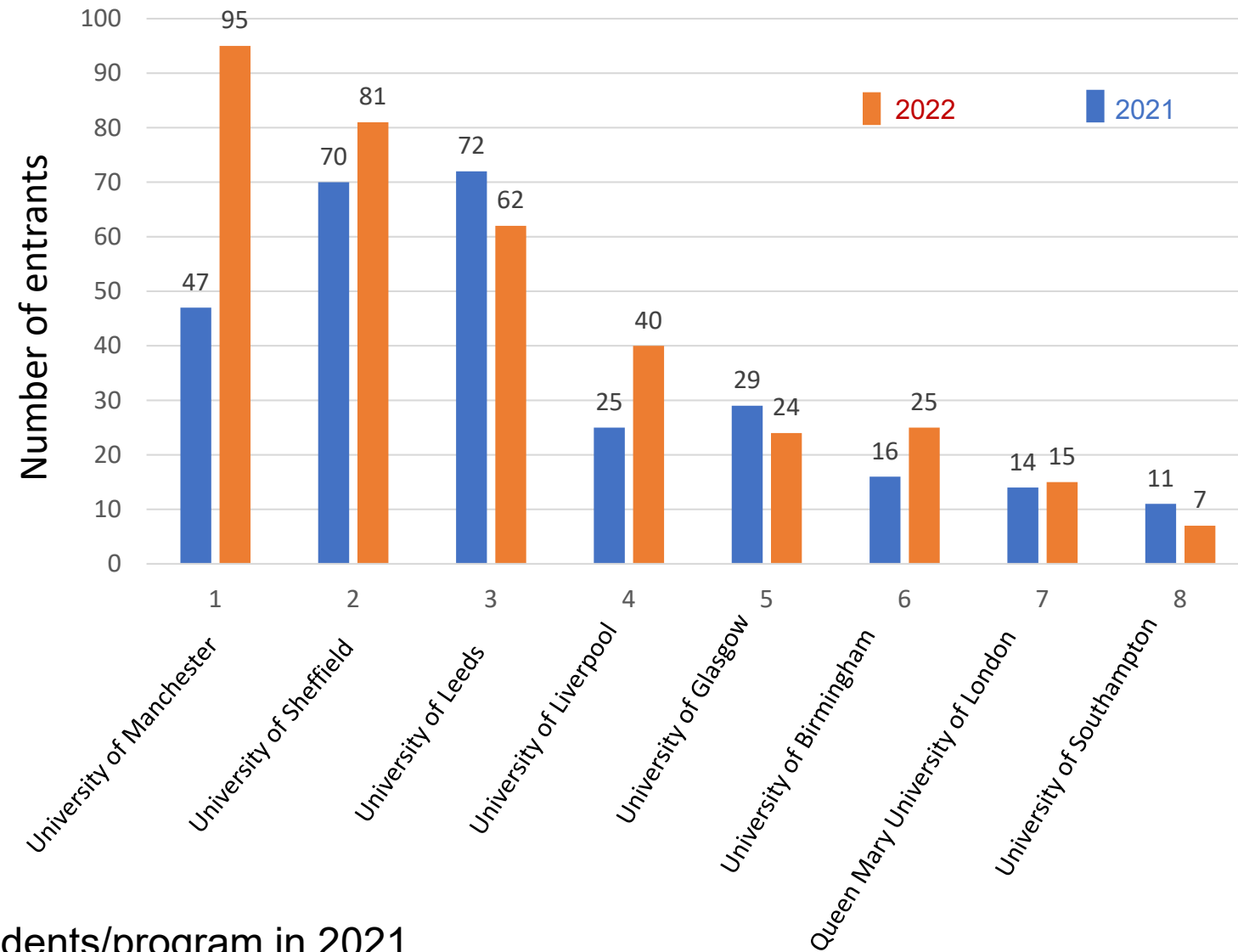
❑ Mean value of about **36** students/program in 2021

❑ Mean value of about **44** students/program in 2022

Mechatronic Systems
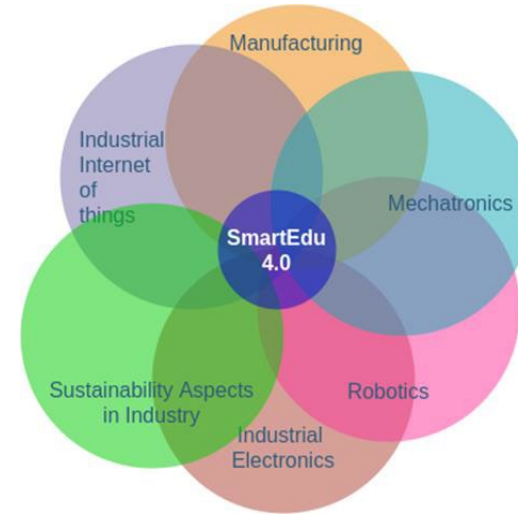

Transportation Applications
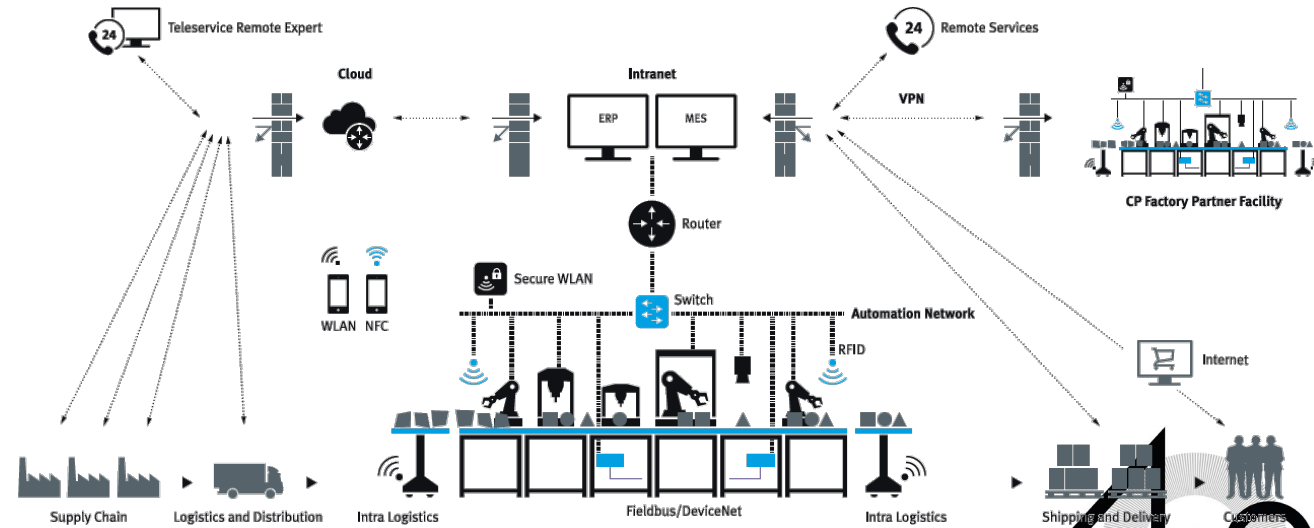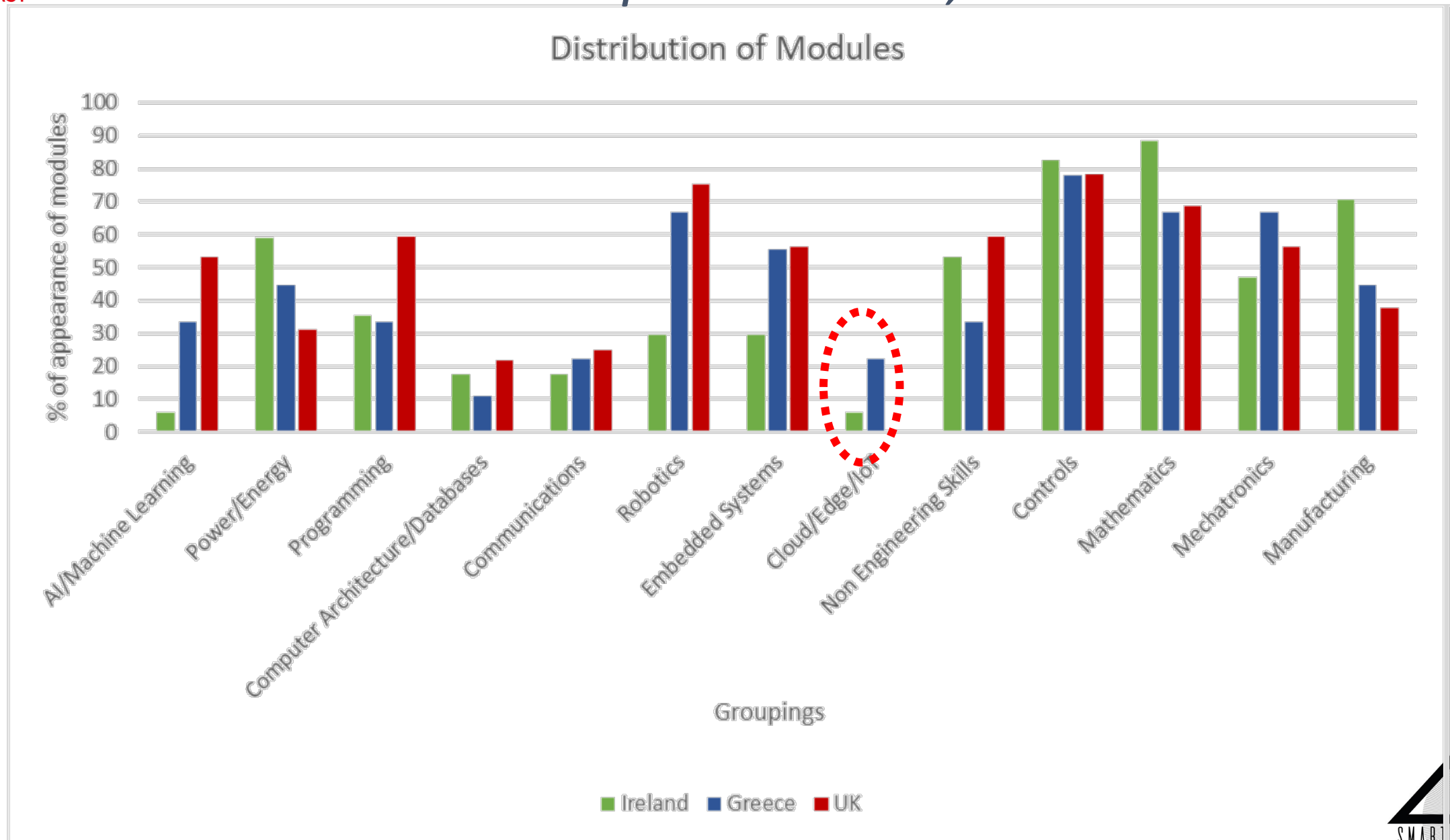

Prosthetics
Arms, Legs, ...

https://www.researchgate.net/figure/a-logo-of-mechatronics

What's Smart-Edu4.0?
Manufacturing Mechatronics for industry4.0

☐ six categories
☐ Covers 13 groups

www.festo-didactic.com

Distribution of Modules

Course and Module Overviews

Overall overview of the UK Universities:

Course Overview: University of Leeds
Mechatronics and Robotics MEng, BEng

❑ **First/Second years:**

- Circuit theory, analysis, and design

- Digital electronics

- Solid mechanics

- Design and manufacture

- Power electronics

❑ **Year three:**

- Embedded systems and key issues in robotics and machine intelligence

Such as:

- Computer vision

- Biomedical engineering design

Course Title: <u>MEng, BEng, Mechatronics and Robotics</u>

Modules:

Year 1
- Programming for the Web10 credits
- Circuit Analysis and Design20 credits
- Communications for Robotics10 credits
- Digital Electronics and Microcontrollers20 credits
- Engineering Mathematics10 credits
- Further Engineering Mathematics10 credits
- Electronic Design Project10 credits
- Introduction to Mechatronics and Robotics10 credits
- Mechanics for Mechatronics and Robotics20 credits

Year 2
- Artificial Intelligence10 credits
- Electronic Circuit Design10 credits
- Power Electronics10 credits
- Control Systems10 credits
- Embedded Systems Project20 credits
- Microprocessors and Programmable Logic20 credits
- Sensors, Actuators and Mechanisms20 credits
- Design & Manufacture for Mechatronics & Robotics20 credits

Year 3
- Machine Learning10 credits
- Intelligent Systems and Robotics20 credits
- Professional Studies10 credits
- Electric Machines10 credits
- Additive Manufacturing20 credits
- Individual Mechatronics and Robotics Project50 credits

Year 4
Compulsory
- Modern Industry Practice15 credits
- Team Project60 credits

Optional modules
- Bio-Inspired Computing15 credits
- Power Electronics and Drives15 credits
- FPGA Design for System-on-Chip15 credits

Module content shows:

Focus on:

❑ Design and implementation of Mechatronic systems and devices
❑ Intelligent system for robotic

Course Title: BEng Mechatronic and Robotic Engineering

Modules:
Year 1

- Introduction to Electronic and Electronic Circuits
- Introduction to Systems Engineering and Software
- Modelling, Analysis and Control
- Physical Systems
- Systems Engineering Mathematics 1
- Digital and Embedded Systems
- Group Control Project and Professional Skills
- Global Engineering Challenge Week

Year 2

- Control Systems Design and Analysis
- Engineering Mechanics
- Mechatronics
- Signals, Systems and Communications
- Systems Engineering Mathematics 2
- Systems Engineering and Object Oriented Programming
- Engineering – You're Hired

Year 3

- Individual Project
- Digital Signal Processing
- Finance and Law for Engineers
- Machine Learning
- Robotics
- State-space Control Design

Optional

- Aircraft Dynamics and Control
- Biomechatronics
- Dynamics of Aerospace Structures and Machines
- Hardware-in-the-Loop & Rapid Control Prototyping
- Intelligent Systems
- Manufacturing Systems
- Renewable Energy

Module content shows:

Focus on:
Robotic and AI

Linking Verb

Mechatronic

Robotic

Machine learning

Focus on:

❑ Design and implementation of Mechatronic systems and devices.
❑ Robotic and AI

Overall Analysis in the UK Universities

❑ **Focus on:**

❖ **General engineering:**

- Study the most exciting aspects of electronics, mechanical design, and artificial intelligence.

❖ **Design and manufacture of Mechatronic systems and devices.**

❖ **Intelligent systems for robotics and Mechatronics**

❖ **What are the skill gaps for mechatronic for the smart factory?**

# Industry 4.0 and Gaps for Manufacturing Mechatronics

Industry is undergoing fundamental changes

➢ **After mechanization (Industry 1.0)**

➢ **Industrialization (Industry 2.0)**

➢ **Automation (Industry 3.0)**

➢ **Now, the threshold of the fourth revolution (Industry 4.0):**

   digitization and networking

Manufacturing processes in factories will be:

❖ More productive

❖ More intelligent

❖ More controllable

❖ More transparent.
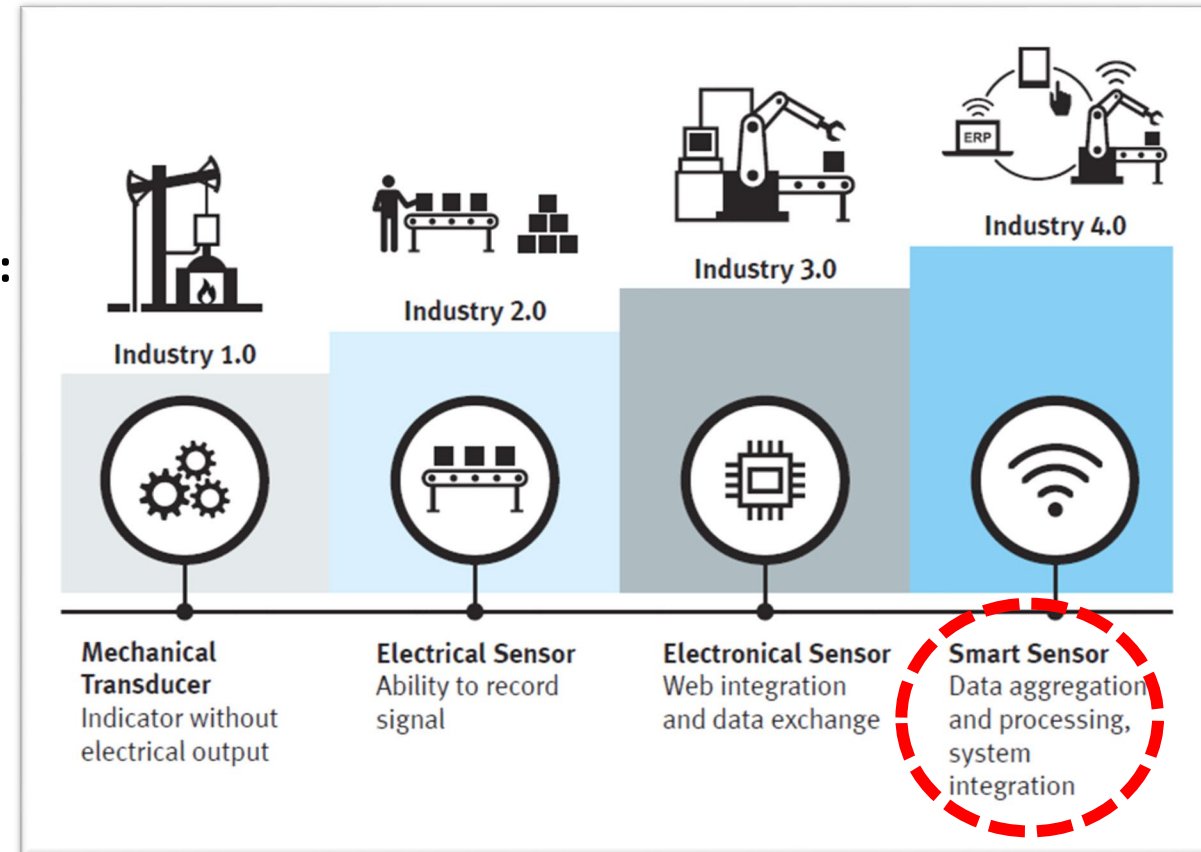
www.festo-didactic.com

Industry 3.0

The third industrial revolution involved:
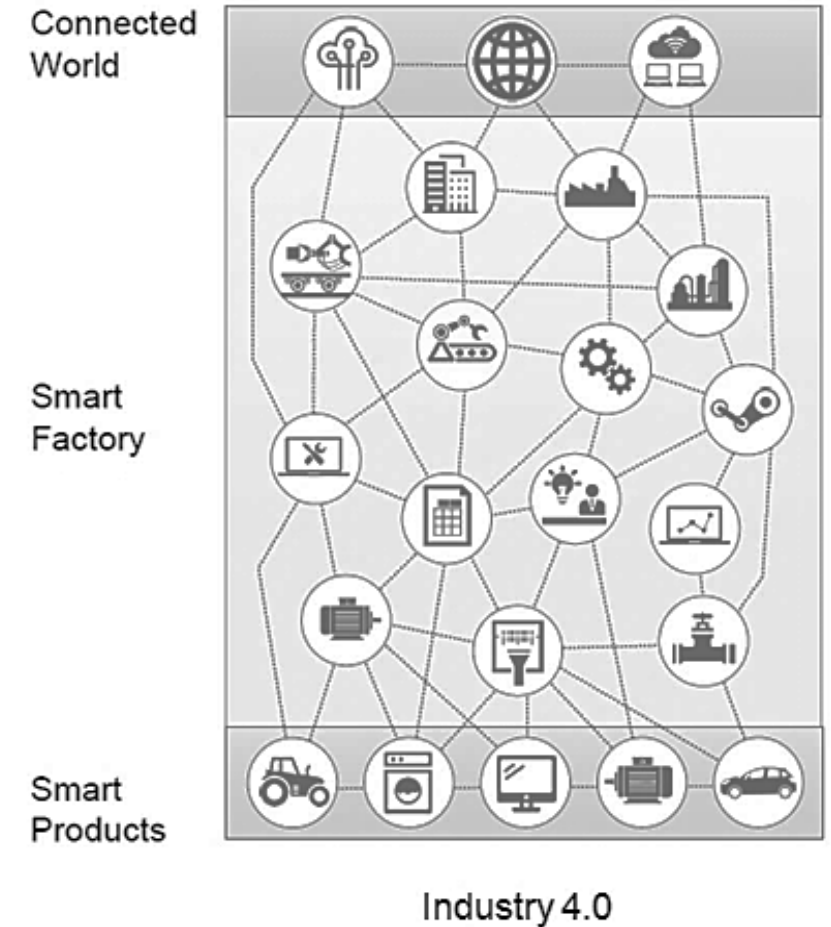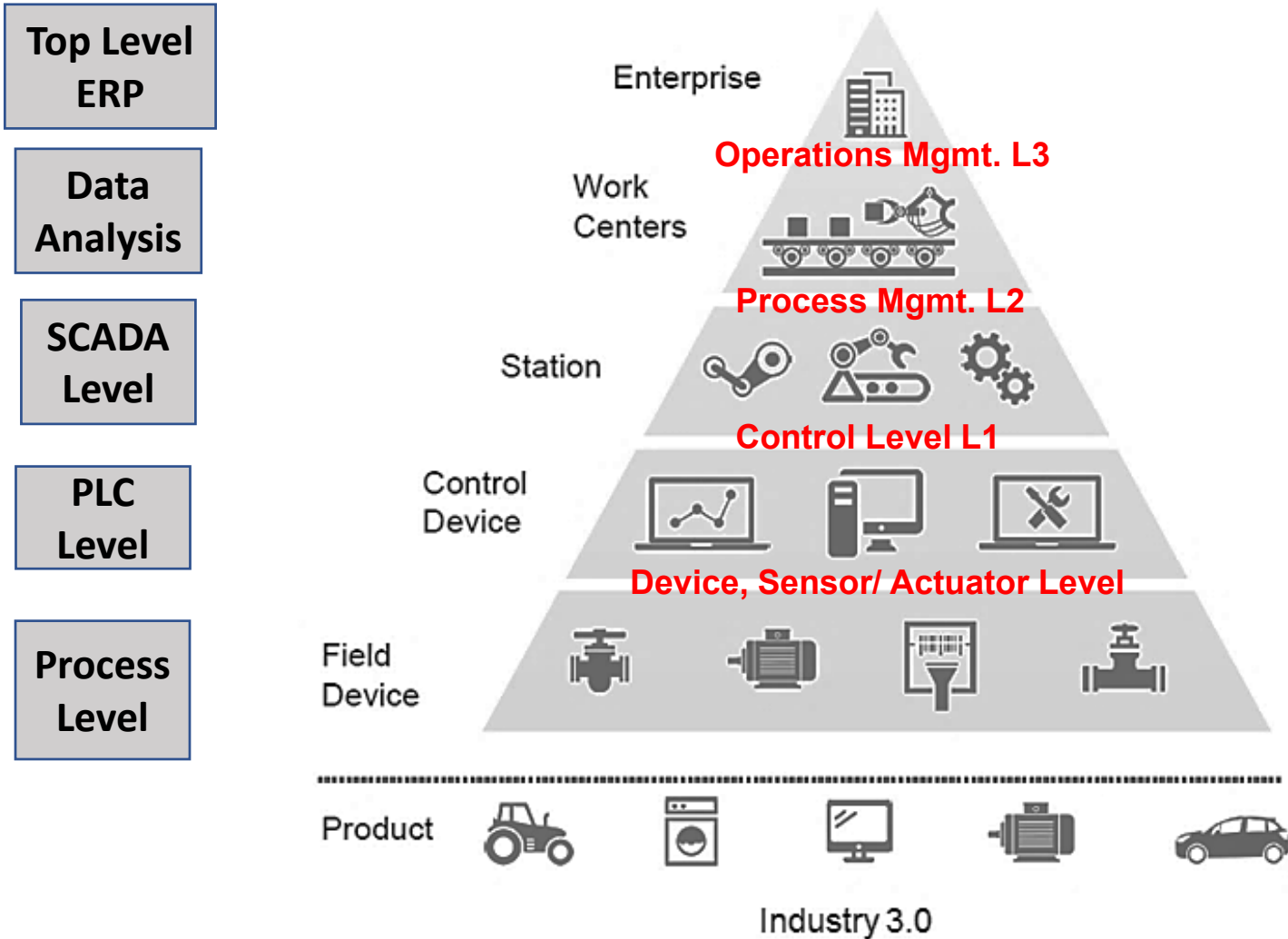
Automation of processes

Communication technologies, such as networked computing, the internet, and wireless communications

Human-Machine Interfaces (HMIs)

Remote sensing and monitoring reduced the need for human operators

❖ **Necessary requirements for Industry 4.0**

❖ **A challenge for the UK and Beyond,** We must think and do beyond the above topics

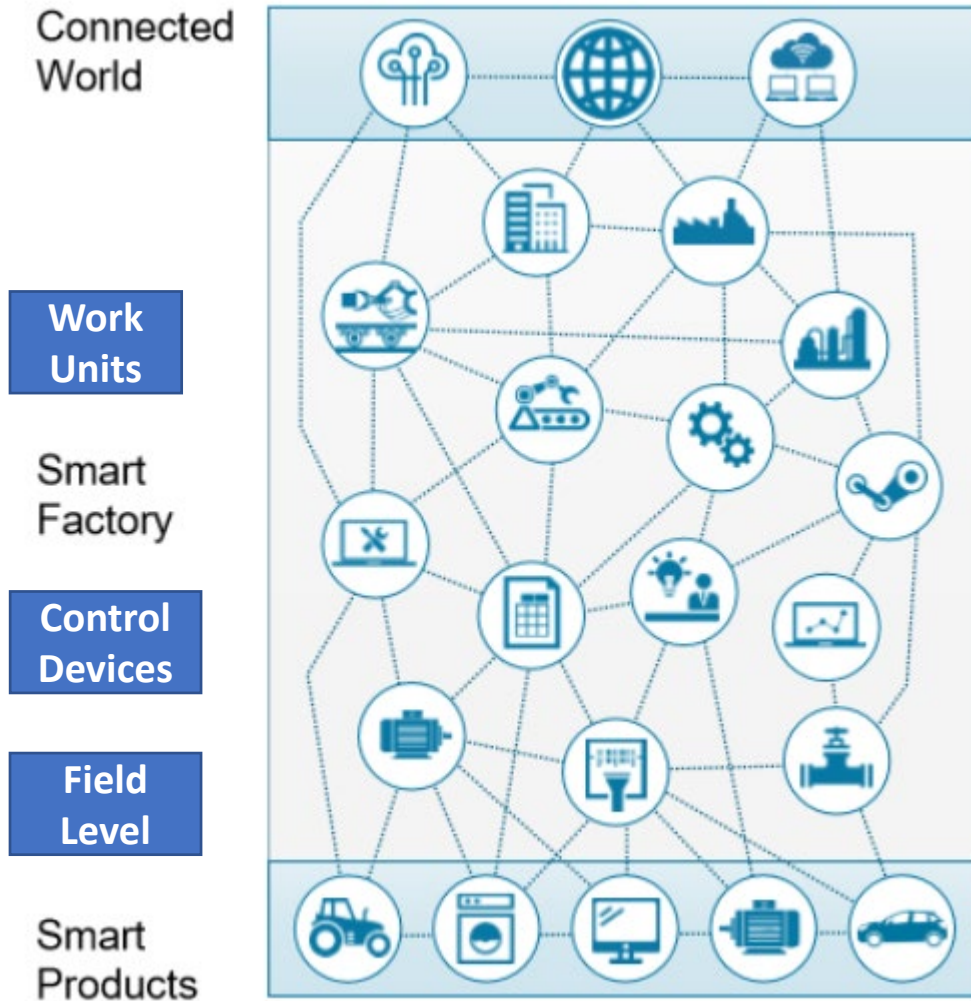# Hierarchies Levels in Industry 3.0 vs Industry 4.0

Left side labels:
- Top Level ERP
- Data Analysis
- SCADA Level
- PLC Level
- Process Level

Industry 3.0 pyramid (bottom to top):
- Product
- Field Device — *Device, Sensor/ Actuator Level*
- Control Device — *Control Level L1*
- Station — *Process Mgmt. L2*
- Work Centers — *Operations Mgmt. L3*
- Enterprise

Industry 3.0

Industry 4.0 (bottom to top):
- Smart Products
- Smart Factory
- Connected World

Industry 4.0

❑ MES - Manufacturing Execution System
❑ ERP - Enterprise Resource Planning

New World – Industry 4.0

❑ The product is part of the network

❑ Flexible plants and machines

❑ Roles distributed in a network

❑ Communication takes place between all agents across

hierarchy levels

CP Factory

❑ Modular and Changeable modern factory

CP: Cyber-Physical

Manufacturing

ERP/MES

Logistics

Assembly Line

Manual Workplace / Quality Assurance
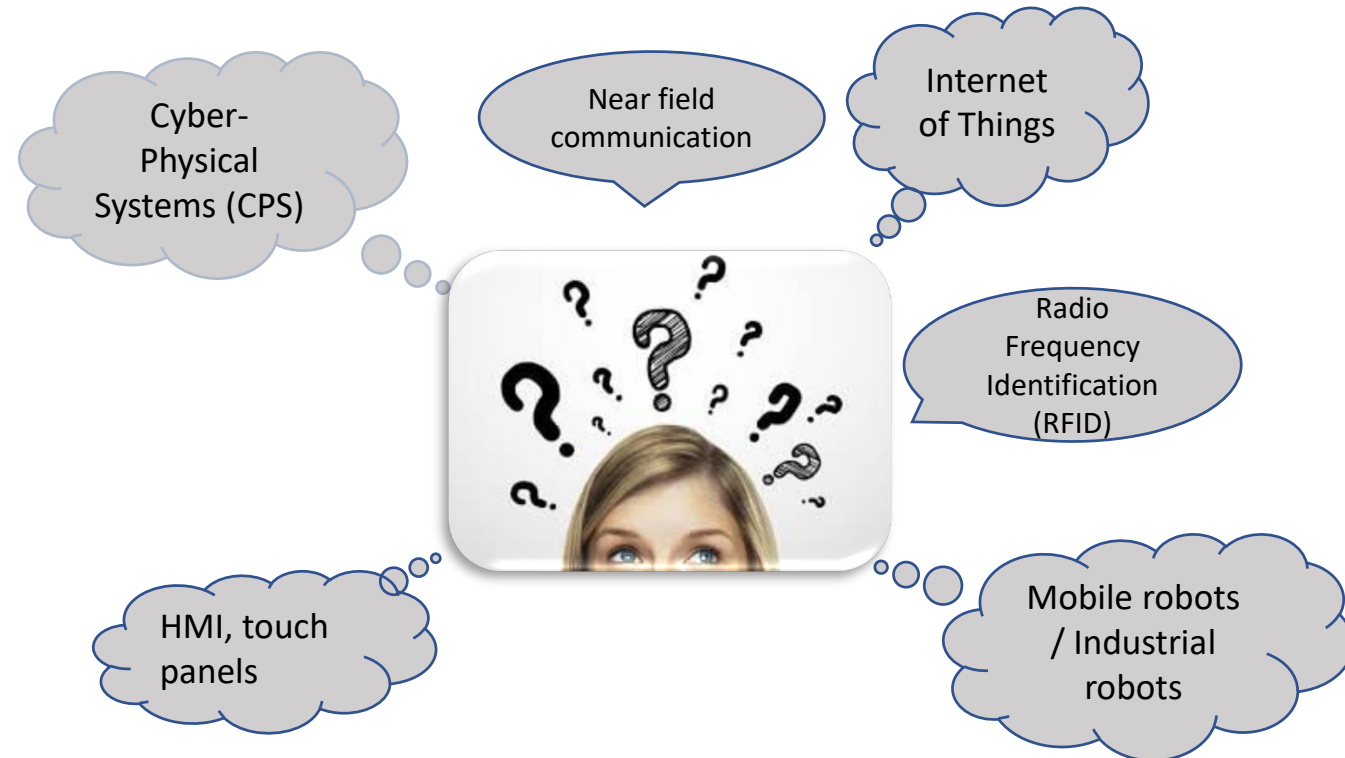
Lean Production

www.festo-didactic.com

❑ Individuality and flexibility and customization in production
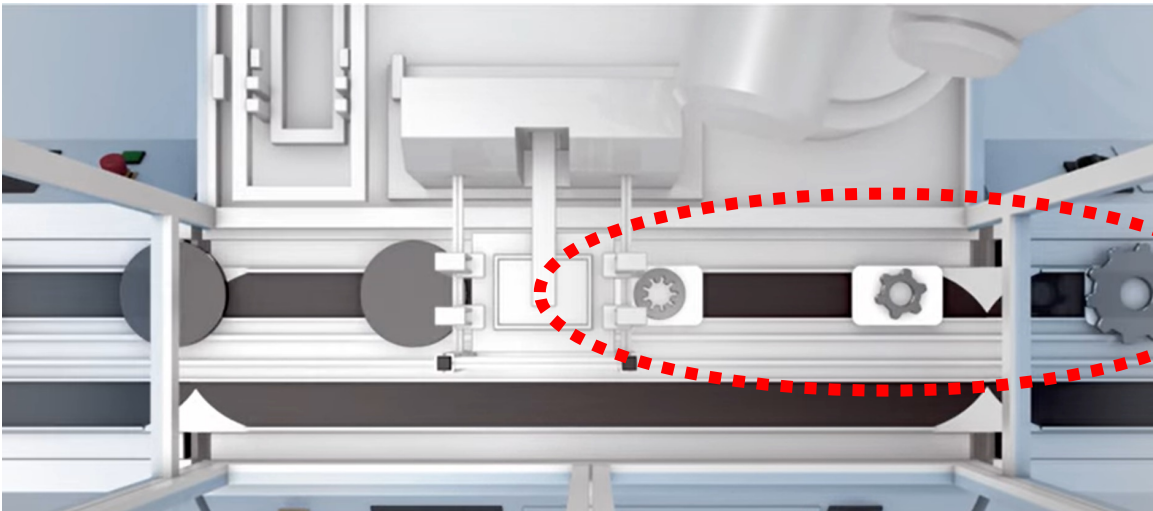
Customization in Gear Production line

Industry 4.0 topics and required skills

- ➢ Smart sensing technology for Industry 4.0
- ➢ Internet of things
- ➢ HMI, touch panels
- ➢ Industrial network technology
- ➢ Robotics: Mobile robots-Industrial robot arms
- ➢ Artificial intelligence (AI)
- ➢ Cyber-Physical system
- ➢ Big Data
- ➢ Cloud computing
- ➢ Modern, decentralized control technology
- ➢ Embedded controller
- ➢ Virtual reality (VR)

Cyber-Physical Systems (CPS)

Near field communication

Internet of Things

Radio Frequency Identification (RFID)

HMI, touch panels

Mobile robots / Industrial robots

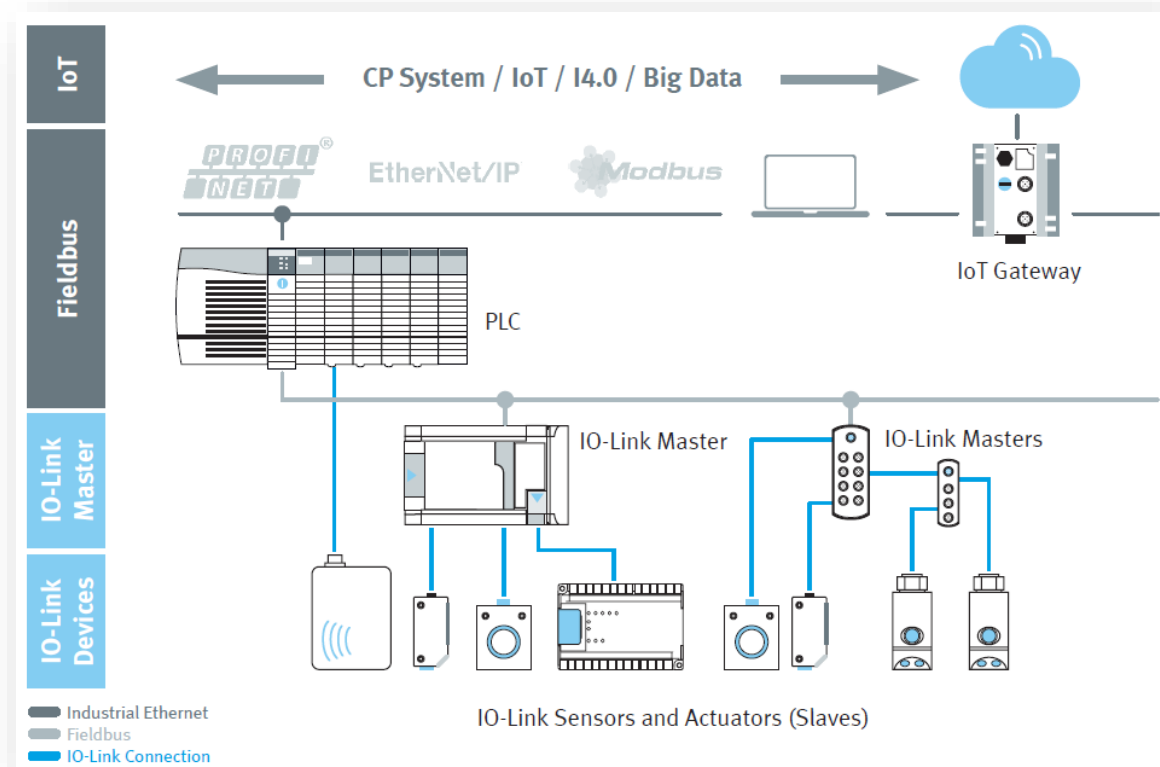# **Skill Gaps and Important requirements** in Industry 4.0

1. Smart sensing technology enables Industry 4.0

Smart sensors enable data collection and processing in all layers of the network

(Machines, PLCs, SCADA, MES, ERP, Cloud) using a communication protocol.

Skill Gaps for Smart Sensors:

1- The right smart sensor for the right application

2- Set up IO-Link communication

3- Adjust parameters, monitor, and adjust smart sensors

4- Integrate sensors into industrial networks

www.festo-didactic.com

Skill Gaps and Important requirements in Industry 4.0

2. Augmented Reality

- ➢ **Identifying the station**

- ➢ **Visualizing all station modules**

- ➢ **Visualizing all station actuators**

- ➢ **Opening the data sheet of the selected module**

www.festo-didactic.com

www.festo-didactic.com

Mechatronics teaching should include:

- Smart Sensors technologies
- Mechatronics
- Cyber-Physical systems
- System mobility and sustainability
- Mobile robotics and industrial robot arms
- Remote monitoring system
- Virtual and Augmented Reality
- Intelligent vertical and horizontal networking
- Embedded systems

2 Minute Survey on Mechatronics Engineering Programmes in Ireland

Please Scan the QR code and answer questions

Any Question?