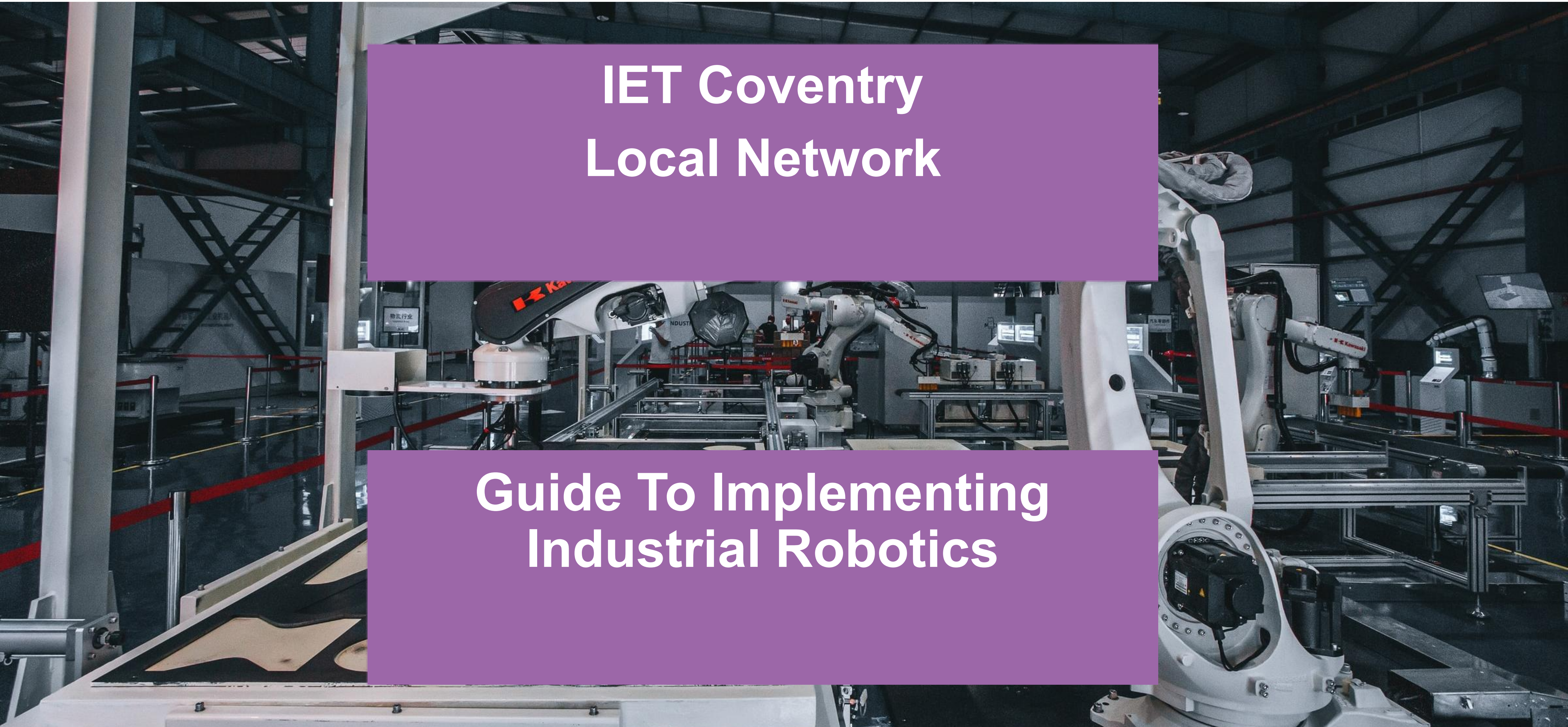
The Institution of Engineering and Technology

IET Coventry Local Network

Guide To Implementing Industrial Robotics



IET Coventry

Speaker

Alan Rossney
B.Eng, C.Eng Eur.Ing FIET PMP MPM
30+ years of engineering & project management experience in large-scale engineering, automation & robotics projects. Worked as; Head of Projects, Program & Project Manager, New Product Introduction Manager, Project & Manufacturing Engineer. Worked on product design and manufacture projects along with facility design projects, as with his current role in Jacobs Engineering consulting on Materials Handling systems. Currently chair the IET Robotics and Mechatronics Technical Network

160K Members across 30 countries

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1.Robotics and Mechatronics TN Overview

Upcoming Events

https://engx.theiet.org/technical-networks/mechrob

30th April, 12.30

•**REDUNDANT ELECTROMECHANICAL ACTUATORS FOR AEROSPACE: DESIGN PRINCIPLES AND EQUALISATION STRATEGIES**

•Speaker Fawaz Annaz

•**Blog ICRA (LK)**

•**London summer school (SL)**

4th June at 12,30

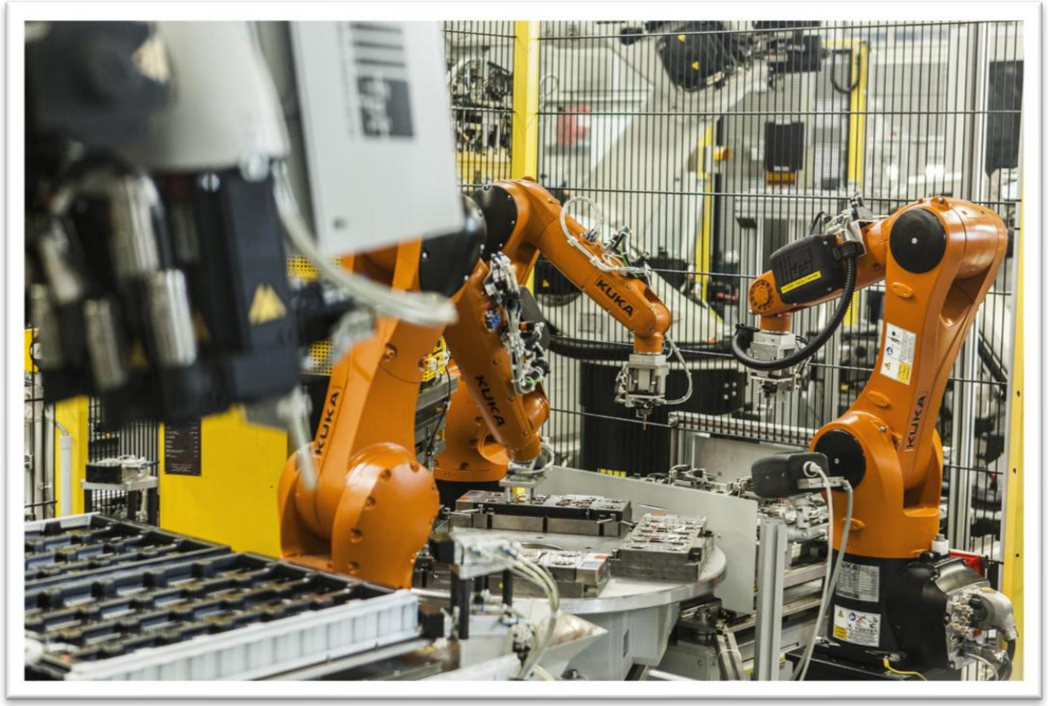
•**Soft Robotics Cross Collaboration (RS)**

11 June, 12.30 ,

•**Cyber security in Robotics Webinar(AR)**

8th Sept, 12.30,

•**Autonomous systems (NV)**



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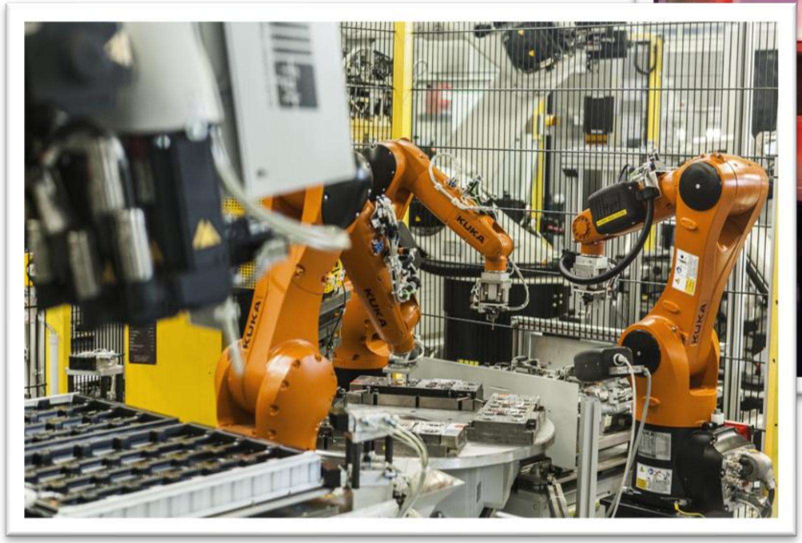
1.Robotics and Mechatronics TN Overview

Previous Events



bit.ly/IETRoboticsEvents

1.Robotics and Mechatronics TN Overview

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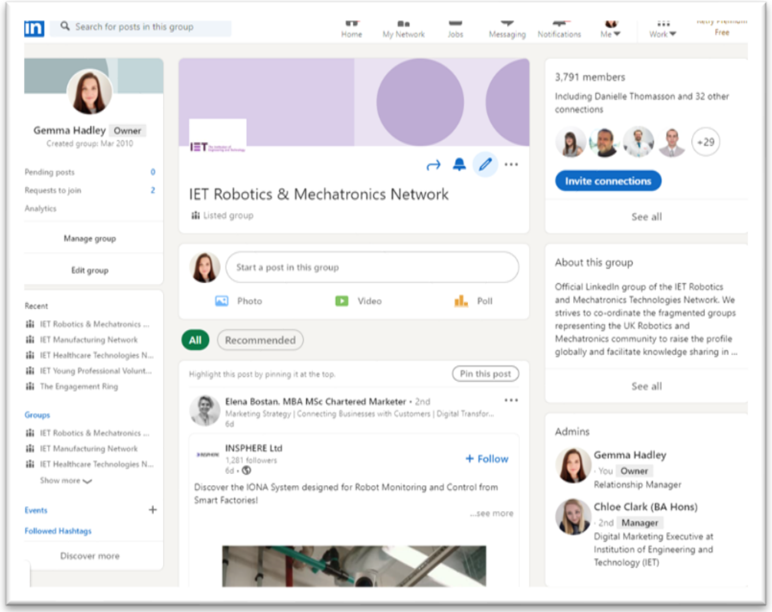
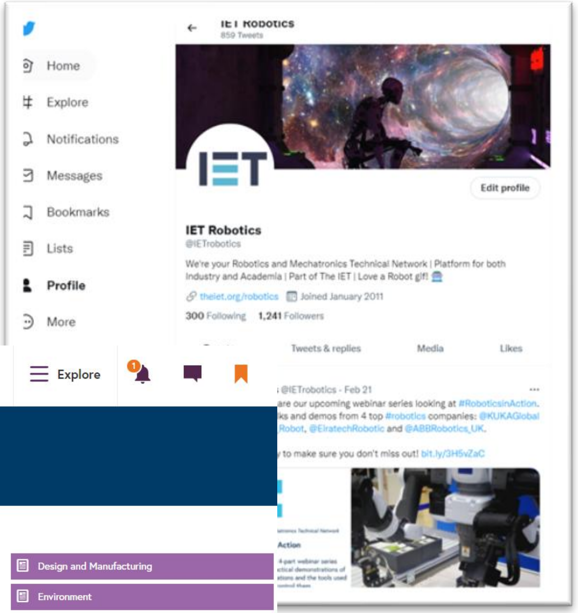
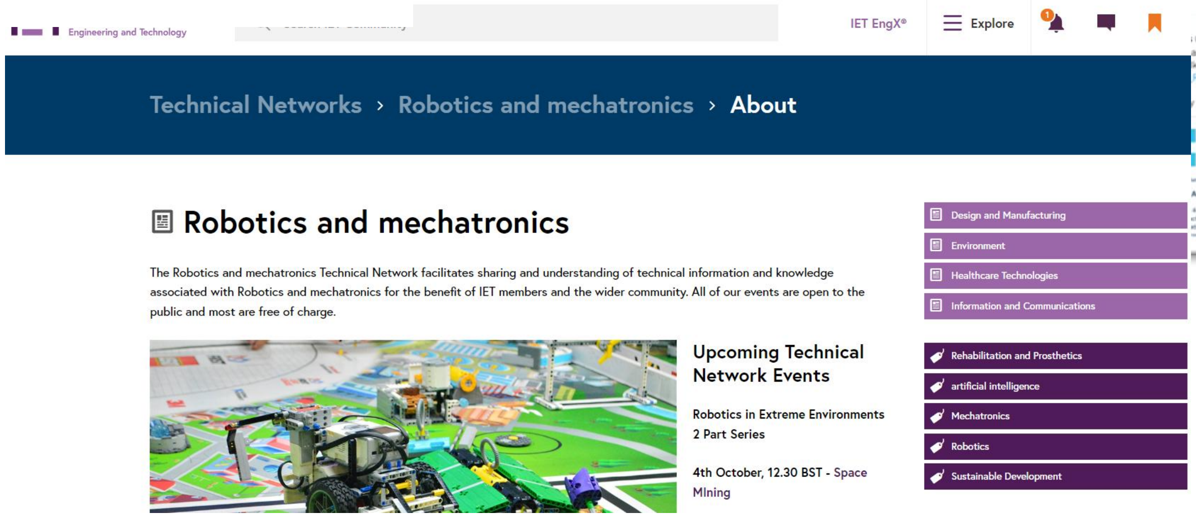
Connect online…



[IET Robotics & Mechatronics on Linkedin]



[twitter.com/IETrobotics]



[Robotics and Mechatronics on EngX]

2. Guide To Implementing Industrial Robotics

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Introduction

The guide to implementing industrial robotics was published by Automate-UK in 2025. This edition was developed as a collaboration between representatives from the Manufacturing Technology Centre, Irish Manufacturing Research, Automate-UK & The IET Robotics and Mechatronics Technical Network

The guide will outline the various types of industrial robots, the benefits & barriers and finally important factors for creating a business case and implementing systems.

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2. Guide To Implementing Industrial Robotics

Types & Applications

As per the findings of the 2022 McKinsey Global Industrial Robotics Survey, primary applications of industrial automation include material handling, palletization, sorting and pick and place.

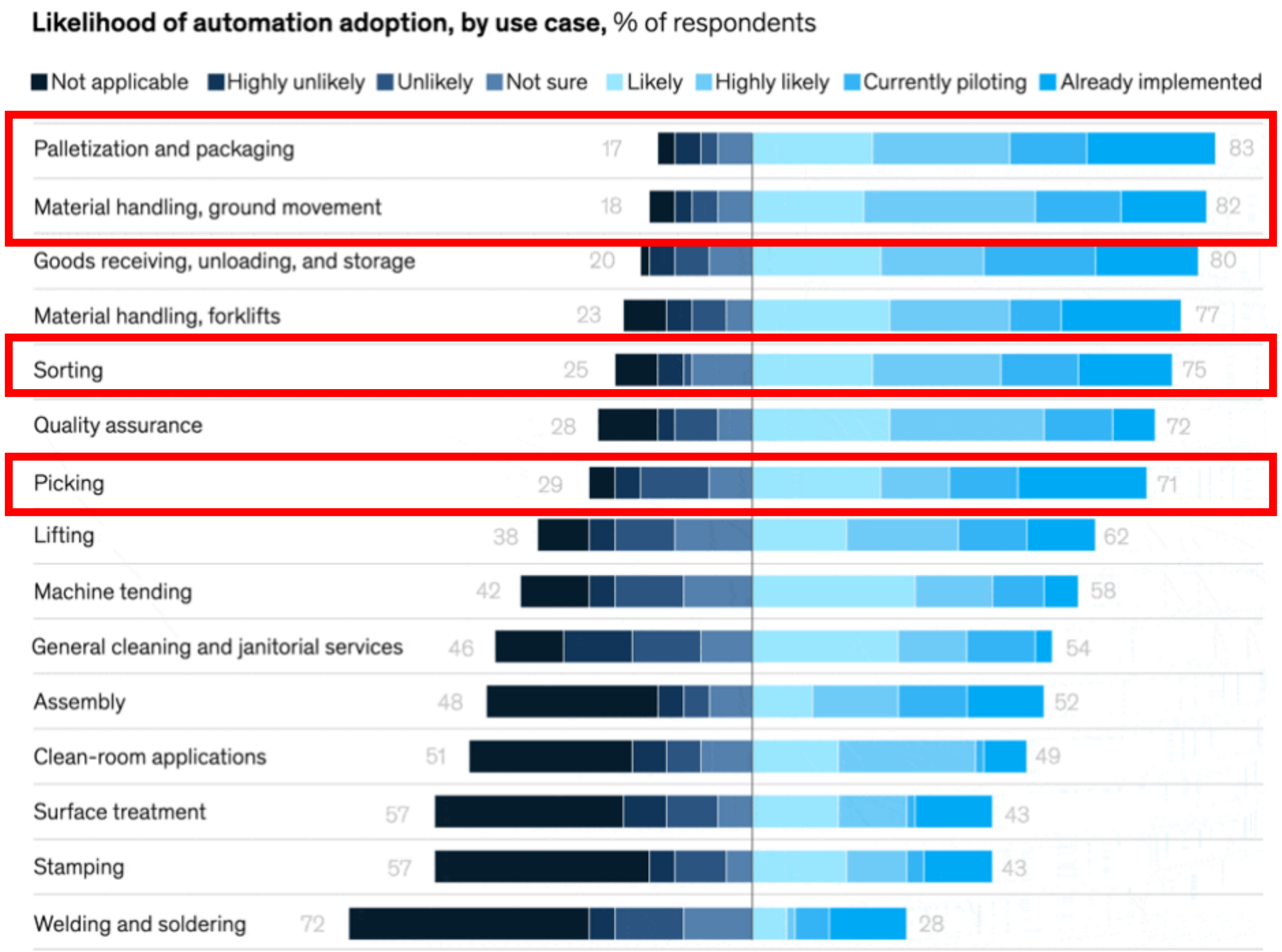

Figure 2.2 Mkinsay Global industrial Robotics Survey

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Types & Applications

Fixed Robots
(a) Tricept and Hexapod Robots

Tricept uses three legs along with a central pillar to hold a head in place. A Hexapod used six legs. These robots are very rigid but offer a limited envelope and orientation. These robots can be used for machining operations.

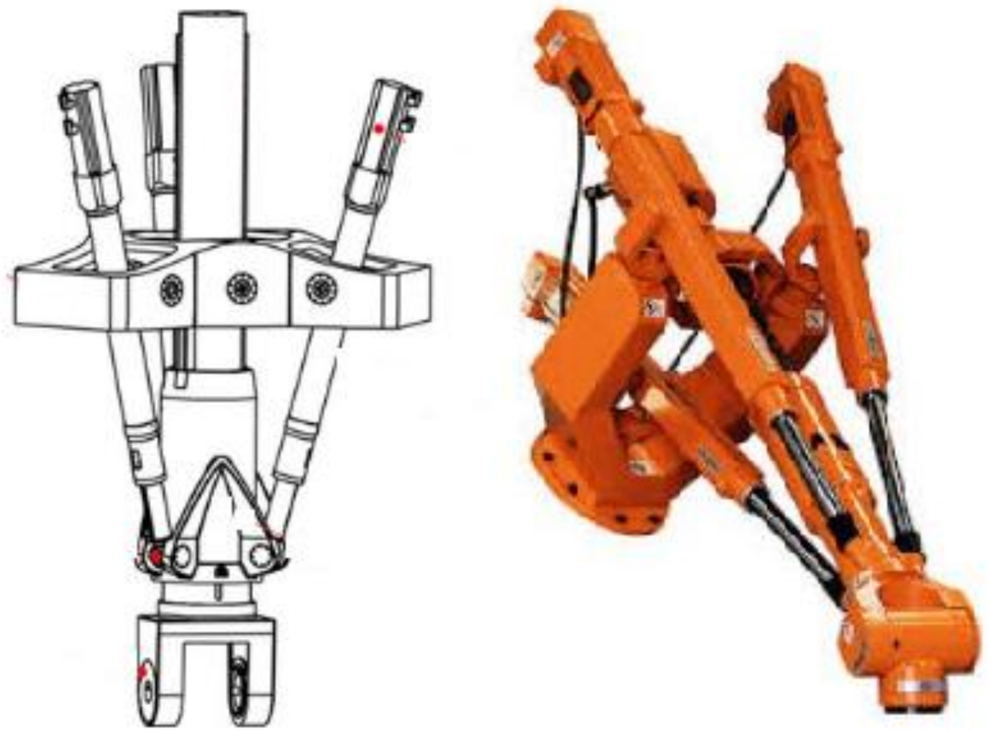

Figure 2.3 Cartesian Source Link

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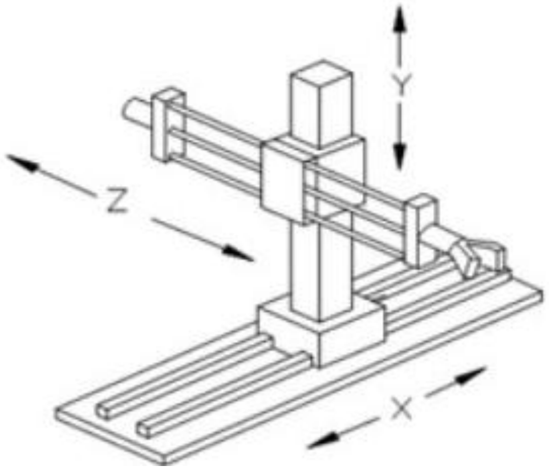
Types & Applications

Fixed Robots
(b) Cartesian

Cartesian Robots move on an X, Y & Z axis and have a cuboid envelope. They can be very accurate but are inflexible. These are predominately used for pick and place operations. These robots have 3 degrees of freedom.



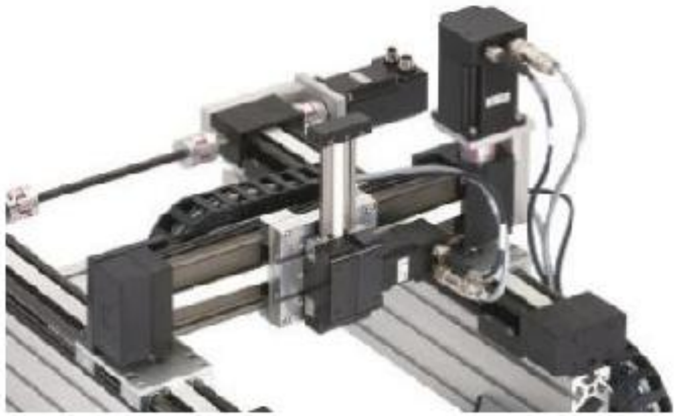


Figure 2.4 Cartesian Robot – source link

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Types & Applications

Fixed Robots
(C) SCARA (selective compliance assembly robot arms)

SCARA robots have 4 degrees of freedom. They can be used for assembly and palletisation. They are very accurate at high speeds.

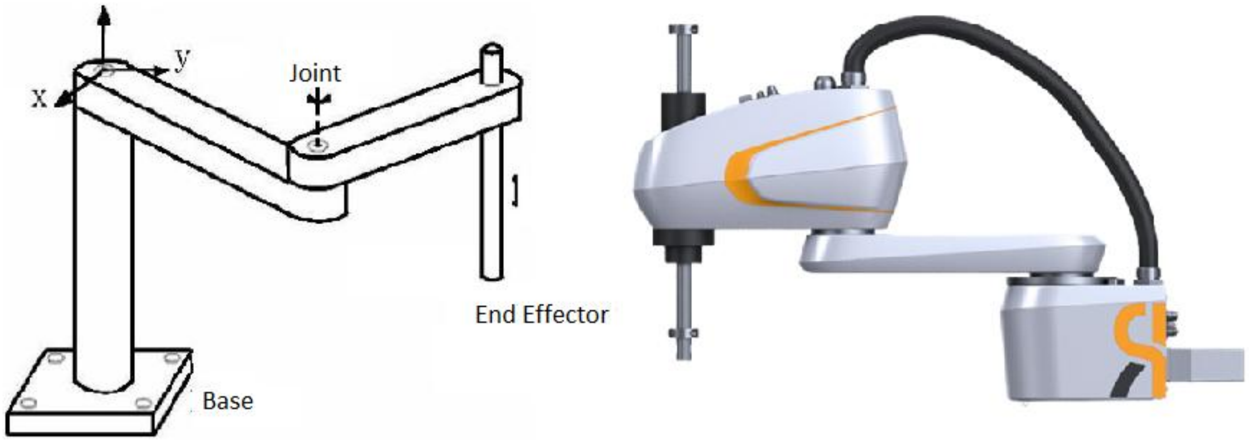

Figure 2.5 Scara robot – source link pic source link

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Types & Applications

Fixed Robots
(d) Jointed arm

Jointed arms come in many different configurations and payload capacities, making them very flexible tools for use in automated assembly lines. Their use and configuration can be combined with many of the other robots mentioned in this document. For instance, it is commonplace to find these arms mounted to mobile robots (next section), on a railed track, atop a hexapod platform, or even a smaller jointed arm mounted to a larger jointed arm; all of which are designed with a goal to provide the required manipulation for an assembly task, such as welding, hardware fastening, painting, or applying adhesives.

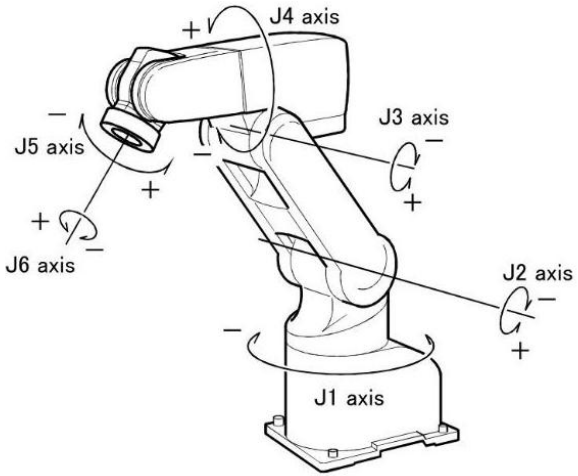

Figure 2.6 Scara robot – source link pic source link

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Types & Applications

Collaborative Robots.

Collaborative Robots, first developed by J. Edward Colgate and Michael Peshkin in 1996 and are commonly referred to as Cobots today, they were specifically designed to facilitate safe interactions between humans and robots. Major robotic manufacturers now widely offer these Cobots.

Cobots have the same degrees of freedom and envelope as jointed arm robots. As long as the part they are manipulating does not pose a risk to humans in the immediate working environment, they do not need a cage around their robot operating area because of a low speed, low payload capacity, and sensors on all motors which will stop operation if resistance to motion is detected. This allows thee robots to operate near human operators.

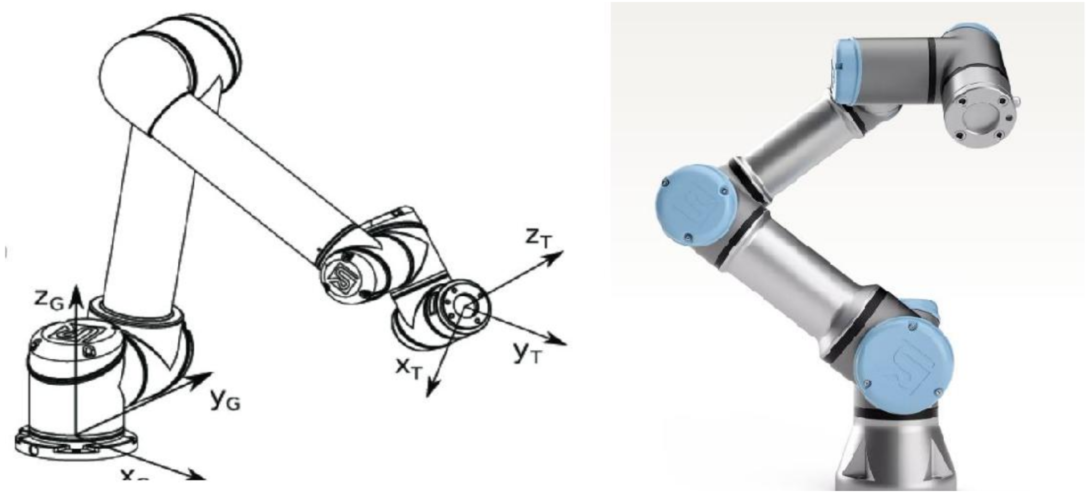

Figure 2.7 Collaborative Robot – source link

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Types & Applications

Mobile Robots

Autonomous mobile robotics (AMRs) are likely to rely on Simultaneous Localization and Mapping (SLAM) for its navigation. Their navigation system utilizes recent advancements in machine vision, LIDAR, intuitive behavior trees, and AI to guide their movements and prioritize tasks based on user inputs. This adaptive approach allows them to alter their routes in response to obstacles or changing manufacturing needs, enabling efficient movement in unstructured environments. While this navigation method is well-developed and stable, it may face challenges in distinguishing routes in areas with a high density of stillage or rack base legs.

Figure 2.8 Mouse Robot – source unknown

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Types & Applications

Mobile Robots
(a) Mouse / Turtle

Mouse / Turtle Robots typically drive under a payload and carry payloads. Payloads can range from 100's Kgs to Tonnes, typical in logistics. Mouse Robots are typically used for intra-logistics in-house transport. Mouse robots are available which can lower or raise their payload. They can be purchased with frames to help stage the payload when delivered. When equipped with a lift these robots have 3 degrees of freedom and do meet the definition of an industrial robot. These robots usually have 2 LIDARs for object detection.

Figure 2.9 Mouse / Turtle Robot – source Geek+

2. Guide To Implementing Industrial Robotics

Types & Applications

Mobile Robots
(b) Tugger Autonomous Mobile Robot

Tug Mobile Robots are more likely to operate in two degrees of freedom only. Tug Robots usually pull carts. They can have 1 LIDAR for object detection as they may not need to operate bi-directionally. As a tug, these Robots can tow multiple carts and payloads can be 10’s of Tonnes.

Figure 2.9 Tugger AMR – source

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2. Guide To Implementing Industrial Robotics

Types & Applications

Mobile Robots
(c) Forked

Forked Robots carry loads that are typical for forklifts and pallet trucks. They are designed to carry shipping pallets, making them suitable for loading and unloading trucks along with transferring pallets of materials between warehouse & manufacturing locations. As the forks can be raised the robot has 3 degrees of freedom.

Figure 2.10 Goods to Person AMR - source

2. Guide To Implementing Industrial Robotics

Benefits

Volume versus flexibility

The traditional view of industrial robots is that they are only for volume manufacturing
with the advancements discussed above to bring collaborative robotics, mobile solutions and their integration with more advanced sensors and flexible tooling, this is no longer the case.
AI is a field that can unlock step change level in system capabilities such as the introduction of Chat GPT-4 in late 2022,
Industrial robots are now able to carry out a wider range of tasks than before, including those that could be categorized as low volume and high variety.

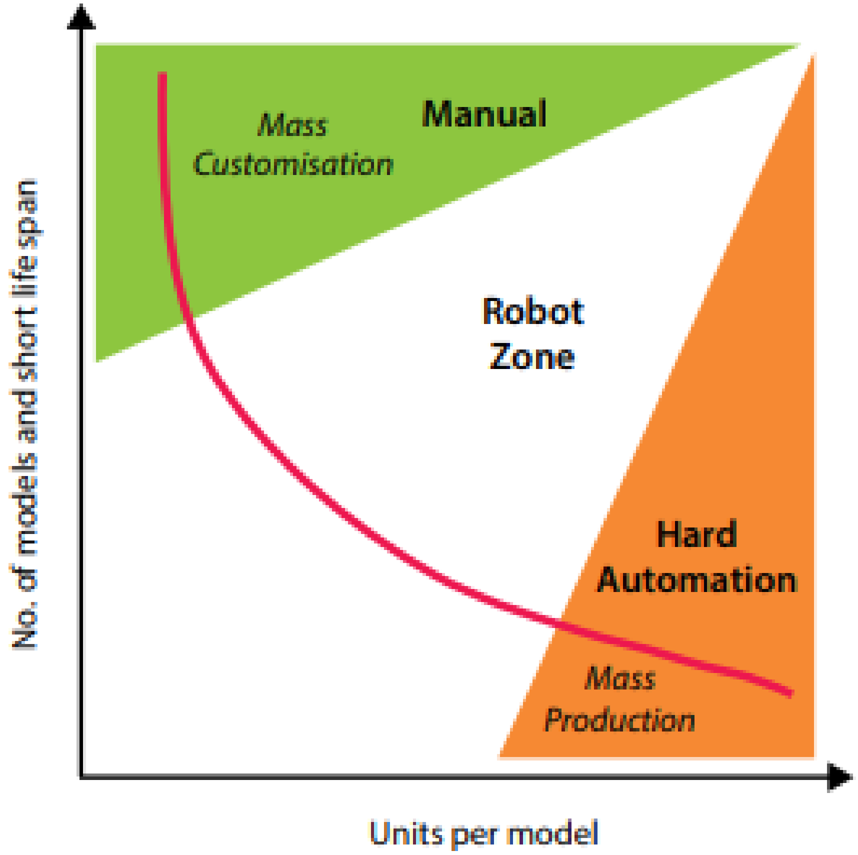

Figure 2.11 Volume Versus Variety Mix for robots

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Benefits

Enhanced Sensory Perception
High-end cameras boast Pixel resolutions that facilitates better detection of smaller objects and defects.
Improved computer processing power for vision and machine learning

Increased Productivity
Robots can work continuously without breaks, leading to higher production rates and increased overall efficiency.

Precision and Accuracy
Robots are capable of performing repetitive tasks with high precision and accuracy, reducing the margin of error in manufacturing processes

Improved Quality
Consistency in production is enhanced leading to better product quality and fewer defects.

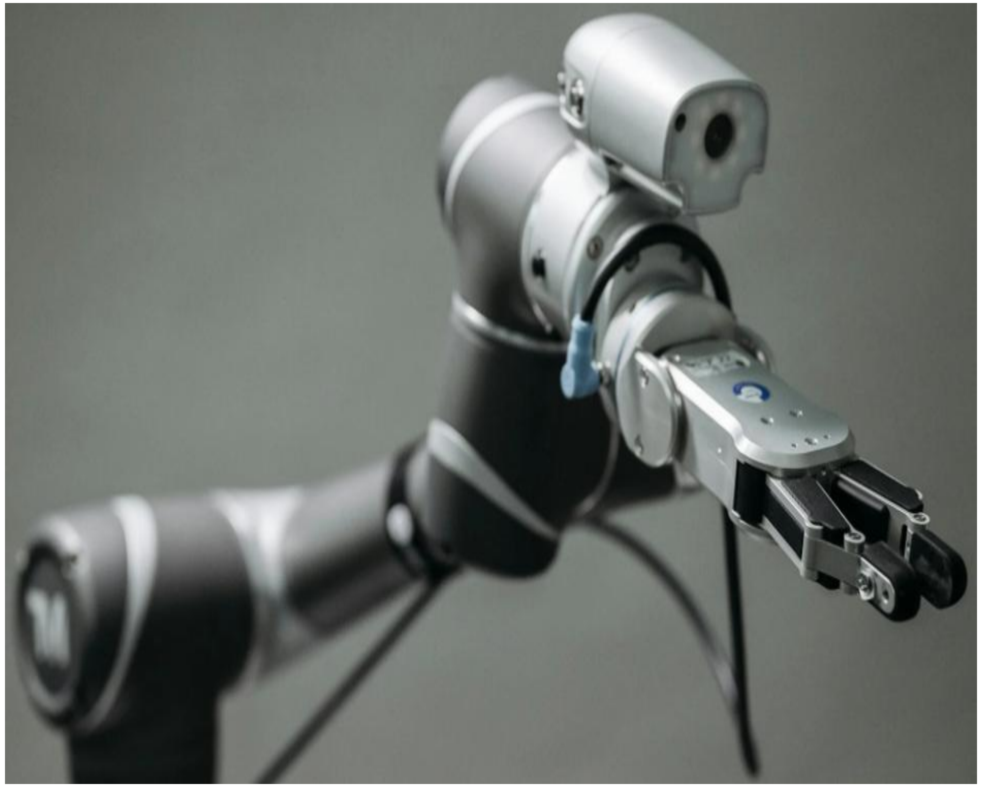

Figure 2.12 Camera sesor

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Benefits

Remote Operations Capability

Facilitates remote operations, allowing monitoring and control from a distance, which can enhance operational flexibility and safety.

A word about jobs

In both the UK and Europe today, there are shortages of labour throughout manufacturing & logistics.
Robot use can lead to creation of more and better jobs (The Impact of Robots on Productivity, Employment and Jobs published by International Federation of Robotics).
As with the evolution of jobs in Information technology the evolution of robotics will bring about many new fields of work and roles, such as; Algorithm auditor, Empathy consultant. Health data analyst, Automated electric vehicle fleet manager, simulated voice user experience engineer, license auditor, machine learning engineer, AI engineer.

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Barriers

Technical risk

The assessment of risk is particularly important for complex technical tasks that are often exhibited by the high mix and low volume scenarios that many small-to medium-sized manufacturers operate. In such a scenario, the product design stage will play a large role in determining the feasibility of using robotics to automate a process. To ensure these risks are fully understood and mitigated against, it is recommended that risk be assesses

Figure 2.13 Light Curtains - Keyence

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Barriers

Payback period

For many organizations payback = 2 -3 years approx. A well-maintained system should be able to provide a minimum of five – 10 years' service,

Health and safety

Unfortunately, Robotics have their own hazards which must be risk assessed during design. If designed and installed in accordance with current regulations and risk assessed, robotic and automation systems will improve the working conditions and safety of employees

Skills level

A lack of appropriate skills, both at implementation and in use, can be a barriers.

Organizations such as the High Value Manufacturing Catapult, the British Automation and Robotics Association, Irish Manufacturing Research, and many other Research Technology Organizations (RTOs) and Universities can help.

Figure 2.14 Fortress Double lock gate access system

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2. Guide To Implementing Industrial Robotics

Barriers

Floor Space

It is critical to define the amount of floorspace available. it can be very expensive to change the machine or plant design in the middle of the project.

Company culture

Resistance to change or a fear that robots will 'steal' jobs are often cited as reasons not to install automation.

To overcome these issues, staff involvement in the automation process needs to start very early on – with the need for robotics and what it means for their jobs openly and clearly explained.

Working environment

The working environment should be considered in the requirements of any automated system. For example, meat processing, agricultural, metal casting & forging, explosive, or wet environments will each have unique requirements that must be considered early in the design of a system as certain precautions will need to be taken.

Figure 2.15 Robotics in Cheese Manufacture- Fanuc

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2. Guide To Implementing Industrial Robotics

Barriers

Integration Complexity

Integrating robotics into existing production systems can be complex. Compatibility issues with existing machinery, production lines, and software systems may arise. Achieving seamless integration often requires specialized knowledge and expertise.

Figure 2.16 House Offsite Manufacture - Kuka

Standards

The absence of standardized practices within the realm of robotics poses a challenge for certain companies, hindering their ability to fully harness the potential of emerging technologies or seamlessly integrate novel types of robots into their manufacturing processes. Some organizations have developed proprietary systems and capabilities over time, which they are inclined to maintain.

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2. Guide To Implementing Industrial Robotics

Business Case

Factors to consider

(a) cost to carry out the process
   a. Human effort,
   b. materials utility costs,
   c. training;
   d. Insurance,
   e. Revenue impacts,
   f. Cost of quality,
   g. Potential downtime,

(b) Investment costs – this includes:
   a. not just of the equipment itself but the effort required,
   b. disruption to normal operations during installation,
   c. Cost of parts for testing, set up etc.
   d. Training,
   e. changes to existing upstream or downstream processes,
   f. Software Licensing and Integration, .

(c) Ongoing costs such as:
   a. Human effort,
   b. Maintenance or spares materials,
   c. utility costs;
   d. Ongoing insurance provisions,
   e. maintenance.

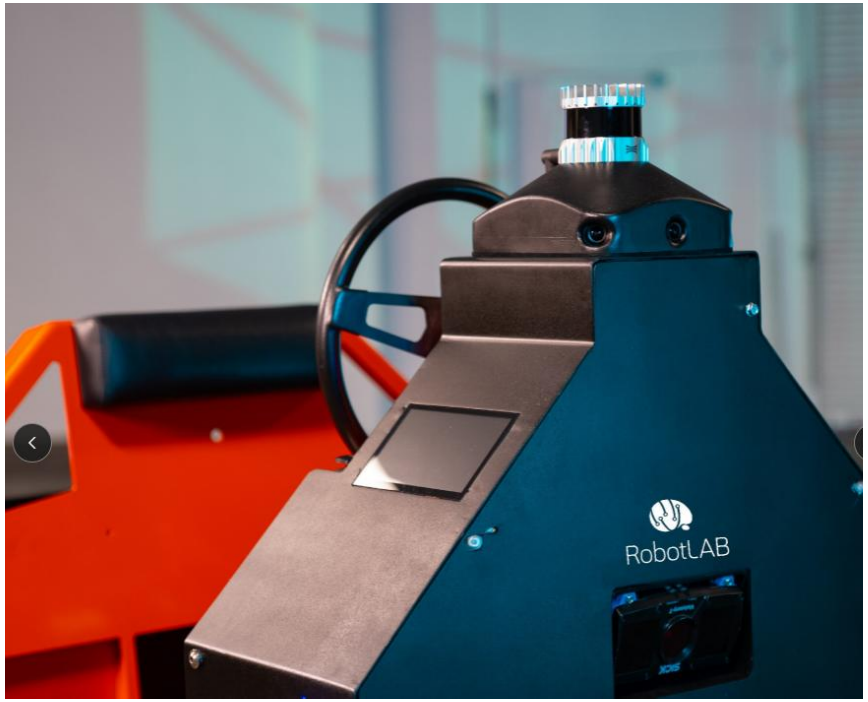

Figure 2.17 Tugger Robot - RobotLab

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Business Case

Return on investment methods

Its worth checking if your organisation has a preferred approach
The ROI calculation attempts to determine the gain made from the investment to the organisation. A simple ROI calculation is the form:
Factors that may also be considered in the ROI calculation include the cost of money in the future (i.e., interest and inflation), long-term costs and returns.
Such calculations are often backed up by analysis tools such as payback calculations, an example of which is shown in Figure 2.18

$$ROI = \frac{(\text{Gain from investment} - \text{Cost of investment})}{\text{Cost of investment}}$$

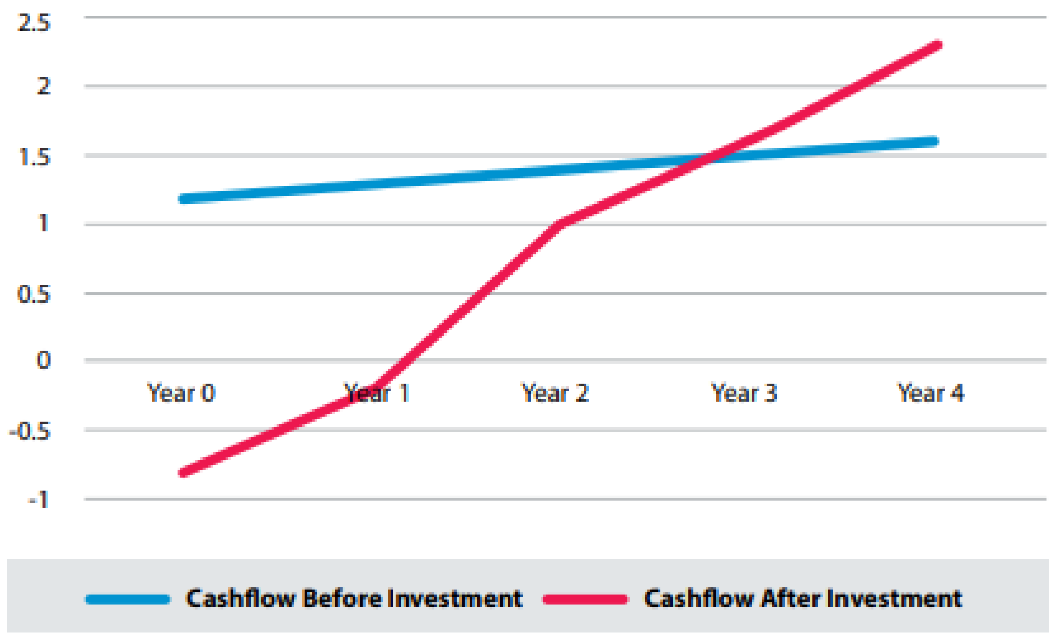

Figure 2.18 Example Return on investment calculation

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Business Case

Preparing the business case

(a) describe the problem you are trying to solve;

(b) describe what the automation will do and the expected benefits that will be realized.

(c) describe what it is you want to invest in and why;

(d) describe what the financial and other benefits will be;

(e) define the risks involved and how they might be mitigated;

(f) describe the ROI calculations (include any assumptions you've made); and
(g) define a high-level implementation plan.

Figure 2.19 3D printing Robot - Kuka

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Implementation

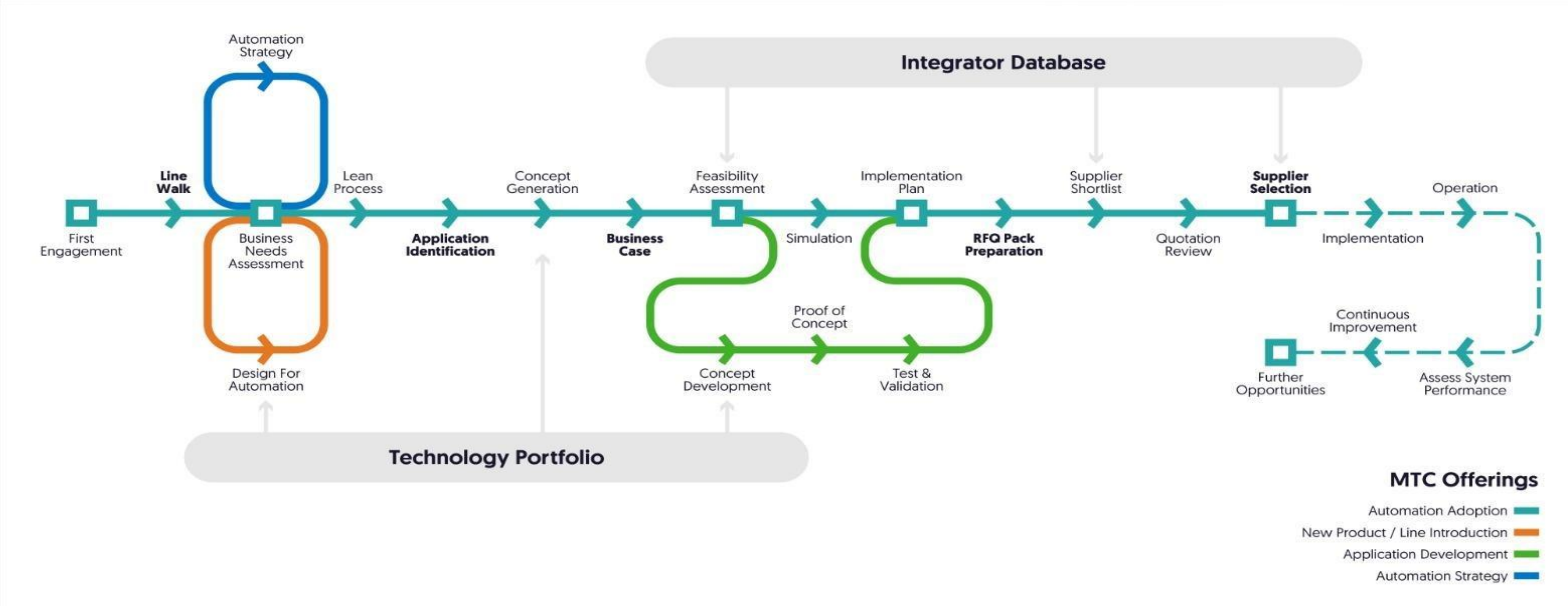

Figure 2.20 MTC implementation Roadmap

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Implementation

three key branches

The Automation Strategy (blue)

the development of a longer-term plan (eg 5 years) for the introduction of automation within a business. It is expected that this would build from relatively simple to more complex applications and include the training of personnel to support.

The Design for Automation (orange) stage

This would apply where the business has the opportunity to modify designs or is introducing a new product.

The Application Development path (light green) relates to those applications where a commercial solution is not available and development work is required..

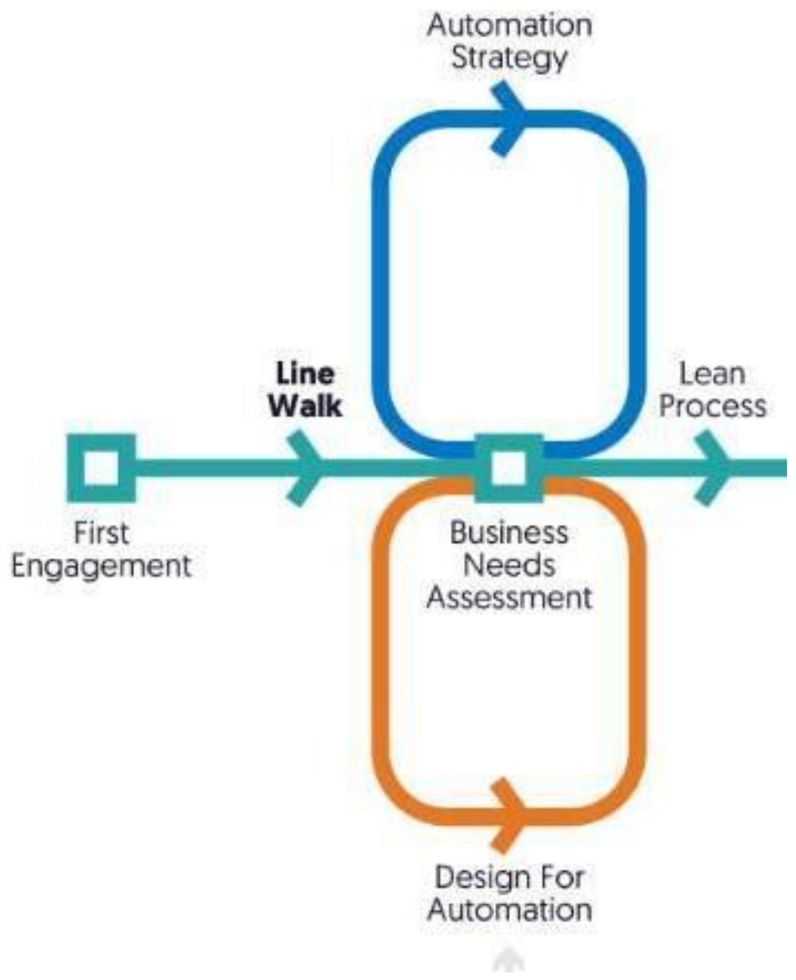

Figure 2.21 MTC implementation Roadmap

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Implementation

Steps

- Line Walk
- Business Needs Assessment
- Lean Process
- Application Identification
- Concept Generation
- User Requirements Specification
- Business Case
- Feasibility Assessment
- Simulation
- Implementation Plan
- RFQ Pack Preparation
- Supplier Shortlist
- Supplier Selection
- Implementation
- Operation
- Assess System Performance

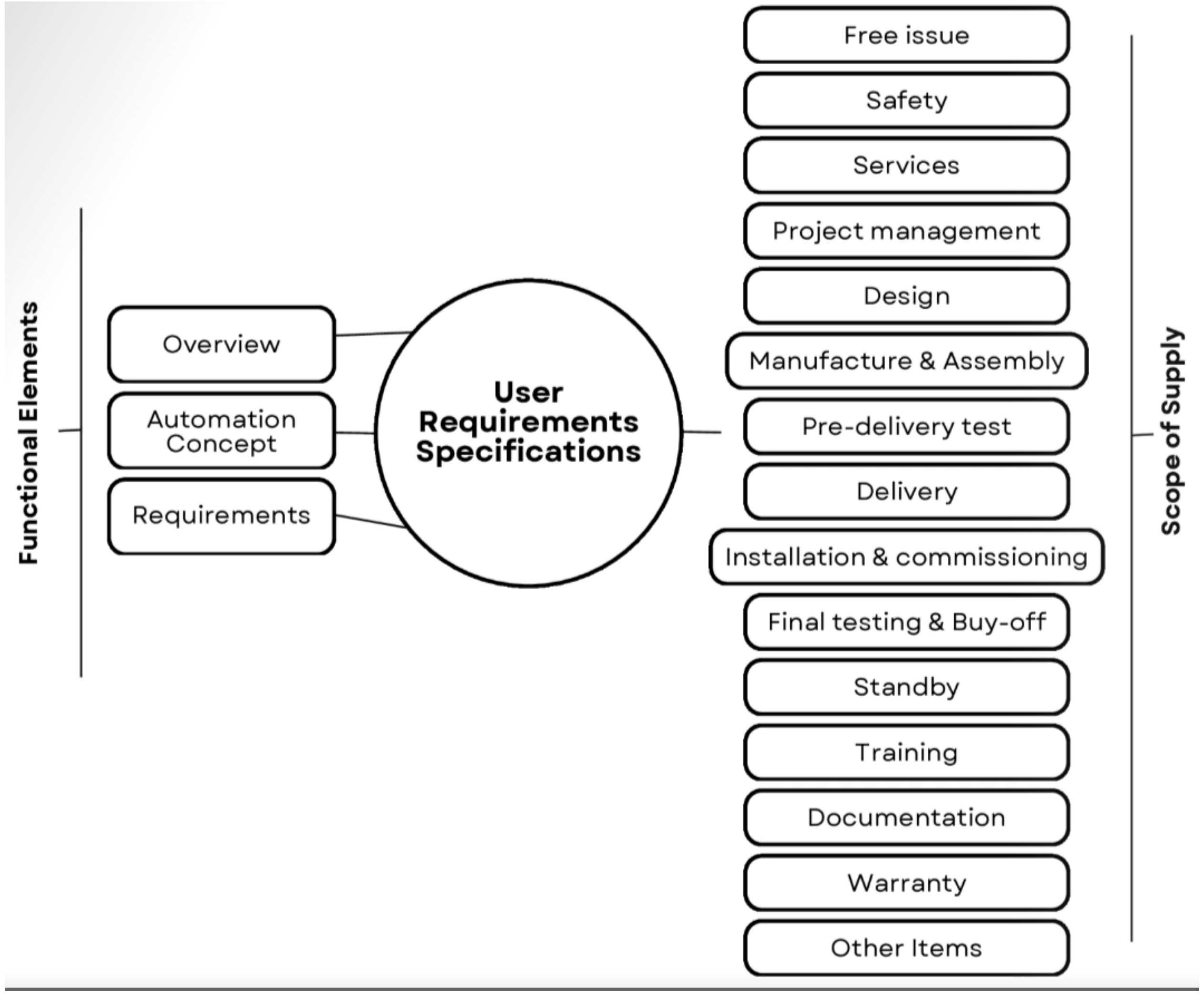

Figure 2.22 User Requirements Specification

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Implementation

Steps

Lean Process

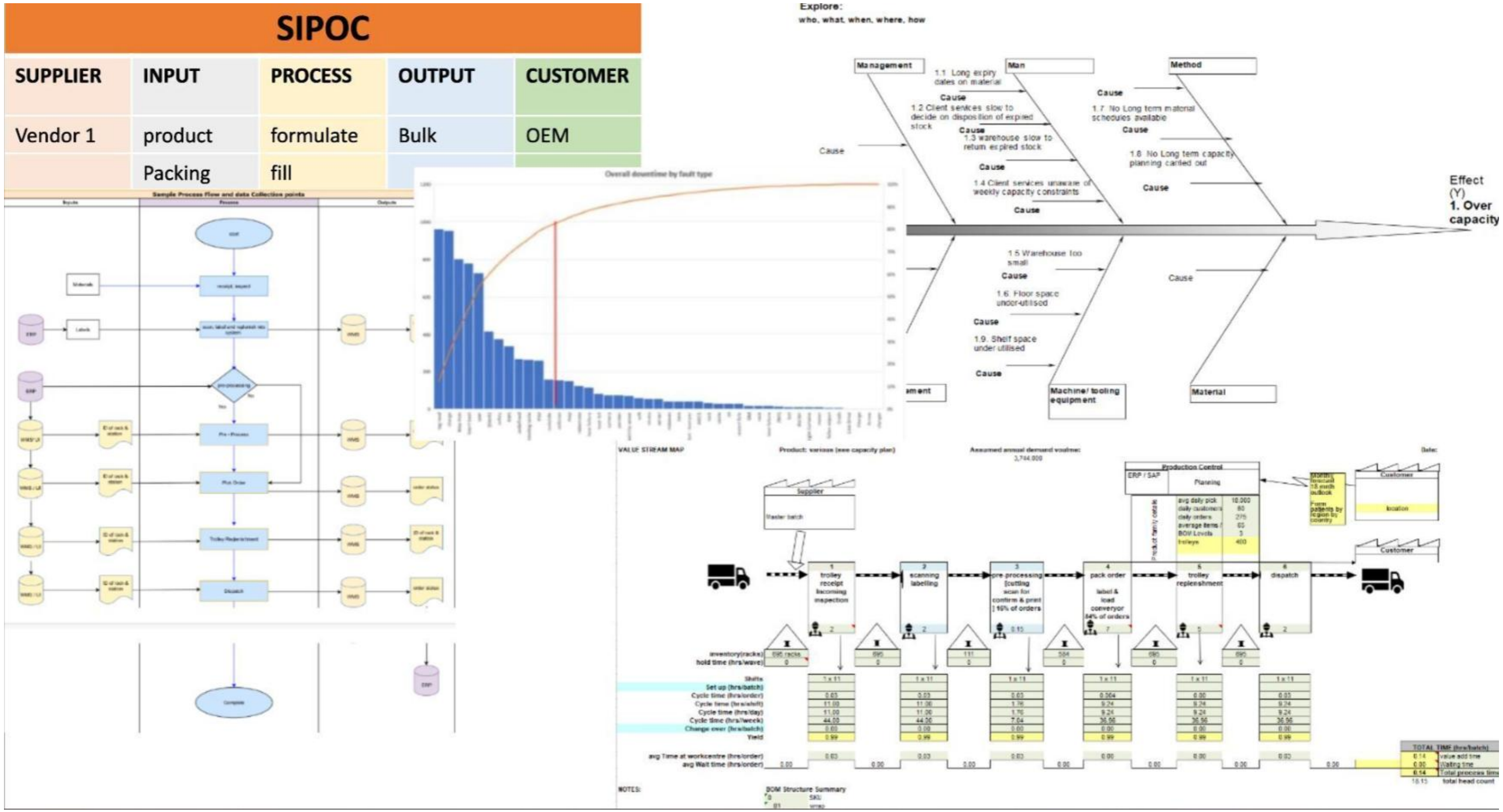

Figure 2.23 Lean Tools Montage

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Implementation

Steps

Simulation Tools

Discrete Event Process Modelling

JaamSim (free)

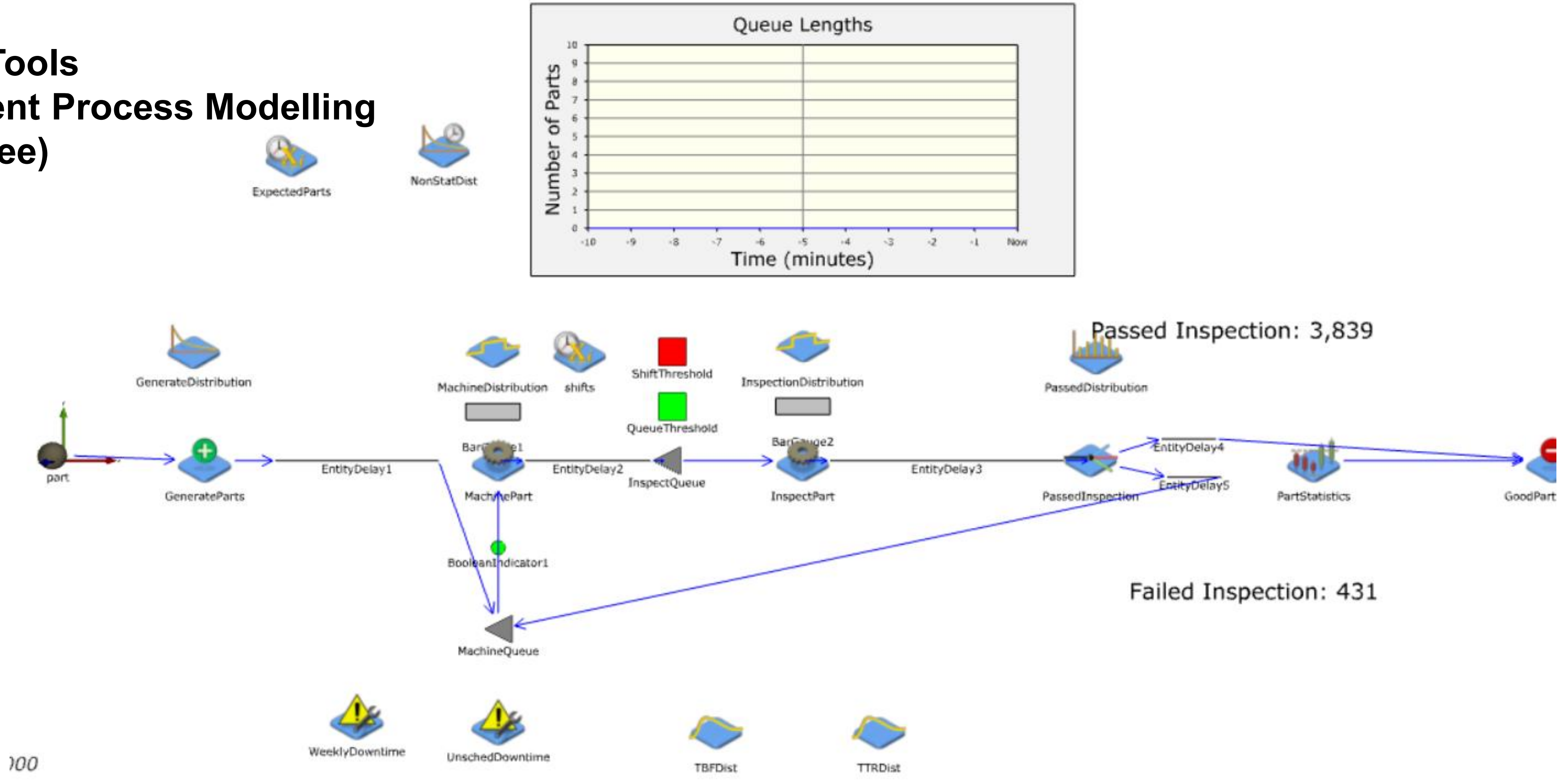

Figure 2.24 JaamSim Modelling of a process

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Implementation

Steps

Simulation Tools
Discrete Event Process Modelling
FlexSim

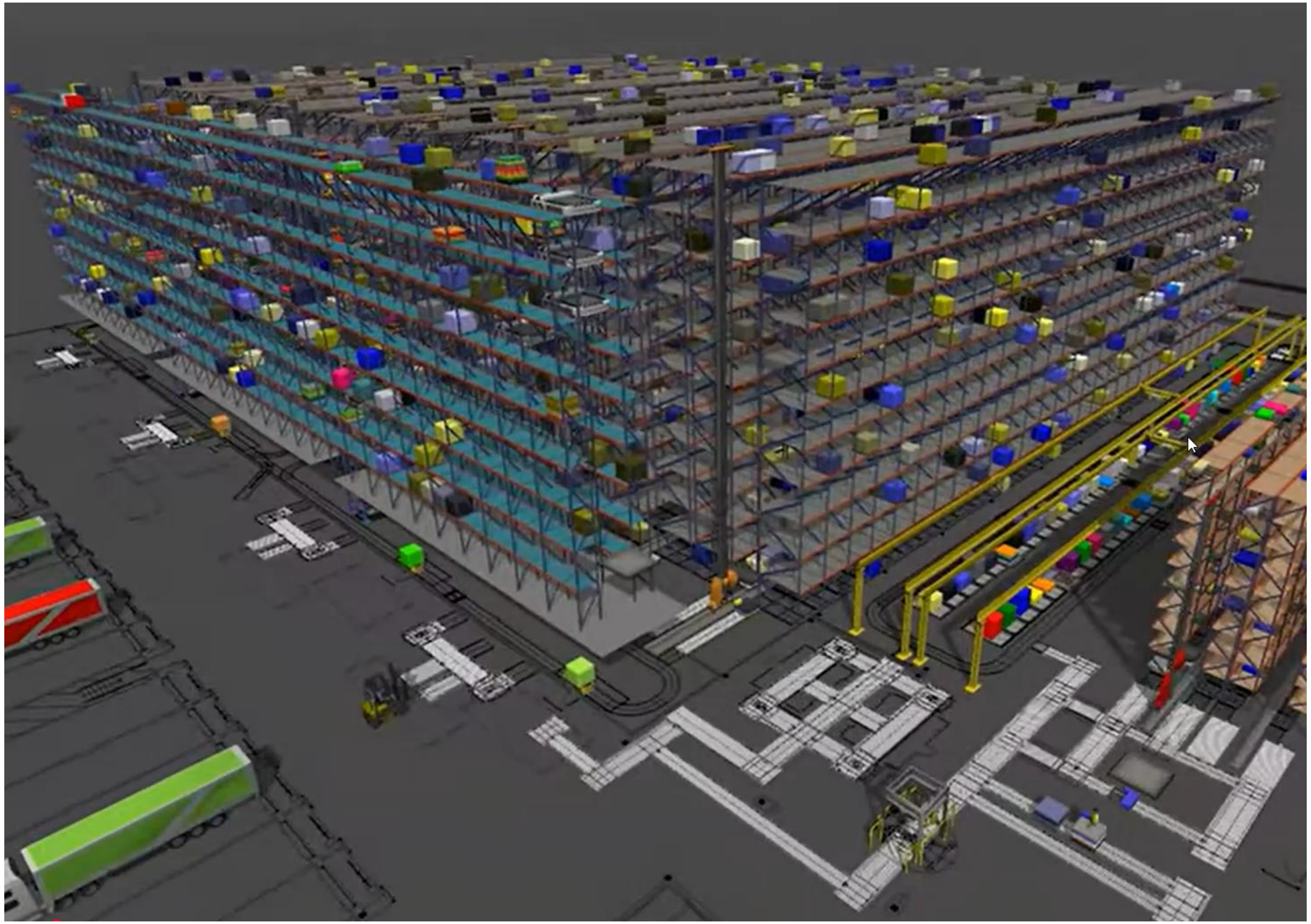

Figure 2.25 FlexSim Modelling of process

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Implementation

Steps
Simulation Tools
Discrete Event Process Modelling
RoboDK

Figure 2.26 RoboDK Modelling of process

[Robot Library | RoboDK]

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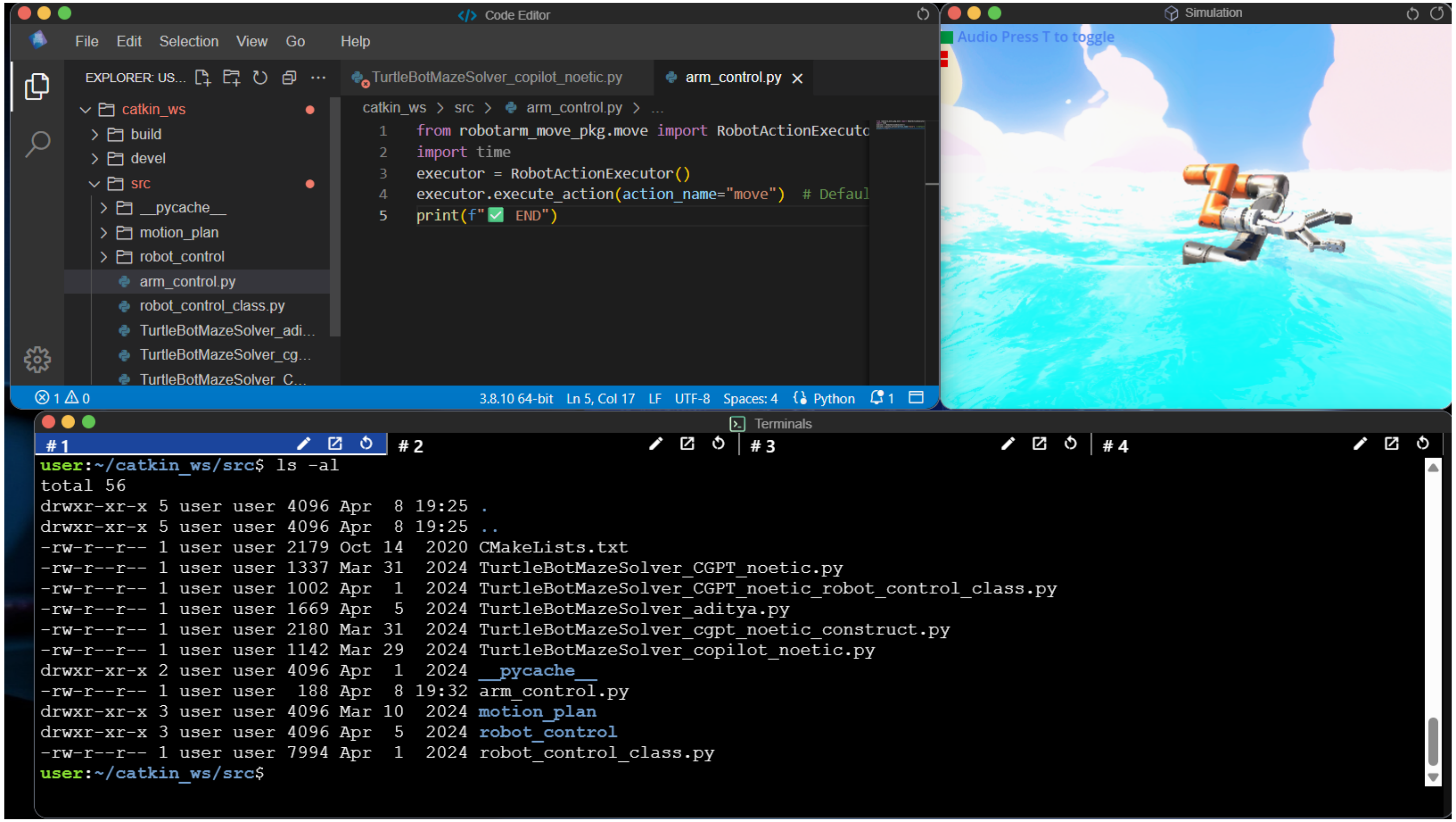
Implementation

Steps

Simulation Tools

Robot Development SDK

ROS



Theconstruct ROS training link

Theconstruct webinar for the IET

Figure 2.27 Example ROS development Environment

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Implementation

Steps

Line Walk
Business Needs Assessment
Lean Process
Application Identification
Concept Generation
User Requirements Specification
Business Case
Feasibility Assessment
Simulation
Implementation Plan
RFQ Pack Preparation
Supplier Shortlist
Supplier Selection
Implementation
Operation
Assess System Performance

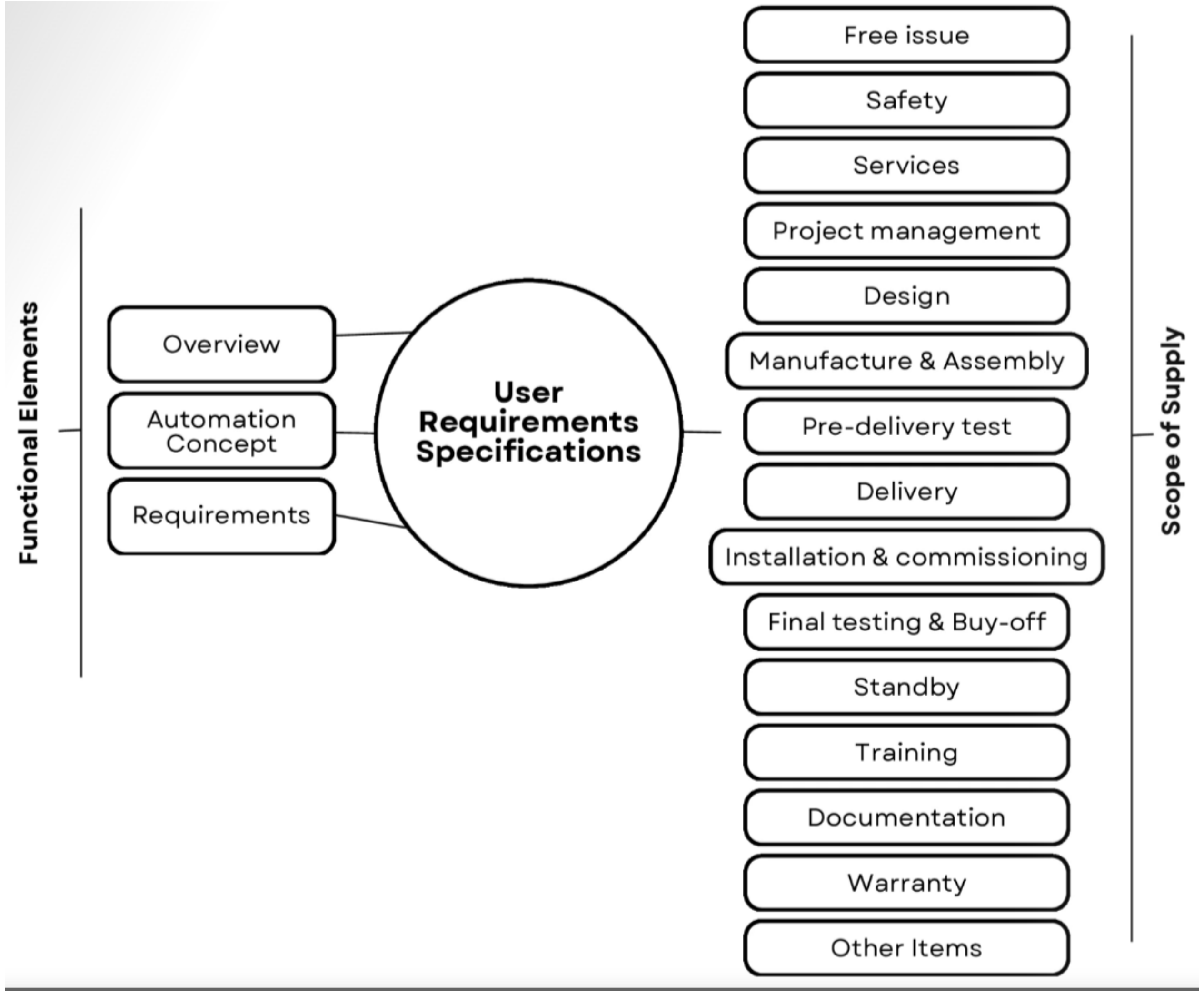

Figure 2.28 User Requirements Specification

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Summary

- Automate the Simple steps first, not the most complex
- Automate Processes which are working well already
- Not every tool in the toolbox is needed to develop a business case and requirements
- Talk to a specialist Consultant to get agnostic advice

Figure 2.29 Kuka Robot in SemiConductor wafer fabrication

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Acknowledgements

Court Edmondson
Irish Manufacturing Research

Mike Wilson
Manufacturing Technology Centre

Jeremy Hadall
Satellite Applications Catapult

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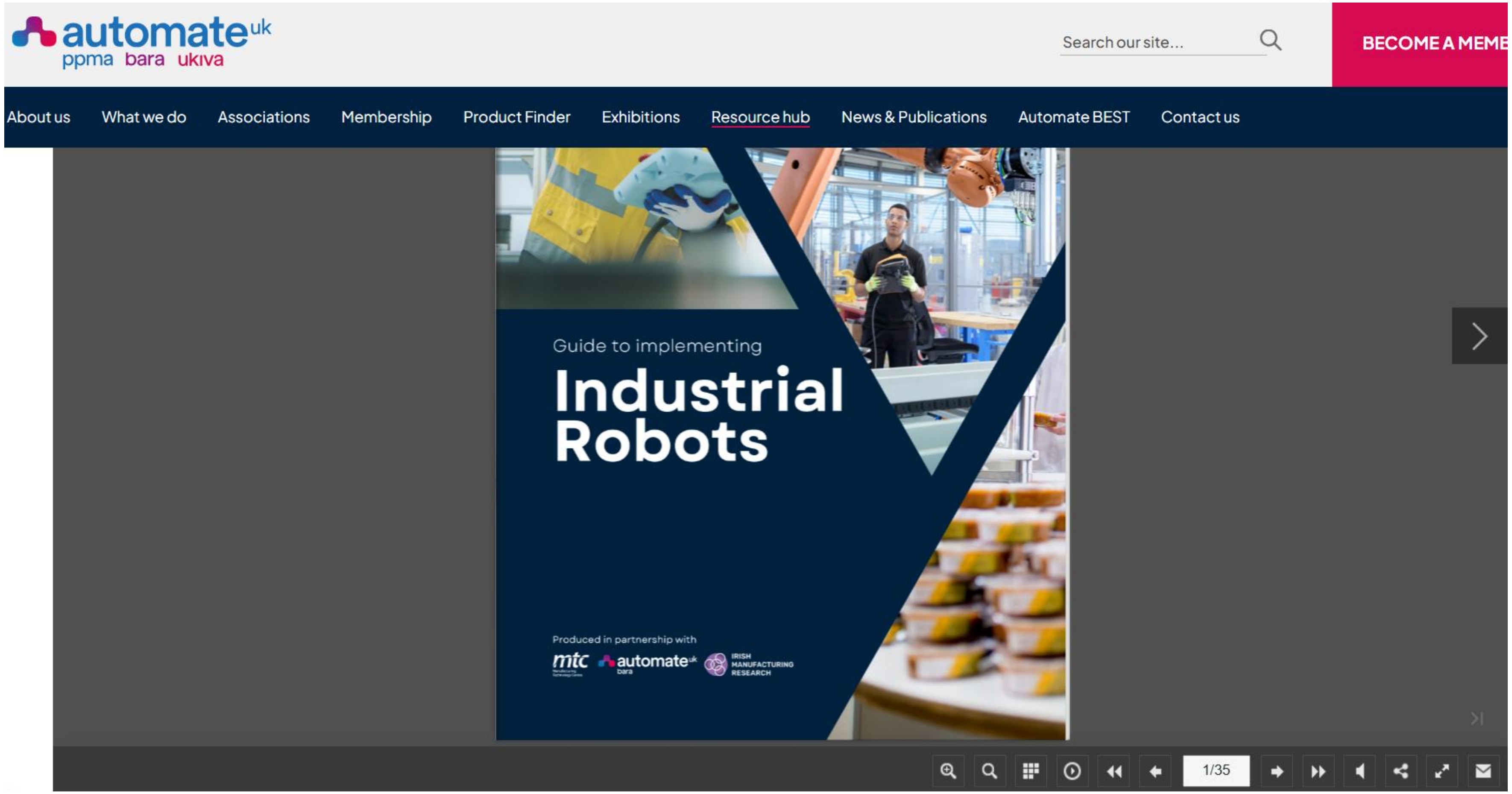

QR and Bit.ly link to the guide on AutomateUK website. Thanks again to AutomateUK for editing & hosting the guide.

https://bit.ly/3O18c56

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Backflip humanoid Bot

Thanks for sticking with me through the day to day of justifying and implementing robotics apps in industry. Now a backflipping robot. You deserve it.

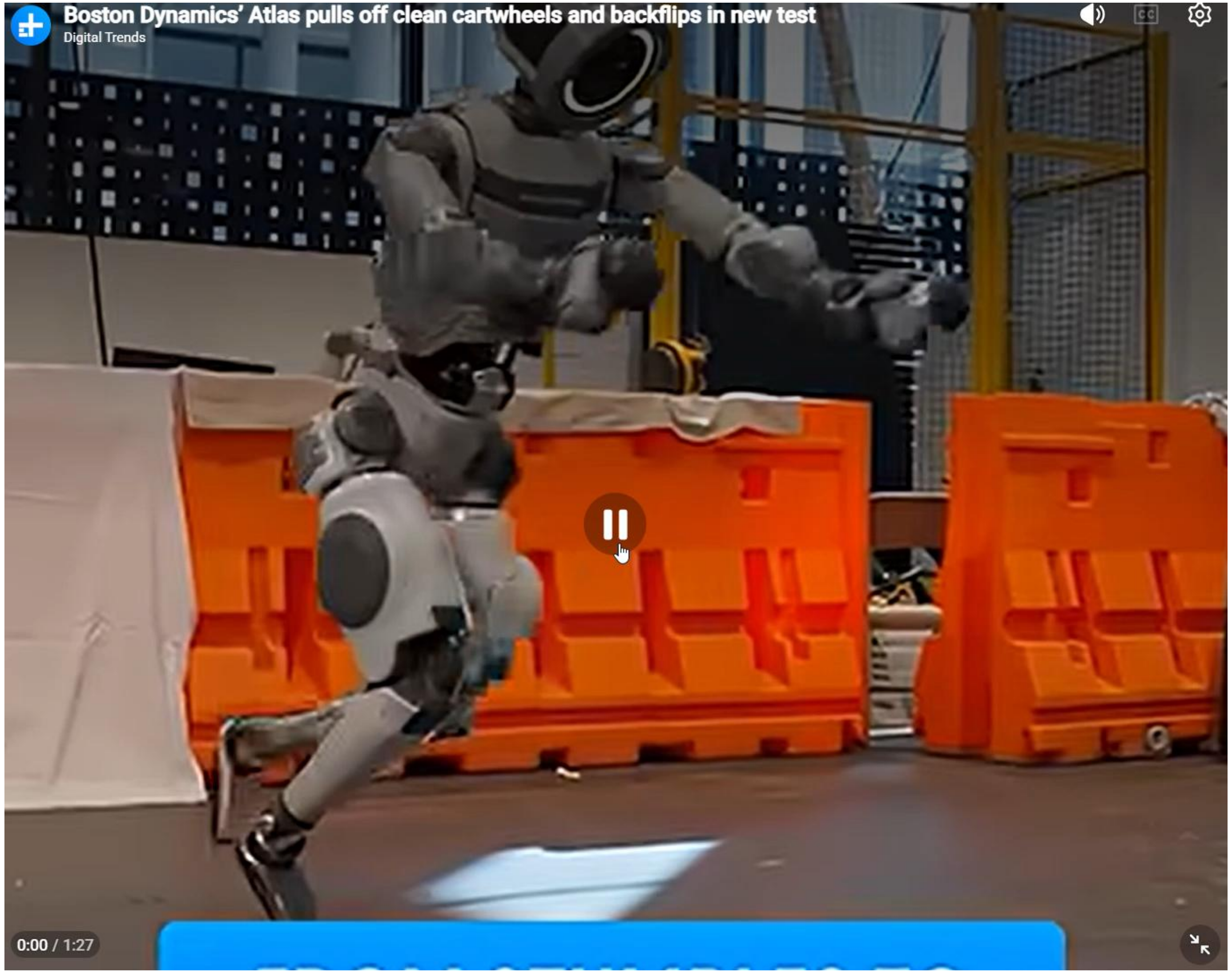

Figure 2.30 Backflipper

3. Q&A

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Link 2 Guide

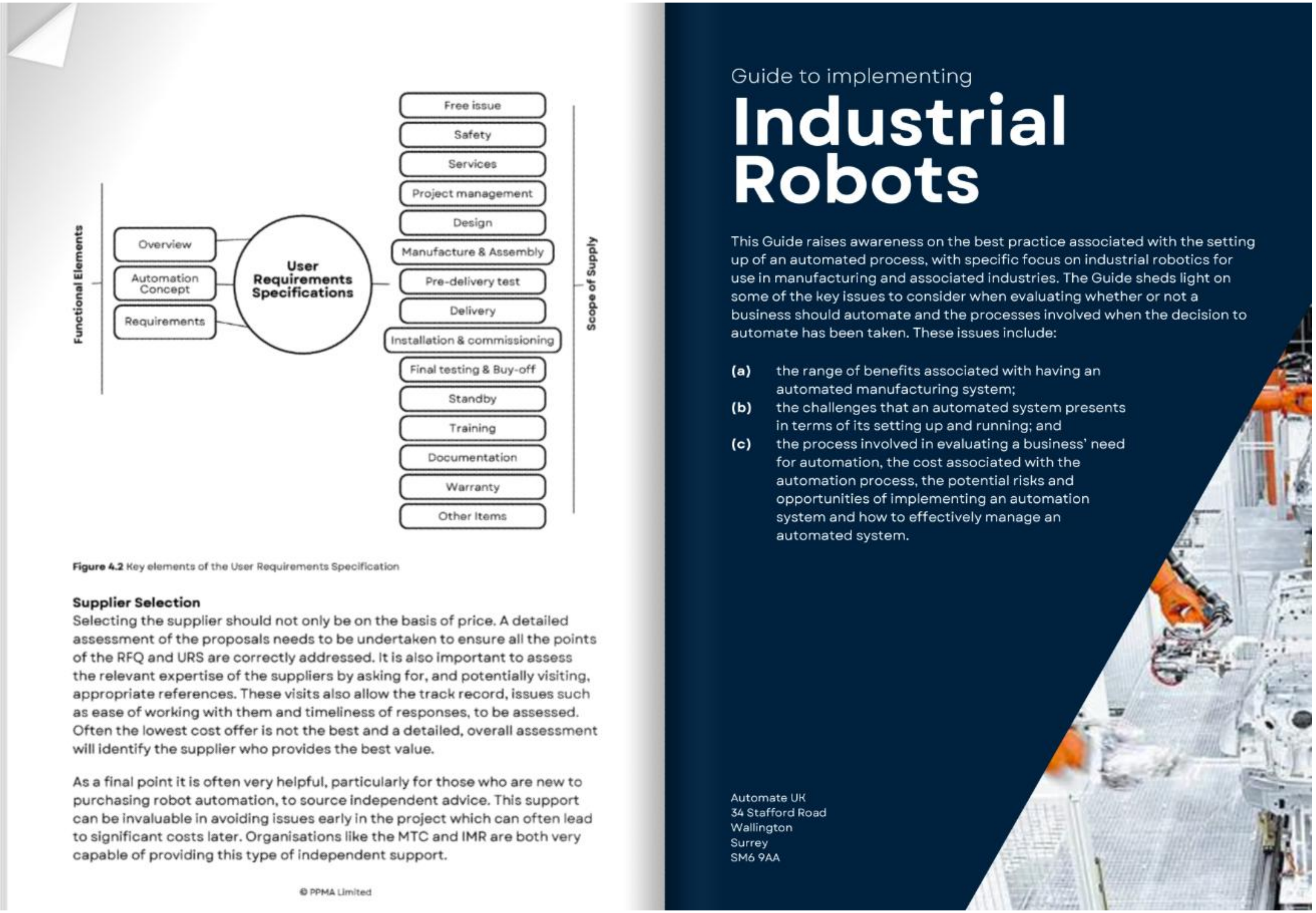

Figure 4.2 Key elements of the User Requirements Specification

Supplier Selection

Selecting the supplier should not only be on the basis of price. A detailed assessment of the proposals needs to be undertaken to ensure all the points of the RFQ and URS are correctly addressed. It is also important to assess the relevant expertise of the suppliers by asking for, and potentially visiting, appropriate references. These visits also allow the track record, issues such as ease of working with them and timeliness of responses, to be assessed. Often the lowest cost offer is not the best and a detailed, overall assessment will identify the supplier who provides the best value.

As a final point it is often very helpful, particularly for those who are new to purchasing robot automation, to source independent advice. This support can be invaluable in avoiding issues early in the project which can often lead to significant costs later. Organisations like the MTC and IMR are both very capable of providing this type of independent support.

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Guide to implementing

Industrial Robots

This Guide raises awareness on the best practice associated with the setting up of an automated process, with specific focus on industrial robotics for use in manufacturing and associated industries. The Guide sheds light on some of the key issues to consider when evaluating whether or not a business should automate and the processes involved when the decision to automate has been taken. These issues include:

(a) the range of benefits associated with having an automated manufacturing system;
(b) the challenges that an automated system presents in terms of its setting up and running; and
(c) the process involved in evaluating a business' need for automation, the cost associated with the automation process, the potential risks and opportunities of implementing an automation system and how to effectively manage an automated system.

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https://bit.ly/3O18c56