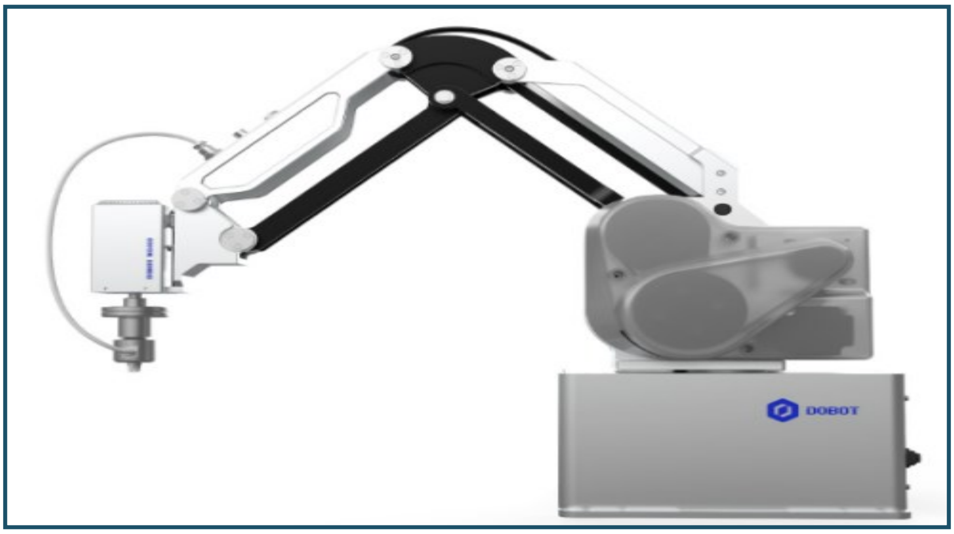
ROBOTICS IN THE MANUFACTURING SECTOR
TECHNOLOGICAL NOVELTY OR MERIT

A robot is a programmable machine that can complete a task typically performed by a human. Robots have different levels of autonomy, ranging from human-controlled to autonomous bots that perform tasks without external influence. The field of study focused on developing robots and automation is called robotics.

Industrial robots are typically seen as a replacement for labour, while collaborative robots, or cobots, possess the innate ability to work in tandem with humans.



Robots are already deployed in scale-intensive manufacturing sectors such as automotive assembly, pharmaceutics and food processing. In these industries, robots increase the productivity and accuracy of manufacturing functions or perform functions that pose health and safety risks to humans.

However, robots are also increasingly used in lower-scale medical, manufacturing and chemical applications. In these contexts, robots are often configured to work closely with humans in a flexible way. The reduced costs of adding sensors and other technologies to robots, and the ease of reconfiguring robots, are rapidly decreasing the costs of ownership of robots in low-scale environments.

For information about the four kinds of robots that can be identified in workplaces see box on page 2.

NEW COMPETENCE REQUIREMENTS

While developing countries are hesitant to embrace robots due to their potential impact on low-skilled jobs, in Europe, robots are seen as a substitute for increasingly scarce skilled labour. The result is that robots may substitute both low and higher-skilled jobs in South Africa as the cost of ownership declines and the difficulty of programming them becomes easier.

TECHNOLOGICAL CHANGE AND INNOVATION SYSTEM OBSERVATORY

The aim of the Technological Change and Innovation System Observatory project is to support the Department of Trade, Industry and Competition (the dtic) and industry sectors to develop an integrated, strategic response to discontinuous technological change and disruptive innovation. It aims to equip public and private organisations to become more sensitive to global technological shifts, and the changing demands placed on the innovation system, the manufacturing sector and its stakeholders.

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FOUR KINDS OF ROBOTS

Articulated robots mimic the movements of a human limb. They can execute functions fast and accurately and are often used in pick and place functions, drilling, welding, inspection, material removal and for dispensing. They can reach into a machine tool compartment and can work around several obstructions. Articulated robots are classified by the number of rotation points, with six being the most common. They range in size from less than 30cm to several meters tall.

SCARA – Selective Compliance Articulated Robot Arm – robots are often used in environments where continuous functions are performed. It has a fixed arm and is better suited for vertical tasks. It is often used to pick items from one platform and then place them on another, usually in the same horizontal plane. They are used for inspection, packaging, sorting or dispensing functions.

Delta or spider robots use three or more mounted motors to actuate control arms that position a wrist. The most common models have a 3-axis movement, but there are models with more. Delta robots are much lighter than other types and are often used in pick and place assembly or inspection functions for lightweight payloads.

Cartesian, line or gantry robots have three or more linear actuators assembled to perform a particular application. When configured above a workspace on two parallel rails, they are typically called “gantry robots”. They perform functions such as pick and place, dispensing, assembly or inspection – fast and accurately. These robots can be procured in a self-assembly kit and, due to their low costs, are often used by innovators experimenting with automation or precision control prototypes. (*Image: www.tecnowey.com, CC BY 3.0, https:/commons.wikimedia.org/w/index.php?curid=25229763*).

The first competence needed to deploy and operate a robot is understanding the industrial process, the materials or components involved, and the precise requirements of each task. In most cases, the robot supplier can assist a manufacturer in designing a solution that fits the manufacturing process. With larger industrial robot deployments, the person who designs or commissions the robot will not be the same as the operator trained to operate or maintain the robot. In most cases, the robot operator will need qualifications or experience in the field in which the robot is applied, with secondary training in using a robot in that environment.

Smaller robots may be commissioned in flexible manufacturing environments by the technicians or operators that will use them. Digital literacy and the ability to programme logical operations are minimum requirements for programming most robots.

Skills and knowledge

In large-scale environments, such as an automotive assembly plant, robots are commissioned by experienced engineers. The engineers must understand the materials and the requirements of each action the robot executes and how each function is related to the following function in the process. Due to health and safety regulations, larger robots must be inspected by a professional engineer or technologist.

The operators working with or near industrial robots are typically trained through specialised training programmes the robot manufacturer accredits.

When smaller articulated robots are used, the skills needed to programme or operate the robot are easily mastered by a person with technical skills combined with the ability to use a computer or tablet application to programme the robot.

A recent development is that robots can be programmed through machine-learning functions. The robot is placed in a learning mode and then shown by a human how to perform a given procedure. This can be refined while additional tasks (like measuring or taking a photo) are added to the routine.

Organisational arrangements

While a robot may displace labour at the point where a function is performed, feeding a robot or processing the materials downstream of a robot often results in increased materials handling, warehousing and other logistics. While a robot may improve efficiency in one area, it quickly reveals inefficiencies elsewhere in the system that need attention. This explains why many manufacturers design and commission a new robotic manufacturing line in parallel to an existing line, as it allows for fault-finding and synchronisation to be completed before production is switched to the new line.

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Value chain effects

When a large manufacturer switches more functions to robots it has a knock-on effect on supply chains, logistics and warehousing. Not only would the throughput of materials increase, but the quality of components or materials would most likely become more stringent. For instance, Ford Motor Company in South Africa commissioned a new robotic assembly line in Silverton in Pretoria in 2022. This affected several Tier 1 suppliers in different ways, depending on how deeply they were integrated into the Ford assembly line. Due to the high capital requirements of the upgrade, Ford in-sourced some functions previously provided by external suppliers.

Market novelty and new functions

Robots improve the reliability of manufacturing operations. This is especially true when used in different functions like welding, assembly and inspection. Consumers benefit from higher quality products that are more reliable.

With the increased regulations around recycling and the circular economy, manufacturers such as Apple and others have shifted to using robots to disassemble products or to sort packaging materials. When an artisan or smaller manufacturer uses a robot, they can assemble more sophisticated products faster and more consistently. This could allow companies to scale their operation while keeping their fixed monthly expenses low.

Strategic impact on firms

Robots allow large-scale manufacturers to add additional shifts and to operate continuously. It usually allows more complex tasks to be performed faster and at a higher quality. Over the past 20 years, manufacturing and assembly tasks shifted to developing or low-income countries. However, with the scarcity of technical and higher-skilled workers in Europe and the United States, robots are increasingly substituting for more advanced job functions. This may have a disruptive effect on the South African manufacturing sector which is reliant on low-skilled labour while facing critical skills shortages in some technical areas.

Robots can reduce potential harm to humans when deployed in sectors such as mining or dangerous environments.

Used in an industrial setting, robots improve accuracy, precision and speed of operations. In the last few years, robots have shifted from being useful only in scale operations to increasingly being deployed in flexible manufacturing environments. This brings cost savings to areas where scarce human expertise was previously a bottleneck.

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As the range of sensors, machine learning applications and processing technologies evolve, robots will spread beyond factories to more workplaces, farms and households. As robots become increasingly able to be programmed to perform a broader range of tasks, they will spread to smaller or more flexible workplaces.

Regulatory requirements

Like many other countries, South Africa does not have a specific regulator of robots. Robots and remotely operated equipment have to be compliant with existing legacy regulations. Health and safety regulations regulate the commissioning of larger robots and movable machines. These installations have to be inspected and approved by a professional engineer. However, it is not clear when a professional engineer is not required.

Most of the major robot suppliers and manufacturers using robots in South Africa adhere to international standards and technical regulations that govern the use and management of robots. For instance, ISO 10218-1:2011 specifies the safety requirements and guidelines for the inherent safe design, protective measures and information for industrial robots.[1]

TECHNOLOGICAL CAPABILITY IN SOUTH AFRICA

The CSIR Learning Factory in Pretoria has a demonstration capability with several articulated robots.

There are local distributors and service experts in all the cities where automotive assembly takes place. Companies that have demonstration units available include:

- SAR Electronic (Pretoria, Port Elizabeth) https://www.sarsa.co.za
- Jendamark (Port Elizabeth, Pretoria) www.jendamark.co.za
- Robotic Innovations (Pretoria) www.roboticinnovations.co.za
- For smaller cobots see www.cobots.co.za, which has details of the wide range of accessories that can be added to a cobot. Wholesalers such as RS Electronics have a catalogue of articulated robots suitable for educational purposes.

[1] See *https://www.iso.org/standard/51330.html*