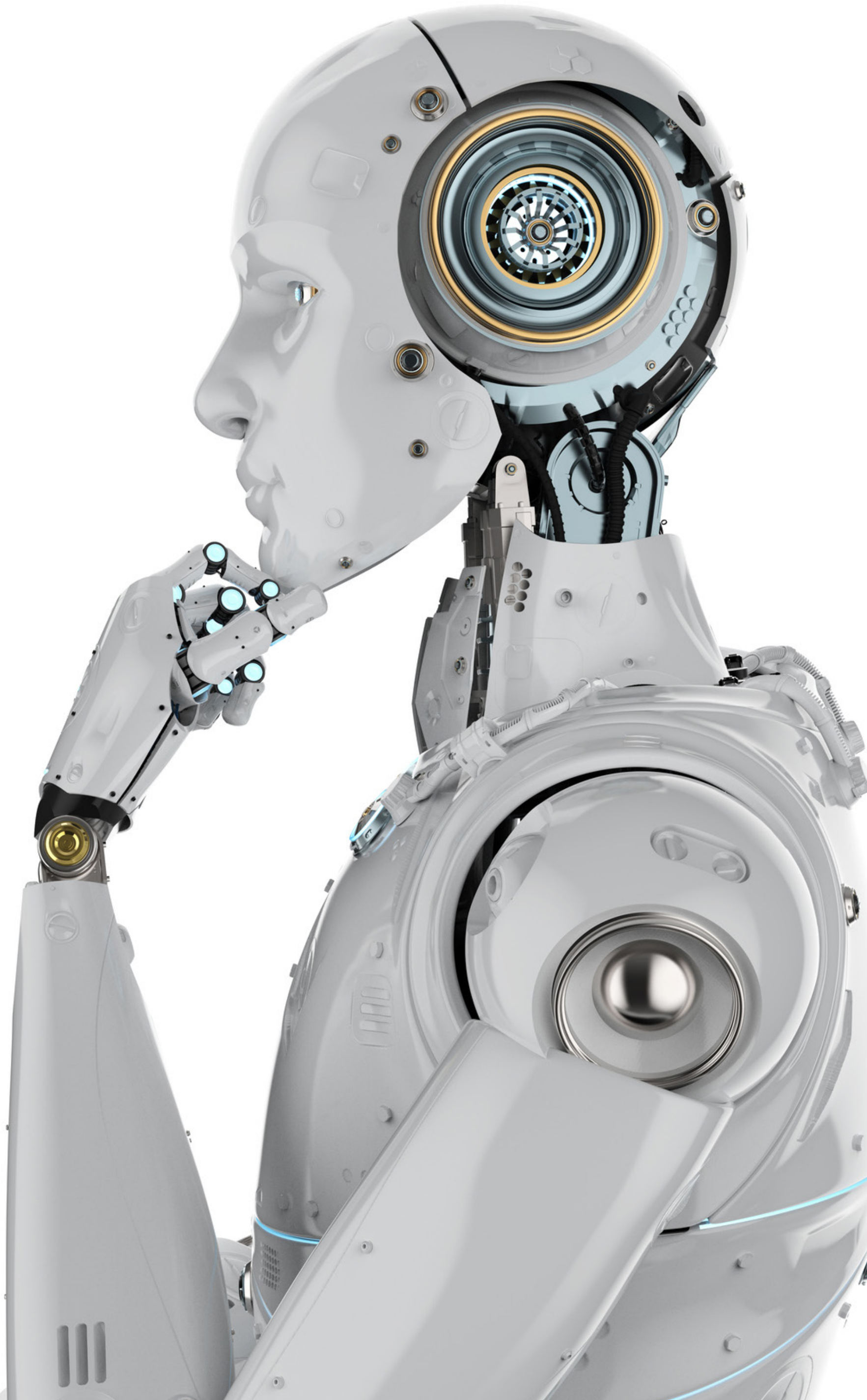
ISSUE 1, 2023

A GUIDE TO ROBOTICS AND AUTOMATION



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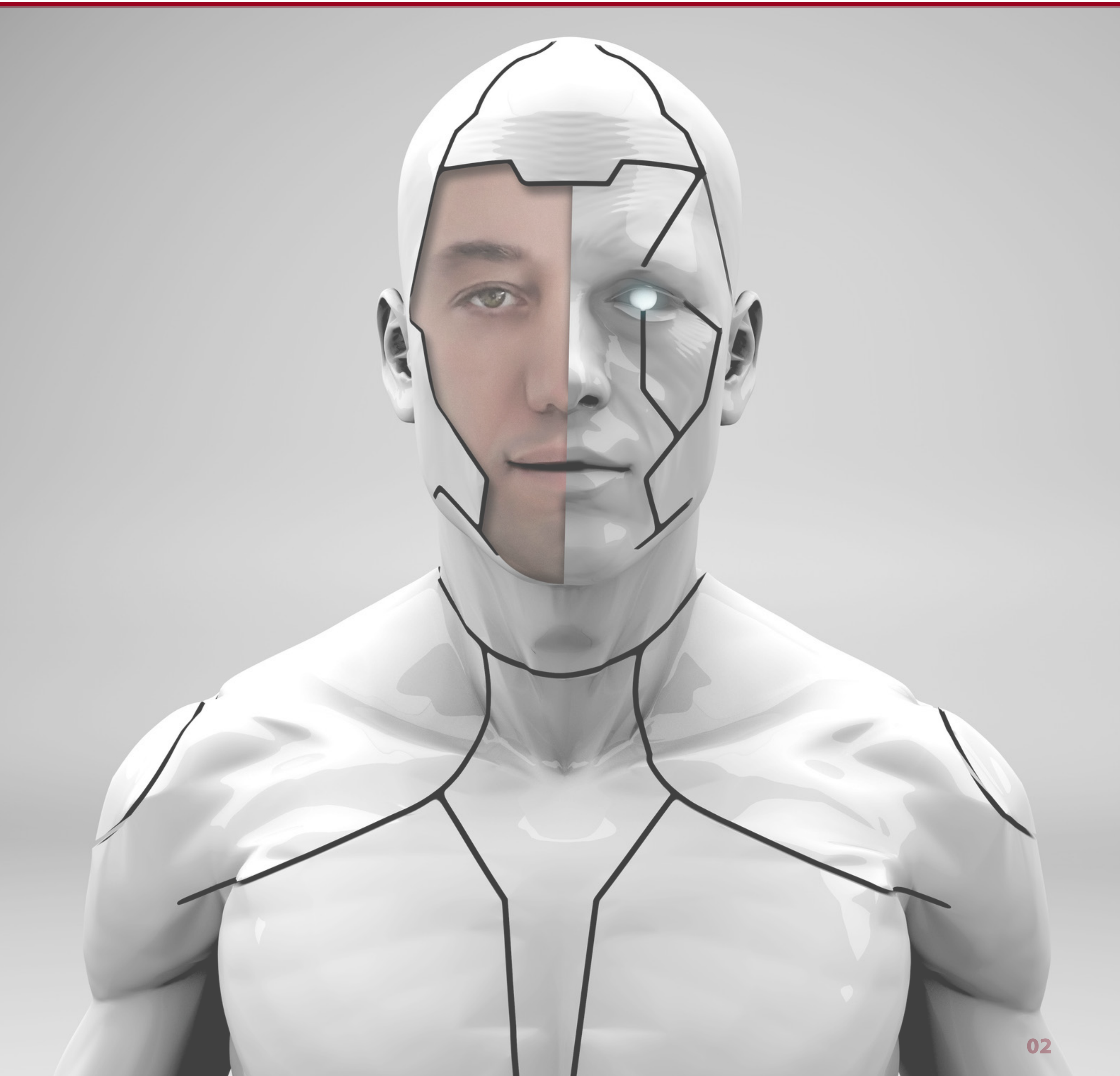

WELCOME

Robots are set to become even more prevalent in our society over the course of the coming years. They will be pivotal in enhancing our lives, in a wide array of different ways. Through the automation of tasks that were previously done by humans, they will enable dramatic improvements in productivity and operational efficiency. This will not just be of benefit in an industrial context, there will be opportunities for robots to help us in carrying out medical procedures, undertaking scientific research, producing the food we need, caring for the elderly and educating our children.

As a high-profile distributor of the latest electronic hardware, Distrelec is able to provide customers with a foundation onto which they can construct more effective, fully-automated workflows.

Underlining Distrelec's continued commitment to more widespread uptake of robotic technology, we have produced a new and extensively updated version of our Guide to Robotics & Automation and we will share it in exclusive editions. The first edition introduces the reader into the world of robotics. It focuses on history of robots, evolution of robots and robotic systems. It is a chance to discover robot types and their applications to finally read about industry 5.0 - is it already upon us, and the possibility of human and robot interaction (cobots).

Raj Patel

Managing Director

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The History of Robotics

Robotics has its roots way back in ancient mythology, when the first 'metal man', Talos, was gifted by Zeus to Europa in ancient Greece, and gear-driven mechanisms were created. But it has come a long way since then. Pre-18th-century inventions and advancements in automation included appliances and musical instruments powered by water, wind and steam. In the 1700s toys and novelties were created that moved by themselves using systems of weights and gears.

Jump forward another century and you'll find the first inventions that involve automation to make work easier, such as Joseph-Marie Jacquard's machine that printed designs onto cloth, or Zadoc Dederick's 'Steam Man', which pulled a cart.

In 1913 the first conveyer belt assembly line was installed by Henry Ford, and in 1920 the word 'robot' was first coined by Karel Čapek. In 1928 the first humanoid robot that could move its hands and head went on display in London, and by 1929 Makoto Nishimura had created a robot that had facial expressions. In just a few years robots that could walk were being shown, and more inventions to speed up work were introduced. In 1942 the DeVilbiss Company designed a paint-spraying robot that could work much faster than a human. In 1950 Alan Turing proposed tests to determine if machines could think for themselves.

The world's first robotic arm was created in 1963 and was quickly followed by multi-jointed arms, and robotic arms controlled by computers. By 1970 we were seeing robots that could detect their own surroundings and react accordingly. And, at the same time in Japan, the first android robot was launched that could walk, grip, transport objects, sense objects and communicate.

Major advancements in movement and walking robots started in the 1970s. KUKA built the first industrial robot with six electromechanical axes, and in 1973 WABOT-1 was created. It was the first full-scale humanoid robot with full control of its limbs, vision and conversation.

The 1980s saw robots with more legs and a greater degree of freedom, and Honda began humanoid research and development. In 1989 MIT created a six-legged robot controlled by four microprocessors, 22 sensors and 12 servomotors.

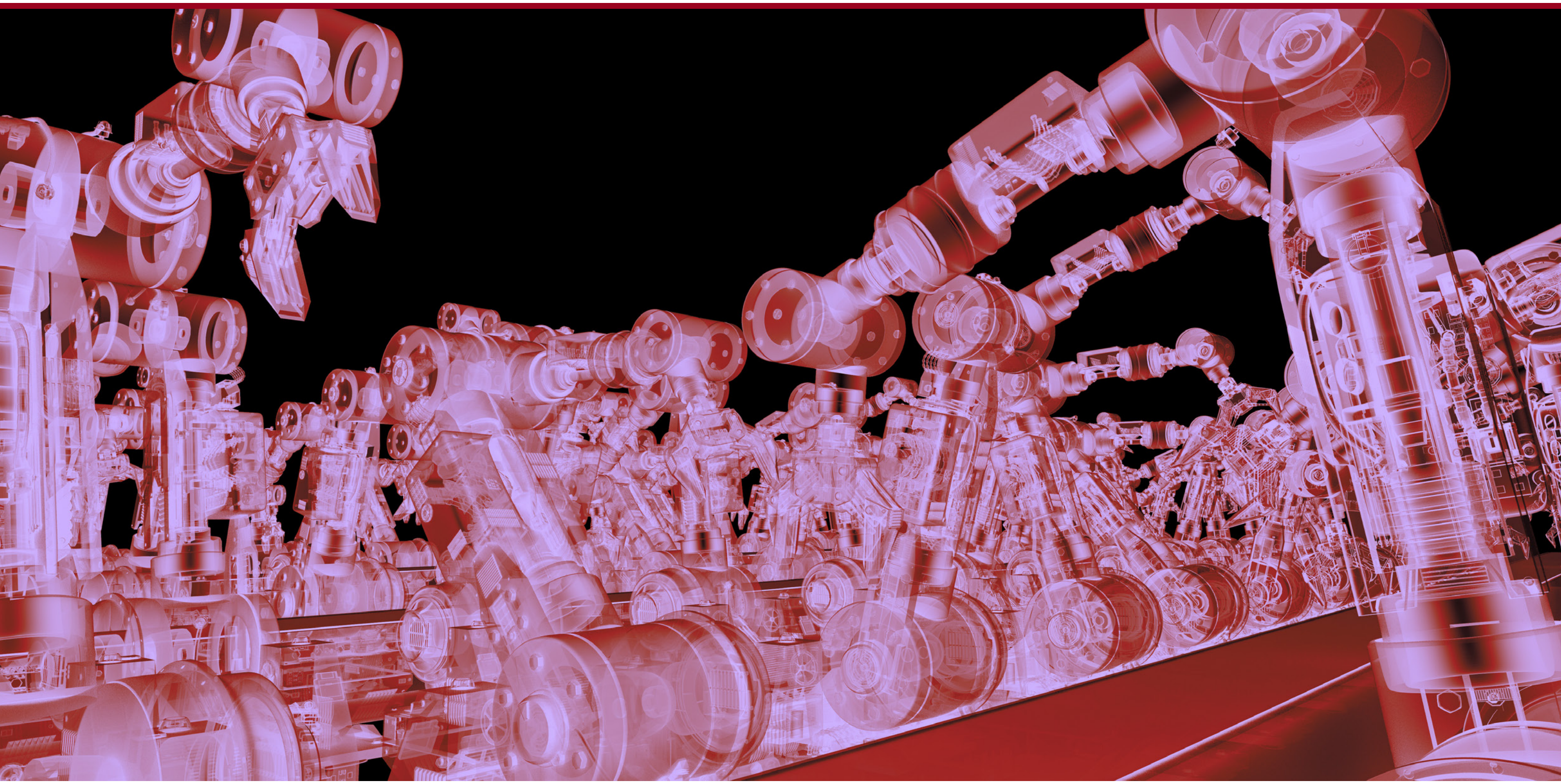
In the 1990s, robotics really took off: from RoboTuna, which explored the oceans, to advances in healthcare with the CyberKnife – a radiosurgery-performing robot, designed to operate on tumours. Robots even went into space. NASA launched its Pathfinder robot, which landed on Mars, ready to explore the Red Planet and send brand new information back to Earth.

The 21st century has seen so many new and amazing innovations in robotics and automation. In 2000 the United Nations estimated that there were over 742,000 industrial robots being used around the world. In 2006 Cornell University revealed its Starfish robot, a four-legged robot capable of self-modelling that could learn to walk after being damaged. In 2011 Robonaut 2 was launched on Space Shuttle mission STS-133 – the first humanoid robot in space – and the next year Mars Rover Curiosity landed and began exploring, sending detailed analysis back to us about the Red Planet's structure.
In more recent years Ekso, the world's first exoskeleton, was released, which enables paralysed people to walk again. In 2015 Nadine, the most human-like robot we've seen, was created by the Nanyang Technological University. And in 2017 the first robot was granted Saudi Arabian citizenship: 'her' name is Sophia.

So looking back, we've come a long way, and it's surprising to see just how early humans decided to create things that could function on their own. And who knows where we will end up? Self-driving cars are coming closer to being a reality, and super-accurate robotic tools are already being used in hospitals around the world. It's going to be interesting to see what's added to the timeline in the coming years.

Ancient Greece	Zeus gives Europa a 'metal man', Talos, as a gift Organs and clocks driven by water power were created
AD 10–70	Hero of Alexandria wrote a book called Automata and invented a wind-powered organ, animated statues, and the first steam engine
1495	Leonardo da Vinci designed the first humanoid robot
1645	The first calculator, the Pascaline, was invented
1913	Henry Ford installed first conveyor belt assembly line
1920	The writer Karel Čapek first used the word 'Robot'
1941–42	Isaac Asimov wrote the Three Laws of Robotics
1942	Paint-spraying robot designed by the DeVilbiss Company
1950	Alan Turing proposed the Turing Test to determine if a machine has the power to think for itself
1963	First robotic arm
1969	Man landed on the Moon
1970	WABOT-1 created in Japan, able to walk, grip, transport objects, sense objects and communicate – the first android robot
1970	KUKA built the first industrial robot with six electromechanical axes
1977	The first Star Wars movie was released, depicting a galaxy shared with robots

1981	First quadruped robot created by Shigeo Hirose
1990	iRobot Corporation founded
1996	Honda revealed its first humanoid robot, P2
1997	NASA's Pathfinder robot landed on Mars
1999	Sony revealed AIBO, a robotic dog
2000	Honda showed its most advanced humanoid, ASIMO, which could run, walk, communicate and interact with its environment
2001	PackBot robots sent in after the World Trade Centre attack to search through debris
2002	iRobot released the first Roomba – a vacuuming robot for the home
2004	The Mars rovers Spirit and Opportunity landed on Mars
2004	Epsom released the smallest-known robot of the time
2012	Mars rover Curiosity landed on the Red Planet
2013	iRobot revealed its first robot doctor
2017	A robot called Sophia was granted Saudi Arabian citizenship
2020	The first world's humanoid robot citizen
2022	Industry 5.0 and human-robot co-working



Robot Types and Applications

This category is for robots used in manufacturing, usually articulated arms developed for specific operations. They are automated, programmable and capable of movement on two or more axes. They are used for welding, material handling, painting, packaging and assembly lines.

The most common types of industrial robots are articulated, cartesian, cylindrical, polar, SCARA and delta. They all have their different uses in the industrial sector.

INDUSTRIAL

These include connections internally within the robotics platform, to the control system, to networked sensors and to other robotic systems.

Articulated: feature rotary joints and can range from two joints to over 10 joint structures.

Cartesian: also known as gantry or rectilinear robots. They have three linear joints, and usually a 'wrist' to allow for rotational movement.

Cylindrical: features at least one rotary joint at the base and one prismatic joint to connect the links. They work in a cylindrical-shape work area.

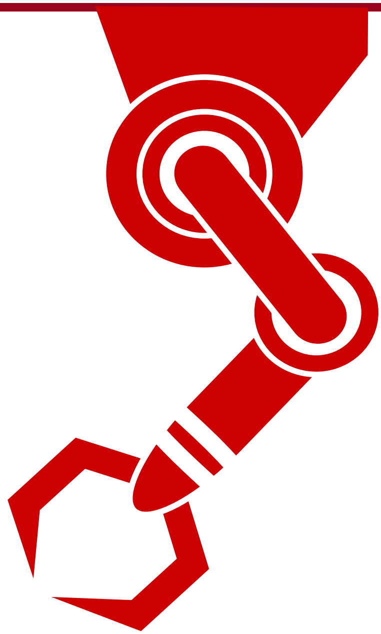
Polar: also known as spherical robots. The arm is connected to the base with a twisting joint and a combination of two rotary joints and one linear joint. They work in a spherical area.

SCARA: mainly used in assembly lines. Primarily cylindrical, they feature two parallel joints that provide compliance along one plane.

Delta: spider-like robots, built from jointed parallelograms connected to one base. Capable of delicate and precise movements, they are often found in food, medical and electronic industries.

DOMESTIC, HOUSEHOLD AND SERVICE

Mainly created for household chores, domestic robots come in many shapes and sizes. There are carpet cleaning robots that tend to be round in shape and low to the ground, and the same is true of floor washing robots. There are more complicated gutter and pipe cleaning robots with brushes and wipers that rotate around a spherical body.



Other types include a hot-air robot to iron shirts, self-cleaning cat litter boxes, kitchen robots that can make or cook food, and security robots that can patrol properties, alerting owners to the presence of intruders.

Outside the house there are garden robots, including robot mowers that work like the indoor vacuum bots, but mow the lawn instead. Robots are also used to clean swimming pools, removing debris and cleaning tiles. There are also magnetic autonomous window cleaning robots that spray cleaning solution onto microfibre pads and gently wash windows.

Service robots include those that are made for social interaction and help those who need assistance. For example robots that keep elderly people company when they are alone for long periods of time, and can be programmed to remind them to take their medication and get up and walk around, as well as other useful functions.

Home telepresence robots can move around in a remote location and enable people to communicate with each other via speaker, camera and microphone. These are particularly useful for healthcare workers checking on their patients.

MEDICAL

Used in medical sciences, medical robots include surgical robots, rehabilitation robots, biorobots, telepresence robots, pharmacy robots and disinfection robots.

With a robot being able to work more exactly and precisely than a human hand, surgical robots are starting to be used in operating theatres all over the world. Robots have been used in all areas of surgery, including neurosurgery and ophthalmology. The CyberKnife robotic radiosurgery system uses image guidance and computer-controlled robotics to treat tumours in the body.

Rehabilitation robots are used for helping people who have lost the use of part or all of their body. They can be passive or active robots, meaning that either the user or the robot makes the movements, but either way the user benefits. Using robots means that every time a movement is made, it is done in exactly the same way, ensuring consistency.

Biorobotics covers robots that have been designed to emulate or simulate biological organisms. It covers the creation of life from non-living matter. It is in its infancy as a field, and is sometimes referred to as synthetic biology or bionanotechnology.

Telepresence robots, also referred to as teleoperation robots, allow off-site health carers to assist, diagnose and talk to patients when they cannot be there in person. They are controlled remotely by a person, in this case by a doctor in their office, and can be moved around a patient's home, assessing their living conditions and allowing the doctor to talk to and look at the patient via speakers, microphones and cameras.

Pharmaceutical robots enable medicines to be handled and distributed with absolute accuracy. Already used in some hospitals, these robots can work 24 hours a day and can be programmed to dispense medicines safely. This leads to fewer cases of cross-contamination and a faster dispensary.

Disinfection robots are relatively new to medicine. They have the capability to disinfect an entire room in just a few minutes using ultraviolet light technology. One of the advantages of this type of robot is that humans don't have to go into hazardous rooms where there is a risk of infection. The robot can simply get to work and clean, reducing the spread of infectious diseases and bacteria.

MILITARY AND SPACE

A number of forces around the world now use robots as part of their operations, including helping with transport, search and rescue, defence and attack. Robots have been in use in the military since World War II, when remote-controlled tanks were first used by Soviet forces. Today there are developments in autonomous vehicles that can cross rough terrain, and weapons systems that autonomously load and fire ballistics. Military weapons are not allowed to be fully autonomous and have to have human input to adhere to the Geneva Convention governing the laws of war.

Drones, autonomous fighter jets and bombers are being further developed to keep humans out of harm's way in combat. Robotic aircraft could be programmed to ascend quicker, and perform movements that wouldn't be possible if a human was on board.

Bomb disposal robots, such as Dragon Runner used by the British Military, allow operators to analyse explosive devices without getting too close. The robots are remote controlled, highly manoeuvrable, and can dig around suspicious devices, as well as pick them up and move them. Dragon Runner has the ability to plant small charges to disrupt devices, and can cut wires. The robot sends video via live feed to the operator, so no one has to enter buildings or unsafe terrains.

In space, robots are used as exploration devices as well as extra arms outside the International Space Station. The rover Curiosity landed on Mars in 2012 and is a mobile laboratory. It travels across the surface of the planet, collecting and analysing samples, and sending the information back to Earth. It can travel over obstacles and cover around 200 metres a day, powered by a radioisotope thermoelectric generator.

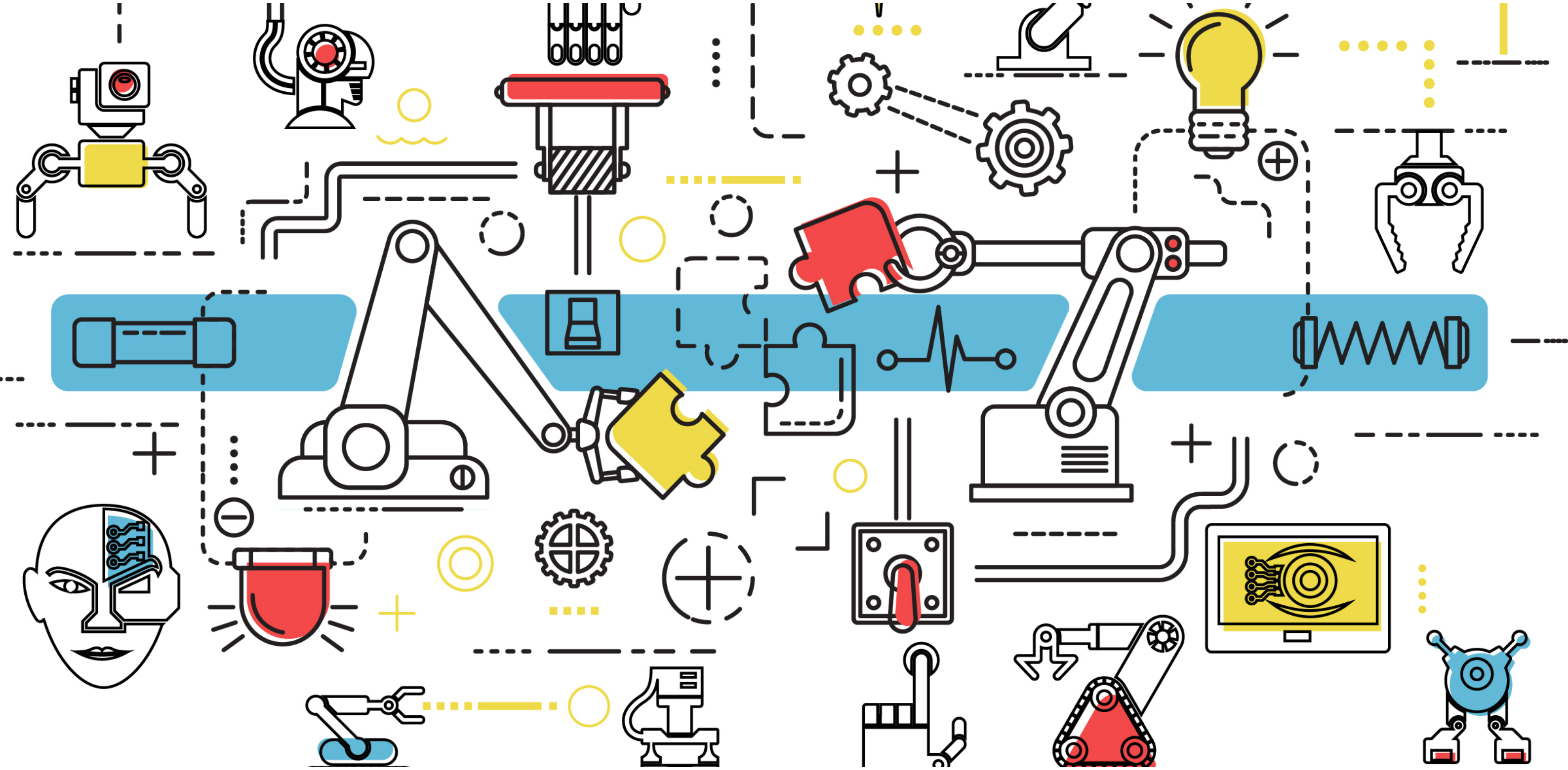
Robotic arms have been installed on the outside of the ISS to deploy, capture and repair satellites, position astronauts, maintain equipment and move cargo.

Another robot found on the ISS is Dextre, a robot handyman used for tasks outside the space station, including the routine tasks done by astronauts during risky spacewalks. Dextre has two arms that are over three metres long, with seven joints and grippers that work like the components in a pocket knife. The grippers have been given sensors that give it an almost human-like sense of touch, and there are tools, camera, lights and a connector to provide power and data as the robot uses electronic equipment or conducts experiments.

ENTERTAINMENT, HOBBY AND COMPETITION

This category covers toys, and robots that you create yourself, either for fun or for competition. There are so many different types, from robo-dogs suitable for children, to robots that fight against each other in gladiator-style arenas. There are also humanoid robots, such as Sony's QRIO and WowWee's Robosapien, that are capable of walking, voice recognition and some level of interaction.

The lightweight Dragon Runner Bomb Disposal Robot is easy to transport and can be deployed in many different terrains (courtesy of Crown)



Industrial Robots

This section discusses industrial robots in more depth. It will look at the worldwide market drivers, different robot types, typical applications, safety considerations, etc.

Industrial robots are driving competitive advantage across manufacturing, enabling companies to respond to the challenges of faster business cycles, greater variety in customer demand, competitive pressure and the challenge of reducing emissions. The falling costs of industrial robots has lowered capital investment requirements, increasing adoption across all industrial sectors.

Figures published by the International Federation of Robotics (IFR) state that there are now over 3 million industrial robots in operation worldwide – and this number is expected to keep on growing. According to analyst firm Research and Markets, the global industrial robotics market will experience a 12.1% compound annual growth rate (CAGR) between now and 2030 - reaching a total worth of 88.55 billion by the end of that period.

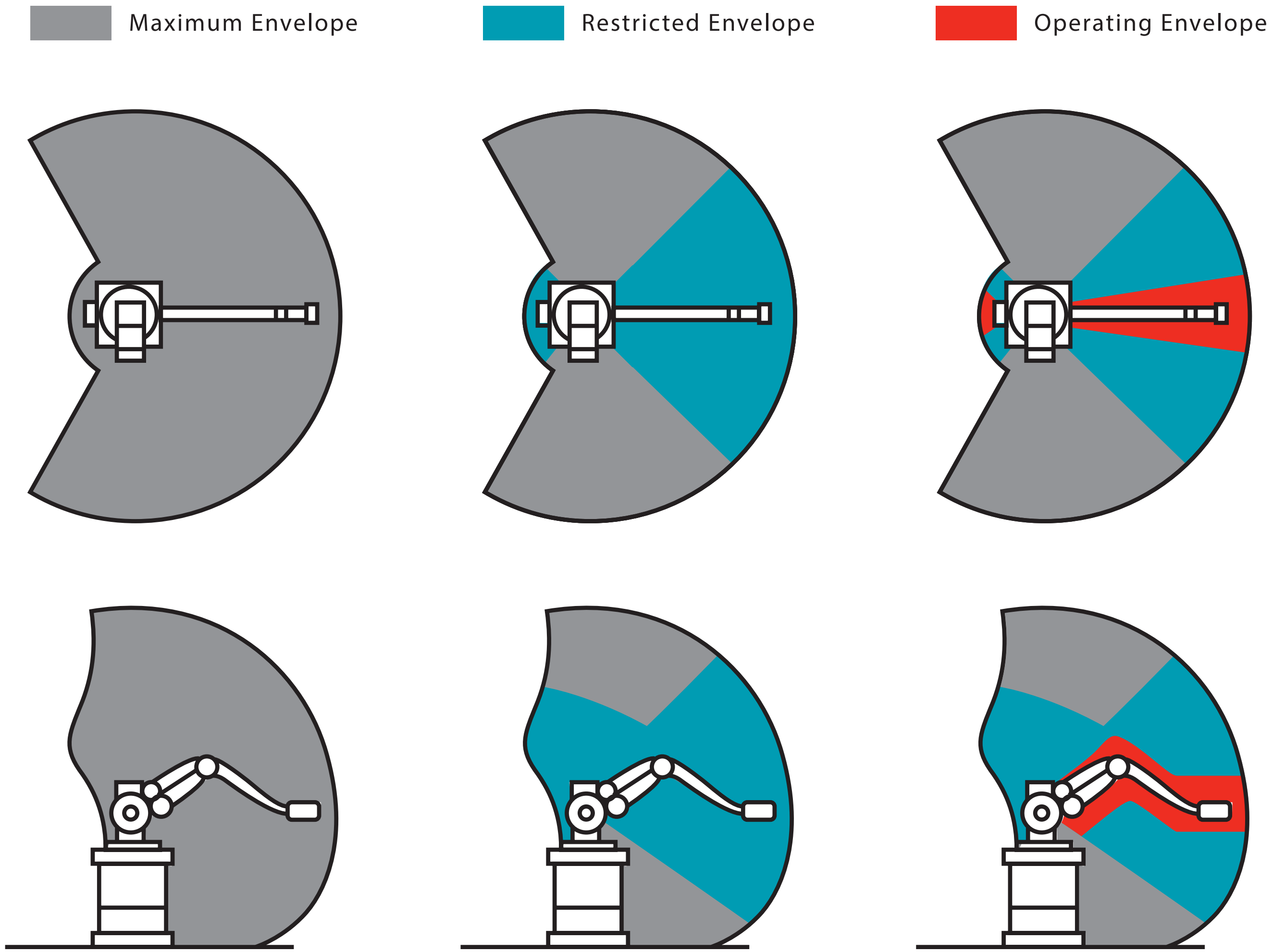
TYPES OF INDUSTRIAL ROBOTS

Most industrial robots are classified as stationary robots, with a robotic arm moving above a stationary base. Stationary robots break down into six main types, shown in Table 1, with the most commonly used being articulated, SCARA, delta and cartesian coordinate robots.

Type	Description	Typical application
Cartesian/gantry	Operate within x-, y- and z-axes using linear guide rails	Pick-and-place work, sealant application, arc welding
Cylindrical	Rotary joint combined with prismatic joint. Movements occur within a cylindrical work envelope	Assembly operations, spot welding, machine tool handling
Spherical	Combined rotational joint, two rotary joints and a linear joint to achieve a spherical work envelope	Spot welding, die casting, gas and arc welding
SCARA	Compliant arm is cylindrical in design and comprised of two parallel joints providing compliance in one plane	Pick-and-place work, sealant application, assembly operations, machine tool handling
Articulated	Rotary joints connect the links in each arm; each joint is a different axis, providing an additional degree of freedom. Articulated robots have four or six axes	Assembly operations, die casting, gas and arc welding, paint application
Parallel or delta	Built from jointed parallelograms connected to a common base. Parallelograms move a single end-of-arm tooling in a dome-shaped envelope	Pick-and-place operations requiring precision

Table 1: Main types of industrial robot

Robots are also specified in terms of various operating parameters, as summarised in Table 2.



The working envelope needs to be considered for each robotic application

Parameter	Description
Number of axes/ degrees of freedom	Two axes are required to reach any point in a plane, three to reach any point in space. Three more axes (yaw, pitch and roll) are required to fully control the orientation of the end of the arm (the wrist)
Working envelope	The region of space a robot can reach
Kinematics	The arrangement of rigid members and joints in the robot, determining the robot's possible motions. Classes include articulated, cartesian, parallel and SCARA
Carrying capacity/ payload	How much weight a robot can lift
Speed	The speed at which the robot can position the end of its arm, defined in terms of the angular or linear speed of each axis or as a compound speed
Acceleration	How quickly an axis can accelerate. Since this is a limiting factor a robot may not be able to reach its specified maximum speed for movements over a short distance or a complex path requiring frequent changes of direction
Accuracy	The absolute position of the robot compared to the commanded position is a measure of accuracy. Accuracy can be improved with external sensing, e.g. vision systems or infrared. Accuracy can vary with speed and position within the working envelope and with payload (compliance)
Repeatability	If a position is taught into controller memory and each time the robot is sent there it returns to within 0.1 mm of that taught position, then the repeatability will be within 0.1 mm
Motion control	For applications such as simple pick-and-place assembly, the robot only needs to return repeatedly to a number of pre-taught positions. For applications such as welding and finishing, motion must be continuously controlled to follow a path in space, with controlled orientation and velocity
Power source	Examples include electric motors and hydraulic actuators
Drive	Some robots connect electric motors to the joints via gears, others connect the motor to the joint directly (direct drive). Smaller robot arms often use high-speed, low-torque DC motors, requiring high gearing ratios with the disadvantage of backlash
Compliance	The amount of angle or distance that a robot axis will move when a force is applied to it. When a robot goes to a position carrying its maximum payload it will be at a position slightly lower than when it is carrying no payload

Table 2: Operating parameters of industrial robots

EXAMPLE APPLICATIONS

Here we look at two examples of industrial robots which have been developed by their manufacturers to meet the specific needs of their intended application.

The IRB 5500 series by ABB

The IRB 5500 series by ABB is an articulated robot with six axes of movement, developed for spray painting on car assembly lines.

The IRB 5500 has three characteristics which make it suited to its chosen application:

- Large work envelope, removing the requirement to have two robots for paint application across a horizontal surface such as a car bonnet, which creates a 'stitching' effect in the centre. A single robot removes this quality control issue entirely.
- High acceleration: for sophisticated applications, such as welding and spray painting, motion must follow a path in space, with controlled orientation and velocity. If a robot slows down too much when reversing, excess paint will accumulate in those regions of the vehicle where the slow movement takes place.
- High payload, enabling closer integration of the processing equipment with the work surface, reducing waste.

The Quattro 800 series by Omron

This is a parallel robot designed for high-speed manufacturing, packaging, material handling and assembly. With the actuators all located in the base, the arms can be made of a light composite material, resulting in moving parts with low inertia, allowing for very high-speed acceleration. Having all the arms connected to the end effector increases the robot's stiffness, but reduces the size of its working envelope.

The following characteristics of the Quattro lend themselves to the targeted applications:

- Speed – 10 m/s (vs 1m/s for IRB 5500)
- Repeatability – 0.1 mm (vs 0.15 for IRB 5500)
- Working envelope – operates within a 1300 mm cylindrical area suited to the size of food production lines

PROGRAMMING INDUSTRIAL ROBOTS

Programming a robot involves the establishment of a physical or geometrical relationship between the robot and the equipment or task to be serviced by the robot. In doing so it is necessary to control the robot manually and physically teach it the coordinate points within its working envelope.

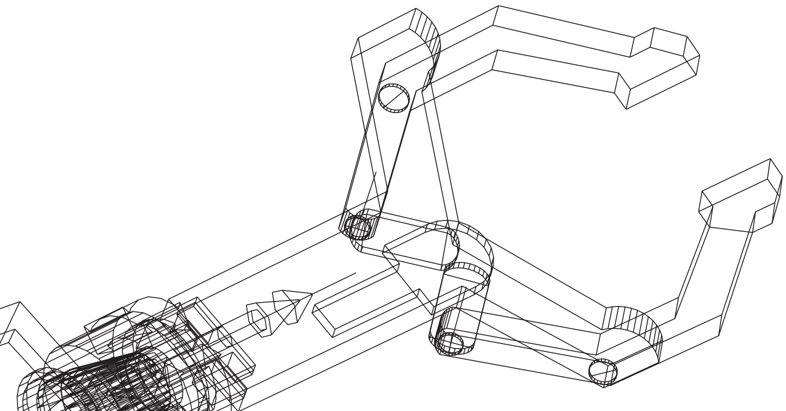
There are three commonly used programming or teaching methods:

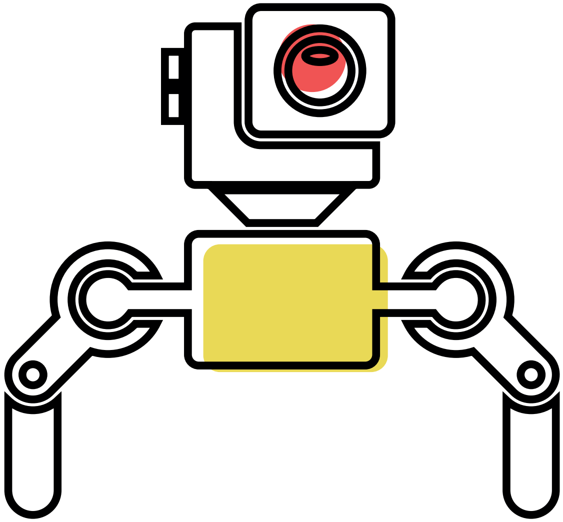
Lead-through programming or teaching

A handheld control and programming unit, or teach pendant, is used to manually send the robot to a desired position. It can also change to a low speed to enable careful positioning, or while testing through a new or modified routine.
A large emergency stop button is usually included as a safety measure.

Walk-through programming or teaching

With the robot in 'safe mode' the user moves the robot by hand to the required positions and/or along a required path while the controlling software logs these positions in the controller memory. The program can later run the robot to these positions or along the taught path. This technique is popular for tasks such as paint spraying.





Offline programming or teaching

The robot and other machines or instruments in the workspace are mapped graphically, allowing the robot to be moved on screen and the process simulated. Simulators can thus create programs for a robot without depending on the physical operation of the robot arm, saving time during application design. Additionally, various 'what if' scenarios can be tried and tested before the system is activated, increasing operational safety levels.

A combination of methods will often be used. Programs created using lead-through or walk-through methods can be reviewed and refined using offline simulators. Operator control panels can also be used to switch programs, make adjustments within a program and also operate a host of peripheral devices that may be integrated within the same robotic system. A computer is often used to 'supervise' the robot and any peripherals, or to provide additional storage for access to numerous complex paths and routines.

ABB's SRP programming toolset for the IRB5500 enables lead-through programming using a simulated paint spray gun with the simulation and offline programming software, RobotStudio, being available for offline review and further development.

SAFETY CONSIDERATIONS AND SYSTEMS

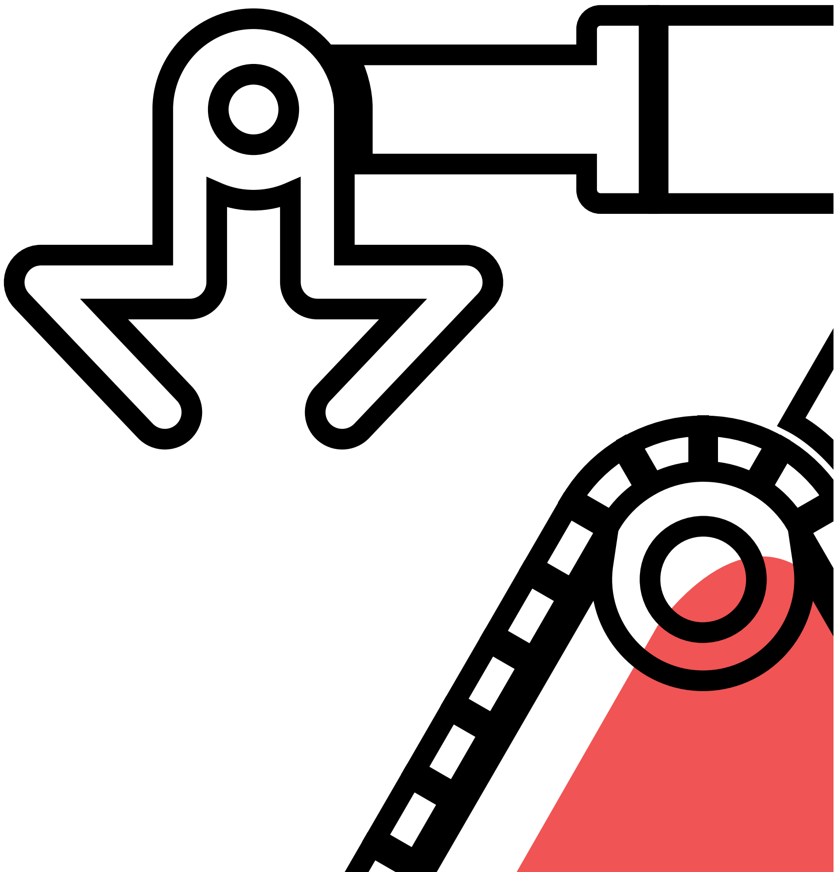
Various safety concerns must be considered when implementing robotic production systems. Care must be taken to ensure separation of humans from the operating envelope of the robot, as the end effector is capable of rapid acceleration resulting in high forces. Physical barriers and locking systems should be deployed to prevent the operator or other personnel from entering the work zone while the robot is operational.

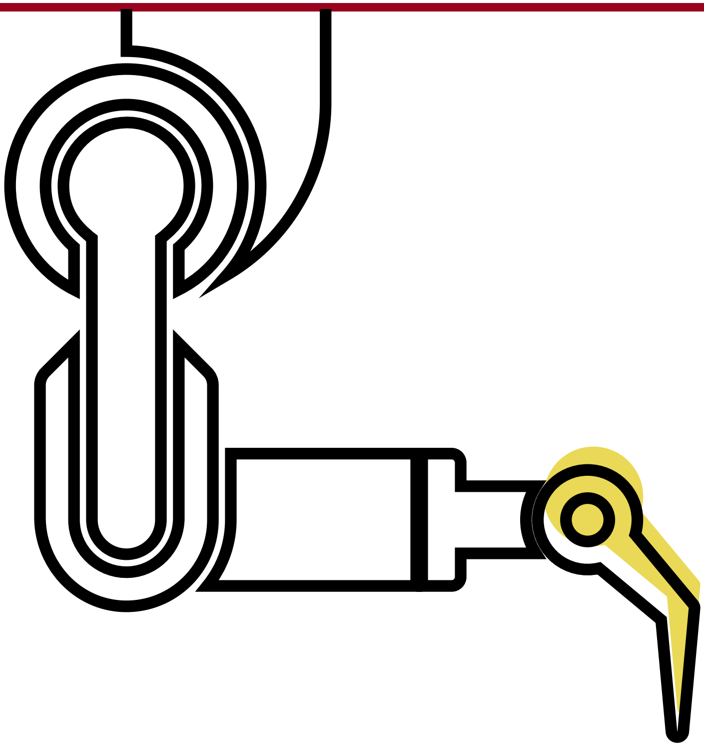
Programming a robot is potentially dangerous, as the operator must be in physical contact with the robot, so safety devices should be in operation, such as a teach mode where the speed of the robot is limited, along with emergency stop buttons. Sensors can also be integrated into the design of the robot to prevent excessive force or limit proximity to unexpected objects.

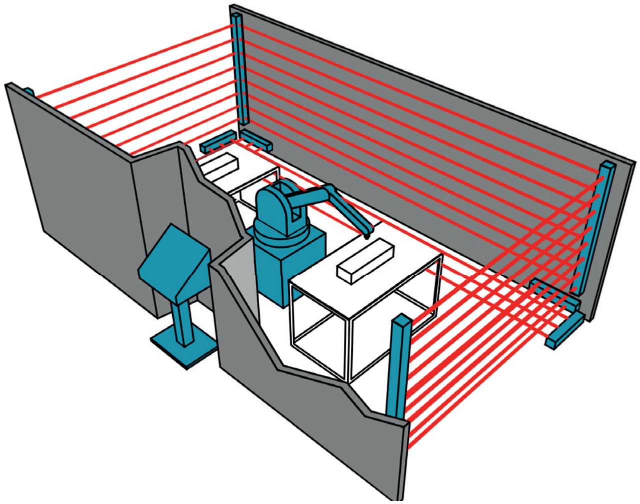
Additionally, the type of robot should be chosen to match the characteristics of the environment in which it will operate – e.g. care should be taken when deploying electric motors in environments where combustible materials or gases may be ignited by static or sparks.

CONCLUSION

This section has provided an overview of the different types of industrial robot that may be deployed, along with a description of how these robots and their characteristics are adapted for specific applications. Consideration has also been given to programming of robots as well as safety aspects, and two robots developed for two very different applications have been discussed.







In addition to emergency stop buttons, light curtains protect human operators from accidental entry into a robot's working envelope

Industry 5.0 - The Next Phase of the Industrial Revolution (or is it possibly already upon us?)

From the mechanized looms and steam engines of the 18th Century through to the cloud computing and artificial intelligence (AI) systems of modern times, industrial technologies have come a long way.

The developed world, as well as numerous emerging economies, have both successfully embraced the fourth stage of the industrial revolution - and are now reaping its rewards. Among these are the realization of major improvements in efficiency and productivity, as well as less wastage and improved product quality.

In addition, Industry 4.0 has acted as a catalyst for the emergence of new technologies, in relation to robotics, the Internet of Things (IoT) and biotechnology, amongst others.

However, things never stand still, and experts are already talking about the next stage of industrialization - which they refer to as Industry 5.0. They are convinced that organizations should seriously start paying attention to the manufacturing principles behind this.

WHAT IS INDUSTRY 5.0?

Industry 4.0 was focused specifically on implementing higher degrees of automation into industrial systems, to raise production output. Industry 5.0, however, brings other dimensions. It puts much greater emphasis on people, business resilience and sustainability, relying on a more nuanced approach.

Unlike its predecessor, one of the key objectives here is to support regular human-machine interaction, so that meaningful collaboration results. On top of this, it is much better aligned with the green agenda - and looks to ensure that industrial activity no longer has a negative impact on the environment.

Here are some of the key aspects that it will encompass:

- Industry 5.0 places human resources as the most important element of a factory's operations. It acknowledges the creative potential that humans have and their ability to adapt to different circumstances (based on prior experience). Therefore, by them joining forces with machines (which are better at repetitive tasks, do not tire, or make errors), it is possible to create an optimal production partnership - with each side playing to its own respective strengths.
- This next wave of the industrial revolution will incorporate flexible and adaptive technologies and ensure resilient supply chains. In the aftermath of the global COVID pandemic, corporations and legislative policymakers are finally waking up to the importance of having intelligent distribution channels to support the manufacturing and processing sectors.
- One of the most important features of Industry 5.0 is long-term sustainability. It recognizes the ecological effects that manufacturing work can have, and argues for the development of greener technologies and the creation of eco-friendly policies to address this.

Industry 5.0 is not just meant to be a 'feel-good', or a way for companies to tick another corporate responsibility box. It has immense benefits for those that fully embrace its principles. In the next section, we will look closer at what these are.

UNDERSTANDING THE ADVANTAGES OF INDUSTRY 5.0

In terms of what Industry 5.0 will mean for companies, and what the implications of its adoption will be, here are some of the main points they need to be aware of:

- **Increased Competitiveness:** Industry 5.0 tackles the challenges of employee skills and training needs, and will enable companies to attract and retain the best talent available in their sector.

- **Hyper-Personalization:** As already mentioned, the most critical aspect of Industry 5.0 is humans and machines working together. People will be empowered to make decisions and apply their ideas, while leveraging the power of machines to design/construct highly customized products for end-users.
- **Profitability:** With robots and human workers combining their strengths in speed, accuracy and creativity, businesses will generate more revenue than they could via outdated legacy industrial practices.
- **Environment Friendliness:** More than any other phase of the industrial revolution's long history, Industry 5.0 highlights sustainability as a major concern. It encourages efficient use of renewable sources of energy, a circular economy and distributed production, so as to protect the environment and address climate change.

Nevertheless, without addressing certain issues, companies will find it difficult to apply the Industry 5.0 concepts on their shop floors. This is why appropriate implementation practices will be paramount.

IMPLEMENTATION OF INDUSTRY 5.0

A key approach to integrating Industry 5.0 into companies' workflows will be through the up-skilling and retraining of staff. Organizations need to ensure their workers are adequately educated in emerging and advanced technologies, in order for them to be able to offer assistance to their robotic co-workers.

The fact that digital education has become more accessible, and also affordable, will help to accelerate this process. Because of it, employees are likely to be encouraged to learn, refreshing their knowledge and adding to their list of capabilities.

Investing in research and development of green technologies and intelligent devices is also crucial. Collaborative robots (or cobots), which will be covered in more detail later in this guide, are one of the finest examples of how humans can interact with machines in a safe and efficient working environment. Equally important is for stakeholders to promote circular production models that involve repurposing and recycling resources, so that waste generation is reduced.

While Industry 5.0 is still in a nascent stage, a few visionary companies have started applying its principles.

REAL WORLD EXAMPLES

The European Union (EU) has established the Industry 5.0 Award to encourage its progression. This will annually honor EU-funded projects that underline the potential benefits that can be derived from Industry 5.0 implementation. Some of the projects nominated for this award so far have focused on areas like cybersecurity, recycling and ergonomics.

Industrial automation heavyweight ABB has placed itself at the forefront of Industry 5.0. This is thanks to the cobot units it is already offering to the market, as well as sophisticated operation management systems. Siemens is another large-scale company that has made a major commitment here, providing products and services in healthcare, logistics and construction that incorporate elements of Industry 5.0.

Opinion is admittedly still divided as to whether Industry 5.0 is the next phase in the industrial revolution, or more of a complement to Industry 4.0 with some added facets included. What is undoubtedly true though is that the global pandemic and the economic turmoil that has come with it have compelled organizations to consider embarking on the transition to Industry 5.0.

Cobots: Reviving the Human Element of Industrial Activity

Collaborative robots - or cobots as they are more commonly referred to - are a perfect example of human-robot interaction.

The concept was first publicized back in 1996 by Michael Peshkin and J. Edward Colgate, two professors from Northwestern University in Illinois. Strategic Market Research estimates that by 2020 there were over 22,000 cobots in operation, and this number is rising rapidly (with a compound annual growth rate above 15% expected between now and 2028). Currently, cobots represent the fastest expanding segment in the global industrial robotics market, according to studies undertaken by Frost & Sullivan.

Cobots are designed to work alongside humans within a shared environment. This is in contrast to conventional industrial robots - which have to be fenced in or isolated, so as to ensure worker safety. Unlike their bulky, complex and expensive counterparts, they are usually compact, relatively lightweight and simple to operate. Most importantly, cobots are versatile and affordable, enabling companies of all sizes to realize the benefits associated with automation.

COBOTS IN INDUSTRY 5.0

Industry 5.0 envisions bringing back human workers to automated factory floors, and having them cooperate with robots in a way that will bring extra value to the production process. The objective of this will be to combine the experience and ability to adapt that humans inherently have with the efficiency and exactitude of robotic systems.

This is where cobots come in. Designed to work in conjunction with people, they are an ideal fit for the core principles of the next phase of industrial progression. In addition to being smaller (thereby posing less of a physical threat), cobots are equipped with advanced sensors and vision technologies. This enables them to detect any risk to people working in close proximity.

Safety is just one of the salient features of cobots though. They are also very easy to install and require only minimal programming expertise to operate. Because of their compactness, installation is simple. It is straightforward for units to be positioned in different sections of the workspace - making them highly versatile and applicable to various tasks.

NOTABLE USE CASES

Cobots bring out the best of humans and machines - drawing on the cognitive skills of the former and the power and consistency of the latter. They are proving themselves to be advantageous to companies across a broad array of different industry sectors. Here are just a few of the success stories already witnessed.

- Machine Tending - Traditional machine tending usually needs the human operator to be confined solely to a specific machine, in order to cater for its requirements while carrying out the assigned task (grinding, welding, etc.). Cobots unshackle the worker by automating the tending process. With simple instructions, cobots can tend to several machines, resulting in boosted productivity. Also, this approach significantly reduces injury risks.

By installing an OB7 cobot, Ohio-based component manufacturer B.I.C was able to automate loading and unloading parts in its turning center cell. This resulted in scrap being cut by half, production output being pushed up by 20% and worker complaints being minimized.

- Packaging and Palletizing - Cobots can handle all processes involving packing, loading and stacking of products onto pallets, especially when there are smaller payloads involved. They can even palletize items in several patterns, and their ability to work all day reduces cycle times and labor costs.

Clearpack, a packaging automation solutions company in Singapore, deployed one of Universal Robots' UR10 cobots. This allowed it to develop an efficient, safe and easy-to-use palletizing system. Consequently, Clearpack's customers have since been able to witness more effective utilization of their warehouse spaces.

An OB7 cobot working in conjunction with a human colleague [Image courtesy of Productive Robotics]

- Quality Inspection - Cobots are compatible with various forms of equipment, such as high-resolution cameras and end-effectors. By just setting up a camera on the deployed cobot, a faster and more accurate quality inspection process can be derived.

Taiwan-based robotics company Techman Robot specializes in making cobots with embedded vision capabilities. It recently deployed its technology in a leading Japanese car manufacturer's assembly lines, for conducting final quality inspection work. The car manufacturer experienced considerable time and cost savings, while also improving quality control.

- **Product Assembly** - Assembly processes, such as screw/bolt tightening, riveting and electronics installation, help streamline production. Cobots are highly opti=mized for automated assembly in relation to medium-range payloads within tight workspaces. Opel's Eisenach automotive plant implemented a factory-wide automation system that included UR10 cobots. These units are being used to drive screws in engine assembly. The company was able to free up its employees from a physically stressful task, that could otherwise lead to long-term health issues and lost working hours.

COBOT-CENTRIC FACTORIES

Cobots are going to usher in a new era of manufacturing where greater emphasis may be placed on customized solutions, and tasks/processes can be altered to solve operational issues or deal with other problems. This new breed of robot is bringing about a unique synergy where human input is able to support high-throughput automation.

The use of cobots will be pivotal in democratizing automation - enabling businesses across all industries, whether they are large or small, to participate. It is helping to shape new manufacturing trends that will be beneficial to society, leading to an upskilling of the workforce and greater job satisfaction, while maintaining the highest levels of productivity.

Our thanks go out to…

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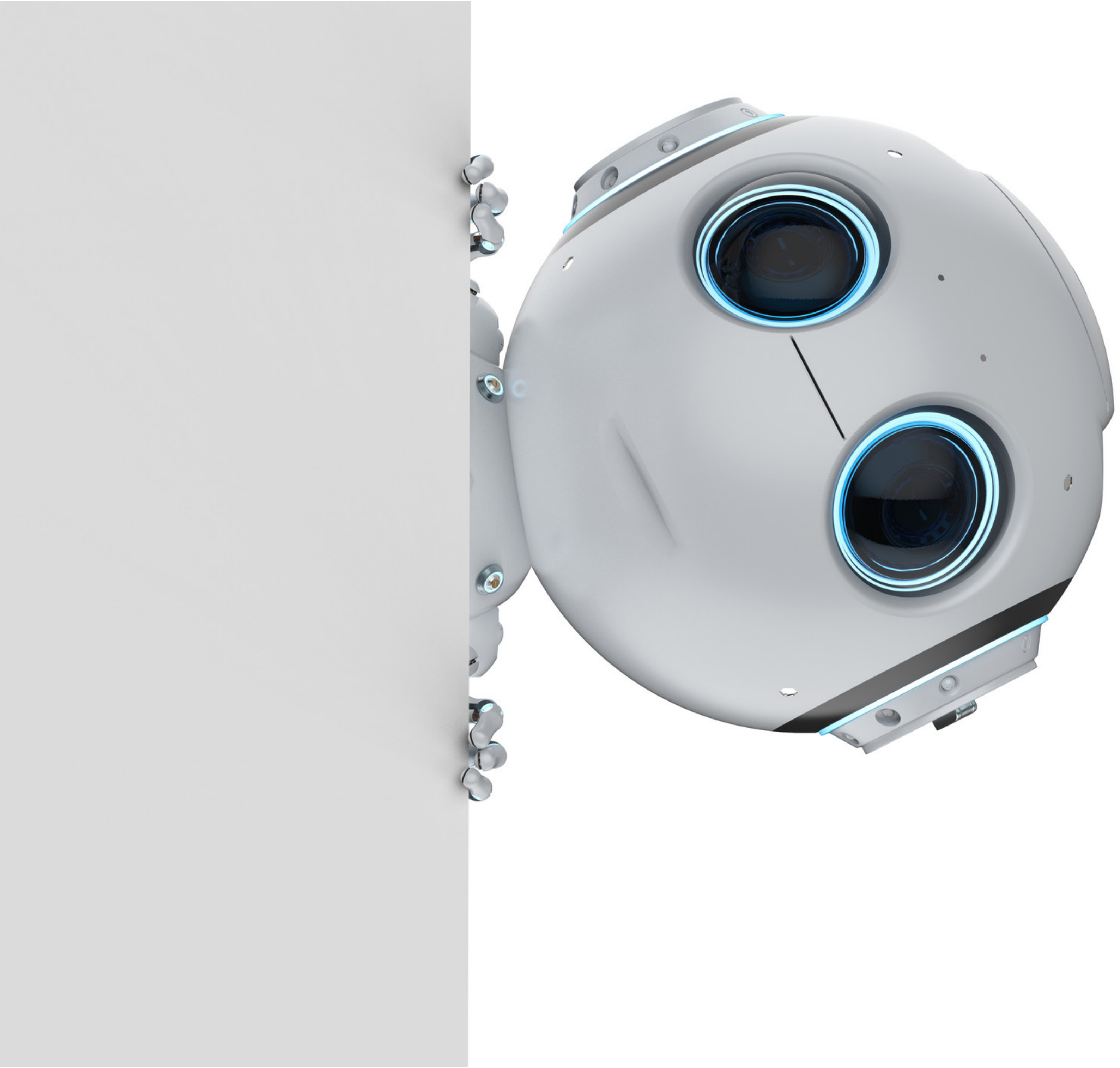

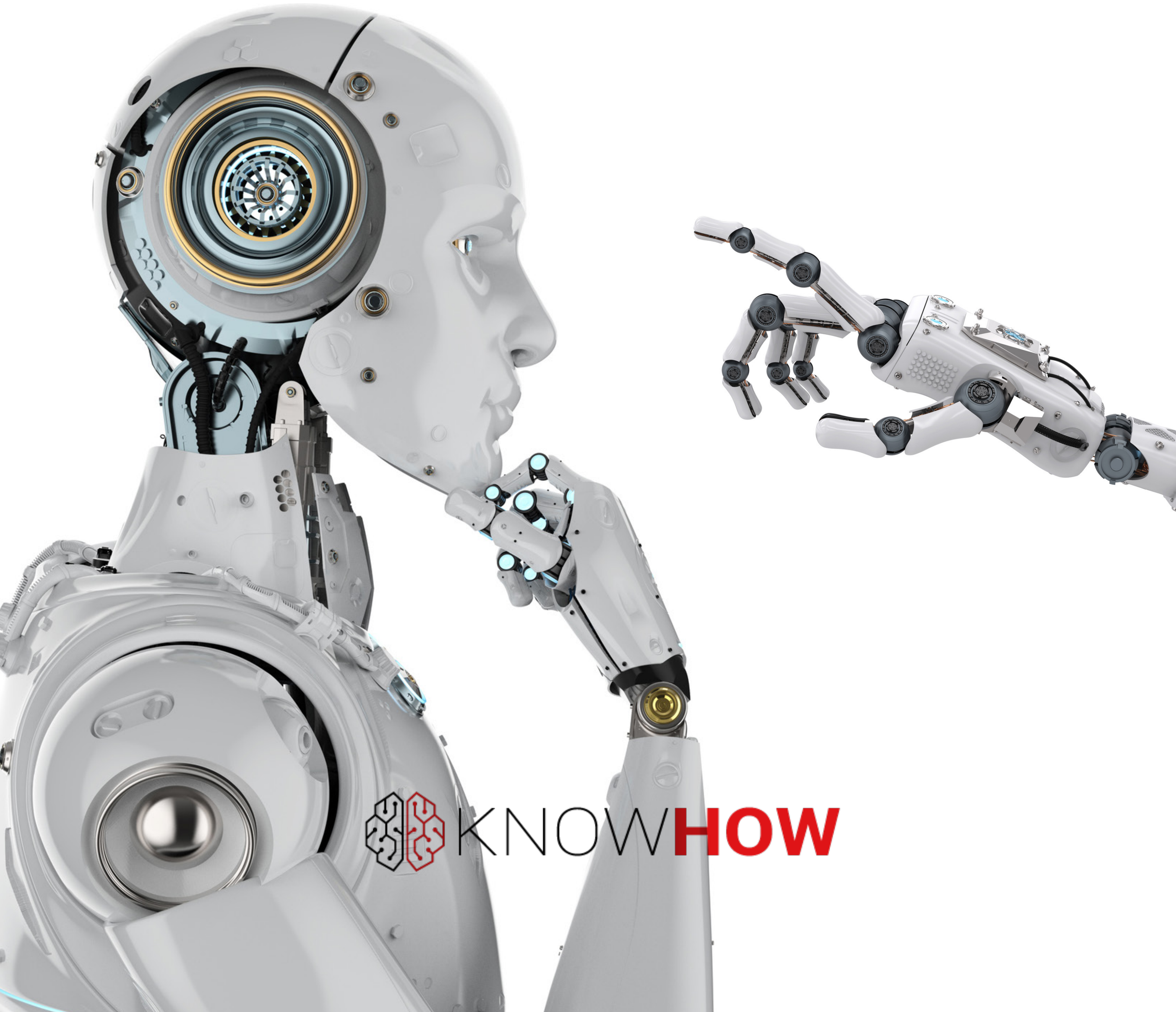
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