INDUSTRIAL ROBOTS

The shop floor of a car factory these days resembles a giant ant colony, with different types of robots bustling about, carrying out specific tasks.

In the past, these jobs were done by people, but they are repetitive and arduous, and the invention of robots came as an ideal solution. Not only do they have superhuman strength, robots are also able to work 24 hours a day, seven days a week, without a break – and without making mistakes. A factory employs a number of types of robots, such as driverless vehicles – whose job is to fetch and carry parts from one process to another – and laser sensors, usually fitted to robotic arms, that inspect the work already done.

It all began in the 1969, when Trallfa, a Norwegian wheelbarrow manufacturer, addressed a local labour shortage problem by devising a robot to spray paint its products. The idea quickly caught on with motor manufacturers, and by the 1980s, entire production lines of robots were putting cars together.

The car industry uses the greatest number and range of robots, from cutting the bodywork out of sheets of steel, right up to fitting the stereo. The painting is the most tricky and time-consumig part of the process, and there are many coats required – and each one must be flawlessly smooth. Every layer must be completely dry before the next one can be applied, and for this, the car has to be placed in an enormous oven. In the past, the painting process was carried out while the car was on the move, but a new way –

‘modular’ or ‘stop-station’ painting – has now been developed, which involves diverting the vehicle from the conveyor belt and sending it into a special painting booth. This is simpler, as the robot itself does not need to move with the car, and the booth can be kept airtight. As well as reducing the likelihood of dust finding its way on to the surface, there is no draught, so the amount of paint needed is kept to a minimum.

Most of the robots used for manufacturing are no more than a mechanical arm on a fixed base. The majority of complex processes are carried out by a ‘jointed’ arm, composed much like a human one, in seven segments with six joints. Each joint is driven by a separate motor, and all are controlled by a single computer.

The three main joints are known as the waist, shoulder and elbow. The first is the waist, which is attached to the base, and pivots sideways, then there is the shoulder, which moves up and down, and the elbow, which also has an up-and-down action. Extending from the elbow is the forearm, ending in a wrist section, with further three joints: one that turns through 360 degrees, one that moves up and down, and another that moves from side to side. This combination of joints allows the arm almost unlimited movement in every direction.

The first computer-controlled arm was the Rancho Arm, developed at Rancho Los Amigos Hospital in Downey, California, and first used at Stanford University in 1963. Featuring six joints, it was originally designed as a replacement arm for humans, but was soon adapted for industrial purposes. Rancho Arm design has changed very little in 40 years, and it is still the model on which most industrial robot arms are based.

At about the same time, Professor Marvin Minsky was developing the 12-jointed Tentacle Arm, with an action like an octopus, and David Silver at MIT was at work on the Silver Arm. This uses delicate touch and pressure sensors for assembling small parts, and fine movements that correspond to those of human fingers.

Jointed robot arms are driven by 'step' motors, powered by digital pulses, which turn a motor in increments of a revolution of its shaft. These movements are known as steps – hence the name – and programmed patterns of pulses on the computer enable precise control of motion. The greater the number of steps per revolution, the greater the precision. In the electronics industry, manufacturing miniscule components such as microchips would be impossible without this kind of accuracy. Step motors are also used in a number of other devices, such as printers and digtal watches.

At the end of a robot's arm is an 'end effector' On a human arm, this would be the hand, but in the case of robots, these vary according to the purpose of the machine. In car manufacturing, they carry devices such as saws, rivet guns and paint sprayers, and in manufacturing production lines they might, for example, screw the tops on to jars or seal packaging.

The area that a robot arm can reach is known as the 'working envelope', and there are various types of arms with different working envleopes for specific types of work. For example, there is the polar arm, which has a rotating base and an arm that swings up and down and moves backwards and forwards. There is also the cartesian – or XYZ – Arm – which is capable of linear motions along three planes: back and forth, up and down, and side to side. In this way, the arm moves in a cube-shaped working envelope.

Finally, there is the cylindrical arm, which moves in a linear way in a back-and-forth and side-to-side motion, with a cylindrical arm that can rotate and move up and down.

Before a robot can carry out a task for the first time, it must be shown how to do it. This is done by a human programmer, who performs the operation with a hand-held controller, and the robot records each sequence of movements, then repeats them again and again in exactly the same way. Once it is running, the actiona are reproduced exactly each time, with none of the variations to which humans are prone.

Just as in any other manufacturing industry, robots have to be made too, and a curious sight it is to see a production line in which fully-made robots crane their metal arms over half-made ones. By the end of the line, the products have, of course, come to resemble their creators, and by the finish, it can be hard to tell which is which.

FACT FILE

Unimate

The world's first industrial robot, Unimate, first conceived at a meeting in 1956 between the inventors George Devol and Joseph Engelberger, who had got together to chat about their interest in science fiction, and came up with the idea of creating a robot that could carry out useful work. Three years later their brainchild clocked in for work on the assembly line at General Motors in America, handling die-cast metal and auto body welding. Still hard at it to this day in factories all over the world, Unimate robots have six programmable axes of motion, and a motorized arm weighing 4,000lbs.

INTO THE FUTURE

Looking at a car production line, with no people in evidence, the bots appear to be running the show. Well, some day in the future, perhaps they will be.

At present, human intervention is necessary for supervision and maintenance. But dealing with technical problems in a factory can be time-consuming and expensive, and can require production to be halted while the problem is remedied. So manufacturers are already researching ways to create machines that can fix themselves or each other

Using diagnostic software, many can already detect problems from within, and it’s likely that soon they will be able to replace their own malfunctioning parts. Most electronic components are now modular in form, and can be easily clicked into place. Once robots are able to eject faulty parts themselves and insert the new ones, there will be no need for the intervention of mere humans.

However, even if there were supervising robots, a human would need to keep an eye on the supervisors. Then machines could be designed to carry out that task too. And then, of course, a human would be needed to oversee that…