Applications for Robots 130

Class Outline

Lesson: 1/13

Objectives

- Describe the reasons manufacturers use robots.
- Describe the advantages and disadvantages of using robots.
- Describe the basic capabilities of robots.
- Describe spot welding robots.
- Describe arc welding robots.
- Describe material handling robots.
- Describe machine tending robots.
- Describe spraying robots.
- Describe assembly robots.
- Describe fabrication and processing robots.
- Describe inspection robots.

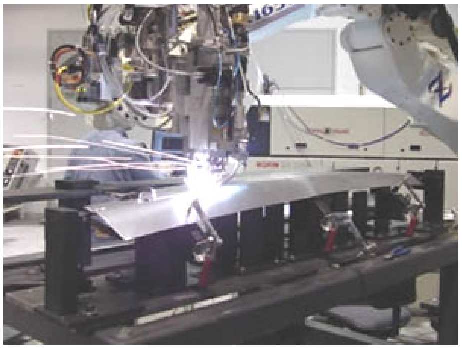

Figure 1. Welding is a common application for industrial robots. [Courtesy of Kawasaki Robotics (USA), Inc.]

Figure 2. Palletizing is a type of material handling performed by robots. [Courtesy of Kawasaki Robotics (USA), Inc.]

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Why Use Industrial Robots?

Industrial robots were originally created to perform jobs that were unpleasant or hazardous to human workers. The primary purpose of the robot was to protect workers from injury. Today, robots provide significant benefits to employers as well as workers. The primary benefit is cost savings through improved efficiency. For example, the painting robot in Figure 1 can repeat a task many times without varying the quality or consistency of the work. Robots increase productivity and reduce waste. Moreover, expenses associated with defective parts and workers compensation claims are eliminated when robots do the work.

Robots do not take sick days or vacation days, and they never get tired. A robot can perform for 60,000 hours or more without mechanical failure. In addition, robots work at an extremely fast pace. The assembly robot in Figure 2 can exchange a part in as little as a few seconds. Because of this, one robot can match the output of several human workers.

An increasing number of manufacturers are beginning to implement robotic technology because they realize that robots can be a key factor in remaining competitive and profitable in a global market. For example, in aircraft manufacturing many tasks have been automated with robots to achieve higher performance at lower cost. In fact, robots are used in almost every industry for almost every type of application. This class covers the most common applications of industrial robots.

Figure 1. This painting robot can repeat a task many times with the same consistency. [Courtesy of Kawasaki Robotics (USA), Inc.]

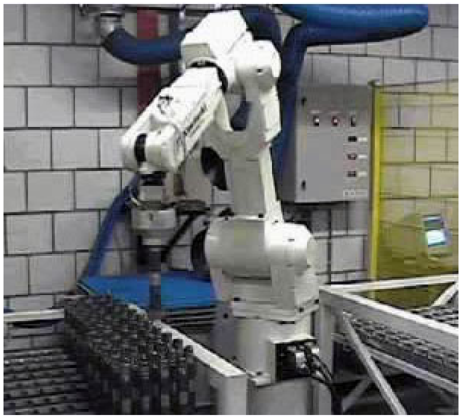

Figure 2. This assembly robot can do the work of several humans. [Courtesy of Kawasaki Robotics (USA), Inc.]

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The Pros and Cons of Using Robots

Because they are stronger, faster, and can work longer hours than humans, robots provide economic advantages to employers. The robot in Figure 1 can be programmed to perform a repetitive task such as palletizing that would be too boring or fatiguing for human workers. The downside is that any time a change needs to be made to the process, the robot must be taken offline and reprogrammed. This can slow down production.

In addition, initial installation can be extremely expensive for large robots. Many robots must be re-engineered in order to conform to the technology standards of their environment. Installation of the robot can disrupt the flow of work on the shop floor. In addition, when transitioning from human labor to robots, employers must adopt new safety procedures to protect human workers from being injured by the robot.

There is some concern that robots will eliminate jobs for human workers. But many industry experts believe that implementing robotic technology will simply shift human workers into different jobs at the same plant. Moreover, the growth of robotics means that there will be a greater demand for workers, like the technician in Figure 2, who can operate and maintain robots. Still, some workers resist implementing robots even when there is not a loss of human jobs.

Figure 1. This palletizing robot can work for many hours without getting bored or tired. [Courtesy of Kawasaki Robotics (USA), Inc.]

Figure 2. The growth of robotics will create jobs for people who can operate and maintain robots.

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Robot Capabilities

A robot can move on its own, sense information about its environment, and use that information to accomplish a programmed task. Robots can change their behavior in response to their environment while automated machines simply follow instructions. Today′s robots are extremely smart and versatile.

Some of today's robots can even "see." The addition of sensors such as television cameras or fixed cameras allows robots to capture images and send them through a central processor. The **material handling** robot in Figure 1 is equipped with vision that enables it to identify and position parts and peform quality control.

Robots perform their work through the use of an **end-effector**. End-effectors are used to grasp and move objects of all shapes, sizes, and materials. The type of end-effector on a robot depends on the function the robot must perform. Some end-effectors take the shape of specialized tools such as welding guns or blowtorches. Other end-effectors take the form of grippers. A **gripper**, shown in Figure 2, is an end-effector that is designed specifically for the purpose of grasping objects.

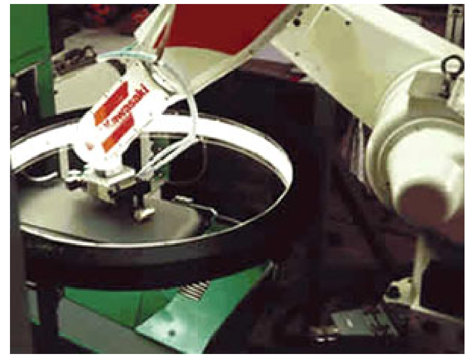

Figure 1. Some robots use vision to perform their work. [Courtesy of Kawasaki Robotics (USA), Inc.]

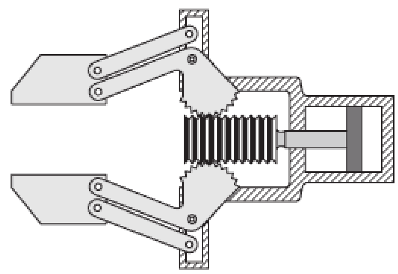

Figure 2. Robots use grippers to grasp objects.

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Spot Welding

Welding is the largest application for industrial robots today. Welding is a joining process that permanently bonds together two separate components with heat, pressure, or a combination of those elements to make one new part. Welding is often an art form that requires a certain degree of skill. Robots are ideal for welding because of their high speed, the uniform quality of their work, and their ability to repeat tasks without wearing out.

Spot welding is a type of welding in which parts such as sheet metal are squeezed together between two electrodes and subjected to a large amount of electric current to form a joint. Spot welding is used primarily by the automotive industry to weld automobile bodies, like the one in Figure 1. The process of spot welding can be extremely noisy and dangerous to humans. The welding gun is very heavy and the size and shape of the **welding gun** can make access to some areas difficult, as you can see in Figure 2. For this reason, robots are well suited to spot welding.

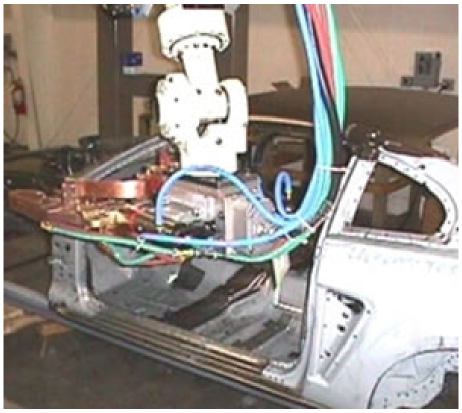

Figure 1. A robot spot welding a car body. [Courtesy of Kawasaki Robotics (USA), Inc.]

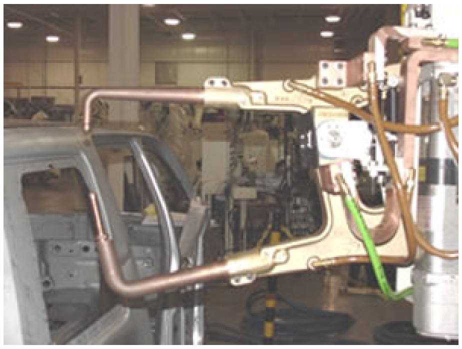

Figure 2. This spot welding gun would be difficult for a human to use. [Courtesy of Kawasaki Robotics (USA), Inc.]

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Arc Welding

Arc welding is a welding process that uses the heat generated from electricity to melt filler metal and base metals to form an airtight weld. During the arc welding process, electricity flows through an **electrode** to the **workpiece**. The space where the electricity jumps from the electrode to the workpiece is referred to as an electric **arc**.

For reasons of safety, robots are increasingly used for applications involving arc welding. The large amount of electricity generated from the electric arc generates temperatures of 6000°F (3300°C) or higher. The hazardous nature of arc welding requires human welders to wear uncomfortable protective equipment for long periods of time. It also generates a great deal of noise, fumes, and intense light. Figure 1 shows the bright light and electrical sparks generated by an arc welding robot.

Arc welding by robots yields higher quality and greater consistency in welds and are commonly used for automobile subassemblies. Arc welding does not require a lot of strength. It can be done by small **payload** robots, like the one in Figure 2. The usefulness of the robot is endurance and consistency. Moreover, the high quality of work demanded by arc welding makes it difficult to find human workers to fill the positions because the demand for skilled workers exceeds the supply.

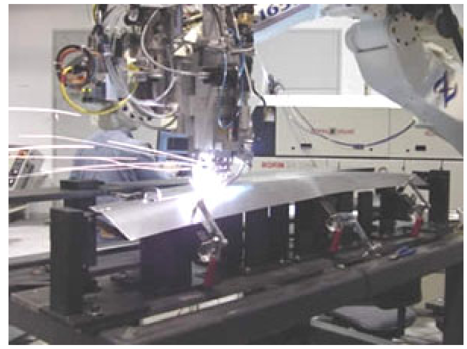

Figure 1. Arc welding can generate a great deal of noise, fumes, and intense light. [Courtesy of Kawasaki Robotics (USA), Inc.]

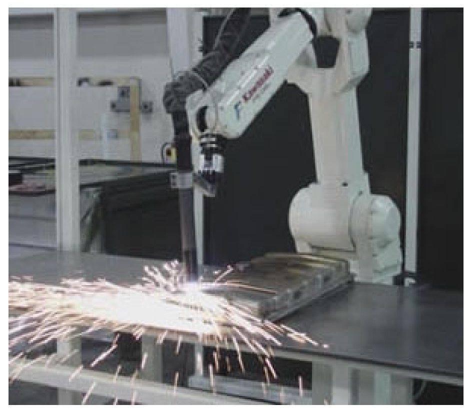

Figure 2. Arc welding can be done by this small payload robot. [Courtesy of Kawasaki Robotics (USA), Inc.]

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Material Handling

Material handling involves picking up and transporting objects such as raw materials, parts, containers, and packing materials. Robots are used for material handling when a high degree of control is required over the method, condition, orientation, and placement of the objects they move. Some typical material handling applications include pick and place, dispensing, palletizing, and packaging. The material handling robot in Figure 1 is moving saw blades.

Pick and place robots are popular in production lines. This type of robot performs simple, repetitive tasks such as picking up small parts from one location and placing them at another location. The end-effector can be any type of gripper, such as a **magnetic gripper** or a **vacuum gripper**, like the one in Figure 2. The robotic arm starts from a "home" position and moves to another location, where it picks up an object. The arm then returns to the home position and deposits the part.

Like pick and place robots, **dispensing** robots can also move objects from one location to another. For example, a dispensing robot can pick up an object such as a medicine bottle and drop it into a slot. Dispensing robots also can apply substances such as adhesives, paints, coatings, inks, and solder pastes onto surfaces. The substances are dispensed from cartridges or valves.

Palletizing robots are used to move objects on or off pallets. The objects can be cardboard, containers, packing materials, or boxes like the ones in Figure 3. Palletizing robots are especially useful for moving objects that would be too difficult or too heavy for humans to move. Palletizing robots also have a higher reach than humans. The newspaper industry is a large user of palletizing robots.

Packaging robots place objects into containers or packages. For example, a packaging robot can be used to populate a box of assorted chocolates. Using a vacuum gripper, the robot picks up a piece of chocolate and places it into a plastic tray that will later be inserted into a box. Packaging robots can work at extremely high speeds. In just sixty seconds, a packaging robot can place over 100 pieces of chocolate into containers.

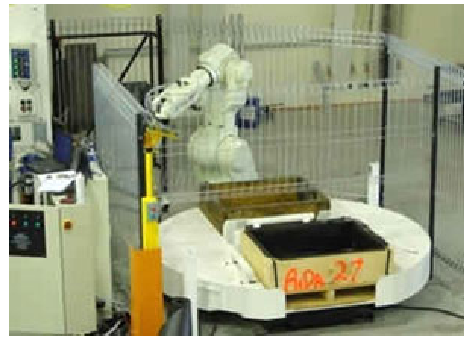

Figure 1. A material handling robot. [Courtesy of Kawasaki Robotics (USA), Inc.]

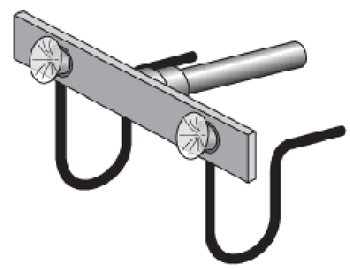

Figure 2. A vacuum gripper with suction cups.

Figure 3. This palletizing robot is moving boxes. [Courtesy of Kawasaki Robotics (USA), Inc.]

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Machine Tending

Machine tending, also known as **machine loading and unloading**, is a more complex type of material handling. In machine tending, a robot feeds parts in and out of a machine, as shown in Figure 1. However, unlike a simple pick and place robot, a machine tending robot manipulates the object as well as moving it. First the robot grasps the workpiece. Then the robot lifts or transfers the piece to a new location. After correctly orienting the object, the robot inserts the piece in its new place.

Machine tending robots are used for loading and unloading objects such as automotive components, transmission parts, and cylinder heads. Figure 1 shows a machine tending robot. Other examples of machine tending functions include holding parts for spot welding and tending injection molding machines.

Rail-mounted, overhead robots known as **toploaders** are often used for machine tending. Toploaders allow the robot a fuller range of movement as it transfers an object from one location to another, as you can see in Figure 2. This type of robot also conserves floor space and allows the robot to tend multiple workstations. Some toploaders can lift objects as heavy as 441 lbs. (200 kg) and can reach as far as 6.5 feet (2 meters) or more.

Figure 1. A machine tending robot. [Courtesy of Kawasaki Robotics (USA), Inc.]

Figure 2. This toploader has a large range of movement. [Courtesy of Kawasaki Robotics (USA), Inc.]

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Spraying

Spraying is the process of applying paint, stain, coating, or plastic powder to an object by manipulating a spray gun. The object being sprayed can be stationary, or it can be sprayed while on a moving conveyor. Sometimes multiple robots will work together to spray a single object. Specialized **nozzles** allow the robots to spray with a high degree of accuracy and very little waste.

Robots are used to spray coatings onto parts such as car panels, furniture, and home appliances. Other applications include coating airplane parts, painting truck beds, and applying prime coat to truck cabs. The robot in Figure 1 is spray coating the inside of a car frame. The highly repetitive motions required in spray painting are well-suited to robots. Robots can paint quickly and efficiently with nearly perfect quality. In cases where a large area requires multiple sprayers, robots can apply paint or coating with a high level of consistency and uniformity of technique.

Robots are also a good choice for **thermal spraying** applications because of the energy and heat involved. Thermal spraying is a process in which heated substances such as **tungsten** or **ceramics** are applied to a surface to protect it from wear, heat, and corrosion. Types of thermal spraying include **high velocity oxygen fuel** (HVOF) thermal spray, which is used for **dry coating**, and **plasma spraying**, in which coatings are applied using a **plasma jet**. Figure 2 shows the jet of a plasma spraying robot.

Figure 1. This spraying robot works quickly and efficiently with nearly perfect quality. [Courtesy of Kawasaki Robotics (USA), Inc.]

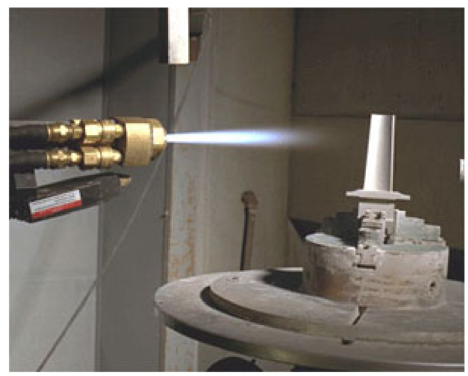

Figure 2. A plasma spraying robot applies coatings with a plasma jet.

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Assembly

Assembly is another application in which robots are widely used. Assembly typically involves fitting or fastening two parts together to create a finished product. This is often done using nuts, bolts, screws, fasteners, or snap-fit joints. Most assembly robots can be found in the automotive and electronics industries. An assembly robot is shown in Figure 1.

Typically **articulated robots** and **SCARA robots** are used for assembly. More complex assembling tasks require the robot to have some type of **sensor** in order to correctly position and insert parts. For example, a vision system mounted above the robot lets the robot "see" parts coming down a conveyor belt. The robot is then able to find the parts and determine whether or not they are properly oriented for the robot's task. Examples of assembly include inserting light bulbs into instrument panels, inserting components into printed wiring boards, and assembling small electric motors.

For humans, assembly can be a monotonous and fatiguing task. Assembly robots have the advantage of being able to work 24 hours a day without stopping. Moreover, assembly robots can work more quickly and consistently than humans. However, not all assembly work is best suited to robots. Human hands are still more nimble than even the best end-effector, as you can see in Figure 2. Robots tend to work best with rigid parts that have little variation in size and shape.

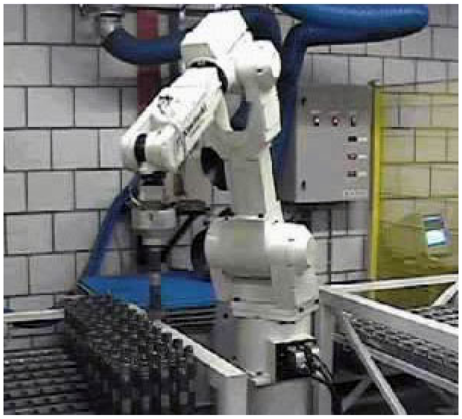

Figure 1. An assembly robot. [Courtesy of Kawasaki Robotics (USA), Inc.]

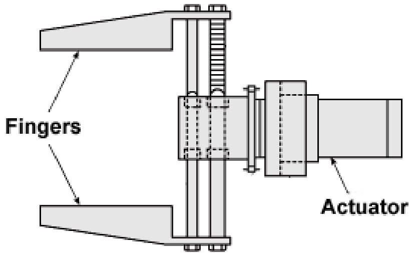

Figure 2. A human hand is much more nimble than this end-effector.

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Fabrication and Processing

Robots can be used for **fabrication** and **processing** applications. Some specific applications include die casting, press work, and plastics processing. **Die casting** is one of the earliest application areas for industrial robots. The **die** is a production tool used to create workpieces consistently within required specifications. For each new workpiece, a new die must be installed on the press. Robots are ideal for die casting because the process involves producing a large volume of parts while keeping changeover time to a minimum. Moreover, in die casting the parts are very hot and could injure human workers who come into contact with them.

Like die casting, **press work** is also an application in which robots were used early on. Press work includes stamping, forming, and trimming. **Stamping** rapidly shapes thin sheets of metal by pressing the metal between two plates that hold various components. These components can bend the metal, punch holes, or even create impressions like those found on coins. Robots can be used to load and unload the stamping machines. A press brake tending robot is shown in Figure 1.

Plastics processing is a growing area of robot applications. **Plastics** are synthetic materials such as nylon and polyester. Robots are used primarily for unloading injection molding machines. **Injection molding** is the process of melting solid plastic resin and forcing it into a mold to cool and solidify. The robot in Figure 2 is tending a plastic injection molder. Robots are also used for secondary operations in plastics processing, such as trimming, drilling, buffing, and packaging finished plastic products.

Figure 1. A press brake tending robot. [Courtesy of Kawasaki Robotics (USA), Inc.]

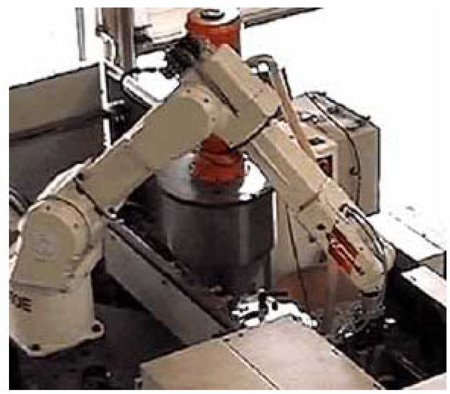

Figure 2. This robot is tending a plastic injection molder. [Courtesy of Kawasaki Robotics (USA), Inc.]

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Inspection

One of the most important trends in robotics has been the development of robotic vision. Robots can use fixed cameras like the one in Figure 1 to "see" objects. Combined with higher computing power and more sophisticated algorithms, vision technology significantly increases the types of work that can be performed by robots and improves the quality of their performance.

A somewhat recent application of robotic vision is **inspection**. Inspection robots are used to ensure quality and accuracy in parts manufacture. For example, inspection robots can be used to check part tolerances. **Tolerance** is a small but acceptable deviation from a desired dimension. The smaller or tighter the tolerance, the greater the cost to the manufacturer if errors occur.

When inspecting tolerances or other part characteristics, the robot compares the desired or ideal part with the actual part being viewed through a camera. Robots are capable of detecting variances as small as +/- 0.1 mm (0.004 in.). Based on the results of the comparison, the robot may choose to do closer inspection of the part, or activate a warning light if the part is defective. Or the inspection robot may sort out the defective part.

Some typical tasks performed by an inspection robot include observation, measuring, and repairs. Inspection robots are used in many areas, including electronics manufacturing, aerospace and automotive automation, food quality inspection, and print quality inspection. Figure 2 shows a robot inspecting an air filter. In addition to providing cost savings by spotting errors and ensuring quality, inspection robots are able to go into areas that are too small or too dangerous for humans.

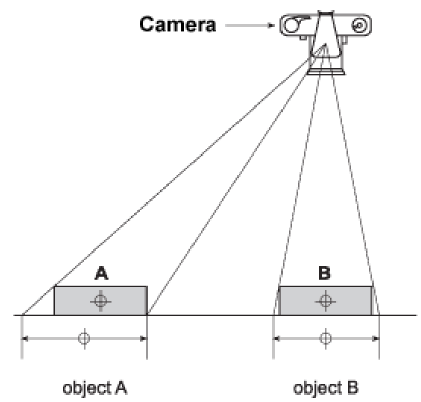

Figure 1. Camera sensors give robots the ability to examine objects.

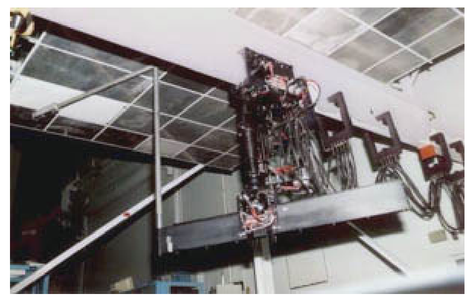

Figure 2. This robot is inspecting an air filter located at the upper left.

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Summary

Industrial robots protect workers from injury and provide cost savings through improved efficiency. A robot can move on its own, sense information about its environment, and use that information to accomplish a programmed task. Welding is the largest application for industrial robots. Spot welding robots are used by the automotive industry to weld automobile bodies. Arc welding robots are used for automobile subassemblies.

Material handling robots pick up and transport objects. Pick and place robots pick up small parts from one location and place them at another location. Dispensing robots apply substances onto surfaces and move objects from one location to another. Palletizing robots move objects on or off pallets. Packaging robots place objects into containers or packages. Machine tending robots feed parts in and out of a machine.

Spraying robots apply paint, stain, coating, or plastic powder to an object by using a spray gun. Assembly robots fit or fasten two parts together to create a finished product. Die casting robots handle parts that are very hot and could injure human workers. Press work robots are used for applications involving stamping, forming, and trimming. Plastics processing robots are used primarily for unloading injection molding machines. Inspection robots ensure quality and accuracy in parts manufacture.

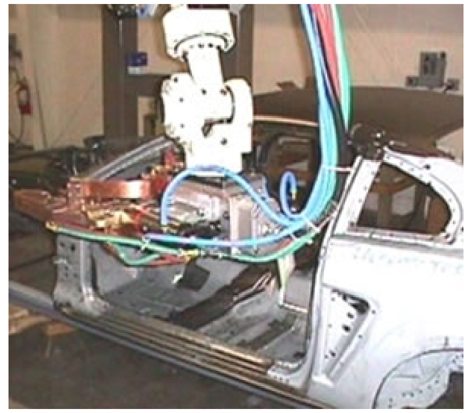

Figure 1. The automotive industry is a large user of spot welding robots. [Courtesy of Kawasaki Robotics (USA), Inc.]

Figure 2. Palletizing is a common material handling application. [Courtesy of Kawasaki Robotics (USA), Inc.]

Class Vocabulary

arc The area in which electricity jumps from the electrode to the workpiece. The heat generated by the arc melts the base metals.

arc welding A welding process that uses the heat generated from electricity to melt filler metal and base metals to form an airtight weld. Robots are ideal for arc welding because it demands a high level of skill that is difficult to find in human workers.

articulated robot A type of robotic arm that closely resembles a human arm. The arm of an articulated robot has revolute joints and the number of joints can vary.

assembly The process of fitting components together into a larger or completed part. Examples of assembly include inserting components into printed wiring boards and assembling small electric motors.

ceramics Inorganic materials that are hardened at high temperatures.

die A worktool in manufacturing that is used to shape or form materials like metal or plastic.

die casting A process in which liquid metal is injected into a mold. Die casting is one of the earliest applications for industrial robots.

dispensing The process of giving out or distributing objects in a container, or applying substances through pressurized force.

dry coating A fast-drying coating that uses little, if any, water. Dry coating usually takes the form of a powder.

electrode A device that conducts electricity.

end-effector The end component of a robotic arm that is shaped like a hand or like a specialized tool.

fabrication The process of creating or building parts from raw materials.

gripper A hand-shaped end-effector designed for seizing and holding.

high velocity oxygen fuel HVOF. A combination of fuel and oxygen that is heated with a torch and applied as a powder coating through a highly pressurized nozzle.

industrial robot A programmable mechanical device that is used in place of a person to perform dangerous or repetitive tasks with a high degree of accuracy.

injection molding A process in which molten plastic is injected into a mold at high pressures. Robots are used for unloading injection molding machines.

inspection The process of observing and comparing parts to identify and correct any defects. Inspection robots are used many areas, including electronics manufacturing, aerospace and automotive automation, food quality inspection, and print quality inspection.

machine loading and unloading The process of loading and unloading raw materials into machinery for processing. Also known as machine tending.

machine tending The process of loading and unloading raw materials into machinery for processing. Also known as machine loading and unloading.

magnetic gripper A type of end-effector that uses electromagnets or permanent magnets to pick up metallic objects.

material handling The process of loading, unloading, placing, or manipulating material. Types of material handling include machine tending, part transfer, packaging, and palletizing.

nozzle The spout at the end of a pipe or tube through which substances are ejected at high velocity.

packaging The process of assembling containers and components for shipping and storage. Packaging robots can work at extremely high speeds.

palletizing The process of placing and securing containers or objects on pallets. Palletizing robots are especially useful for moving objects that would be too difficult or too heavy for humans to move.

payload The maximum load that a robot can manipulate.

pick and place The process of picking up an object or part in one location and placing it in another location. Pick and place robots are popular in production lines.

plasma jet A device that delivers a highly pressurized stream of hot plasma.

plasma spraying A type of thermal spraying in which material is applied to a surface with a plasma torch. Plasma-sprayed coatings are highly resistant to wear and corrosion.

plastic A material consisting of very large molecules characterized by light weight, high corrosion resistance, high strength-to-weight ratios, and low melting points. Most plastics are easily shaped or formed.

plastics processing A process in which plastic is molded, formed, or extruded. Plastics processing is a growing area of robot applications.

press work Manufacturing applications that include stamping, forming, and trimming.

processing The procedures performed and actions taken before a part is ready for distribution.

SCARA robot Selective Compliance Arm for Robotic Assembly. A type of cylindrical robot that has 4 axes of movement: X, Y, Z, and Theta Z.

sensor A device that detects the presence or absence of an object, or certain properties of that object, and provides feedback. Robots use sensors to interact with their environment.

spot welding A type of welding in which parts such as sheet metal are squeezed together between two electrodes and subjected to a large amount of electric current to form a joint. Spot welding is used primarily by the automotive industry to weld automobile bodies.

spraying The process of applying paint, stain, coating, or plastic powder to an object by manipulating a spray gun. Robots are used to spray coatings onto parts such as car panels, furniture, and home appliances.

stamping A metalworking process that bends, imprints, or punches holes into thin sheets of metal. Robots can be used to load and unload stamping machines.

thermal spraying A process in which heated substances are applied to a surface to protect it from wear, heat, and corrosion.

tolerance An acceptable deviation from a desired dimension that still meets specifications.

toploader A robot that is rail-mounted overhead. Toploader robots have a fuller range of movement and conserve floor space.

tungsten A high melting point metal that is immune to oxidation or corrosion by acids.

vacuum gripper A type of end-effector that uses suction cups for gripping flat objects.

welding A joining process that permanently bonds together two separate components with heat, pressure, or a combination of those elements to make one new part. Welding is the most common application for industrial robots.

welding gun A large end-effector used by robots for spot welding. Spot welding guns are usually pneumatic.

workpiece A part or component being processed or worked on by a robot.