Automation in Production Systems and Management
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Fundamentals of Robotic Systems
Lecture - 49
Robot Classification System, Industrial Robot Applications

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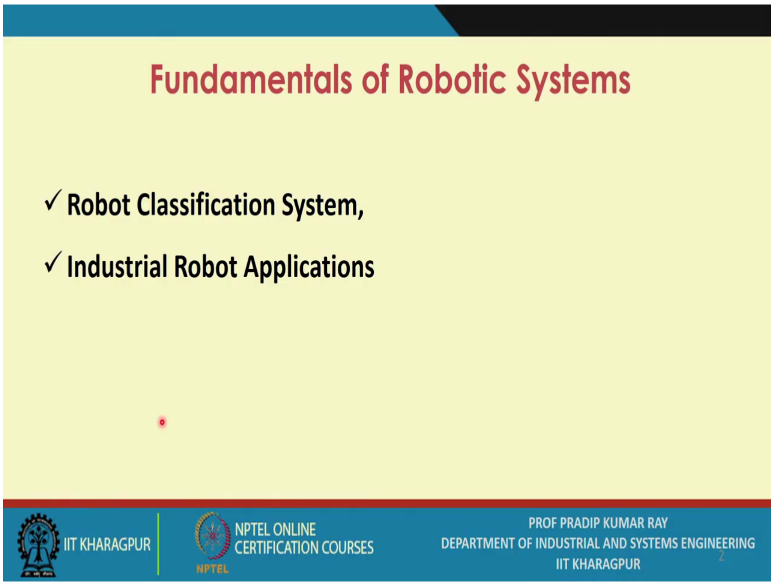

During this lecture session, I will be referring to the classification system for robots and Industrial Robot Applications.

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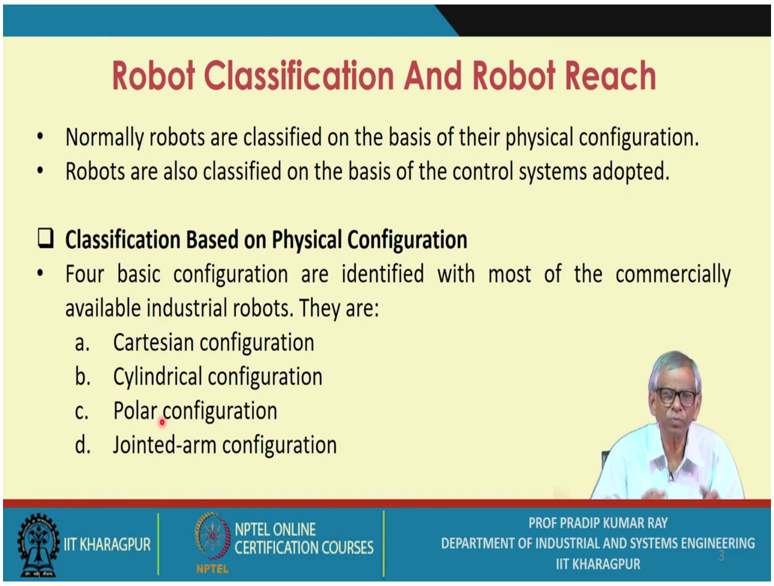

Normally robots are classified on the basis of their physical configuration. Robots are also classified on the basis of the control systems adopted.

Classification Based on Physical Configuration

Four basic configuration are identified with most of the commercially available industrial robots. They are:

a. Cartesian configuration

b. Cylindrical configuration

c. Polar configuration

d. Jointed-arm configuration

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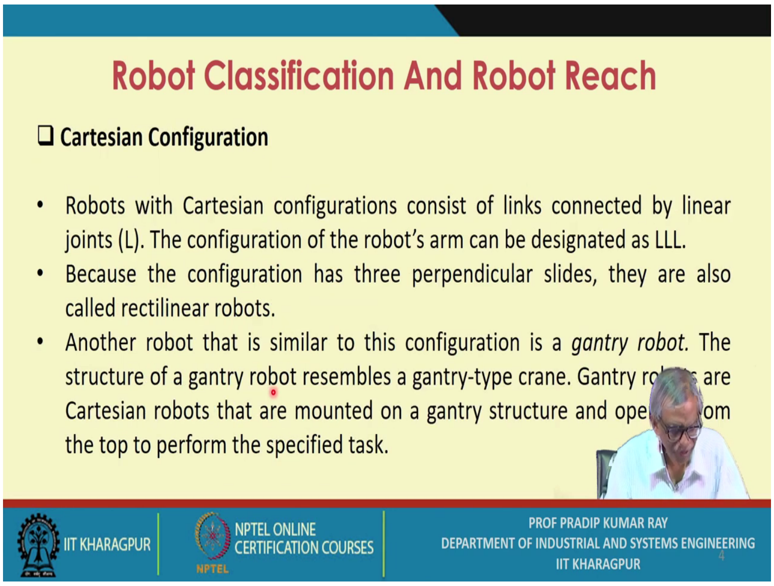

Robots with Cartesian configurations consist of links connected by linear joints (L). The configuration of the robot's arm can be designated as LLL.

Because the configuration has three perpendicular slides, they are also called rectilinear robots.

Another robot that is similar to this configuration is a gantry robot. The structure of a gantry robot resembles a gantry-type crane. Gantry robots are Cartesian robots that are mounted on a gantry structure and operate from the top to perform the specified task.

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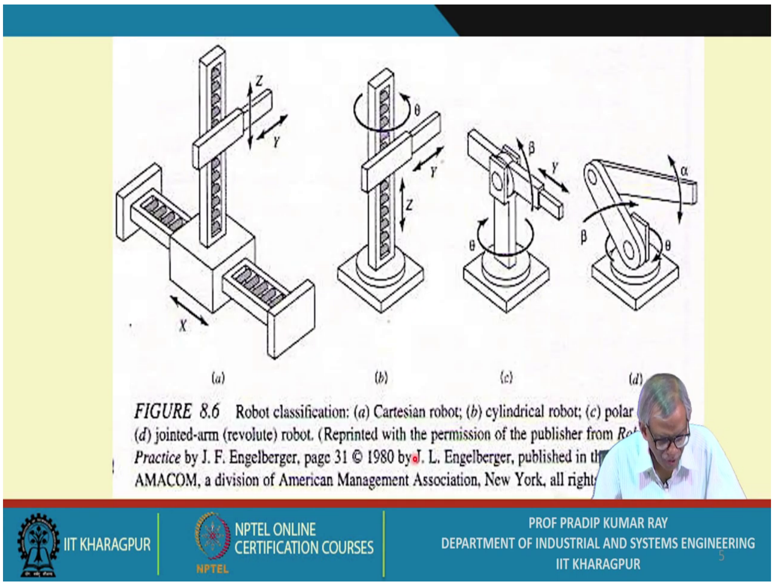

These are the four types of configurations. This is the Cartesian type robot that means there is movement in the x direction, there is a base, you can move. Then this one is essentially another direction, y direction and then there could be movement on the z direction.

The second one is the cylindrical robot that means this one is the base and this structure you have over here. This on z axis, this movement you have; x is on linear directions, this may be the horizontal, this is the vertical. But then the entire particular link, you might say it is a link, this can rotate around this one, that is why it is called cylindrical.

This sort of the robot structure, the physical configuration you will come across. Third one is basically the polar robot. This one is rotating around the base. This is one rotation and this one and this is the joints you have and this is the link. So, this is the rotational joint, the rotation takes place along this direction; this is said this is alpha, this is said beta and there also will be the horizontal movement, that is the shown as y.

So, this is basically called like polar, polar robot. And this one is the jointed arm or the revolute robot, the revolute term already you have come across, what is the revolute joint, this is one particular physical configuration for a robot and this is basically referred to as that the revolute robot.

Along the base, so this one can move, this entire structure, the entire this two can move. Similarly, this there will be rotation along with this; that means the joint is essentially the rotational joint and similarly and the other the part. So, another end of the link, you have another the rotational the joint.

And with this rotational joint is linked with or this is it is connected with another link. So, this is a typical revolute robot. So, this is also referred to as the jointed arm robot. So, just you go through the textbook. So, all these details are given.

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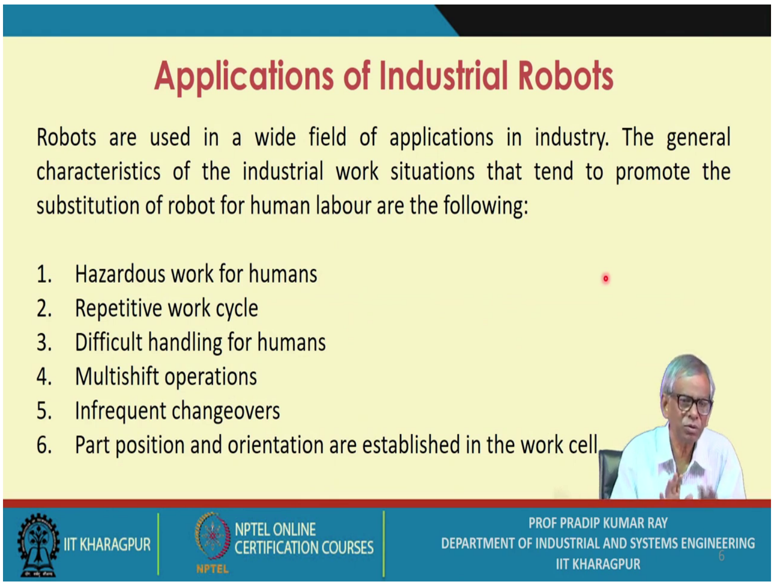
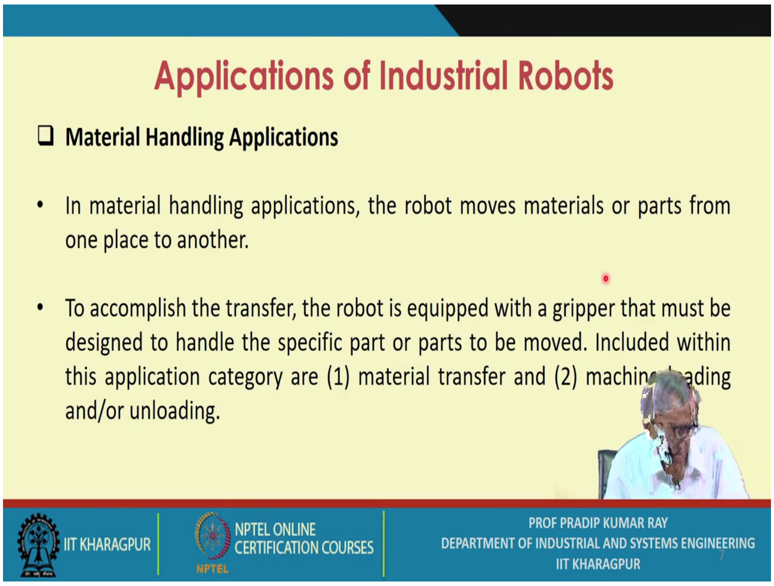


Robots are used in a wide field of applications in industry. The general characteristics of the industrial work situations that tend to promote the substitution of robot for human labour are the following:

1. Hazardous work for humans
2. Repetitive work cycle
3. Difficult handling for humans
4. Multishift operations
5. Infrequent changeovers

Part position and orientation are established in the work (Refer Slide Time: 10:47)



There are four the types of configurations you have, the first one is your Cartesian robot, when you refer to the physical configuration. The second one is a cylindrical robot, the third one is the polar robot and the fourth one is the revolute robot.

In material handling applications, the robot moves materials or parts from one place to another.

To accomplish the transfer, the robot is equipped with a gripper that must be designed to handle the specific part or parts to be moved. Included within this application category are (1) material transfer and (2) machine loading and/or unloading.

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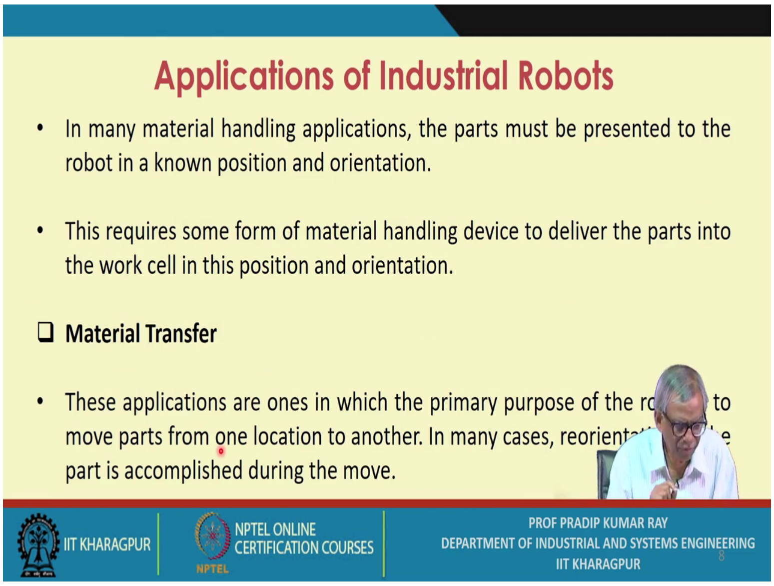

In many material handling applications, the parts must be presented to the robot in a known position and orientation. If there has to be part programming. In an automated system, this location should be known. This requires some form of material handling device to deliver the parts into the work cell in this position and orientation.

Material transfer, these applications are once in which the primary purpose of the robot is to move parts from one location to another. In many cases, reorientation of the part is accomplished during the move, by the different stage, you carry out this the material transfer.

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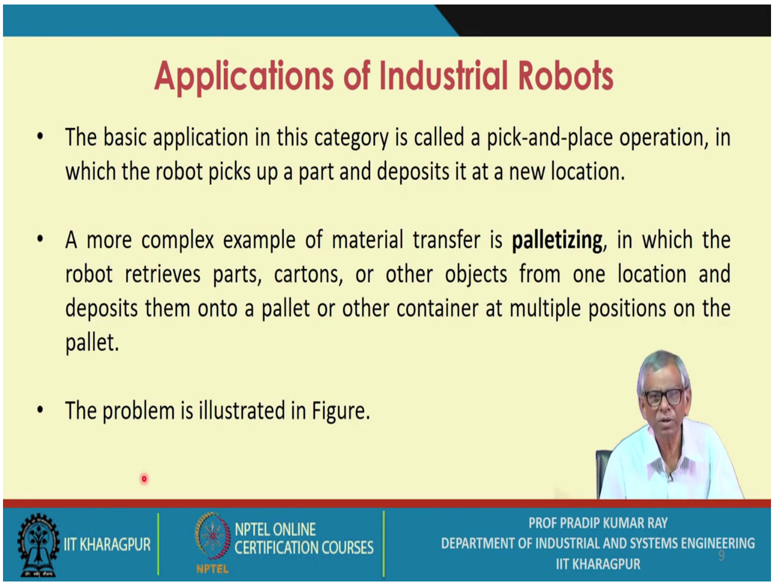

The basic application in this category is called a pick-and-place operation, in which the robot picks up a part and deposits it at a new location. A more complex example of material transfer is **palletizing**, in which the robot retrieves parts, cartons, or other objects from one location and deposits them onto a pallet or other container at multiple positions on the pallet. The problem is illustrated in Figure 8.11.

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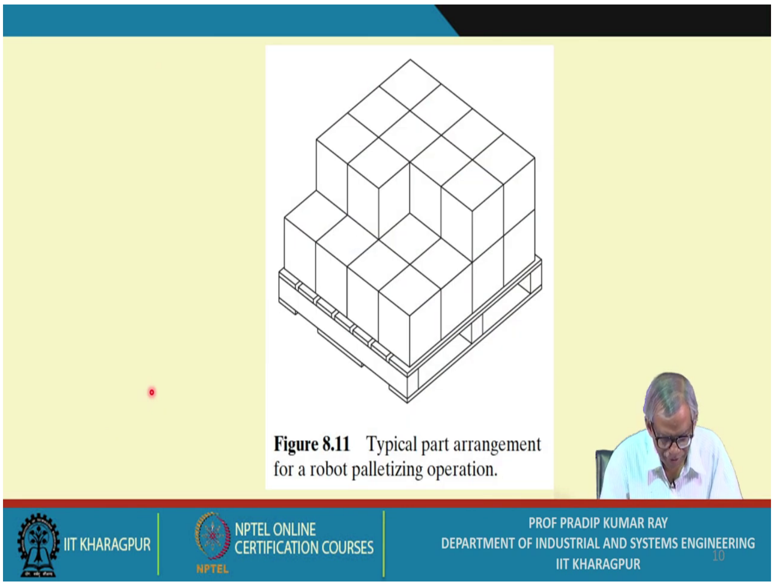

This is one problem, the typical part arrangement for a robot palletizing operation. All these parts are to be arranged like this, the each one may be a carton. First you just pick up this one and then you transfer to one location.

Next comes this one, how the robot, in which direction the gripper moves that also specify, the location is to be specified location, the gripper the hand goes over there. It picks up the object and then you transfer it some locations and from there again it goes over there, in the second location, picks up the object, then it transfers to another location, these are all to be the properly defined.

And you have to arrange these objects in a particular manner. This is a part of design of a robotic system. And this design is very common in fact for material handling purposes.

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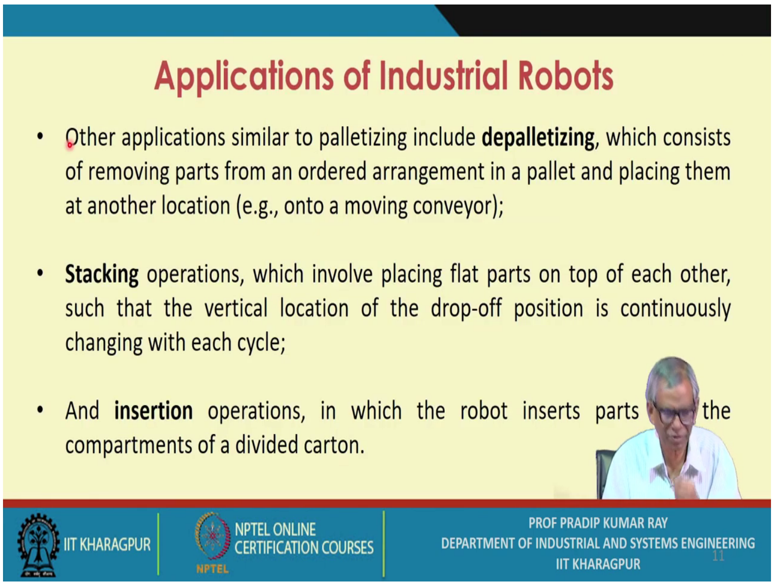

Now, other applications similar to palletizing include depalletizing, which consists of removing parts from an ordered arrangement in a pallet and placing them at another location (e.g., onto a moving conveyor);

Stacking operations, which involve placing flat parts on top of each other, such that the vertical location of the drop-off position is continuously changing with each cycle;

And insertion operations, in which the robot inserts parts into the compartments of a divided carton.

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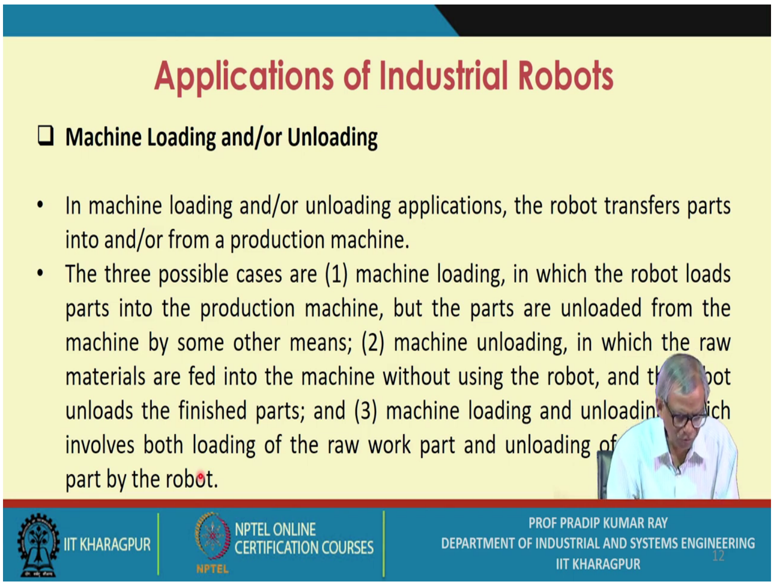

So, as far as using robot for material handling purpose, this is very common in fact. In machine loading and/or unloading applications, the robot transfers parts into and/or from a production machine. The three possible cases are (1) machine loading, in which the robot loads parts into the production machine, but the parts are unloaded from the machine by some other means; (2) machine unloading, in which the raw materials are fed into the machine without using the robot, and the robot unloads the finished parts; and (3) machine loading and unloading, which involves both loading of the raw work part and unloading of the finished part by the robot.

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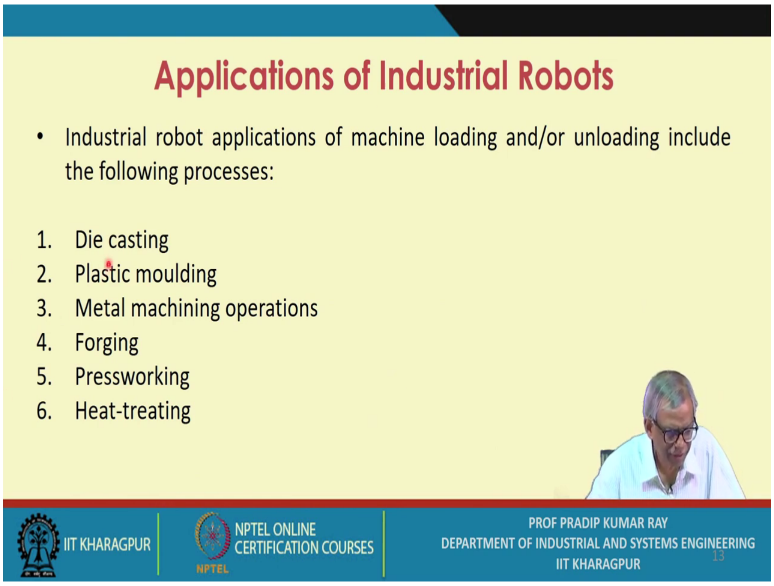

Industrial robot applications of machine loading and/or unloading include the following processes:

Die casting, Plastic moulding, Metal machining operations, Forging, Pressworking, Heat-treating

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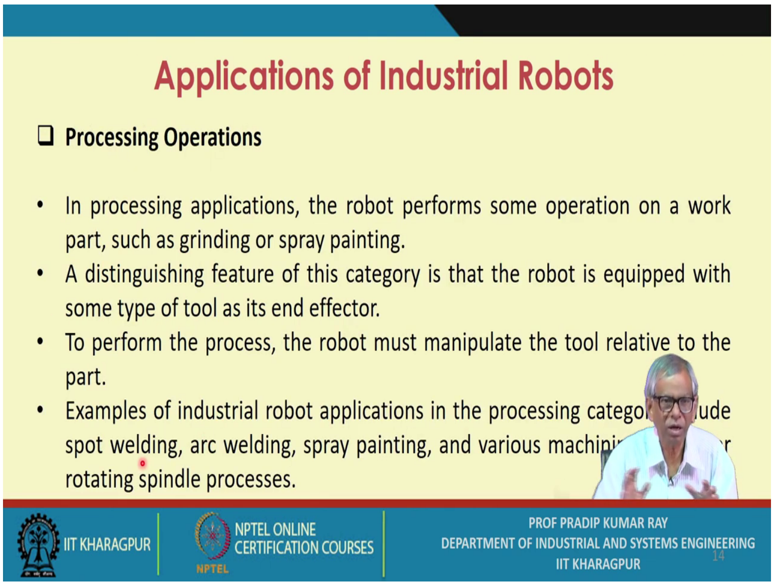

In processing applications, the robot performs some operation on a work part, such as grinding or spray painting. A distinguishing feature of this category is that the robot is equipped with some type of tool as its end effector. To perform the process, the robot must manipulate the tool relative to the part. Examples of industrial robot applications in the processing category include spot welding, arc welding, spray painting, and various machining and other rotating spindle processes.

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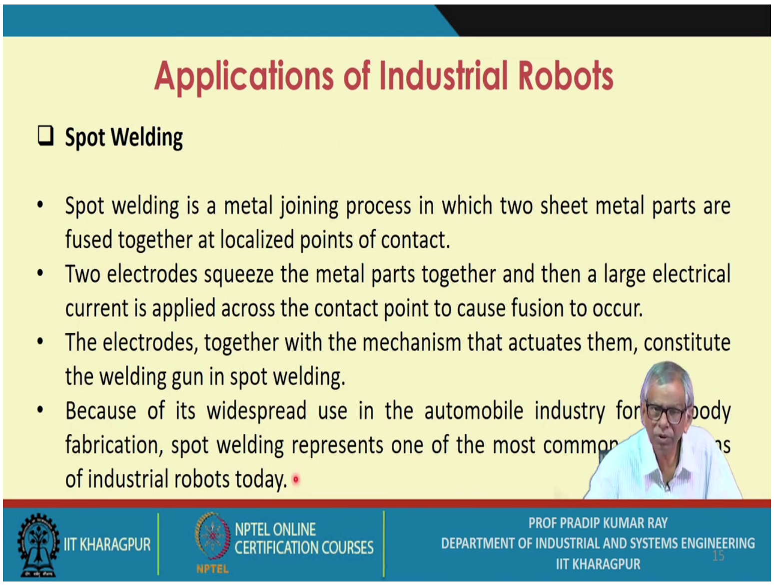

Spot welding is a metal joining process in which two sheet metal parts are fused together at localized points of contact. Two electrodes squeeze the metal parts together and then a large electrical current is applied across the contact point to cause fusion to occur. The electrodes, together with the mechanism that actuates them, constitute the welding gun in spot welding. Because of its widespread use in the automobile industry for car body fabrication, spot welding represents one of the most common applications of industrial robots today.

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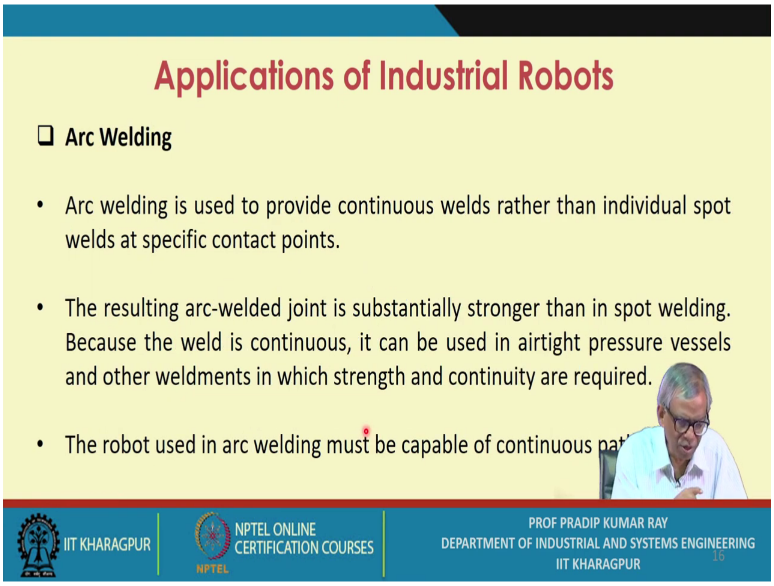

Arc welding is used to provide continuous welds rather than individual spot welds at specific contact points.

The resulting arc-welded joint is substantially stronger than in spot welding. Because the weld is continuous, it can be used in airtight pressure vessels and other weldments in which strength and continuity are required.

The robot used in arc welding must be capable of continuous path control.

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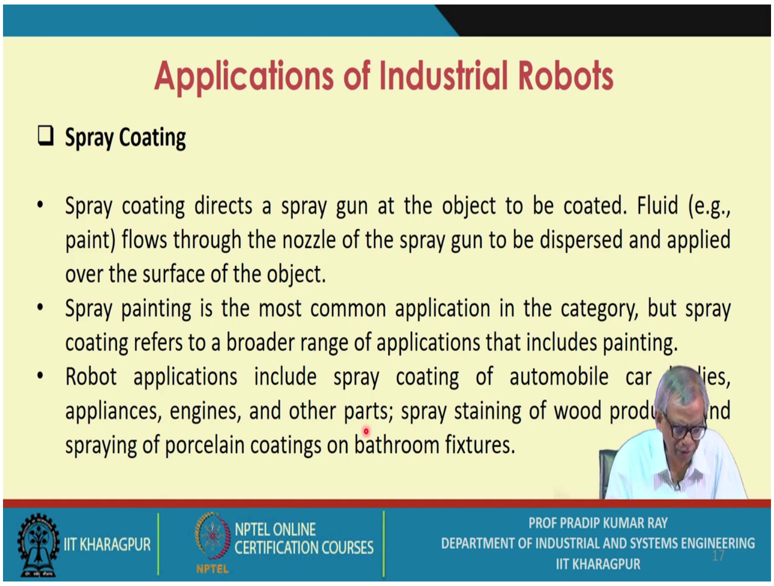

Spray coating directs a spray gun at the object to be coated. Fluid (e.g., paint) flows through the nozzle of the spray gun to be dispersed and applied over the surface of the object. Spray painting is the most common application in the category, but spray coating refers to a broader range of applications that includes painting. Robot applications include spray coating of automobile car bodies, appliances, engines, and other parts; spray staining of wood products; and spraying of porcelain coatings on bathroom fixtures.

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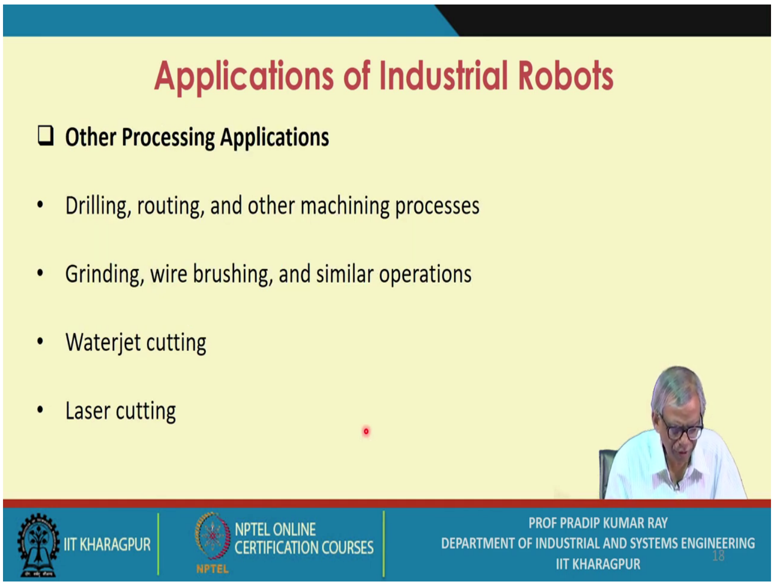

What are the other processing applications? The drilling, then for routing and other machining processes the grinding, wire brushing and similar operations.

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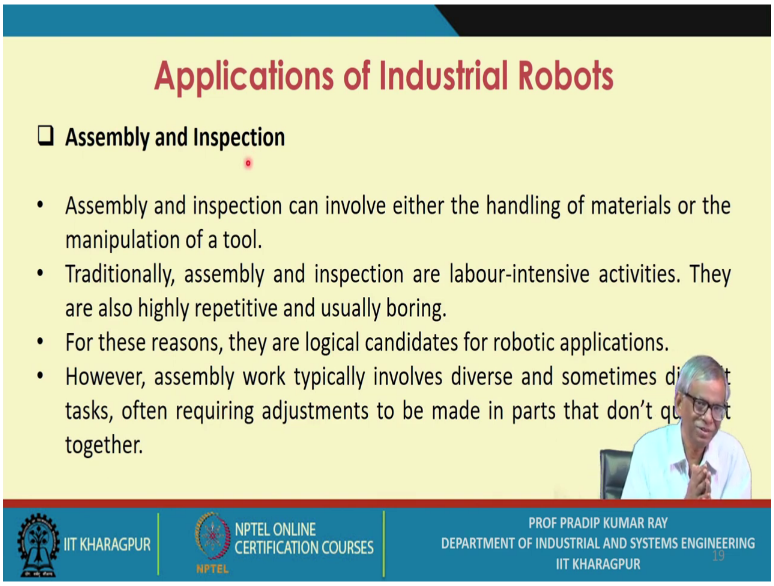

Assembly and inspection can involve either the handling of materials or the manipulation of a tool. Traditionally, assembly and inspection are labour-intensive activities. They are also highly repetitive and usually boring. For these reasons, they are logical candidates for robotic applications. However, assembly work typically involves diverse and sometimes difficult tasks, often requiring adjustments to be made in parts that don't quite fit together.

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Assembly involves the combining of two or more parts to form a new entity, called a subassembly or assembly. The new entity is made secure by fastening the parts together using mechanical fastening techniques (e.g., screws, bolts and nuts, rivets) or joining processes (e.g., welding, brazing, soldering, or adhesive bonding). Because of the economic importance of assembly, automated methods are often applied. Fixed automation is appropriate in mass production of relatively simple products.

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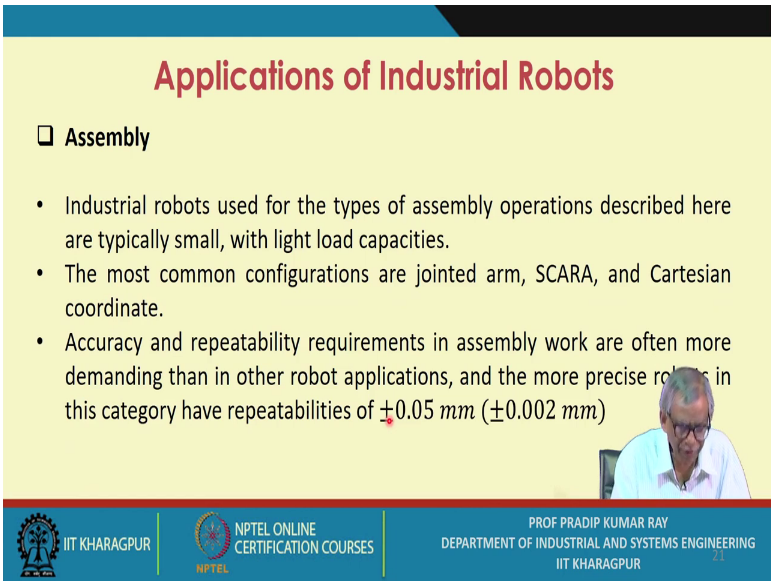

The robots are used assembly operations. Industrial robots used for the types of assembly operations described here are typically small, with light load capacities. The most common configurations are jointed arm, SCARA, and Cartesian coordinate. Accuracy and repeatability requirements in assembly work are often more demanding than in other robot applications, and the more precise robots in this category have repeatabilities of

$$\pm 0.05\ mm\ (\pm 0.002\ mm)\ \pm 0.05\ mm\ (\pm 0.002\ mm)$$

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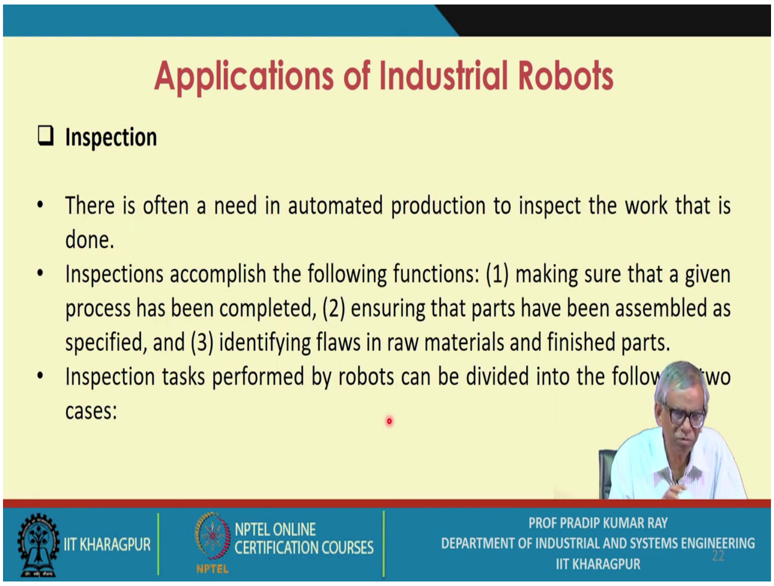

There is often a need in automated production to inspect the work that is done. Inspections accomplish the following functions: (1) making sure that a given process has been completed, (2) ensuring that parts have been assembled as specified, and (3) identifying flaws in raw materials and finished parts. Inspection tasks performed by robots can be divided into the following two cases:

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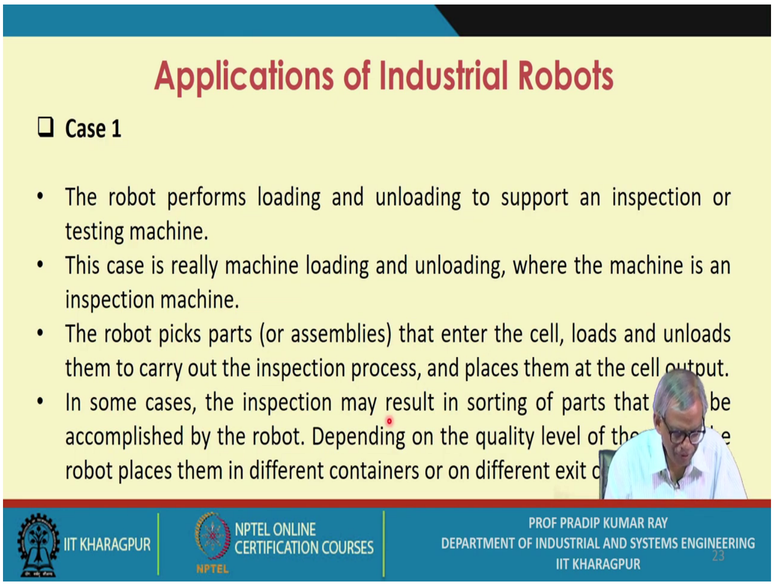

Case 1

The robot performs loading and unloading to support an inspection or testing machine. This case is really machine loading and unloading, where the machine is an inspection machine. The robot picks parts (or assemblies) that enter the cell, loads and unloads them to carry out the inspection process, and places them at the cell output. In some cases, the inspection may result in sorting of parts that must be accomplished by the robot. Depending on the quality level of the parts, the robot places them in different containers or on different exit conveyors.

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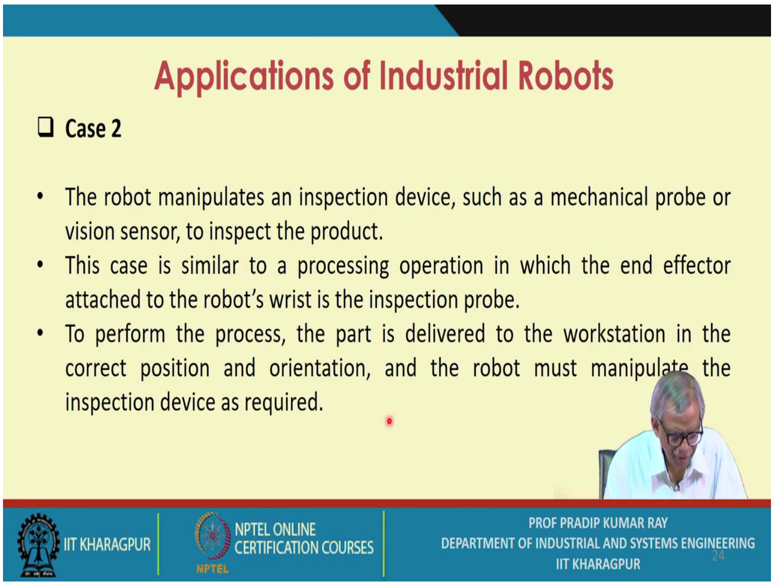

Case 2

The robot manipulates an inspection device, such as a mechanical probe or vision sensor, to inspect the product. This case is similar to a processing operation in which the end effector attached to the robot's wrist is the inspection probe. To perform the process, the part is delivered to the workstation in the correct position and orientation, and the robot must manipulate the inspection device as required.

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