Automation in Manufacturing
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Week – 08
Mechanisms
Lecture – 03
Material handling systems

Well, I welcome you all to the lecture-3 of week-8. In lecture-3, we will be studying various Material handling systems those are used in the Automation in Manufacturing.

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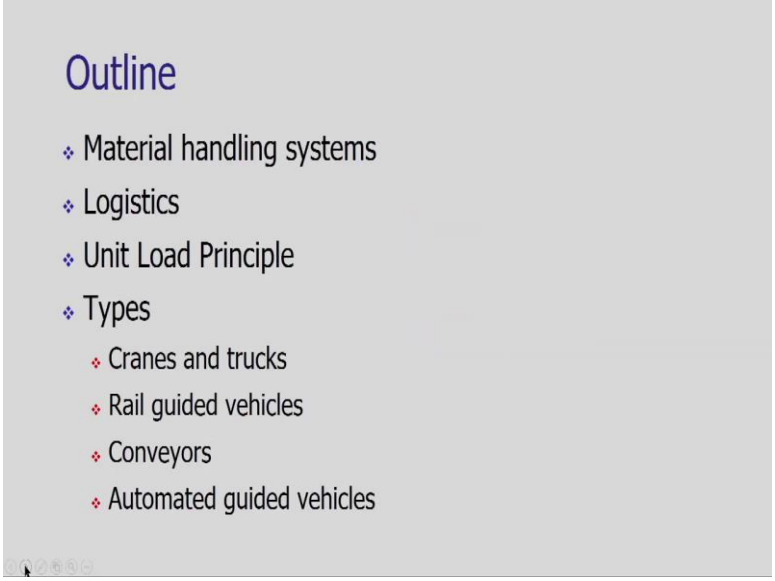

The outline of the lecture is on our screen. At start of lecture, we will study the various material handling systems, their concepts, definitions. Then we will have a discussion on the concept of logistics and unit load principle. After that we will study various material handling systems in detail. These are cranes and trucks, RGVs (Rail Guided Vehicles), conveyors and automated guided vehicles.

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In industry or in any shop floor we are dealing with various materials, parts and products. The materials, parts and products are to be moved, we have to store them, and we have to track them, we have to make a record. And this is so quite usual in any commercial infrastructure. The term logistics or the word logistics we often use which is related to the materials.

Logistics is nothing but acquisition of the material, acquisition of the parts and products, activities related to movement of these commodities, storage of these parts, products and distribution of them in the factory, or in the enterprise. It is not only acquisition movement storage and distribution. The operations related to planning and control of these functions is called as the logistics. Of course, all these things we are doing to satisfy the customer demand.

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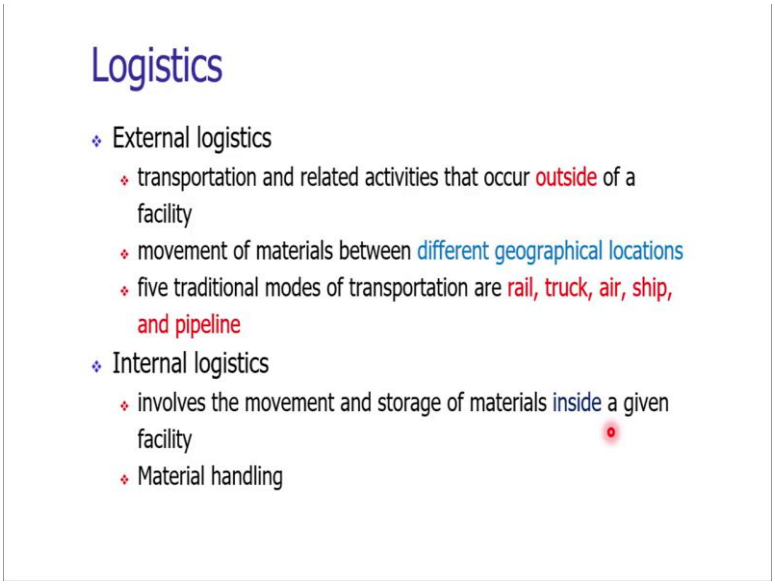

The logistics can be defined as an external logistics or it can be an internal logistics. When we are saying that we are transporting the goods or the product outside of a facility, the operations related to the storage, transportation of the goods and products outside the facility can be said it is a external logistics.

When we say that we are moving the material from one geographical location to the other geographical location, it involves basically the transport of the material, raw material, finish finished goods, semi-finished goods, products from place of manufacture to the destination that maybe market destination or the distribution destination.

We are carrying out the transportation of raw material or the finished or semi-finished goods in external logistics through various transport systems such as rail, truck, by air, or by ship, or by using the pipeline as well. The fluids say water or the petrochemical gases, they are transported through the pipeline.

In case of internal logistics, we are moving or storing the materials inside a given facility. In the enterprise, there are various things are needed. And when we are storing them we are acquiring them and making a record of all the things, then the operations related to this is called as the internal logistics. The basic element and important element in the logistics is the material handling. And in this lecture, we are studying the various material handling equipment those who are important for the automation purpose.

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We need the material handling equipment for variety of operation. The first is the transport operation. For that purpose, we need transport equipment. We need the equipment for positioning. We got the material over the conveyor at the destination, but we have to locate them at proper place.

We have to feed the tool to the spindle. For positioning, we need certain mechanical equipment, these are called as the positioning equipment. Unit load formation equipment – we are assembling, we are taking the commodities together, and we are storing them at a as a unit. To make the commodities as an unit, certain equipment are used these are called as unit load formation equipment.

Storage equipment, variety of equipment are needed to store the commodities at the workplace. Positioning means we are talking about specific application; storing means in a bulk way we are we need certain equipment that is to be used for storage of the bulk material or bulk commodities. In a factory, there are many equipment, there are many tools, raw materials, finished products. We need to have the proper record, efficient record of all this elements.

For that purpose, we should have automated identification equipment. For that purpose, the mechatronics based systems are used. It may be bar coding based technology or the RFID technology. Tthe identification and control equipment are the 5th type of material handling equipment which are required in automation and manufacturing.

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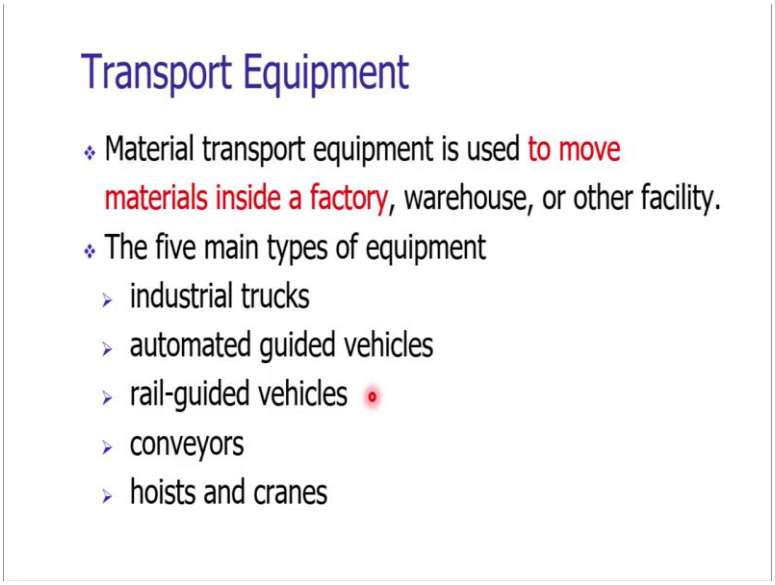

The transport equipment as I mentioned are required to move the materials inside a factory or warehouse or the facility. There are basically five types of equipment are used. And these are industrial trucks, automated guided vehicles, rail-guided vehicles, conveyors, hoists and cranes.

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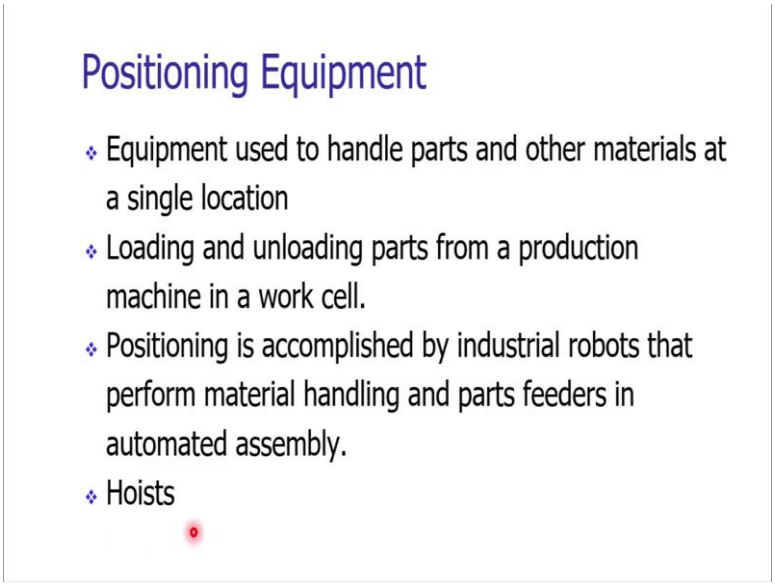

Positioning equipment, as mentioned are used to handle the parts of the materials at single location only. Say at feeding of the tool or orientation of the tool in a machining center or pick and place arrangement at the ASRS. The loading and unloading parts from

a production machine in a work cell can be treated as a best example of the positioning equipment.

In general, these activities are carried out by industrial robots which are performing the material handling, part feeding in the automated assembly. For positioning of bulky components or bulky tools say dies, molds or machine parts, we are using hoists which are lifting the components, and they are positioning wherever it is required.

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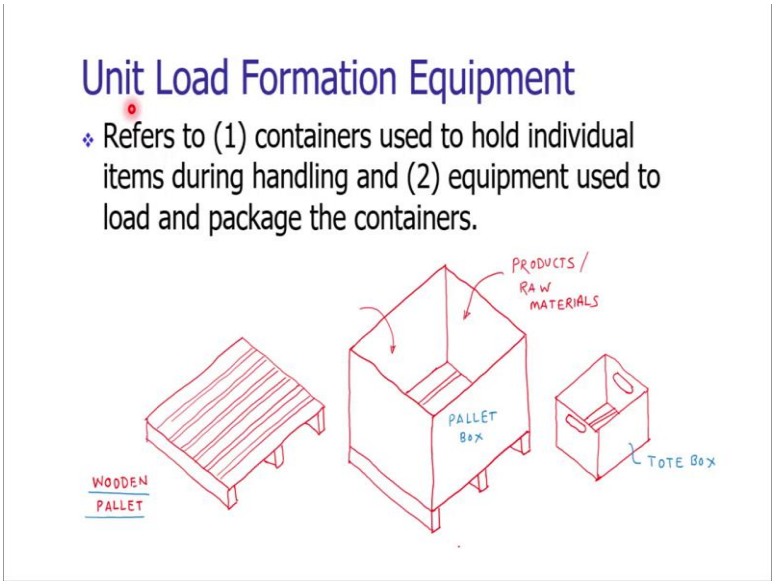

Unit load formation equipment, the unit load formation basically deals with making a container which is holding the individual atoms together, so that we can easily handle them. Let us consider we are having a wooden pallet. The wooden pallet is nothing but a platform of specified size, standard size over which we are putting the finished products say the boxes over each other and with specified number of boxes we are considering that as a unit of a pallet.

After that we are wrapping that specified number of packets or boxes together and that will be considered as 1 unit of 50 boxes, 1 unit of n number of products. We can also have a smaller version of the wooden pallet. This is a box or a basket kind of thing. In the tote box as well we can have the commodities such as the food products say fruits, berries, or apples.

1 tote box of apple that will be considered as a unit load. If the products are heavy if the products are more, we can have a larger version of the unit load and that is called as the pallet box. In the pallet box, we can accommodate or we can have the products which are stored in a semi-finished way.

Let us consider we are using certain raw material for some operation, we are storing that in a pallet box, and that will be utilized for the sub assembly or the processing operations. To transfer the finished products or to make the unit load of finished products, in general wooden pallets are considered. For making a unit load of the commodities which are in process which are yet to be processed we are using the pallet box given for handling the larger volume we are going for the pallet box.

We can put the products or the raw materials inside the pallet box. Of course, we are not wrapping this material by using the plastic. This is also used to handle the raw materials or semi-finished products.

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Palletizing, basically, an operation which is automatically shrink wrapping the plastic film around the unit load which is there on the pallet and that wrapped unit of the products will be sent for the shipping. The operations related to shrink-wrapping the plastic film is called as the palletizing. We need to arrange the products on the pallet, so that they will not fall down and then we have to wrap them by using the plastic film. To

carry out this operation, we need the automatic machines, these machines are called as the palletizers.

In a similar way, we also need depalletizers as well. Consider we are having a distribution center of the same enterprise. From the manufacturing unit, we are getting the palletized products. We need to now depelletized them and we have to unload the cartoons from the pallet. To carry out this operation in automatic way, we need the equipment these are called as depalletizers.

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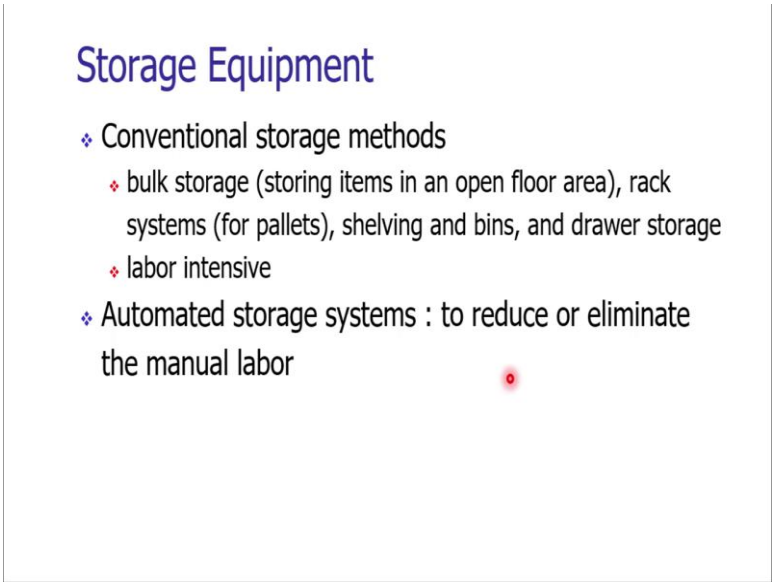

Storage equipments, the conventional method is the bulk storage that is on the open floor area. Consider we are having food grain bags which are store in a food grain godown. We are stacking the food grain bags, and generally these kind of storage is on the open floor area. Even in the industry, we are using the open floor area for stacking of the bigger size boxes or the cartoons. The rack type of system is the more sophisticated way. The racks are designed to accommodate the pallets. We have to prepare the pallets of the commodities or the products and straight forward we can put this pallets inside the rack system.

The rack system may have the specified numbers, they are coded basically. And we can easily automate the process of the rack system. Such systems are called as automated storage and retrieval system which are having the automated racks. We also use shelving and bins, the shelving and bins are utilized to store smaller components, a screws, nuts,

various tools. We are using drawers, but handling of the shelving and bins it is manual, it is a labor intensive. Overall, the handling of the open floor area storing and the rack system storing non-automated way is labor intensive.

For that purpose, we have to go for automated storage system which is suddenly reducing and eliminating the manual labor. When we are automating the process of storage in the racks and handling of the various items inside the rack, that will converted into automated storage and retrieval system.

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As mentioned before we have to identify and control these commodities or equipment in the shop floor. We have to keep track of these materials that to be moved and store. For that purpose, we are using barcode technology which often we use in the retail markets as well. In the retail markets say in the garment markets as well we are using RFID technology that is a Radio-frequency identification technology.

Both these technologies are also used in industry. We are tracking, we are providing first the barcodes to the palletized unit loads and then we can retrieve the specified pallet for either dispatch or for unpalletization or for its further utilization.

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Now, what are the various design consideration that to be studied? The design of a material handling system basically depends upon the materials that to be handled. What type of material we are handling, what is the quantity and distance that to be moved? When we are choosing a certain material handling equipment, first of all we should know what is the type of material whether it is a solid, or it is a liquid material, or it is a the gases product. Based on that, we have to choose appropriate material handling technology.

Quantities, whether it is a low quantity medium quantity or high quantity, then the distance for how long the material handling has to be carried out for how long we have to transport the material inside the warehouse or the automated industry. Based on that as well a suitable choice can be made with available options with us. Then what kind of production facility we be getting served by the material handling?

Whatever the products or the commodities we are transporting for which purpose for which production operation we are utilizing them. Whether it is a machining operation, or it is painting operation, or packaging operation, how much precision is there, whether it is a clean room or non clean room, whether it is a general purpose shop floor, so all these aspects are very essential that to be consider when we choose or when we design a material handling system.

Of course, the next parameter is the budget, the cost. The type of material that to be remove, the type of material that to be moved, the quantity or distance that to be move, what kind of application of that metal is there during the transportation and the cost associated with that.

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During optimal selection of material handling equipment in automation, we have to consider the type of layout of the plant for which we are selecting the material handling equipment. In the industry basically three types of layouts are used. These are process layout, product layout and fixed position layout.

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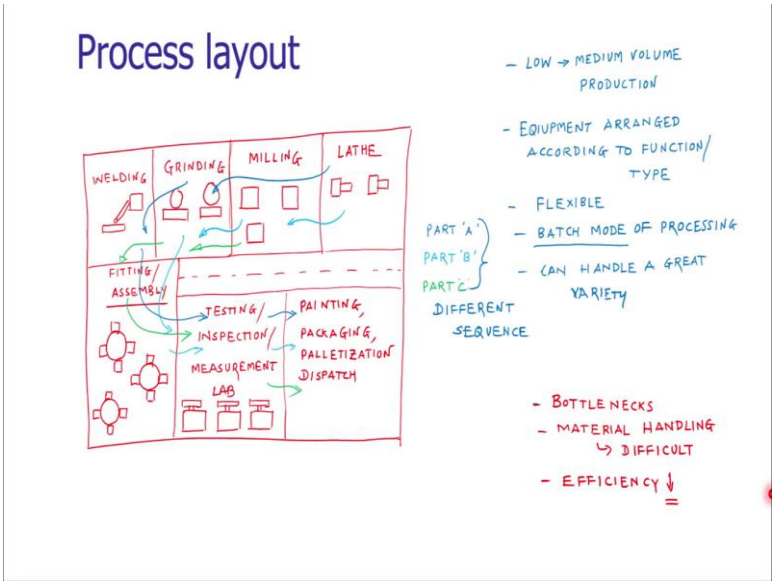

The layout is nothing but arrangement of the equipment or facility inside a factory. In process layout, we are arranging the equipment or the facility based upon the similarity of their utilization. On our screen, you can see a facility related to the tool room. Here we have grouped various equipments based upon their utilization. We can see the sections based upon their utilization, a lathe section, a turning section where we are reducing the diameter of the work pieces.

Milling machining operations, grinding operations which are finishing operations, semi-finishing operations. Welding operation, it is a joining operation or assembly operation. Fitting and assembly related activities. The equipment machines which are similar in utilization are grouped together and we have made a sections of them.

Also we are having a testing and inspection or measurement lab. We are all the finished or semi-finished products will be tested tools will be tested inspected. At the end, we can have the painting, packaging and the pelletization. Consider there is a part A which is to be processed at lathe operation and the grinding, welding, it will go to testing, it will not have any fitting related activity.

Part B is moving from lathe to milling operation, from milling to grinding and from grinding it will come to the fitting operation. After that it will go to inspection and testing and then it will be package. There is one component that is part C which is to be

process only on milling that finished on grinding, it will be welded, then it will be processed in the inspection section directly.

If we look at the operations which are need to need to be carried out on part A, part B, and part C are different, their sequence may also be different. The process layout is basically catering the low volume production or the medium volume production. Around say 1 to 100 number of parts that to be manufactured for that purpose the process layout is ok.

In process layout, the advantages that we can have a great variety of parts that can be processed. The part A, B and C are entirely different in their processing. The flexibility is the biggest advantage of the process layout and it is basically used for the batch mode of the operation. When we are carrying out the work parts in batch mode, we can easily have the process kind of layout.

When we are transporting the material from one shop to the other shop, we have to choose the equipment accordingly. Here we cannot have the conveyor based arrangement. We cannot lay down the conveyor that would be the fixed mode of transportation. Here we can have the AGVs that Automated Guided Vehicles, or we have to carry out that by using the cranes. Otherwise, we have to use the fork lift trucks which are manually operated, but definitely the fixed automation cannot be employed for the process layout.

When we are processing in a batch mode, based upon the limited availability of the equipment in shops, there are chances of having bottlenecks. Consider 50 number of components are having very less time of processing at lathe, but they are having more time of processing at the milling operation. There may be a bottlenecking. For that purpose either we have to increase the number of equipment at the milling operation, or we have to wait or we have to lose our time. That losing of the time is definitely losing the efficiency of the system.

Due to the bottlenecking as well we cannot have efficient material handling. The material handling is difficult in a process kind of layout. Thus the layout of the company, the layout of the factory is an important aspect in selecting the material handling equipment during the automation process.

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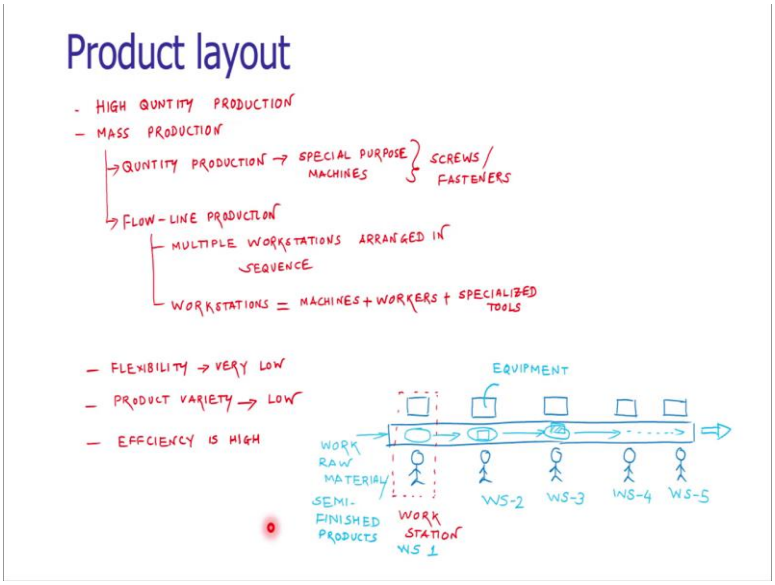

Consider there is a scenario that is of high quantity production. The company is having only one product and we have to produce the product at a high volume at the mass scale. Then mass production as well the production may be a quantity based production. Quantity based production means a manufacturing of screws and fasteners if the companies having the objective to manufacture only one product that is the screw.

We can have a special purpose machine we are just now producing a large quantity of the screws and nuts per day that is the product. And we are just selling them that out that is called; that is called as the quantity production, a single product, single commodity which may not be having any assembly.

The second type of mass production is flow line based production. System is there and that system is having variety of sub systems. These sub systems may be produced in house or some of the subsystems might have procured from the outside, we are outsourcing them.

At a faster rate, at a rapid rate, we have to assemble the sub assemblies, we have to assemble the parts which are either produced in house or outsource. For that purpose, we have to have a dedicated transfer line, such type of production facility is called as flow line production facility. The flow line production facility may have multiple number of workstations, these work stations are arranged in a sequence.

Consider we are having a transfer line. The transfer line is having multiple workstations. A workstation is defined as a unit which is having an equipment and the concern manpower. It may be worker, or it may be an engineer, it may be a skilled or semi skilled person and then there is a required tooling – specialized tooling.

Nowadays, the 100 percent automation factories are replacing the human work workers by the robots. A machine, specialized tooling and the control element that may be human being or the robot is together called as the workstation.

In flow line production systems, we are having many such work stations which are arranged in a sequence. The raw material is entering in that transfer line at one end, the commodities are entering at one end and the workstations are processing this commodities and at the end of the flow line at the end of the transfer line we are getting the semi-finished product or the finished product.

The characteristic of product layout is that its flexibility is very low. In certain cases if the system is very hard and probably we may not have any chance to incorporate any changes in the product design. So we have to redesign or rearrange the entire hardware of the flow line. Therefore, the flexibility of the product layout is very low. The product variety naturally is also very low. W are working only on one product.

In quantity production, consider we are having a special purpose machine which is manufacturing only one type of product for the variation in that product we have to go for another type of special purpose machine. The machine may not have the capability to accommodate the variations in the design. However, the efficiency of the product layout is very high. We are producing enormous quantity of the work parts or the systems per day.

The product layout is basically utilized for mass production systems. When we are trying to have the material handling system for mass production systems, the conveyors, the robots, the indexing mechanisms, these are very useful. Consider we want to just have the sequential motion of the work part instead of using the trucks or AGVs, we are simply using conveyors. And over the conveyors, the parts are moving. And there are equipment that are that equipment are processing the parts which are just moving on the conveyor.

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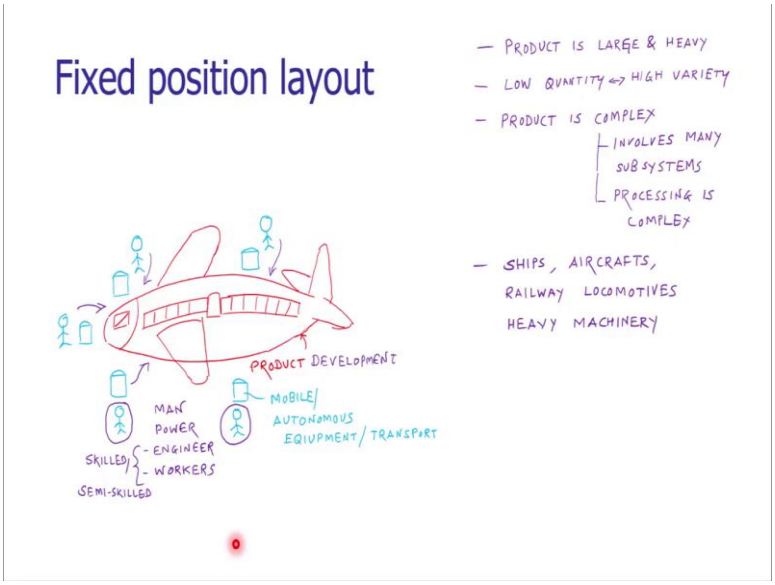

But you consider in certain cases we are having only one product, one system that to be developed. Consider case of aeroplane manufacturing or ship manufacturing, or we can have an example of the railway locomotive manufacturing or heavy machinery. For such applications which are very heavy, very bulky which are difficult to handle very difficult to move from one shop to the other shop.

In this situation, we are arranging the workstation, we are arranging the equipment around this product itself, around the system itself. We are taking the machines, we are taking the equipment at the site itself, and then we are carrying out the processing. Such type of layout is called as the fixed position layout.

Here you consider we are building up an aeroplane. We need the equipment. Now, to get the equipment from the storage, the equipment may be a machine. To get the equipment from the storage from its destination to its work place, we need to have certain material handling equipment. For that purpose, either we can go for forklift type of trucks or we have to go for the hoist or cranes.

We cannot use here the conveyors, because if we lay down the conveyors that will definitely obstruct the material movement of the other operation. Either we take this equipment or you can mount the equipment on mobile devices you can have the wheels into this equipment, so that we can easily take them to the fixed position of manufacturing.

In fixed position layout, the quantity is very less maybe one or two products that to be manufactured. The designs are very complex; they are involving many subsystems. The processing of the products is very complex. Many sub systems are involved and we have to assemble them, the processing is difficult and complex.

Naturally the efficiency of fixed position layout is very minimal, because we are developing only one product per unit time. It may be in days or in may be in months or years.

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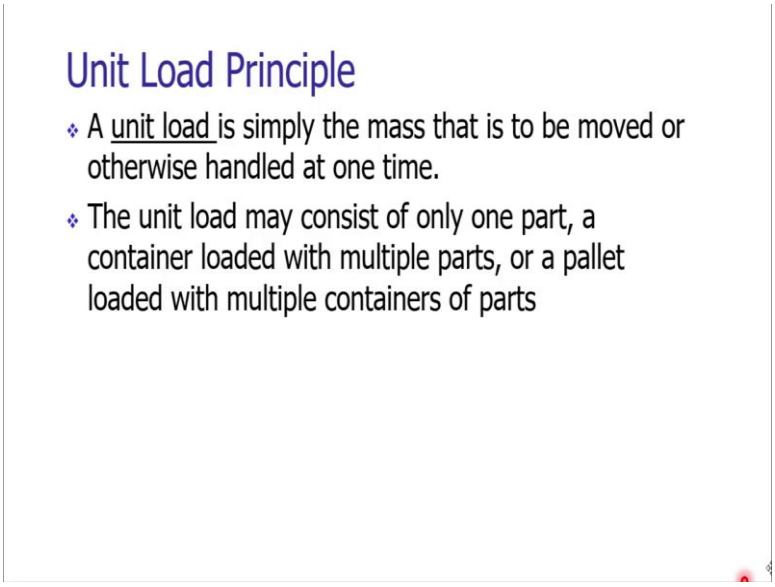

We have seen the term unit load. Actually let us have the formal definition of the unit load. The unit load is simply a mass that is to be moved or otherwise handle at one time. What the unit load may comprise of? It will have either one part say only one product or a system which we are putting on the pallet, or we may have a container with multiple number of parts.

Or these multiple number of parts are loaded on the pallet and then we are palletizing them, then we are wrapping them with the plastic. This is this unit load is very much useful in record making, in handling of the parts.

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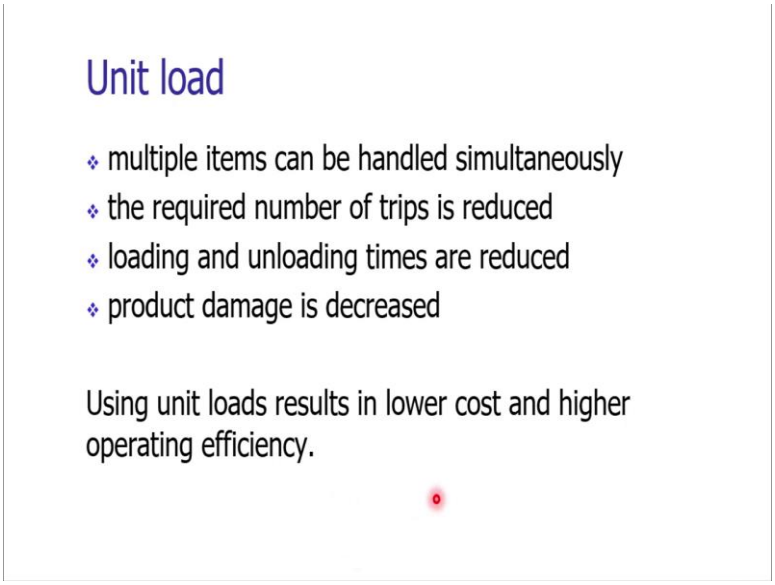

The concept of the unit load or the principle of unit load is helping us to handle the multiple number of atoms simultaneously. Based on this, we can efficiently manage the logistics, we can efficiently count the number of trips and we can even reduce the number of trips.

If we are making the parts palletized we are arranging them in a proper manner, then we can reduce the number of trips of the material handling inside the factory, or it may be the outside of the factory as well.

The loading and unloading times is also reducing, we are not handling a single box or a single product, they are handling multiple atoms which are temporarily bounded together. Since the handling is efficient the product damage would be less. Thus by using the unit loads we can reduce the cost and we can increase the efficiency.

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There are many transport equipment used in the industry. And these are industrial trucks, and that industrial trucks may be the manual or they may be powered. Automated guided vehicles, rail guided vehicles, conveyors, cranes and hoists.

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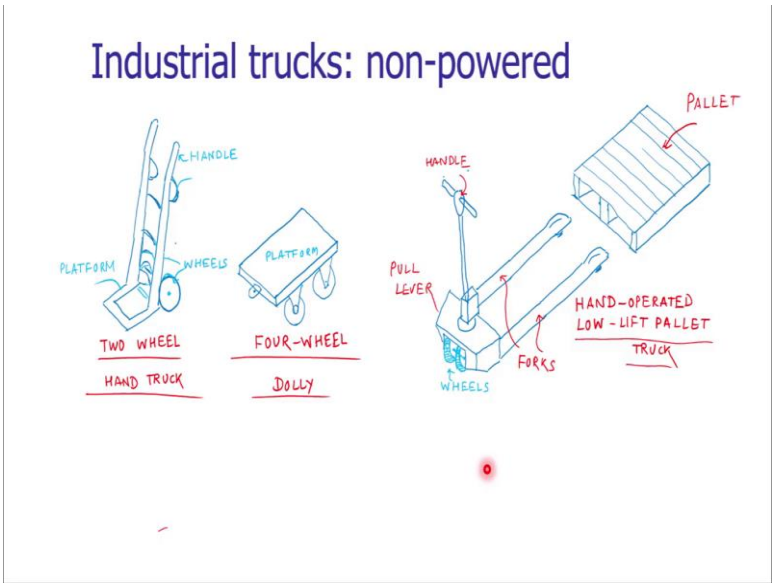

Some simple equipment which are often used on the shop floor and these are the industrial trucks. Some examples are there on your screen. These are non-powered trucks simple two wheel hand truck which is used to transport lighter products. This is the platform over which we are putting the product, and then we can easily convey them. Or

we can have the four wheel dolly, either you can drive the dolly manually or you can drive number of dollies by using an automated guided vehicle. Four wheel dollies are very much useful in the airports for transfer of luggage from areophane to its destination that is the conveyor.

We can also have the hand operated low lift pallet trucks. They do have the forks. The forks will be inserted into the pallet and forks will be lifted hydraulically, but the lifting is very small. As the forks are lifting the pallet the commodities will be lifted and then we are transferring them to the desired location. All these trucks are non-powered.

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As per as the automation are concerned, we are using the power trucks. Though they are manually operated, but these entities are very much useful in semi-automated industry. Where we are talking about material handling in process layout or in fixed position layout to handle the bulkier component say dies and molds or the tools or the raw material, we need to have an equipment that is the power truck of the forklift truck.

This is a typical arrangement you can see. Here we are having the forks and there is a hydraulic system, hydraulically we are lifting the forks. The lifting is comparatively very high. There is a train and it is having a very heavy engine. That engine is operating the hydraulic system as well. By using the hydraulic system, we are operating the forks and that forks are lifting, and then we are maneuvering we are transporting or conveying the commodities at their desired location.

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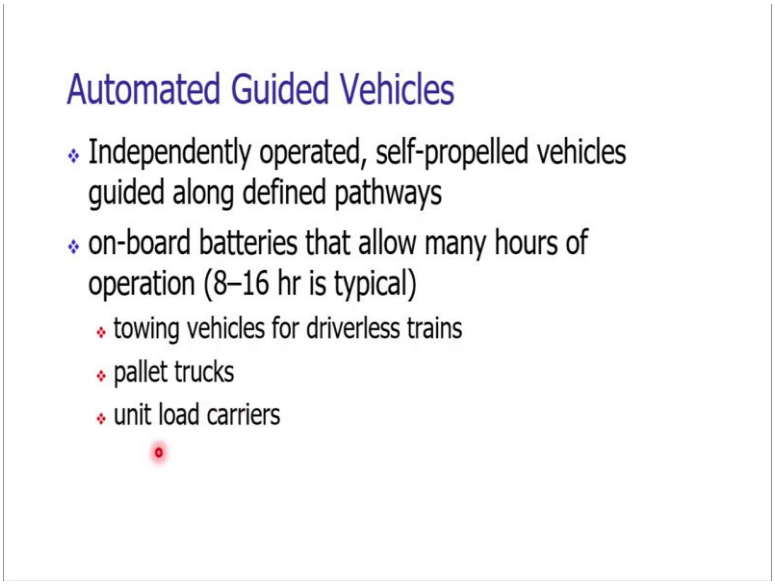

Automated guided vehicles are widely used in automation. These are independently operated, they are independent. They are propelling themselves. They are self-propelled vehicles, they are guiding themselves. The AGVs are having onboard batteries. The battery life may be around 8 to 16 hours. There are basically three types of AGVs are used in the industry. These are towing vehicles, pallet trucks or unit load carriers.

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On our screen, we can see a towing truck, say driverless towing truck, it is remotely controlled by a central computer or it is self-propelled or self-controlled as well. It has

the forks and over the forks a palletized commodity can be seen. This is a wooden pallet over which a unit load is placed. The unit load can easily be handled by the forks of this the AGV; the AGVs having the capability of controlling remotely wirelessly.

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This is another variant. It is the unit load carrier. This unit load carrier is having low height, and we can handle only the typical unit load for which it has been designed. Only one pallet at one time is being handled by such system.

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The next one is the pallet career. Consider we are having a AGV and which is driving which is taking along with it a dolly. And over the dolly, we are having the pallets. We can have a multiple number of dollies which are arranged in sequence. And based upon the capacity of the AGV, it can drive the dollies.

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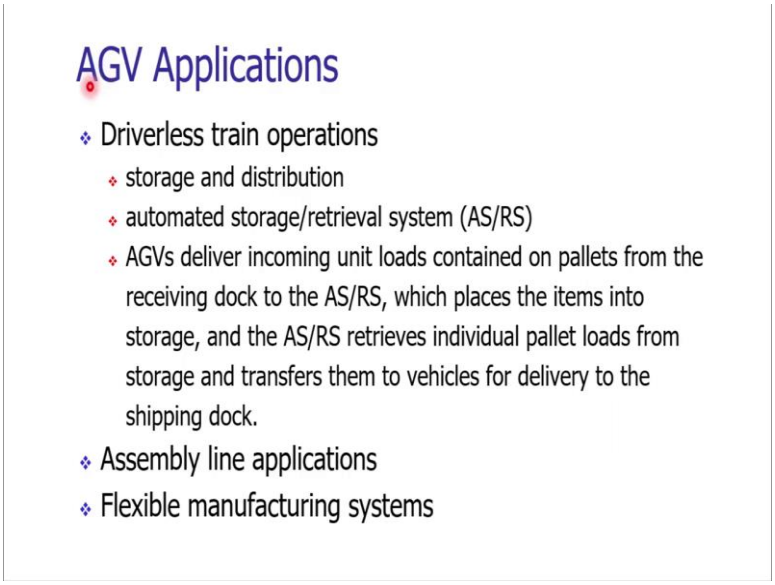

The AGVs are providing the driverless train operations. We can efficiently handle the storage and distribution. The AGVs are basically used for automated storage and distribution of commodities or the raw materials. AGVs are the integrated part of AS RS automated storage and retrieval system which we have seen in our very first week of this course.

We have seen one video where AS RS is taking assistance of the automated guided vehicle. How the AGVs are helping? The AGVs are feeding the automated and storage retrieval system. They are getting the unit loads on pallets from the receiving dock. Consider a truck has arrived in an enterprise of raw material and it is having multiple number of unit loads.

Now, AGVs will go to this dock, they will receive the unit loads, they will receive the pallets, and then they are feeding that pallets to the AS RS in a systematic manner the AS RS system is placing these atoms into the storage. The AS RS also retrieving the individual pallet from the load and then they are transferring that to the vehicles for delivery purpose.

Consider we are storing the atoms now. And after certain time, we have to deliver them. This is the case of a distribution center. We got the unit loads from the factory. Now, we have to distribute them, it is a storage, it is a warehouse. AGVs are taking in the pallets from the dock, they are putting them in the automated storage retrieval system. At the time of delivery, at a time of the shipping, we are requesting the AS RS to get back the stored pallets, and then that stored pallets will be transferred to the trucks at a docking station.

The AGVs are also helpful in assembly line applications. And as mentioned for the process type layout, the process type layout is widely used in flexible manufacturing system. When we are talking about the best type of production, when we are talking about the medium volume medium variety of production the AGVs are very much important. We cannot have a permanent arrangement say conveyors in the process layout.

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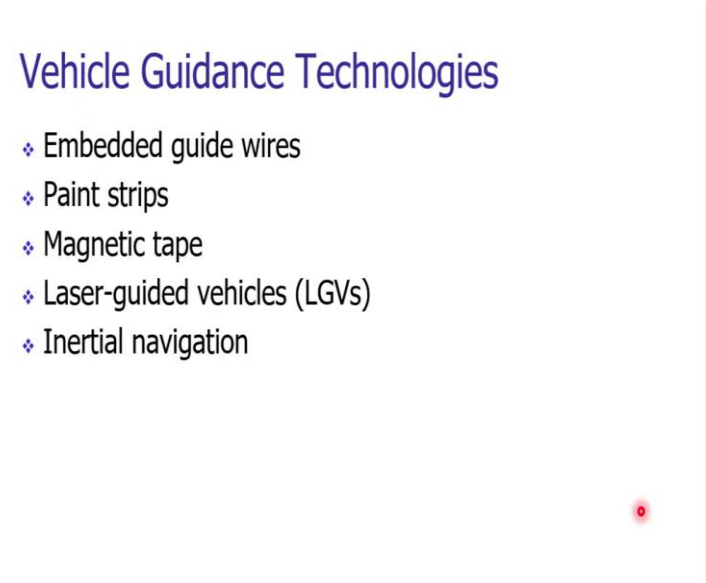

There are basically five types of guidance technologies are used in the navigation of the automated guided vehicles. We can use either the embedded wires which are guiding the AGVs. We can have paint strips or magnetic tapes. Some of the guided vehicles are working based upon utilization of the laser based technology these are called as the LGVs – the laser guided vehicles. We can also use the gyroscopes for the navigation purpose; these are called as the inertial navigation based AGVs.

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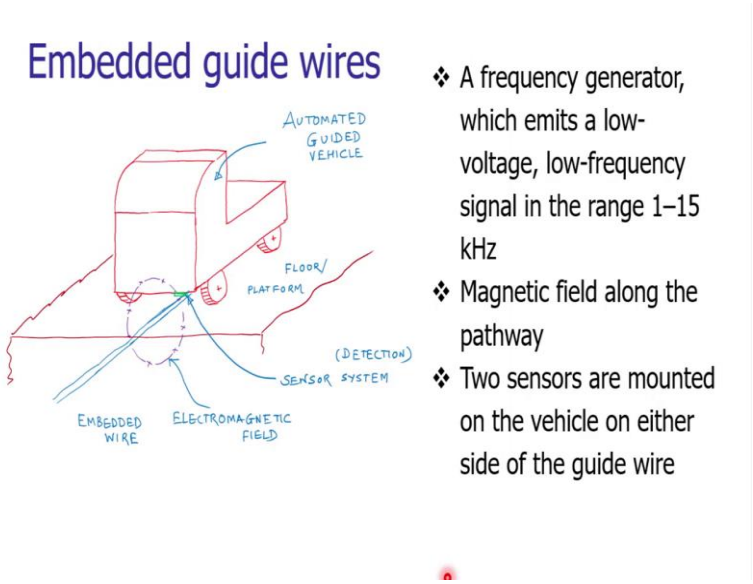

Embedded guide wires based technology; we are cutting a slot over the shop floor. And in that slot, we are embedding the wire which will be guiding the AGVs. This wire is generating low frequency signals based upon the input which is given. The frequency is around 1 to 15 kilo Hertz. Due to this low frequency signals, the magnetic field is getting generated. And that magnetic field will be utilized to navigate the AVG along the defined path. The magnetic field will be sensed by the induction based sensors.

On our screen, you can see the automated guided vehicle which is having the sensor arrangement at its bottom. And the sensor is sensing the magnetic field which is generated by the embedded wire. According to the sensor signals, the navigation or the control unit of AGV will control the speed and direction of movement of the AGV.

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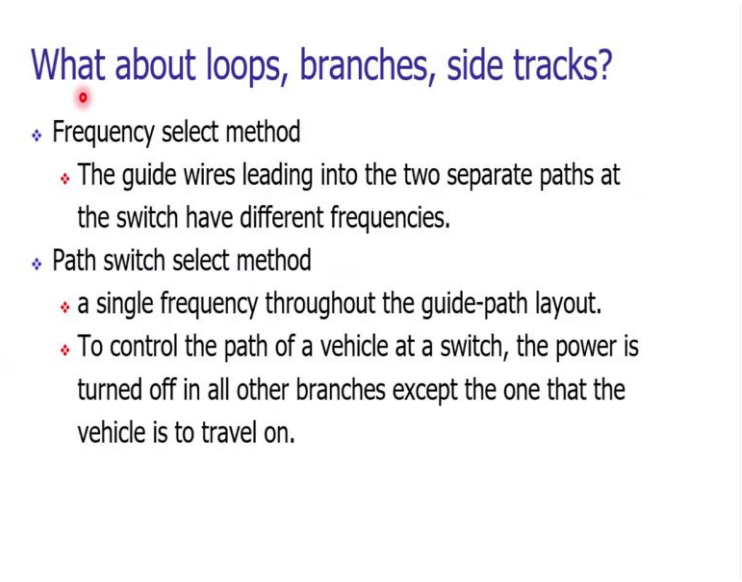

What will happen when we are working in loops or branches or side tracks? To handle these situations in embedded guide kind of technology, we are working with the frequency select method or the path switch select method. In frequency select method, the guide wires into two separate paths are having different frequencies. In the loops or in the branches or in the side tracks when we have to change the track we can have the different frequency of the signals electrical signals which are there in the guide wires.

When the central computer is giving instruction to the AGV or the program of the AGV itself is having the instruction to select a particular frequency or to look for a particular frequency, if that frequency is available along the branch path the AGV will the AGV will follow that. At branching if the programmed frequency is matching with the available frequency of the branch path, the AGV will follow that particular path; or we may have the paths which select method.

When we are having the options, the right option or the option that to be chosen we are giving the electrical signals to that particular option only. The electrical signals or the magnetic fields at all other paths will back switched off. We are switching off the electricity to all other not required paths. Whatever the path is to be utilized that particular path signal will be on. As it is on, the AGV will follow that particular path, and it will convey the product along that path only.

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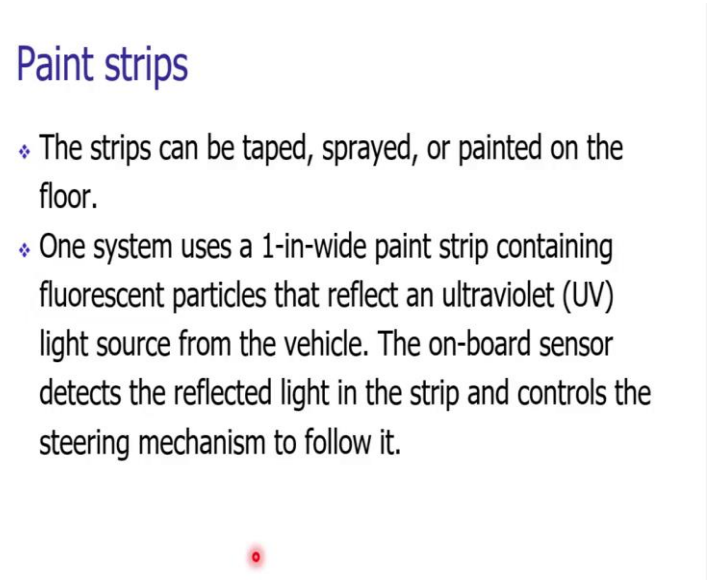

We can have the navigation by using strips which are painted. These strips are having fluorescent particles which are reflecting the ultraviolet light. The onboard sensor of the AGV will detect that light. This phototransistor, it will detect the light, and accordingly it will get maneuvered along that particular path.

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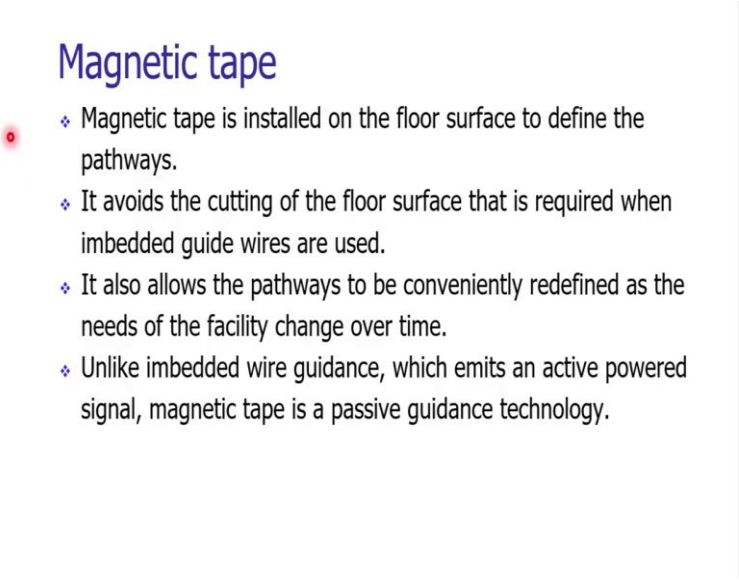

We can also have the magnetic tapes. Instead of having the painting or painted arrangement, we can have the magnetic tapes which are installed on the lower surface along the defined pathways. The magnetic tapes arrangement is avoiding the cutting of

floor surface which is there in the embedded wire technology. We have to cut the floor system. That can be saved by using the magnetic tape arrangement.

We can easily redefine the path. If we remove the magnetic tape from the floor, we can rearrange, we can relocate the magnetic tapes and we can change the path very easily. The magnetic tapes are generating passive signals in the embedded wire technology, the active signals are being generated, but in magnetic tape it is a passive signals of course that need to be converted into the active signals by using the signal processing devices.

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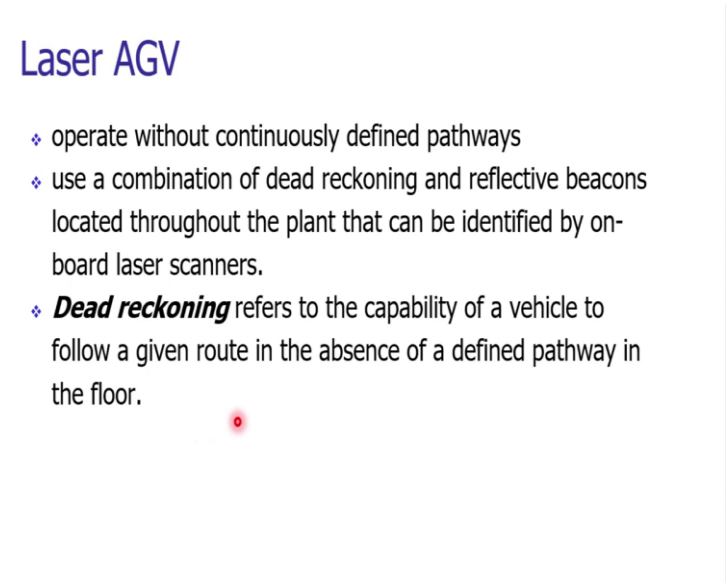

We can use lasers for the navigation purpose. In laser based AGVs, there is no need of any wire which is embedded, there is no need of any magnetic tape or we may not required as a the painted strip on the floor. In laser based AGV, we are using a combination of dead reckoning and reflective beacons. Beacons is a mechanical element which is having the reflections on it.

Various reflective beacons are arranged in the plant and the AGV is having a laser. The laser being is being continuously transmitted from the AGV, that laser will get struck to the beacon. And from that beacon, it will get reflected. The reflected signal from the beacon will be stored inside the processing unit of the AGV and that stored information will be utilized to know the current position of the AGV and it is utilized to compute the destination that to be achieved.

The dead reckoning is a term that is refer to the capability of a vehicle to follow a given route in the absence of defined pathway in the floor. It is basically a system which is making the AGVs capable of finding the path or following a path when a defined pathway is not available on the shop floor. We are not having any embedded wire technology, we are not having any magnetic strips, we do not have any the painted strips over the floor.

The AGV is free to move and based upon the beacons which are available based upon the programming it is having, the AGV is taking its own control then it is moving on its own inside the shop floor. This particular capability of having navigation control with the in the absence of the defined pathway that is called as the dead reckoning.

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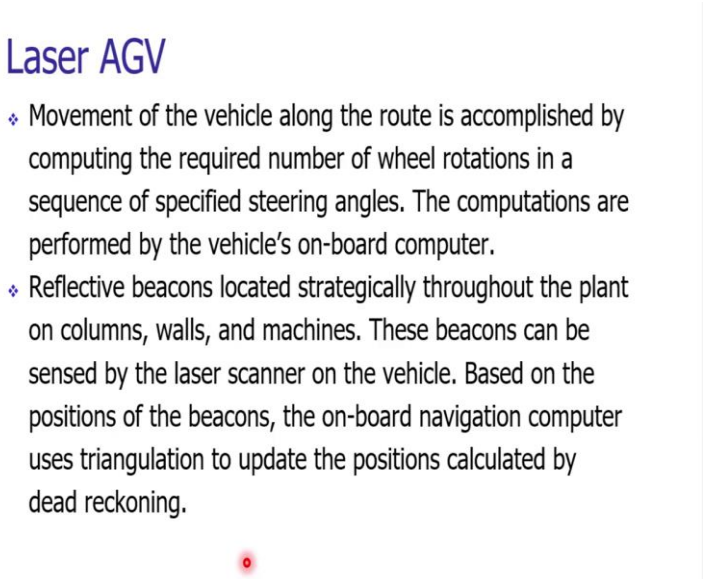

In the laser AGVs, the movement of the vehicle along the route is obtained by computing the required number of wheel rotations. During the movement of the AGVs, the number of rotations of the wheels are computed, servomotor may be there or a stepper motor may be there, and that number of rotations are utilized to get the required location of the AGV. The computer is computing the present location of the AGV based upon the number of rotations. Of course, the steering angles also need to be considered to get the required destination as well.

Inside the factory, the reflective beacons are located strategically. The beacons are located at variety of places strategically. The lasers are sending the laser energy that is

photon based energy and they are getting reflections, the AGVs are getting reflections. The reflections received by three beacons inside the shop floor can be utilized to have the triangulation, can be utilized to get to find out the present location of the AGV.

Of course, the reflections from the beacons and the programming or the methodology of dead reckoning made the AGVs self-propellant, self-sufficient to take its own pathway inside the factory.

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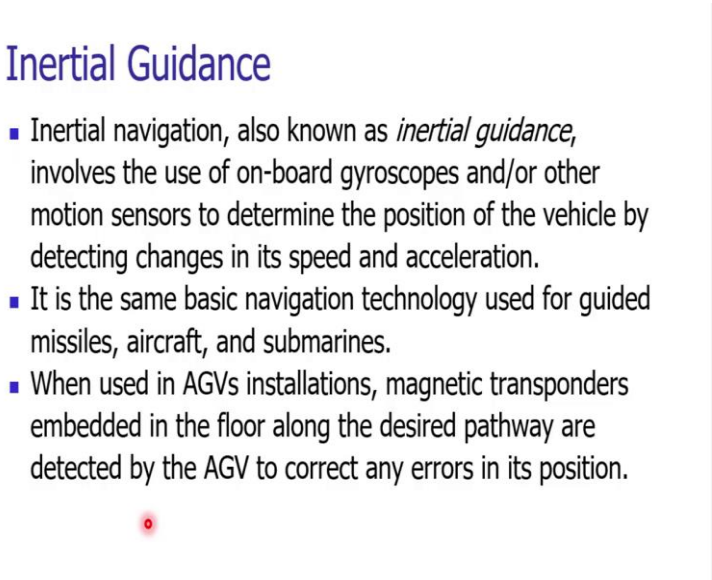

We can also have the inertial guidance. Inertial guidance, basically we are using on-board gyroscopes and motion sensors to determine the position of the vehicle by detecting the changes in the speed and acceleration. Gyroscopes are mounted. And these gyroscopes and motion sensors are continuously computing the speed and acceleration. And based on that, the microprocessor of the AGV is continuously recording the position of the vehicle.

Similar technology is used in the aircraft, submarines and the missiles. In addition to the gyroscopes, these AGVs also have the magnetic transponders which are embedded in the floor. These are the additional systems which are ensuring whether the AGVs following the correct path or not. Basically the AGVs are very much useful in the process layout kind of manufacturing automation.

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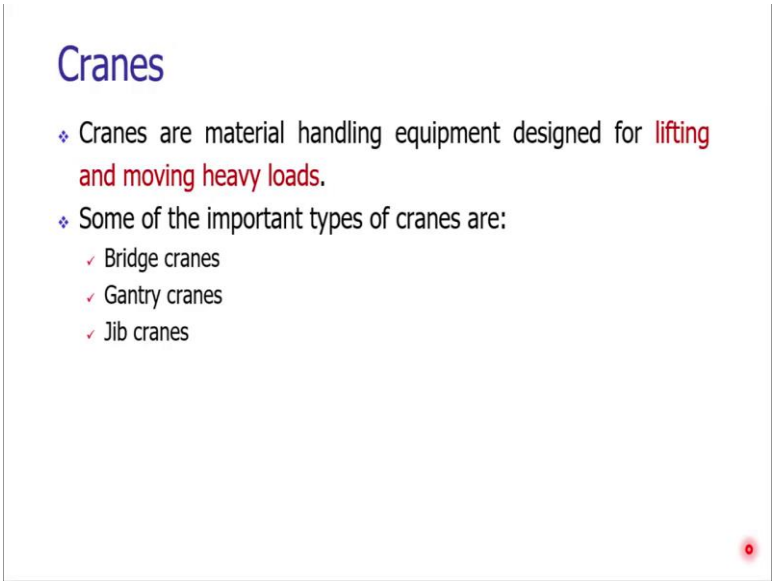

In the manufacturing industry, we are using cranes to handle or to lift the heavy loads, heavy parts. The heavy loads or heavy parts may be the dice, molds, machinery, raw material. There are three types of cranes which are used in the industry these are bridge crane, gantry crane and jib crane.

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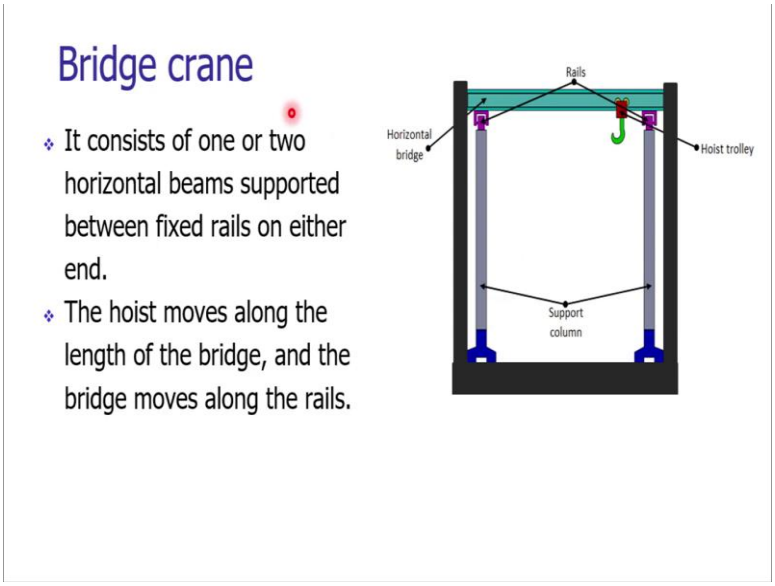

In bridge crane, there are one or two horizontal beams which are supported on the fixed rails on either ends. And these horizontal beams are moving in the direction perpendicular to the plane of paper. These horizontal beams are hosting the hoist. This is

the hoist. And this hoist is moving along the z-direction. We can move the hoist along the length of the horizontal beam. Let us consider this is the x axis moment of the hoist trolley. The horizontal beam is moving perpendicular to the plane of paper that is the y direction. And that perpendicular moment to the paper is possible by using these two rails. These rails are supported by supporting columns.

The end of the hoist can be moved along the vertical direction that is the z-direction. It will come down it will leave the object, and then we can move the object or the product along the x-direction or along the y-direction. The bridge crane is basically used to handle heavier objects. The big manufacturing industry, when we want to handle a very huge size work parts, components or machinery, bridge cranes are utilized.

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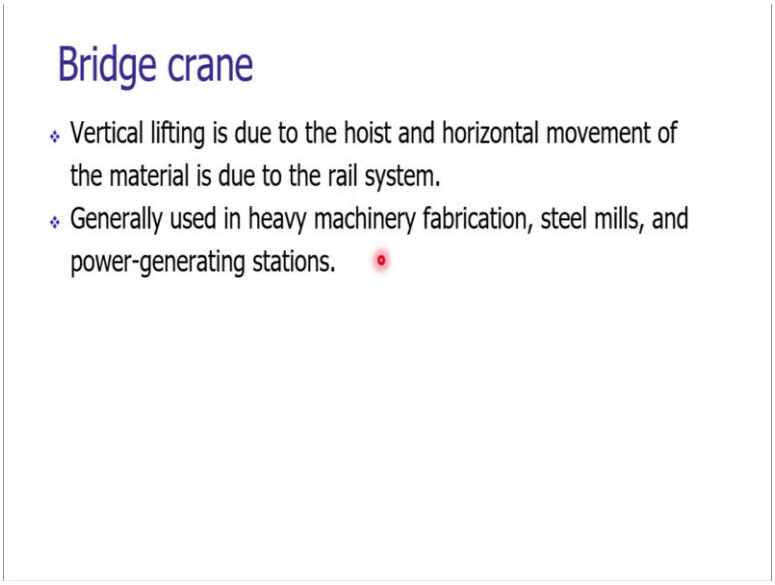

In bridge crane, the vertical lifting is carried out by using the hoist, whereas the horizontal movement is done by using the rail system. As mentioned, the bridge crane is used to handle the heavy machinery, steel mills and it is basically used in power generating stations where we need to handle the impellors turbines of large size.

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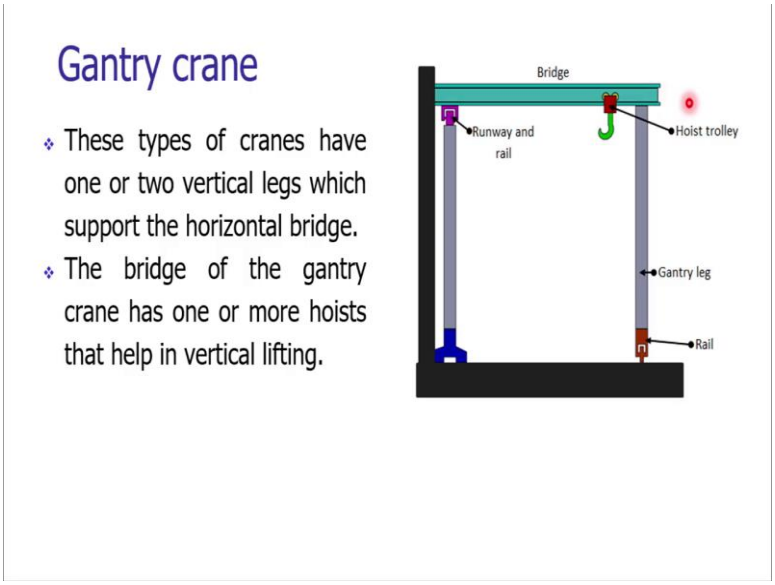

The next version is the gantry crane. It is very similar to the bridge crane itself, but the handling capacity of the gantry crane is lesser than the bridge crane. In gantry crane, we are also using a bridge which is supported at one end on the runway and a rail which is hosted on a support column. The other end of the bridge is supported by a gantry leg. And the gantry leg is moving over a rail.

The arrangement of the gantry crane is smaller, and we can handle small or a medium type of work parts, not very huge work parts are being handled by the gantry crane. The gantry crane we can move inside the warehouse, inside the shop floor or the factory. We can take the crane anywhere we want and we can handle the work parts.

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There are certain variations in the gantry crane as well. We can have a double gantry crane which is having two legs, which are moving over the rollers. The other types are like half gantries or the cantilever gantries. In half gantry crane, there is a single leg on one end of the bridge, and the other end is supported by the rail mounted on the wall.

The same configuration we have seen in our previous slide, that is the half gantry crane. In cantilever type, the bridge extends beyond the length of the support length. This is the half gantry crane. If the bridge is extending beyond the support provided, then that type of crane is called as the cantilever type gantry crane.

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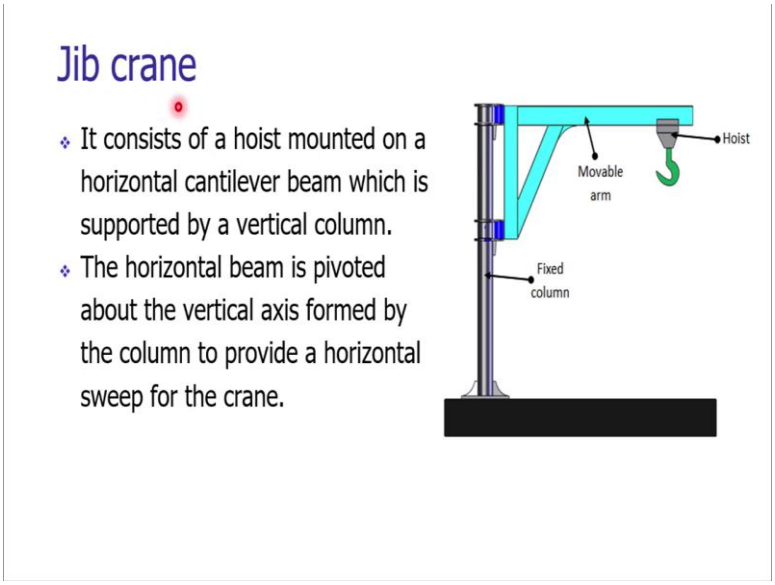

The third variant of crane is jib crane. In jib crane we are using a movable arm which is pivoted to a fixed column. This movable arm is hosting the hoist. Hoist can be moved along the length of the column. Suppose, there is the work part or the commodities which are placed on the floor, the hoist will come down and will lift it. The movable arm can rotate about the axis of the fixed column. It can rotate about this axis, so that we can cover up considerable area inside the shop floor.

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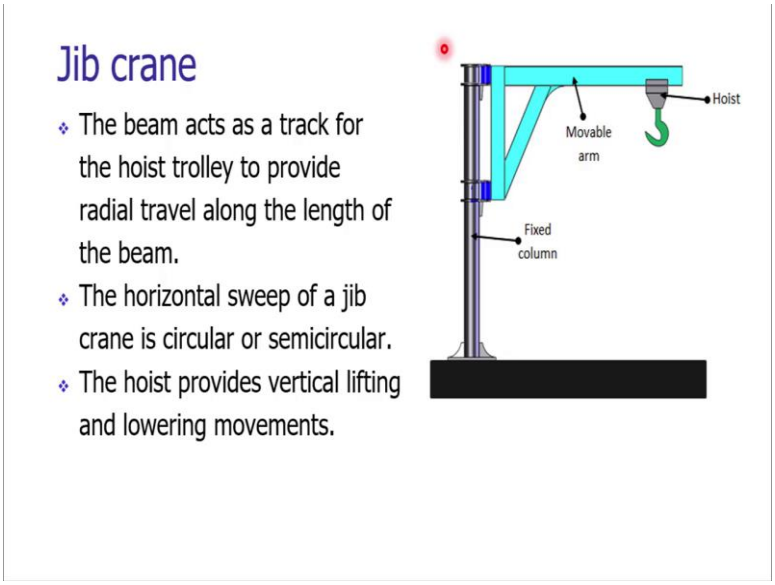

The hoist is moving along the length of the movable arm, and the horizontal sweep of the jip is circular or semicircular. If it is circular, it can cover up the considerable area and we can utilize the jib crane for wide variety of applications. The movable arm is providing the radial travel to the hoist.

We can have the radial travel along this direction away from the center of the column. The movable arm can sweep about the jib axis. It may be circular or semi circular form. And the hoist is moving in a downward direction. Lifting the work part up and then it is moving in upward direction. Then either it can move in a radial direction towards the center of the column, or it can be rotated about the column of the jib crane itself.

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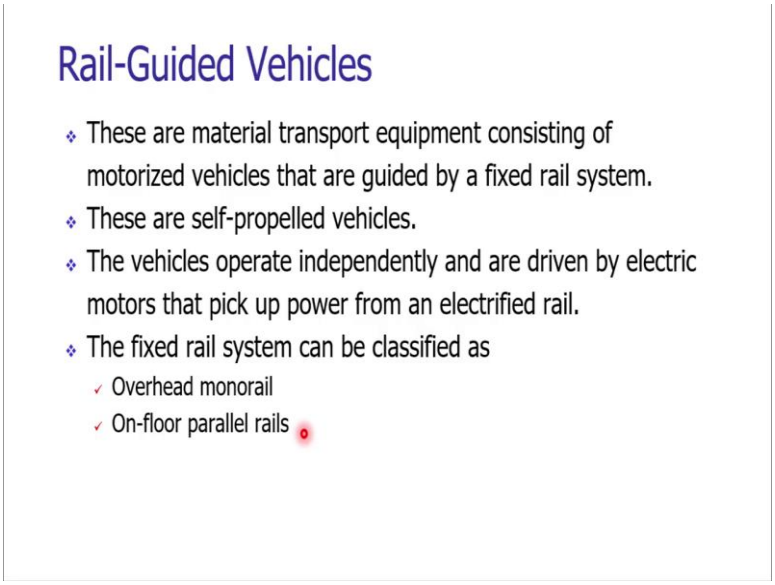

The manufacturing industry also employ rail guided vehicles. These equipment are consisting of motorized vehicles which are guided by fixed rail system. The typical motorized vehicles are there which are fixed to the rail system. These vehicles are self-propelled; they are getting propelled by themselves only. They are operating independently and are driven by electric motors. These are the electrical driven vehicles, and they pick up the power from the electrified rail. We can have basically two classes of the fixed rail system and these are overhead monorail or on floor parallel rails.

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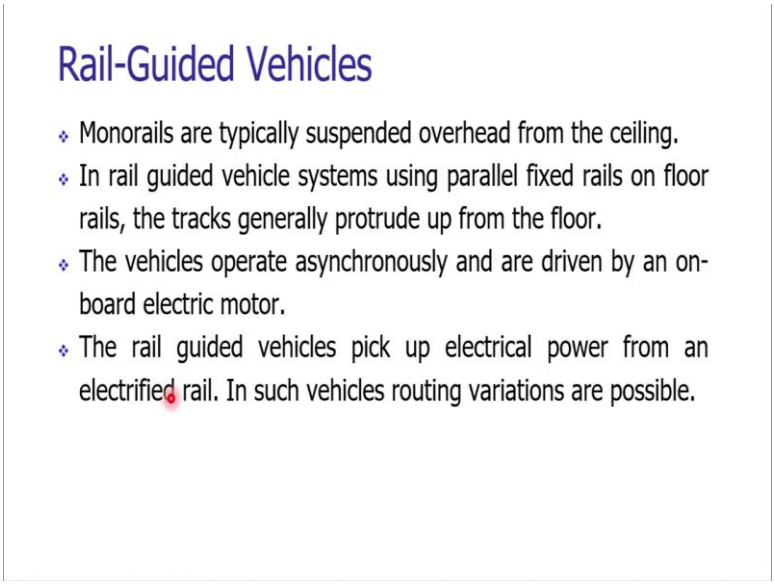

In overhead type monorails, the rails are suspended overhead, they are suspended from the ceiling. As the work parts or the machinery or the raw material is being carried out in over on position, we can save a lot of floor space when we are employing the monorails. The work parts are moving along the rails which are mounted above the floor space.

The ground space can be utilized. It can be saved for other another operation or for some other purpose as well. In rail guided vehicle systems using parallel fixed rails, the tracks are generally protruding up from the floor. We are having a typical rails which are protruding up from the floor, and over which the vehicles are moving.

The vehicles are moved in an asynchronous way and they are being driven by the onboard electrical motors. Basically the rail guided vehicles are picking up the electrical power from the rail itself. And in such vehicles, we can easily have the routing variations. We can change the route or we can change the speed of the electrical vehicles easily.

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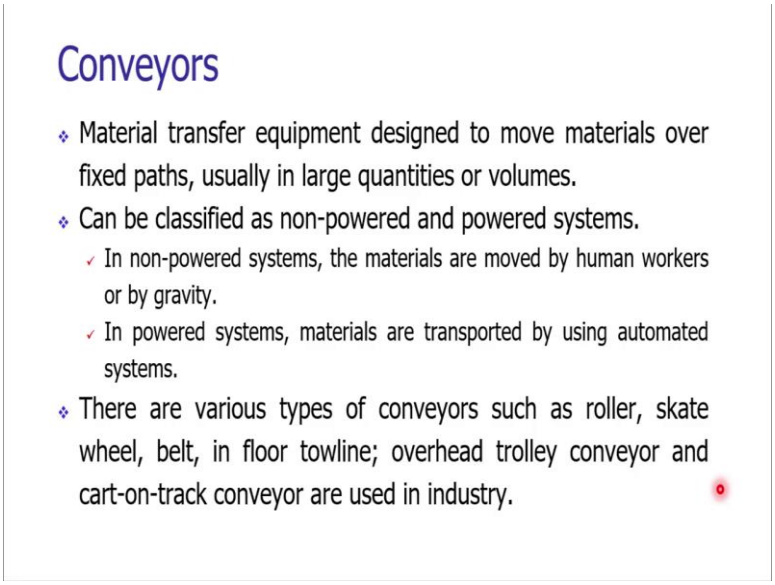

The manufacturing industry also employed or utilized conveyors, particularly in the product layout kind of system where we want to get in the raw material at one end of the floor line and the finished product would be done at the other end of the floor line. The conveyance of the raw material from one end to the other end has to be in a continuous mode or in intermittent mode based upon the requirement of the operation, which is possible by using the conveyors.

When we are supposed to handle the large quantities or the volumes, the conveyors are best suited. We can have non-powered conveyors or the powered conveyors. In non-powered systems, human intervention is required, we have to employ the human workers to handle the systems or we can utilize the gravity. We can have the slope and roller, roller type of conveyors. And by using the rolling friction and the gravity, we can easily convey the materials.

The power systems are more sophisticated systematic ways to convey the commodities. Of course, we have to spend a power to get the required work done. There are various types of conveyors such as the roller, skate wheel, belt, in floor towline; overhead, overhead trolley conveyor and cart-on-track conveyor which are used in the industry.

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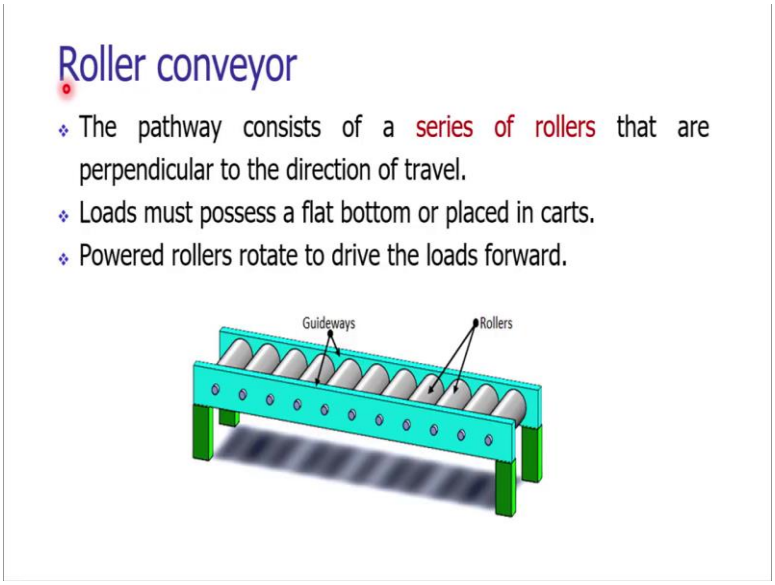

Some of the conveyors will be studied now. The roller conveyor is the basic and simple example of the conveyor system used in the automation. It comprises of a series of rollers which are perpendicular to the direction of travel. The construction is very simple we are having two frames two guideways, and there is a set of rollers which are connected in between these two guideways. We are using the rolling friction here. The cartons which are having the flat bottoms can be easily conveyed over the roller based conveying system.

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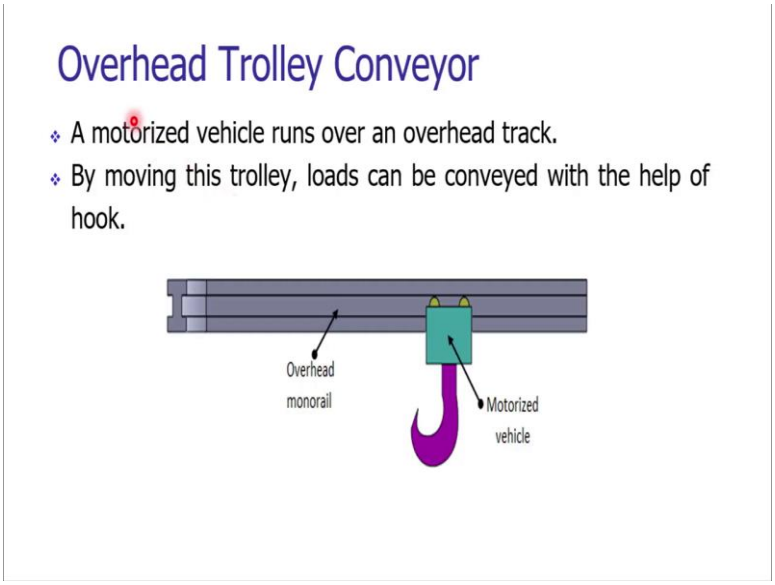

We can have the overhead trolley conveyor. By moving the trolley, we can easily convey the objects with the help of a hook. Over the overhead monorail, we are having a motorized vehicle and it has the hook. We can hand the work part in the hook and then we can easily convey the work part along the length of the overhead monorail.

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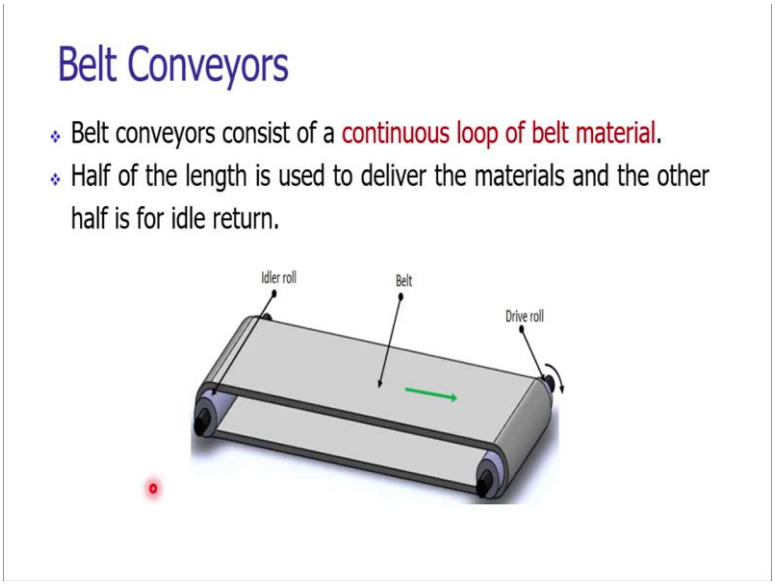

These type of arrangements are basically used to convey dies and molds. The belt conveyors are also very popular and important type. It consist of continuous loop of belt material. So, this is a belt. There is a continuous movement of the belt. The belt is driven by the drive role and there is an idler role. The drive role is being operated by the electric motor. The idler roller is helping to have the sufficient tension in the belt.

At any movement we can notice that the half the length of the belt is being utilized for the convenience. However, the remaining half will not be utilized for the conveyance that we can consider as a limitation of the belt conveying.

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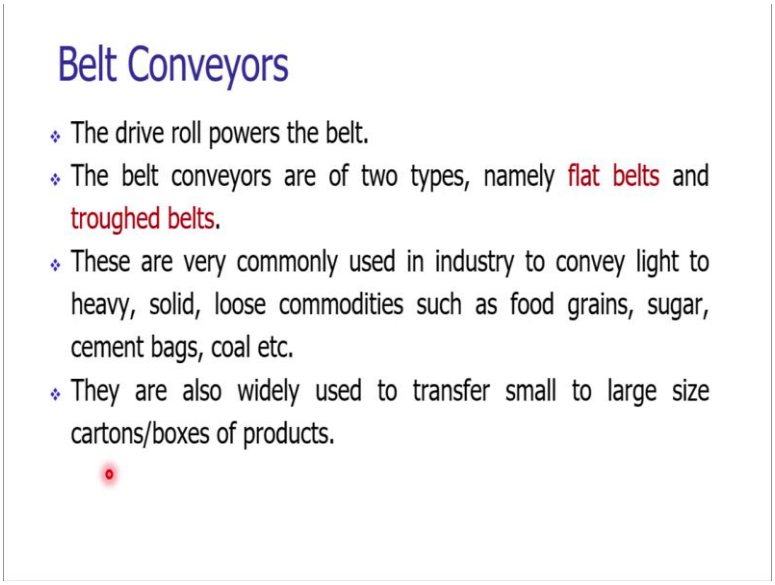

We can have two variants of the belt conveyors; these are flat belts and troughed belts. Belt conveyors are commonly used to convey light to heavy solid or loose commodities such as food grains, sugar, cement bags, coal. Even belts can also be used to convey the flat material or flat bottom material. This flat bottom material may be cartons or the boxes of the products.

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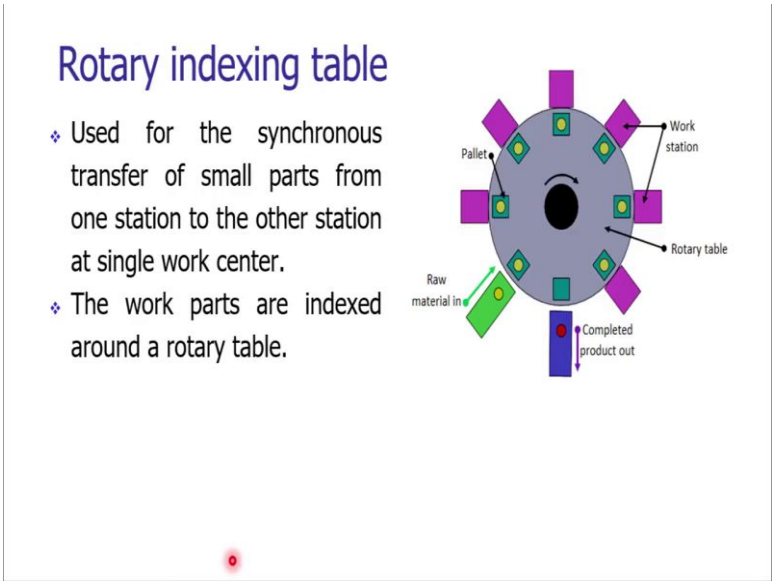

In automation industry, the rotary indexing tables are heavily used. We have already seen the rotary indexing operation in our previous lecture. The rotary indexing table is

required for the assembly operation. Here we can notice a rotary indexing table which is mounted on a spindle, and that spindle is being intermittently rotated by the indexing mechanism. On the rotary indexing table, we are having pallets. And there are workstations which are arranged on its periphery. The raw material will be taken in the loop of the rotary indexing operation.

Here the raw material is taken. And as the rotary table is indexed in clockwise motion, that raw material will be processed at variety of work station. After completion of the processing at the last work station at the unloading station, the work piece the processed work piece or the finished product will be taken out. The indexing table can itself be considered as conveyance system. Basically this type of system is used in product type of layout.

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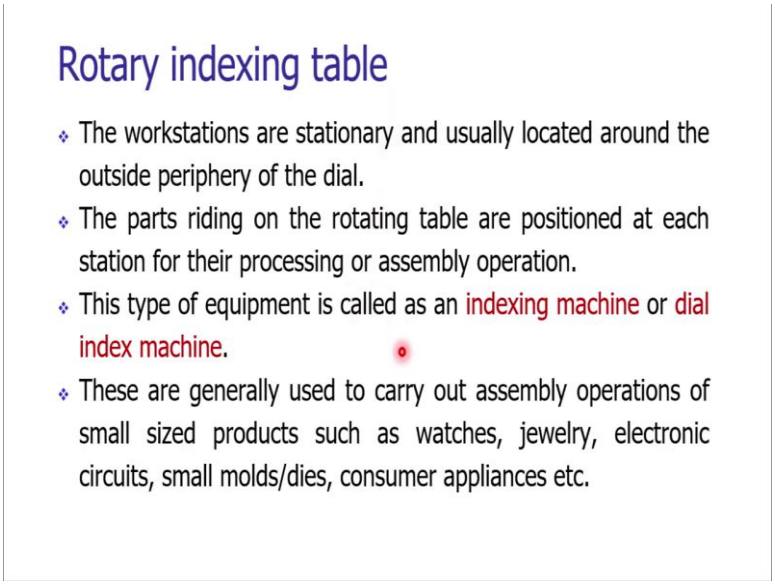

We can summarize this as: the work stations are stationary while the table is rotating, and the work stations are arranged around the periphery of the dial. The rotary indexing table is also called as the dial index machine. The parts are riding on the rotating table are positioned at each station for their processing. The rotary indexing table is generally used to carry out various assembly and processing operations required in watches, jewelry, electronic circuitry, assembly of small molds or dies and to create or to develop the consumer appliances.

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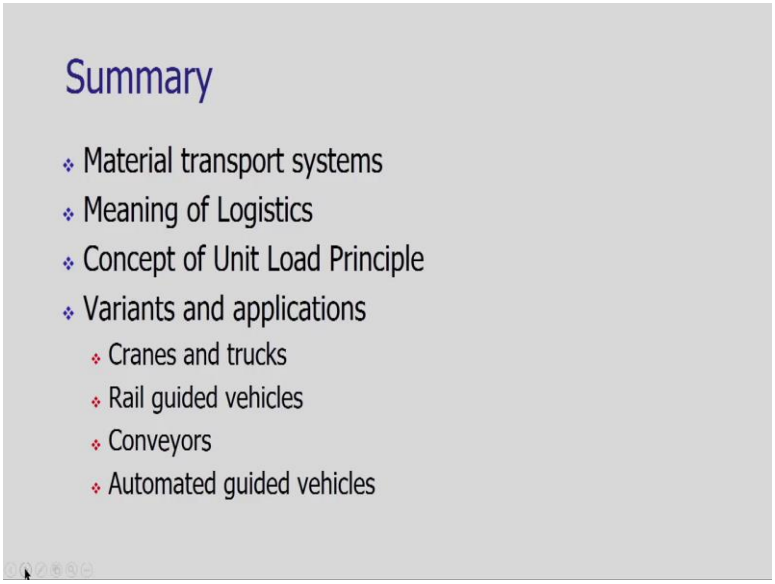

Well, my friends let me summarize this lecture. In this lecture, we studied the various material transport systems; we studied the meaning of logistics and the concept of unit load. After that we had a detailed discussion on variants and applications of the material transport systems. There are many types we have seen the cranes, trucks, rail guided vehicles, conveyors and automated guided vehicles which are used in the automation industry.