Manufacturing Systems Management
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Lecture – 29
Role of basic elements, Critical success factors

In this lecture, we study the cell control and just-in-time manufacturing principles further.

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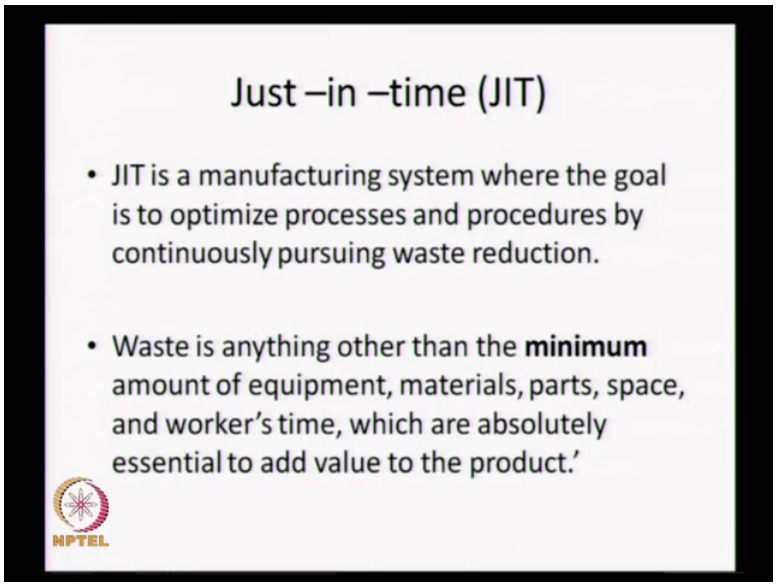

In the previous lectures, we have defined; what is just-in-time manufacturing. Just-in-time is a manufacturing system where the goal is to optimize processes and procedures by continuously pursuing waste reduction. So, the main emphasis on JIT is waste reduction and waste is defined as anything other than the minimum amount of equipment, materials, part space and time which are absolutely essential to add value to the product.

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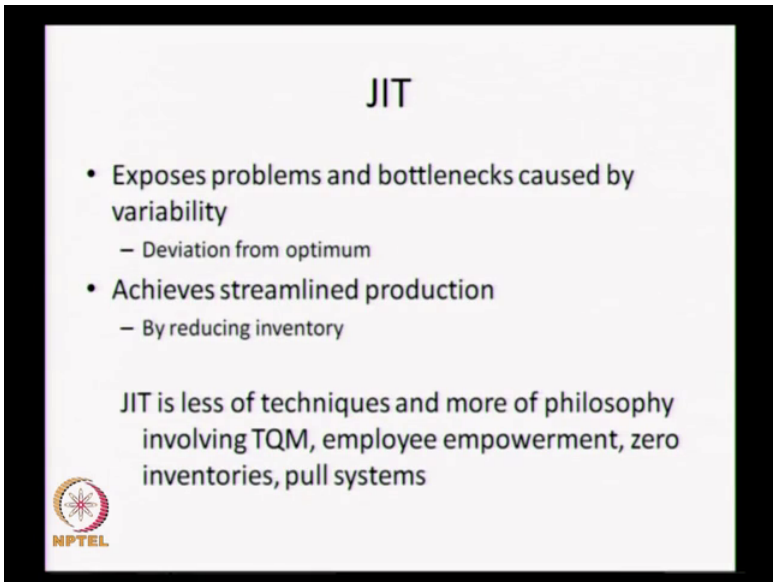

We have also seen that JIT is more of a philosophy that involves TQM total quality management, employee empowerment, zero inventories and pull systems.

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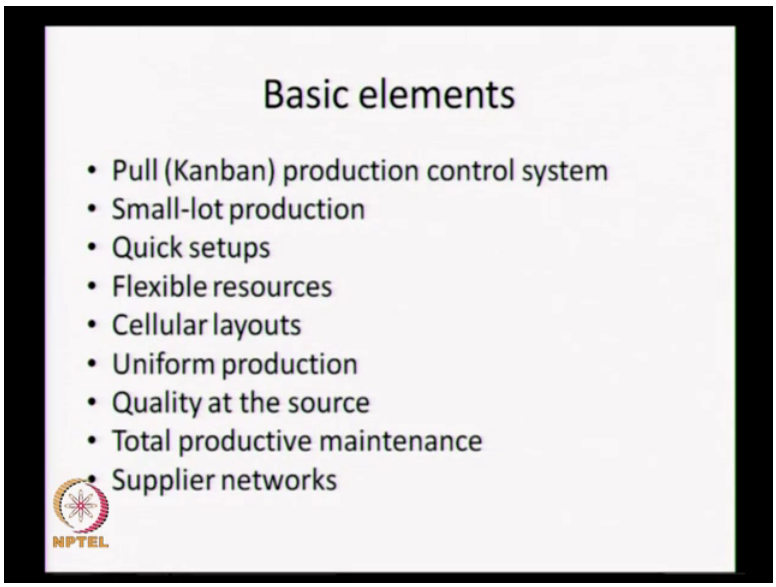

We have spent some time understanding the basic elements of JIT. We started with understanding the importance of cellular layouts which help in production control as well as minimize material movement. We also understood that the resources have to be flexible in order to produce different types of products using cellular layouts. It is also necessary that the variation in demand is not very high, so that uniform production can

be maintained. Quick setups enable us to have shorter production runs which is an important requirement of manufacturing.

We then looked at aspects related to quality maintenance and supplier and said that quality at source would prevent material being sent back as rejects back to the supplier which also gave us the importance of supplier networks and having reliable suppliers who deliver material in time and suppliers who are located physically close to the factory.

We also studied their productive maintenance is required so that the machines that are there in the cells are available and non availability of the machine does not prevent manufacturing or production from taking place. We finally looked at pull or Kanban control production system and explained how the Kanban controlled system works Kanban represents a card and along with the card there are containers and by fixing the size of the container and the number of containers in the system at any point we are able to control the inventory in the system.

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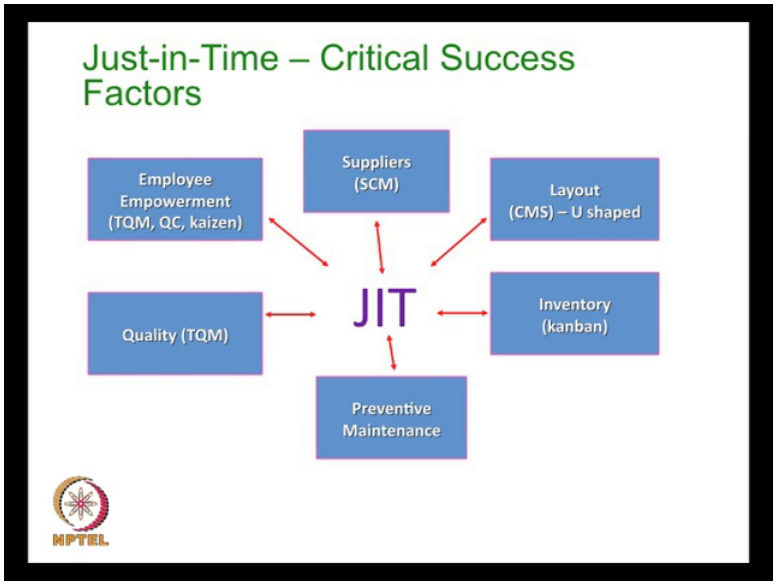

We now move on this is a schematic or pictorial representation of the success factors in just-in-time manufacturing.

So, we start with layout and the ideas of layout come from cellular manufacturing. So, if we have a just-in-time system incorporated into an existing cellular manufacturing

system we have a lot of benefits particularly in terms of control in terms of inventory, etcetera. So, layout whatever we have learnt in this course as layout relevant to cellular manufacturing, particularly operator allocation issues and layout issues on nadera cells, layout issues on unidirectional flow u shaped cells etcetera are all important in the context of just-in-time manufacturing. So, layout are changing the layout to suit the just-in-time manufacturing system is extremely important.

At the same time the layout will also depend on the size weight and shape physical features and characteristics of the product and suitable layouts have to be designed keeping in mind physical features of the product and the material handling requirements for the product during transportation.

The next important one is inventory just-in-time talks about waste elimination and in every organization we find excess inventory in the form of waste. So, inventory control using a Kanban control production system would help us reduce inventories and gain cost advantage by reducing inventories. Another important factor is maintenance we have already seen the importance of maintenance and if we follow a cellular layout then each cell will have functionally dissimilar machines and which makes it all the more important that the machines are available continuously when required if we had a functional layout then there are machines of the same or similar type in the cell and even if one machine is not available briefly another machine can be used as a substitute. But in a manufacturing cell in particular we have machines which are different and sometimes machine substitution is not possible and entire production in the cell can come to a standstill if machines are not available.

So, the emphasis on preventive maintenance is very very high and all organizations that follow the just-in-time manufacturing philosophy would concentrate a lot on preventive maintenance. Quality is extremely important and manufacturing particularly in a cell if there are rejects and rework it takes away enormous amount of time from the cell. So, quality of raw material the responsibility for quality of raw material lies with the supplier. So, quality at source raw material quality goes with the supplier work in progress quality inspection is carried out by the operator themselves. Single piece transportation enables that if there are quality issues they are identified very quickly and very early in the stage of in the stages of manufacturing and rejects and rework can be carried out for very small quantities and corrective actions can be made.

Employee empowerment again follows with total quality management principles. The role of the employee is extremely significant in the implementation of JIT systems. Now these are systems where if there is a problem the employee or the operator is empowered to stop the cell and find out where the difficulty is in addition to having that kind of control. In addition to having ownership and responsibility of the manufacturing, in the cell the employees also participate in several activities such as quality control quality circles QC, kaizen continuous improvement, suggestion schemes etcetera. So, the operators meet regularly they sometimes they even take a 5 or 10 minute break from hectic activity sit in specific areas and they discuss about the difficulties and issues in manufacturing using the cells following a JIT system. They come up with important suggestions which are taken up for discussion and consideration and changes are made based on the inputs from the employees.

In addition they have kaizen or continuous improvement methods where they suggest small changes particularly to in design and manufacture and sometimes in the processes so that the productivity is increased. In addition to these quality circle is an important activity which the employees or operators are involved when the company implements JIT or cellular manufacturing. Quality circle is a group that is specifically created to solve an existing problem and this group is made entirely of people who are at the operating level.

They meet for a specific period of time say one hour in a week, they meet at a place that is slightly away from the workplace maybe in another office or in a different area, they discuss for about an hour nearly about 10 weeks or 12 weeks and they look at an existing problem, they first establish that the problem exists through data collection and analysis then they brainstorm. And then draw a cause and effect diagram to identify the critical causes and after the critical causes are identified they take the important ones among the critical causes and once again discuss and brainstorm and provide solutions to overcome the difficulty.

The solutions presented by quality circles are implementable and they are at the level where they are involved in the implementation both in terms of decision making and in terms of the operating aspects. So, employee empowerment is an essential component for success using just-in-time manufacturing.

Last but not the least suppliers play an extremely important role we will see some more aspects of suppliers in the later part of this lecture, but we have already seen that suppliers have to be reliable and dependable with their delivery dates. Any delay from the supplier can cause disruption in the production because inventories particularly at the raw material stage is controlled by small lot ordering from the suppliers. And in order to facilitate small lot supply these suppliers have to be located physically close to the factory or sometimes are provided with space where from they send material periodically to the factory depending on daily requirements and predefined schedules.

So, this picture tells us what are the critical success factors and their roles. It is also important to understand that all these factors are important and in addition to them there are many more factors there are factors important factors such as set up time reduction flexible resources which are not explicitly mentioned here, but they are implicit in the sense that a u shaped layout in cellular manufacturing involves set up time reduction. So, that small lot production is possible. It is also necessary to understand that all of these are important and all of these are equally important. Even though we started from layout and looked at each one of these factors they the order is not important, but collectively all these factors coming together is important for the success of JIT.

It is also to be understood that in order to be successful all these initiatives have to be started or all these initiatives have to be made together. If the organization does not start all the initiatives the initiatives on layout Kanban systems, maintenance, quality, employee empowerment, TQM, suppliers, etcetera; if they do not start all the initiatives, but have part of them then the benefit will be less than part that is implemented. Many times we think that if there are 7 or 8 initiatives that are needed if we carry out two initiatives we may get 25 percent of the benefit it normally does not work that way largely because there are situations where these initiatives are also dependent on each other. For example, if we do not start the supplier initiative and carry out the u shaped layout and Kanban control systems then we will be able to control the work in progress inventory, but we will not be able to control the raw material inventory.

If we do not have the preventive maintenance initiatives then we will suffer particularly with respect to cellular layout because sometimes if the machines fail then production suffers and so on. So, since each one of these are directly related to each other it is necessary to look at all of them together and not sequentially one following another.

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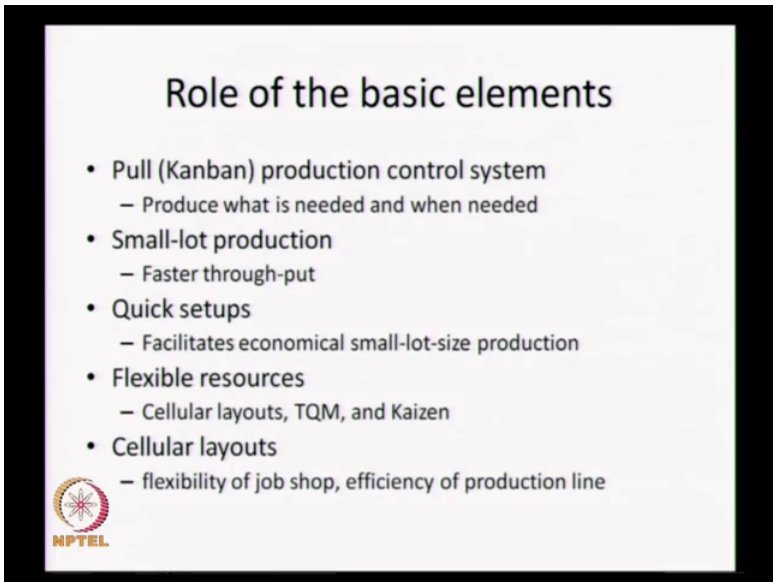

Now, what are the role of the basic elements? We have seen these basic elements here we spend a little more time on this. So, the pull system or a Kanban controlled production system, essentially eliminates waste by producing what is needed and then it is needed. So, we will see the role of the basic elements in terms of the fundamental principle of JIT that is to eliminate waste.

So, when we have a Kanban controlled production system we produce what is needed we produced a demand, since we have produced demand we have produced what we can sell and we produce what is needed and what the customer wants we do not produce more than the demand therefore, there is no waste of overproduction we do not produce more. So, there is no overproduction there is only enough production that is needed. And we also produce when it needed make daily and sell daily. So, if the shipment has through happen in the evening and if it is possible to start the production in the afternoon and send it by evening we will do that by afternoon if it is necessary to produce the previous day and send it we will keep a day's inventory and then send it to the customer.

Small-lot production, small-lot production enables faster throughput and enables items to be sent to the customer quickly. It also enables multiple delivery schedules, even if the daily demand is large the daily demand can be split into 3 or 4 equal deliveries and production and throughput is faster because of small lot production which enables

multiple deliveries to the customer. Quick setups facilitates economical lot size production.

Now quick setups means changeover times are reduced changeover times are reduced we will be able to have smaller sized production batches or it directly enables small lot production. It also enables more time available for the actual production, even though setup is extremely important because we have to change over from one product to another the time actually spent on the setup or on the changeover we do not manufacture anything. So, to that extent time for manufacture is less if the setup times or more. If the setup times are less of the waste is reduced because more time is now available for manufacture, but by judiciously mixing changeovers and products we will be able to produce a variety of products and small runs.

So, that the inventory waste is reduced. So, quick setups help in reducing the set up time in terms of wasteful time help in reducing the inventory. So, when we say it reduces the set up time and wasteful time it does not mean that setup is a non value adding activity, it is a value adding activity it is a very important activity by itself it is not a waste, but if setups take a lot of time then the excess time taken is a waste and that is eliminated.

Now by having flexible resources we will be able to incorporate cellular layouts, we will be able to incorporate total quality management initiatives and continuous improvement initiatives. Now, these help in eliminating waste cellular layouts help in less material movement and the wastage due to time and effort spent on material movement is reduce. TQM increases the employee empowerment and morale and therefore, enables smoother and good quality production. TQM and kaizen also result in continuous improvement initiatives which are aimed directly at waste reduction and they help gain time in processes and systems.

Cellular layouts incorporate the flexibility of the job shop and the efficiency of the production line as we have already seen cellular manufacturing in a way can be seen as something where the advantages of job shop as well as the flow shop are brought in. So, cellular layouts bring more control and therefore, eliminate other forms of wastes due to lack of control cellular layouts facilitate single piece production and single piece transportation particularly eliminating excess inventory and wastes through excess inventory.

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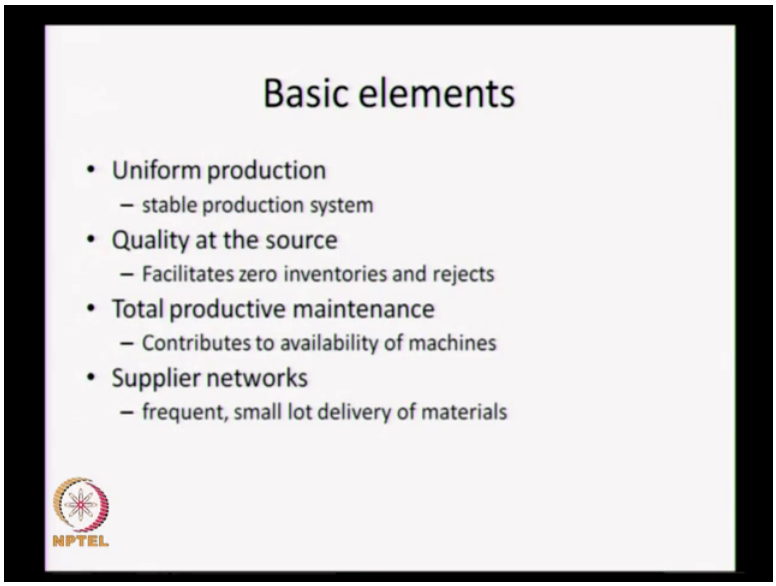

Uniform production also eliminates waste, uniform production is able to give a very stable production system and because the production is uniform and stabled there are less inventories of finished goods and once again this helps in eliminating wastes due to invented.

Quality at source facilitates zero rejects and zero inventories. Time spent on inspection which is essentially not a very high value adding time with respect to the production is eliminated and therefore, we are able to overcome that waste and gain time by doing quality at source. When quality is ensured at source we have minimal rejects and the waste due to transportation and rework is also eliminated. So, quality at source eliminates waste.

Total productive maintenance increases the availability of machines and automatically reduces the wastes incurred through non availability of machines. Supplier networks enable us to have frequent and small lot delivery of materials and small lot delivery of materials means that inventory in the system is reduced. So, if we see most of the times all the basic elements are aimed at reducing inventories at the raw material stage by having supplier networks quality at source etcetera the work in progress stage through cellular layouts through Kanban systems and through total quality management initiatives and finish good stage through Kanban systems and delivering to the customer as and when required through small lot production.

So, the primary emphasis is on minimizing waste particularly minimizing inventories. So, it can be thought of as a production control mechanism largely aimed at reducing inventories where the manufacturing forces on itself systems and procedures by which careful elimination of inventory building is carried out. Now we once again come to the wastes idea.

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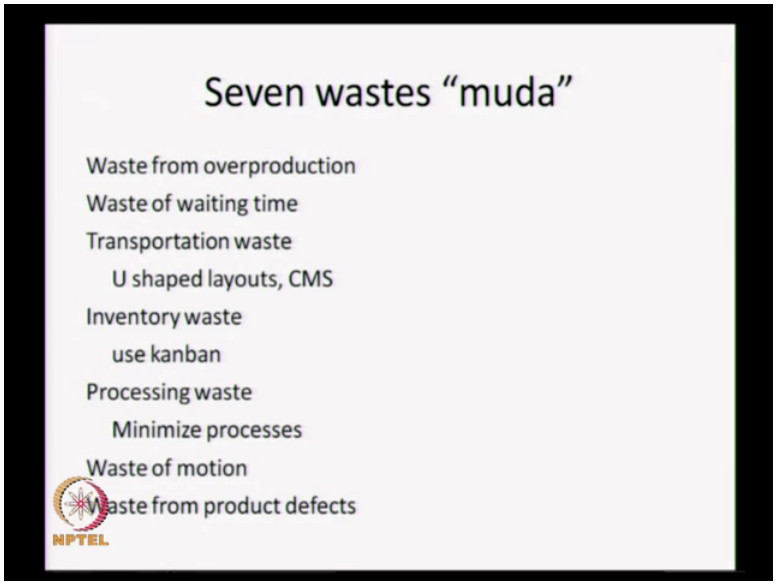

We have already seen that JIT is all about eliminating waste. So, we now look at how wastes can be classified. So, wastes are classified into seven distinct entities it is called seven wastes or 7 muda and these seven wastes are waste from overproduction, waste a waiting time, waste of transportation, waste of inventory, waste of processing, waste of motion and waste from product defects. So, these are the 7 wastes.

Now every waste in the organization we should be able to classify them into one out of these 7 or alternately we will look at these wastes and then see which are the activities that follow into these wastes and then try to eliminate those activities that result in wastes. So, waste from overproduction essentially means that we produce more than what is required. So, if the daily demand or today's demand is d we do not produce more than d or we should not produce more than d. So, if we end up producing more than the demand then there is over production. As we have seen earlier sometimes in order to capture the demand variation it may be necessary to build a small amount of inventory

particularly when the demand exceeds the capacity other than that building excess inventory by overproducing is a waste and that has to be eliminated.

Now, that is element by Kanban controlled manufacturing systems and by following a pull system approach whereby we do not produce unequal quantities of all the parts and build up inventories due to differences in the production quantities of the various parts. We then move to waste a waiting time waste a waiting time results because of lack of scheduling. So, when we bring in cellular layouts the scheduling problem takes a backseat, but the transportation or within cell transportation batch size and production batch sizes become important and since machines are located close to each other waiting time is eliminated single piece transportation also helps us in minimizing the waiting time.

Once again waste of transportation in traditional systems items were transported to long distances because machines were not available together or machines that are capable of doing the same set of operations were close to each other. Whereas from a product point of view the product requires machines doing different types of operations to be located close to each other. So, u shaped layouts and cellular manufacturing made possible to have different machines, machines having different manufacturing capabilities, but similar in terms of requirements of the product to be brought close to each other and transportation waste was eliminated.

Inventory waste is eliminated by multiple things including Kanban which essentially controls the amount of inventory or work in progress inventory in the factory or in the manufacturing system. Proper supplier networking and proper amount of material coming from the supplier to meet daily demand helps us in reducing the raw material inventory then there is a processing waste. So, this processing waste and waste of motion are two important aspects that come from more traditional industrial engineering.

So, when we look at processing waste we are talking about process design job design and so on. So, when we have to make a particular part or a product initially there is a design and then there is a manufacturing. So, here we talk about optimizing or minimizing wastes that could have happened both the design stage, process planning stage and in the processing stage. So, here we talk about more traditional aspects of industrial engineering where we emphasize on job design and do it carefully sometimes use other

principles of bringing design and manufacturing together so that other wastes related to these processing is eliminate. Waste of motion once again comes from traditional approaches to industrial engineering where we could do a motion study or we could do a work study to try and understand how certain times are wasted or certain unwanted activities are carried out and by saving the wastes through proper study of motion it is possible to reduce waste of motion.

Last but not the least waste of product defects is directly related to quality and inspection. So, through proper inspection and by particularly giving the responsibility of inspection to the operator the ways from product defects is eliminated by looking at quality at source the wastes coming out of bad quality raw material is also eliminated. So, this way the 7 wastes are classified and these classification and understanding these seven wastes and being able to link every wasteful activity to one of these 7 and trying to provide means of eliminating them helps us achieve the objectives of just-in-time manufacture. Now here are some of examples of a waste.

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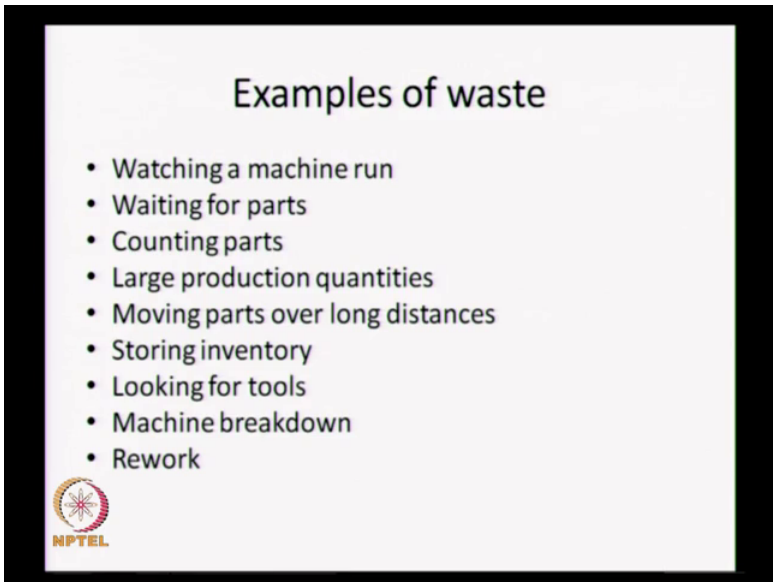

Watching a machine run, now watching a machine run becomes a waste because at this time when the machine is running and making a product the operator is not being utilized. So, the operator time is being wasted. So, this aspect we have seen in cellular manufacturing particularly when we have automatic machines how an operator can be assigned to multiple machines and the maximum of the operator time and the machine

time will be the throughput. So, here we have a situation where the operator as a resource is not fully utilized.

Waiting for parts, if a machine is waiting for parts then it means that there is there are some issues about the scheduling and the schedules scheduling is concerned about minimizing jobs waiting for the machine and machines waiting for the parts. Many times machines waiting for the parts or job waiting for the machines happens because the batch processing times are not equal it may not be possible to bring the batch processing times equal the individual processing times will be different for different parts on the machines, but the batch sizes can be synchronized. So, that batch processing times can be brought together.

Sometimes machine is waiting for the parts because of transportation batch sizes if machines are far away from each other then it is not economical to transport every piece from one machine to another or transport a very small quantity from every machine to another. So, this would result in large transportation batches and therefore, the transportation batch would be equal to the production batch itself. But if machines are brought closer to each other in as in the cellular layout then waiting for parts is eliminated because we can have single piece transportation between the machines.

Now, counting parts is seen as another example of wastes. Now counting of parts happens at the inward goods inspection and many times what we observe is that when goods are received or items are received there is an inverse good inspection. Sometimes counting of all the items is eliminated by weighing them and then by finding out the weight the number of items in the particular consignment or in the particular batch can easily be understood. But the more fundamental point is that if all the invert goods are being inspected counted to find out the number that has come it is also possible that the same things have been counted when they were dispatched from some other place.

So, there is a certain amount of double counting that happens all the time and so much of time and effort particularly on counting the parts should be avoided and eliminate. If we have a good understanding with the supplier which is an integral part of these kind of systems it is enough to count it once either at the supplier side or at the inverts good side.

So, accounting of parts is seen as an example for waste large production quantities is a waste large production quantities invariably result because of using the economic batch

quantity formulae not very consistent. So, large production quantities will create particularly waste of time in the assemblies because assemblies have to wait for the items to come in large production quantities also result in a lot of inventory in the system which is a waste. Moving parts over long distances is seen as a waste because the transit during that time, there is no value addition to the product there is a lot of time and energy that is spent in moving these parts, but the effort spent on this activity cannot be directly charged to the customer or cannot be added to the cost of the product. So, we need to eliminate this waste which is moving parts over long distances storing inventory as we have already seen is a waste. So, storing excess inventory is a waste and this has to be eliminated.

Looking for tools is seen as another example for wastes. Now these things are eliminated by what is called five s which essentially talk about housekeeping in the context of JIT housekeeping is extremely important and no time should be lost in searching for items. Now there is this thing called 5s which talks about 5 activities which are useful in housekeeping. So, some of them are (Refer Time: 34:56), c t on etcetera now they essentially stand for sort items systematize them keeping the place clean a place for everything and everything to be kept in its own place so that simple things do not take away our time. If we actually go back and check a lot of time is wasted on identifying something.

Now, good product identification mechanisms in the factory is a way to eliminate this waste of time spent in identifying the products. Similarly good mechanisms to identify tools have to be made so that the waste of time in identifying the correct tools is also eliminated. Machine breakdown is another example of a waste because the machine is not available and at this time production is not happening and there is a lot of waste of time. So, machine breakdowns will have to be eliminated. And rework is also a waste because the same activity is done again because the first time it was not done well. So, the amount of time effort and money is a waste. So, these are some of the examples of wastes there are many more wastes and JIT is a way by which we systematically eliminate all these wastes.

Just revisiting the waste of overproduction we eliminate by reducing setup times by synchronizing quantities by compacting layout and through visibility.

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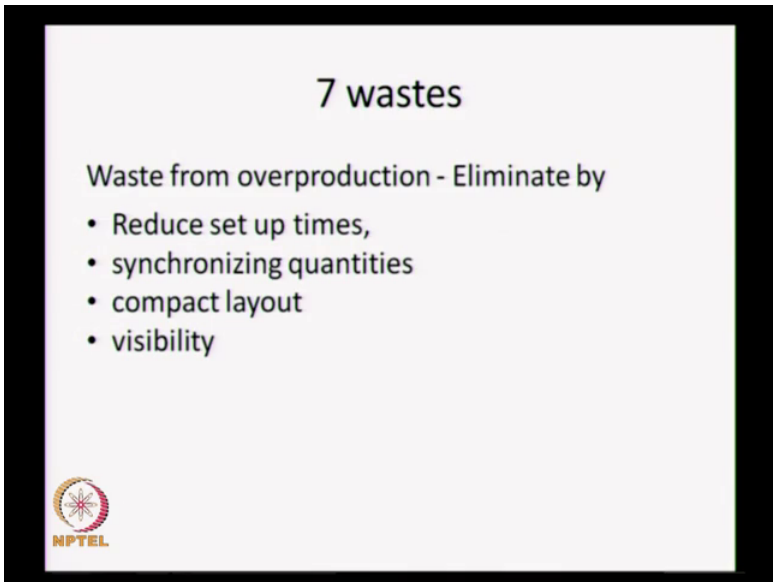

Now, we have already seen the advantage of reduced setup times small lot production is possible the batch sizes can be adjusted and we can synchronize the production quantities. Synchronizing the production quantities helps in all the parts or sub assemblies being produced at the same quantity and there is no excess inventory buildup. Compact layout also helps in wasting overproduction compact layout minimizes space in the cell. So, when there is less space there is less inventory. Visibility is another way to do that by making the whole thing transparent to people who are coming around people do not want so much of inventory to be seen. So, automatically visibility is a way by which we have reduce inventory and overproduction.

Now, we look at some aspects of suppliers. We have already seen here that suppliers and supply chain management principles are one of the critical success factors in successful implementation of JIT.

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So, some aspects of suppliers, first and foremost is we need few suppliers. So, when we need when we have few suppliers they can work very closely with them, having a large number of suppliers makes the job of working closely with them a little difficult. So, fewer suppliers is important and nearby suppliers is also important nearby suppliers are important because the suppliers have to deliver in small quantities. So, transportation cost comes down when we have nearby suppliers and fewer supplies. So, when we have fewer suppliers then each supplier will be giving or supplying many items and transportation costs and time is reduced.

Long term contract agreements with the suppliers are important because if the suppliers have to supply multiple quantities or in short quantities somebody has to observe the cost of transportation and then the supplier also has to be told or is happy that there is a long term contract agreement and therefore, it is also possible to work closely with the supplier and reduce the supplier costs.

Steady supply rate the supplier should be capable of supplying at a very steady rate as and when required and the supplier should deliver frequent deliveries in small lots. This aspect we have seen if we have to implement a Kanban controlled system which regulates the inventory in the cell. There is no point in having a lot of raw material inventory in the store. So, if we want to minimize the raw material inventory from the store then the supplier should supply or deliver in small lots. We have already seen that

quality of the incoming material the responsibility for quality lies with the supplier and quality is at source. So, the buyer or the organization should help the supplier meet quality requirements.

Buyer schedules inbound freight. Now these things are quite common today that if we follow just-in-time manufacturing systems and we work closely towards a stable production schedule the daily production quantities can change. So, earlier days when schedules were drawn entirely a week before and the schedules were given to the supplier. Now, today with more advances in supply chain management and sharing information through software and enterprise resource planning software systems now schedules are now worked out on a daily basis or even if the scheduling is done a week ahead the requirements are now told to the supplier and the supplier should deliver the daily demand for the plant. So, the buyer now not only tells the supplier that the total demand for the week is so much, but this demand has to be split and delivered in frequent deliveries of small lots.

So, the buyer schedules the inbound freight and the supplier follows the schedule that is given by the buyer sometimes if there are rescheduling and the buyer does some ray scheduling as the result of which the supply quantities change. Now sometimes the buyer communicates it to the supplier sometimes the supplier has access to relevant buyer data and the supplier logs into the systems to see what the demand for the next day is and then the supplier keeps such so much of demand ready so that the production happens on the next day. So, there is a lot of trust and there is a lot of interaction between the supplier and the buyer. The supplier is not seen as an external entity to the organization, but the supplier is seen as an integral part of the system using who are using the supplier the organization wants to benefit and meet the customer demands effectively.

So, the supplier is not seen as someone who is alien or who is away from the organization because the supplier is paid money. Even though the supplier is paid money for all the items that is purchased the supplier is seen as a person who cooperates who takes part in all the challenges that the organization faces.

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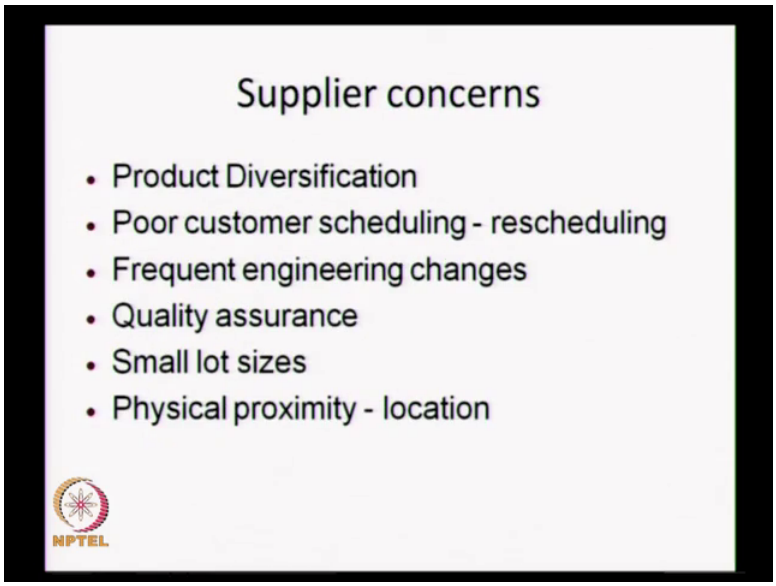

Now, the supplier also has some concerns, now what are the concerns from the supplier point of view. Now first we will look at the last point which is physical proximity now in order to deliver items in time the supplier has to locate himself or herself closer to the organization. So, this involves the supplier having to rent space or borrow space and if the suppliers manufacturing facility is not very close to the buyer then there is a lot of transportation costs that the supplier has to incur in transporting items from the suppliers manufacturing place to the buyers place. So, there is an issue with physical proximity.

Sometimes the company gives space to the supplier the supplier keeps inventory there and delivers it in small lots, but the supplier has to bare the cost of inventory that is kept. Sometimes a cluster of suppliers talk to logistics providers and in a single truck the items are supplied to the buyer daily. So, this way the supplier need not store so much of inventory near the buyer location, but by combining several suppliers through a third party logistics provider items are picked up from all the suppliers and are delivered to the buyer, but in spite of all these supplier concerns are with respect to the physical proximity and the location.

Second one is product diversification. Now today is an era where the customer wants to buy frequently. So, new products have to come into the system very frequently and new products will have a lot of engineering changes and new products can also be diversified

products over a longer period 10 years or 15 years the organization decides to diversify and get into a completely different range of products.

Now, this particular supplier who has taken the trouble of locating himself or herself physically close may not be capable of making and supplying items for new products and diversified products. So, there is a supplier concern that even though the supplier is there for a longer period 15 years or 20 years if there is product diversification by the company then the supplier also is forced to diversify the products that the supplier deals with which is an issue for the supplier. Similarly when you are variants of the products come it necessitates engineering changes and when engineering changes happen the items that the supplier has to provide can also change and the supplier may find it difficult to provide those items. So, product diversification and frequent engineering changes are concerns for the supplier.

Now, poor customer scheduling and rescheduling. Now, if the customer is scheduling every day or if the customer is rescheduling in particular then it becomes very difficult for the supplier to produce or buy and send these items in time unless the supplier has inventory of these items. So, if the manufacturing or the customer does not want to build inventory and therefore, changes the daily requirement now it is indirectly forcing the supplier to build inventory. So, the inventory has to be built somewhere else so the supplier has to bare; the brunt of this change because the supplier cannot meet so much of changing schedules unless the supplier builds inventory now, as much as the customer does not want to build inventory it is only fair that the supplier also should not build inventory. So, it is a challenge that the supplier faces.

Quality assurance is another challenge, now the owners on quality is on the supplier the supplier cannot afford to send items that are defective or items that cannot be used immediately and that is going to give a black mark or that is going to leave the whole relationship in bad taste. So, the supplier should take the responsibility of ensuring that all the items that go from the supplier meet the quality requirements of the customer because the customer may have even eliminated inverts goods inspection because the supplier is expected to ensure 100 percent quality.

So, this brings in a lot more difficulty or concern on the supplier in the supplier has to create systems which will enable or which will ensure that the items have good quality.

Again sending in small lot sizes is an issue because of increased transportation and increased transportation cost it is always the tradeoff between inventory cost and transportation cost. So, these are some of the concerns that the suppliers have.

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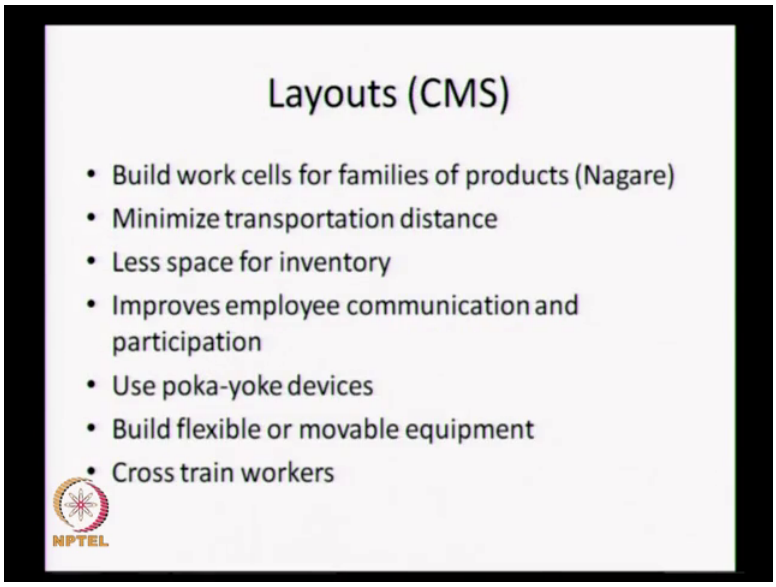

Now, there are two other things that we will do, one is to talk about layout we have already seen most of these in the cellular manufacturing.

So, build work sells for families of products. So, create part families something that we have already seen, minimize transportation distance by looking at cellular layouts and u shaped layouts. Create less space for inventory, so that less inventory is stored. Improve employee communication and participation that we have seen in a cellular manufacturing system following JIT if there is an issue the employee is empowered to stop the cell solve the problem and start again. Use poka-yoke or full proofing devices, so that even during the manufacture enough and sufficient full proofing happens, so that inspection and other activities are carried out and certain other process parameters are under control by visible devices.

So, poka-yoke and full proofing is an extremely important aspect of layouts and cellular manufacturing. Build flexible or movable equipment, so that small layout changes can also take place. This is a little difficult, but people are working towards it and cross trained workers, so that they can work on a variety of machines within the cell.

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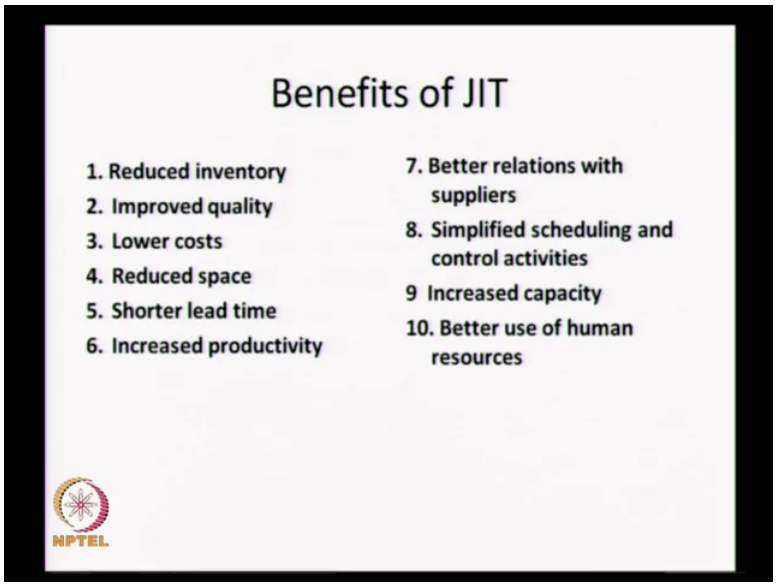

So, if organizations do all of these they will get all possible benefits of JIT and these benefits also we have seen reduced inventory, improved quality, cost of production comes down, space requirement is less production happens in short lead time and small runs, productivity is increased because employees morale is very high and they are empowered to do things, better relationships with suppliers, simplified scheduling and control activities, capacity gets better and more businesses can come in and finally, we have better use of human resources. So, several organizations have been implementing this just-in-time and have benefited immensely by the use of just-in-time manufacturing systems.

So, in the next lecture, we will look at some models that we have which can be used to make effective decisions in the context of just-in-time manufacturing systems.