Manufacturing Automation

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Lecture – 01

Hello and welcome to the course on Manufacturing Automation. As I said in the introductory part, this course will basically focus on the automation of manufacturing industries; and manufacturing processes including the manufacturing automation. This course is intended for a wide audience including the engineering undergraduate and postgraduate students and the practicing engineers as well. Now, let us see what manufacturing automation stands for.

First of all, the word manufacturing came from the two words: manus and factus from the Latin words and that does mean doing by hand. Well, when this word was coined/ when this word was generated, the concept of manufacturing, I mean, there the scale of manufacturing was much less than what we can see these days. Population was much less and that is why the demand on the manufactured products was much less than what we have right now.

So, in our days instead of doing by hands, now we are using the machines and subsequently the machines are being automated. Now what does it mean that we are using the machine - meaning that we are replacing the muscles, tendons of a manpower- of a human being with mechanization, with different kind of machines. Moreover, those machines have also to be controlled. So, our brain, memory are now replaced by the control technology. Therefore, mechanization and the control together make the automation in the following way.

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This is what we are calling as the automation, that is, the mechanization and the control technology. So, as a definition, the manufacturing automation can be described as a term, applied to all measures taken which will cause a process to be carried out wholly or partly according to a previously set program, and that is without the intervention of the human activity for its control, because the control is given by replacing our brain, memory, nerves, etcetera.

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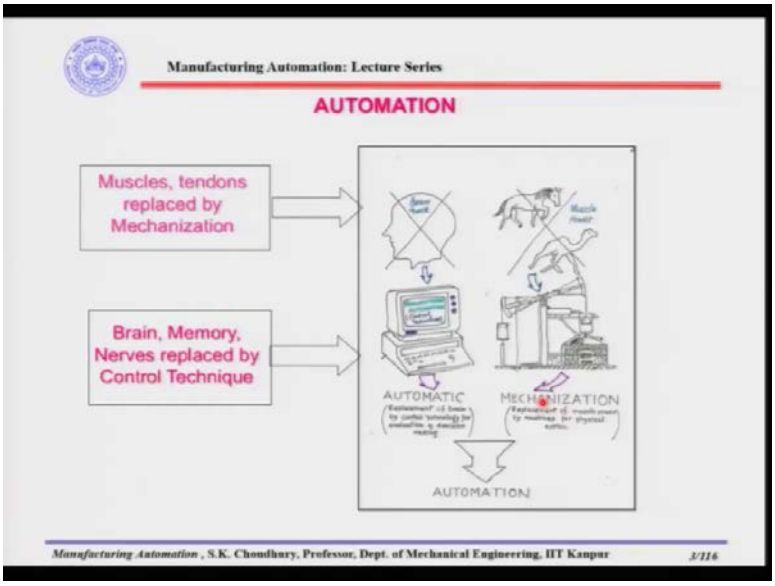

Here it is. Muscles, tendons are replaced by the mechanization. For example, we have the muscle power here, which is replaced by the mechanization, which is a kind of a machine. Further, we have the brain power of the human being, which is replaced by the control technology and together they are actually making the automation.

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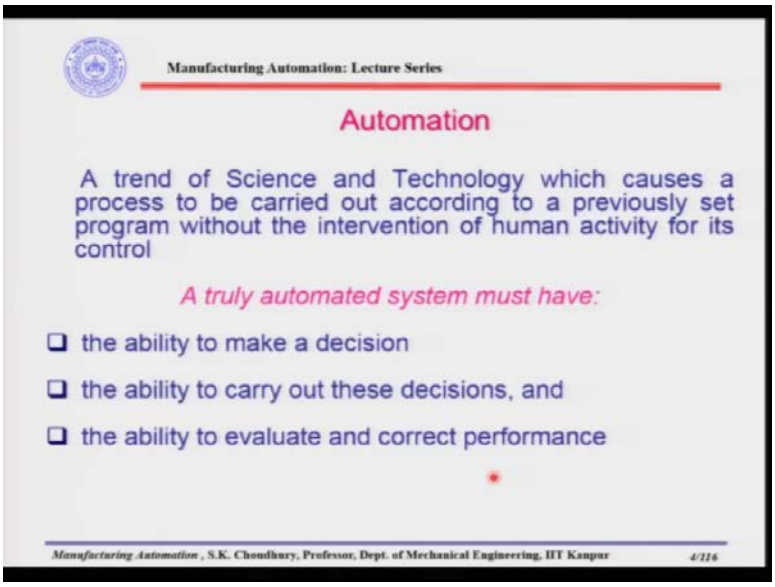

Therefore, this is a trend of science and technology, which causes a process to be carried out according to a previously set program without the intervention of the human activity for its control. Well, if that is a truly automated system, that must have three criteria, one is that it has to have an ability to make a decision. Second, it should have an ability to carry out these decisions, and the third is the ability to evaluate and correct the performance.

Now, if you see these three criteria - the ability to make a decision, to carry out the decision and to evaluate and correct the performance, this is what we do every day.

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Meaning that, suppose we have an object and we have to put that object in our pocket. So, before we do that, we decide that we have to put this pen in our pocket and then we try to carry out this process. So, we take this pen by our hand, grip is just enough to lift the pen, and then we take the minimum path to take it into the pocket; and we always see that this process is followed exactly and I am not carrying that pen roundabout, I am keeping that pen just following the minimum path.

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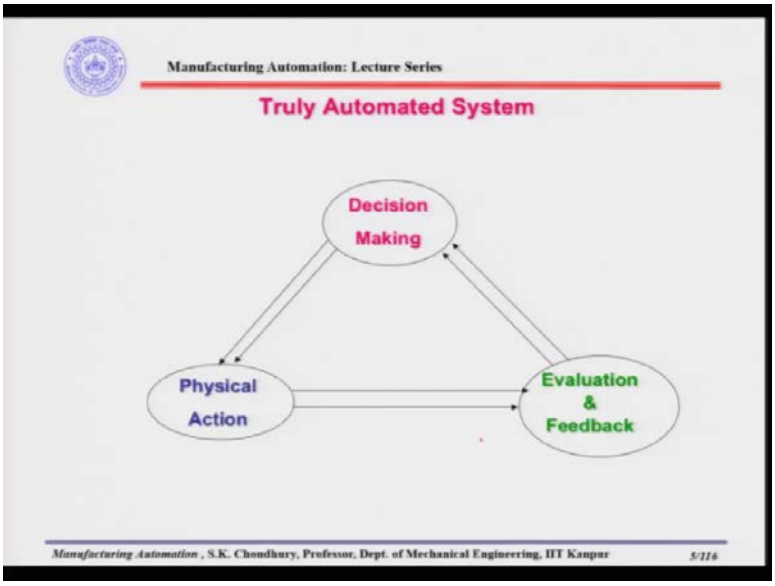

So, what we are having is the decision making, evaluation and feedback and the physical action being carried out in this way, for example, as shown in this picture.

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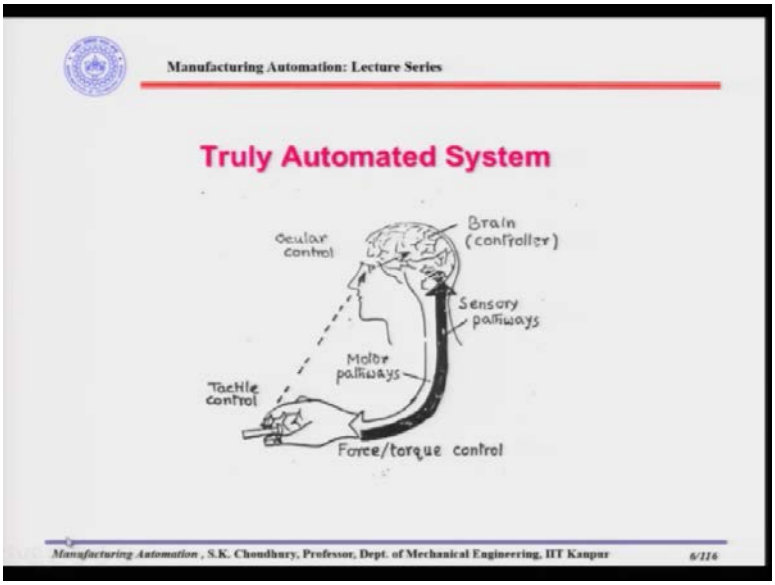

Here what we are having is that, we have the ocular control, which is our eyes; we have the brain and we have the hand which is actually doing the work. So, through the ocular control, the sensory pathway and the motor pathway, as it is shown here, we are actually following the decision, that has been made, for example, to put a screw in the threaded hole.

So, the brain is taking the decision that we have to put that threaded part in the threaded hole and that decision is going through the sensory pathway to the brain. The brain is giving the command to the hand to carry out the decision. Now, when we are putting the screw in the threaded hole, whether it is going rightly or not, is being controlled by the ocular control; we are looking at it and if more torque is required we are actually applying more torque or less torque accordingly which is being controlled continuously. So, this is what the human being is doing for day-to-day activity and the same process we want to replicate in the automated system.

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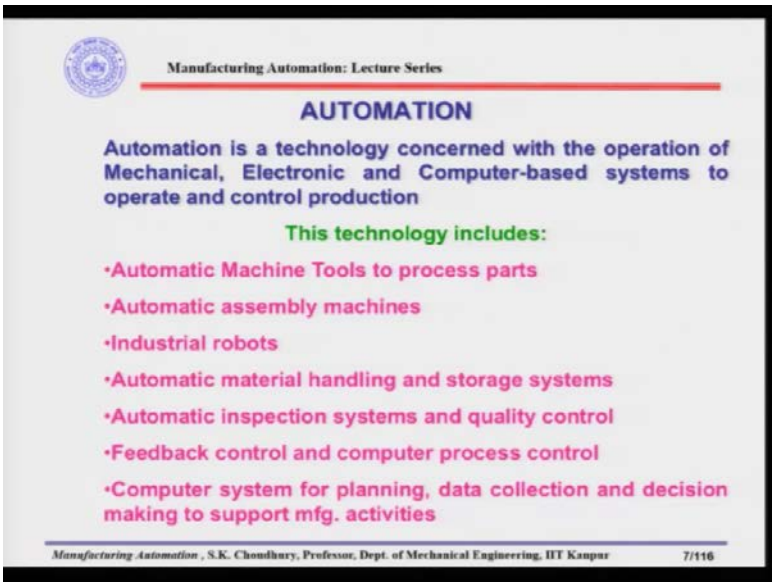

Therefore, automation is a technology concerned with the operation of mechanical, electrical and computer based systems to operate and control the production. Now this technology will of course, include the automatic machine tools to process the parts or the automatic assembly machines if an automatic assembly process is being carried out. It will have the industrial robots to help the manufacturing process or the assembly process. It will have the automatic material handling and storage system. Material handling and storage system is that, when one part after processing in a machine has to be carried over to the next machine for the subsequent operation, which is not done by the human being anymore.

So, there will be industrial robots to help the parts to be carried over from one machine to another machine for further operation or for one sub assembly from one machine or one workstation to another workstation. Automatic material handling and storage system has a great role to play here, because it has to not only transfer the parts, but it has to transfer the part in a right orientation and whether that orientation is maintained or not is actually one of the responsibilities of the material handling and storage system.

Next is the automatic inspection systems and quality control; in the automated systems or automated manufacturing mostly, this kind of automatic inspections is in-built in the machine itself. That means, when the machine is producing something or the machine is assembling an assembly, whether it is doing rightly or not, this kind of signals will be

generated, and the feedback will be given to the same machine so that, the machine can correct itself. So, these are called the feedback systems and those we will discuss at a later stage of the lecture. Next is the feedback control and computer process control, as I said, and finally, we will have the computer system for planning, data collection and decision making to support manufacturing activities.

So, as you see here, these are the technologies which the automation will include. They are practically the same as we have in the mass production. For example, the mass production is also a technology, which is involved in producing the manufacturing parts. So, what is the difference between the mass production and the automation, let us see.

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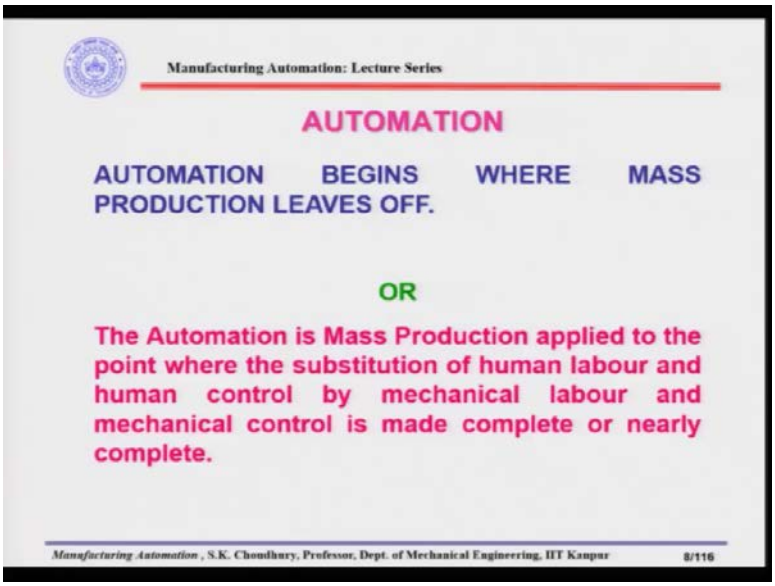

Actually we can say that the automation begins, where the mass production leaves off; what does it mean? We can say that the automation is mass production applied to the point where, the substitution of human labour and the human control by mechanical labour and mechanical control is made complete or nearly complete.

Automation can be considered as a changeover from the mass production and it will not come overnight; it will be coming gradually and that is why many of the techniques of the mass production will be used in the automation as well. We cannot throw out all the techniques, all the mechanisms from the mass production, and many of them will be adapted to the automation. However, the basic point is that it is the substitution of the human labour and the human control by mechanical labour and the mechanical control;

which is either complete or it is nearly complete, and as I said that it cannot be done overnight.

At this point, therefore, there is a question that will arise regarding whether it will create the widespread unemployment. We can have the argument, for and against the automation on that issue. As was mentioned earlier, automation is eliminating the human labour, which is going on for thousands of years; it is not the first time that we are doing it.

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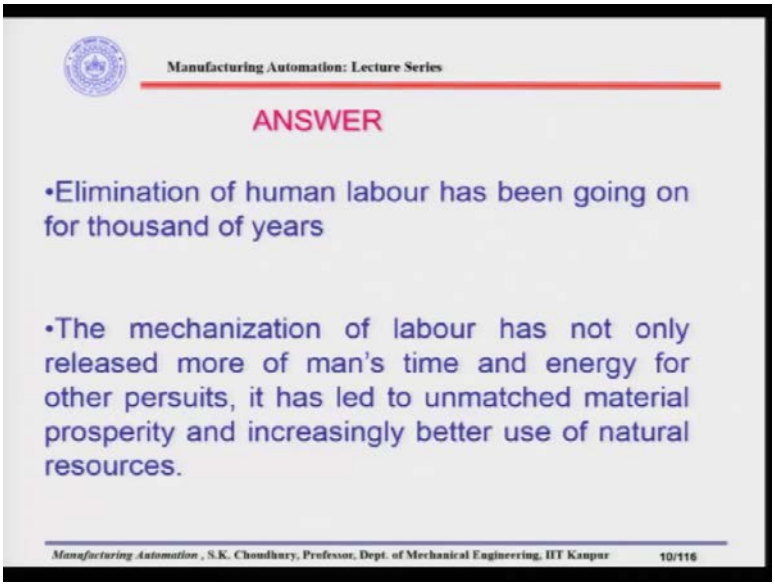

And this is being done, the mechanization of labour has not only released more of mens' time and energy for other pursuits, it has led to unmatched material prosperity and increasingly better use of natural resources. What does it mean? That when one person was doing something, the productivity or the production rate was much less than if it is being done by few of the persons. And the other thing is that, a particular process was being done by several people.

So now, because of the mechanization, because of the automation, gradually we are trying to free those people, those who were involved in the same activity and they are actually doing the other jobs requiring the higher skill. For example, designing, they are actually installing something, they are designing the end product, they are designing the control technology and so on.

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So, greater productivity of the mass production has opened and enlarged many fields of employment like; designing, production, maintenance, packaging, distribution, selling, advertisement, etcetera. So, these are the areas which actually are giving more employment. So we are creating new kind of jobs. I will give you an example. Suppose you open up any, let us say, Shriram Honda generator or a pump.

Now if we open the pump, you will see inside the pump there are many small parts like nuts, bolts, washers, springs, which are not made by the company making that pump. For example, let us say Kirloskar pump, so Kirloskar is not making the small parts which are there inside the pump. This is because they have found out that it is economically not feasible to manufacture them; rather they will concentrate on manufacturing the basic units, basic parts, which are required for making the pump, for assembling the pump.

What they are doing is that they are asking some other manufacturers to produce those small parts for them. So, those are the ancillary industries, which are being generated because the Kirloskar has started making the pump. So, the automation, similarly, is generating more and new works, new workplaces and generating employment. So, it is not only not creating unemployment, but it is generating new jobs.

It has also made possible the phenomenal expansion of the material processing industries like metalworking, fuel, rubber and synthetic industries for example, which were not there earlier when the automation was not introduced.

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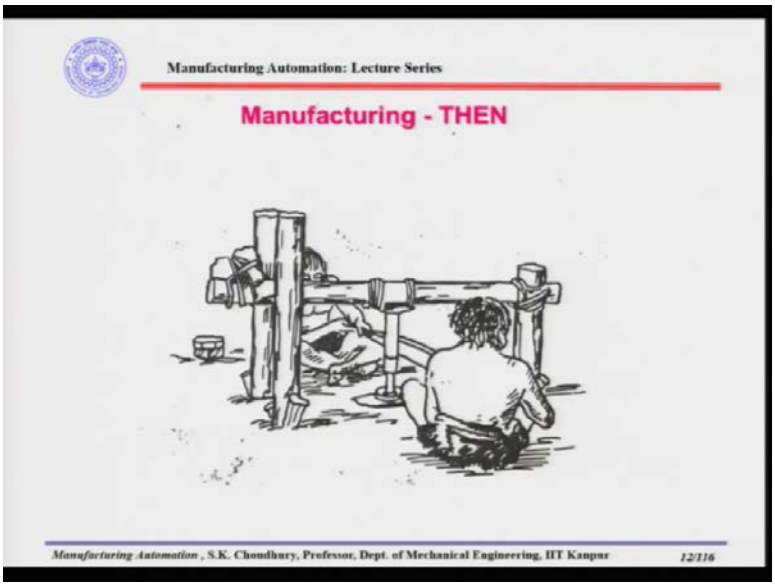

So, what we see is that this is the manufacturing ‘then’, when two persons are actually involved in making parts for a very long time and subsequently what we have is that manufacturing ‘now’

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where you can see that very few people are involved in the production and that too they are not operators, they are actually the managers, they are the people who are observing, and with a higher skill, whether the manufacturing process or the assembly process is carried out properly.

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And what we see next is the manufacturing 'soon', which is our dream which has been tested over, but it is not very successful till now. Here you can see that there is no person involved in the production as it is. These are all automated production, automated machines, automated flow lines, we have the automatic storage system, we have the AGVs - automatic guided vehicles, which are actually working as a material handling system and so on. So, this is our dream, which is going to come very soon for which we have to put some effort.

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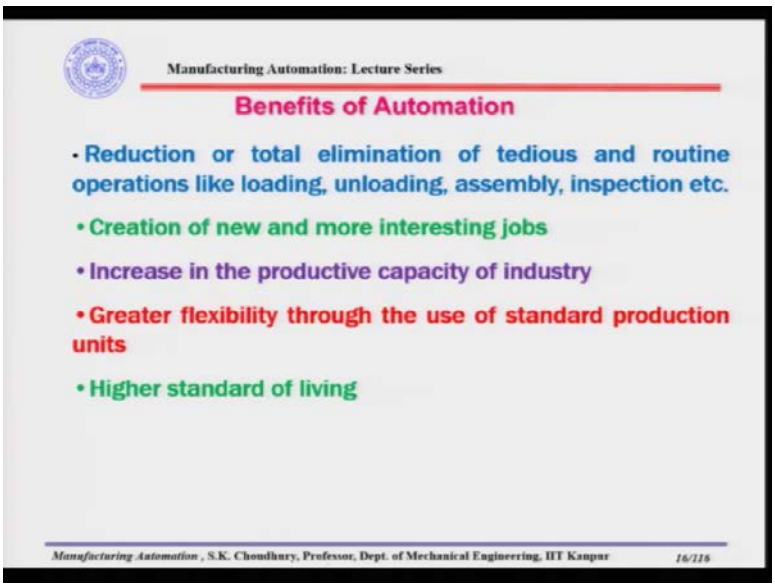

What are the benefits of automation let us see. Benefits are manifold as previously I said. First of all, the reduction or total elimination of tedious and the routine operations like loading, unloading, assembly, inspection etcetera. As you understand, these processes are time consuming and very tedious; and a person - human being gets very quickly tired out of that. So, basically if we can automate those processes, then not only we will reduce the unnecessary works which are taking a lot of time, but also we can increase the productivity.

Now, second point which is very high beneficial for the automation, is the creation of new and more interesting jobs. That is what I said just now that, new interesting jobs are being created requiring higher skill. In future the production will have less number of operators; will have more number of people who will be involved in the management, will be involved in the design, who will be involved in the design of the end products or the assembly and so on.

So, those are the higher skills, which will be required for the people who are being involved in such new and interesting jobs, which will be created by the automation. Next point is the increase in the productive capacity of the industry. The basic reason how we can increase the production rate or the productive capacity of industry is that we are eliminating the time consuming jobs. Like for example, the loading, unloading, inspection, for example.

Now another way how we can increase the productive capacity of industry is that, we can design the new type of machines which can perform different kind of jobs at the same time. So, in that way the productive capacity or the production rate is increased. Next point is the greater flexibility through the use of standard production units, which can be rearranged and assembled in different ways to get the end product; which actually is an example of the building block technique. Many of you must have played in your childhood with the Lego or with the small blocks and using those blocks in a different way you could have made a house, a home, a ship, an airplane and so on.

So, these are the building blocks techniques which also can be applied to the automation. Here the flexibility will be increased; that means, the building blocks will be the standard products, but the final product using those standard products can be very different. So, there we have the lot of flexibility in this. Next point is the higher standard of living. If

the automation is used correctly, in that case we can increase the production rate, we can decrease production time, particularly for the production processes involving time consuming processes.

That way we are increasing the profit and that profit when distributed will be given to the people who are involved in that. So, the overall the standard of living will be higher.

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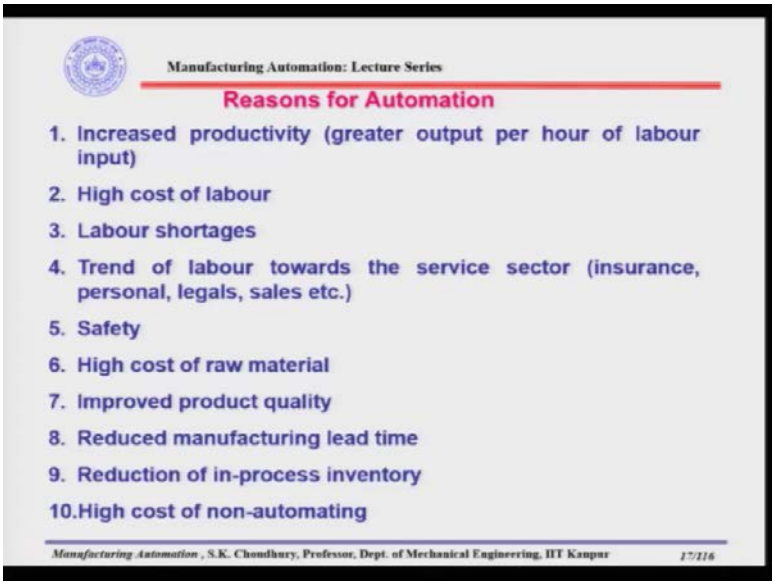

That is overall the answer to the question whether the automation will create unemployment. Now, let us see what are the reasons for automation? That means, why we should go for the automation? First of all we need the greater output per hour of the labour input; that means, we have to increase the production rate. Increasing the production rate will actually decrease the cost as well, as you know that.

And it will also increase the standard of living. So, that is the first thing that we should look for. Now, if we have the high cost of labour, only then we can justify the high initial investment in the cost of the machine and the equipment for the automation. Because, the automatic machines, automatic equipment are quite expensive in comparison to what we are using for the mass production, for example.

So, that can be justified by the high cost of labour - if the cost of labour is very high. Next point is the labour shortage that actually forces us to go for the manufacturing automation. Fourth point is the trend of labour towards the service sectors, like

insurance, personal, legal, sales, etcetera. Many people are going to those sectors and therefore, we do not have the people for being engaged in the production or the assembly.

Therefore, that is one of the reasons for going for the automation. Fifth point is the safety. Automation makes the workplace very safe. Take an example, suppose we have the welding being done inside closed area - inside an automobile body for example, or inside a closed room.

The fume and the toxic gases which are coming are very harmful for the operator. Whereas, in the automation we will have different kind of manipulators, different kind of robots, which will be doing this kind of jobs and this is quite safe for the human being. Sixth point is very important point, which is the high cost of raw material. When we have the high cost of raw material, it dictates that we have to use that raw material very precisely and very carefully. In the sense that we cannot afford to have the waste, we cannot afford to have the parts which are actually reject.

So, when the manufacturing automation or the automation overall is used, the rejects will be minimum and that is one of the reasons to introduce the automation, particularly when the raw material cost is very high. Next point is the improved product quality, because it is being done by the machine and without the human intervention, the product quality is very high.

Let me give you an example. Suppose a human being is involved in the production process. Normally what we see is that from 9 o' clock morning, when you start working, the quality of the product is good. At the end of the day, when the human being is getting exhausted it actually affects the quality and the quality becomes poorer. So, when the machine is involved in either assembly or in manufacturing/production process, the machines do not know what is exhaustion and the product quality will be the same at 9 o' clock in the morning or at 5 o' clock/ 5 pm in the afternoon.

Therefore, along with the improved product quality, one more thing which is very important is the consistency in the quality; that means, all the parts will have the same quality level. This is very important particularly for assembly, for example. Point number 8 is the reduced manufacturing lead time. What is manufacturing lead time? It is the time

between the customer order, when you are taking the booking from the customer, and the product delivery.

So, this time is very important to maintain. If you are not maintaining that time and not able to deliver the product in time, in that case sometimes the customer may reject the product. That is why you may find many of the rejected parts in the market. For example, in case of clothes, there are lots of rejected clothes which are of very good quality but rejected only because the lead time is not maintained.

In case of manufacturing, this is important because the capital will be locked. So, in case of manufacturing automation or in case of automation over all, this manufacturing lead time can be maintained because we know the exact timing for the production of that particular part or for the particular assembly.

Therefore, automation is very well justified where we have this as a problem. Next point is the reduction of in-process inventory. What is it? In-process inventory is the capital locking; that means, we have the parts which are waiting for the assembly; and this is simply not required - this is waste in time and money because it is a capital locking.

So, in automation in-process inventory can be reduced because the parts can take minimum time in the routing between the machines. So, that way the in process inventory can be reduced. And finally, the high cost of non-automating; that means, firms which are not automating will not be able to compete with the other customers and with other manufacturers which are using the automation.

Thank you very much.