Computer Integrated Manufacturing
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Lecture 4
Automation in Manufacturing System

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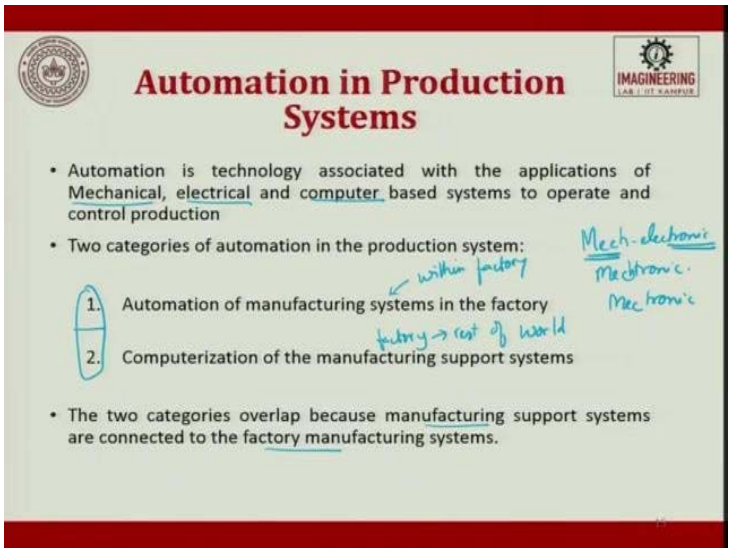

When we talk about automation in production systems, automation is a technology which is associated with the application of mechanical, electrical, computer based systems to operate and control production. I repeat automation is a technology which is associated with the application of all the three mechanical, electrical and computer. That is why today we call it as mechatronics. Mechanical and electronics, so we call it as mech-tronics, or we call it as mechatronics.

Somewhere some people write it has m, e, c, h, electronics or they write it as m, e, c, t, r, o, n, i, c, s. So, it is nothing but mech and eletronics. So, mechanical, electrical, which is also electronics and computer based. There are two categories of automation in production systems automation of manufacturing system in the factory, computerization of the manufacturing support system are the two levels or two different automation which are there in the production system.

One, within the factory, one factory and rest of the world. The two categories overlap because manufacturing support system are connected to factory manufacturing system. So, this is

connected with this. So, this is within the factory and this is factory and rest of the world, where customers are there, money is there, energy is there all those things put together.

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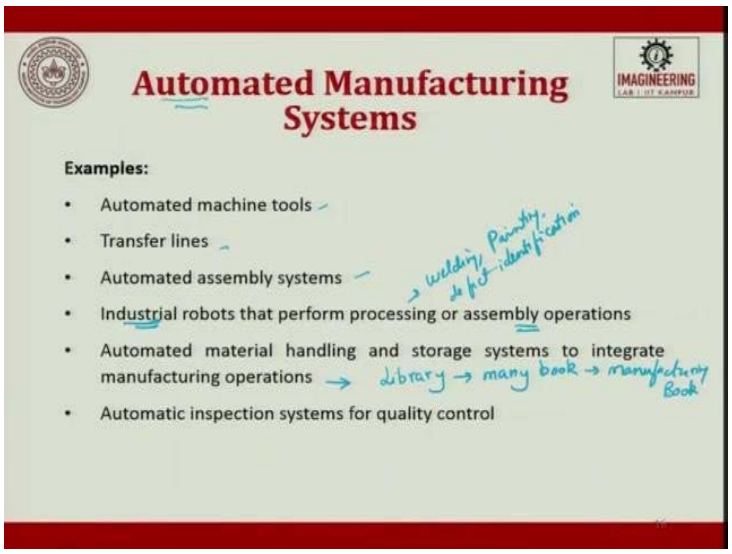

So, examples of automated manufacturing system or automated machine tool is a is part of automated manufacturing system, transfer lines, automated assembly systems, industrial robot that performs processing like processing like welding, painting, today it also does defect identification or assembly operation where robo is used to for assembly operations.

The automated man material handling and storage system to integrate manufacturing operation, material handling automated material handling and storage system. Let us take a simple example, let us go to a library, and in a library, you have many books, and you have chosen to pick up one manufacturing book. So, if you have to do that you will go to library get to see the access number what is that book and where is that book then go to the floor where there is the book kept, that means to say in a rack, then go to that particular rack start spending time and then finally you will get a manufacturing book.

So, you see that it is a lot of time consuming. Generally, when you go to library searching for a book takes a lot of time. But when you look at a factory where for example car factory they have 10,000 parts. Now, all these parts have to be stored in a three dimensional space. You cannot spend so much of time in identifying each of these locations. So, it is better what they do is they have an automated material handling system, where you try to tell which part you want, then immediately there is a shuttle which goes to that location and pull ups the bin and comes and delivers to you.

So, automated material handling and storage system to integrate the manufacturing operation is also an automated manufacturing system. Then the last one is automatic inspection system for quality control is also automated. Today, we are talking about non-contact measurement where in which we are talking about using laser.

So, moment you start using laser a drawing which has generated in that by the design program to product design department to manufacture you have manufactured, now you use non-contact techniques use the same data check whether the part is to the expectation or not and then you record the quality variation that is what it is.

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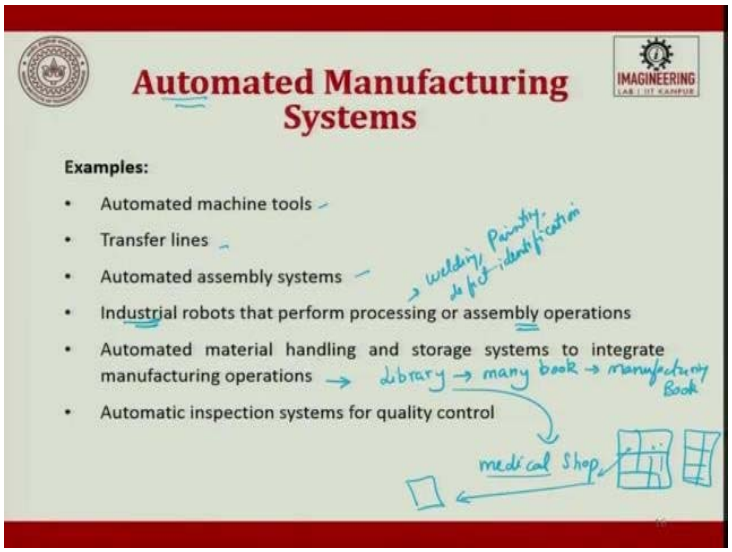

Another example which I would like to give for this library is a medical shop, I do not know how many of you have gone to a medical shop, and you see there are so many racks, and in each of those racks, there are maybe thousands of medicines available. When you go with the prescription, the pharmacist exactly goes to the location pull ups that and comes and delivers to you. So, here it is manual, but suppose if you can do it automatically, that will be great. So that is what is automated material handling and storage system, so he is using three dimensional space, he tries to load at the location and when he wants, he pulls it out from the location.

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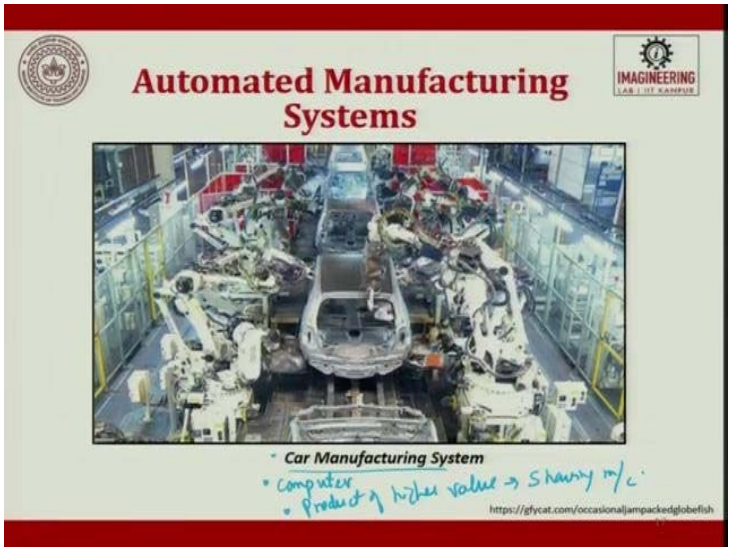

So this is a feel for you, wherein which this talks shows you about car manufacturing system. So where in which robos are involved. It is completely automated, spot welding process is used. The locations are already predefined, and from car to car, you can have variation. The complete assembly is done without manual intervention. This talks about automated manufacturing system for batch production; this is very good.

When I say batch production, again, I am not talking about in terms of thousands, but in terms of 10, 20, where there is a lot of product variation. So, then you use computer assisted robots, which will help you in producing it. The advantages there is a consistency of the process. Today, almost all the car companies, computer companies and products which are of higher products of higher value. For example, even your shaving machine, automated shaving machine are all done by automated manufacturing systems.

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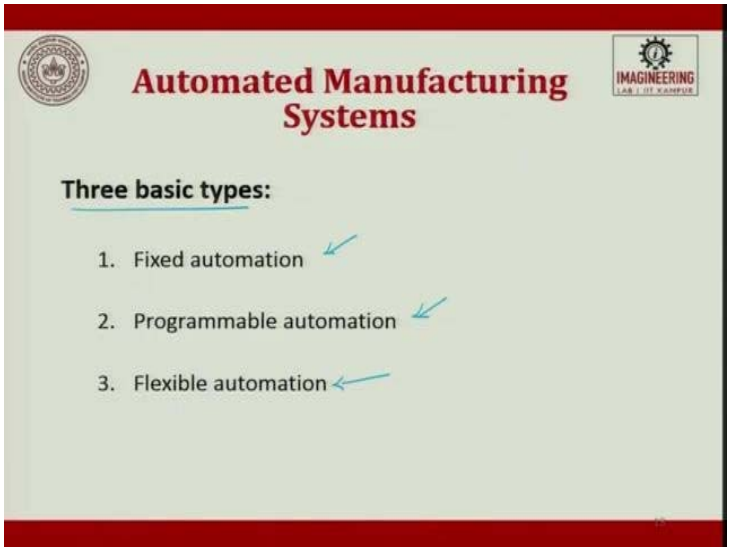

So, in automated manufacturing systems, again there are three types one is called us fixed automation, the other one is called us Programmable automation, the third one is called us flexible automation.

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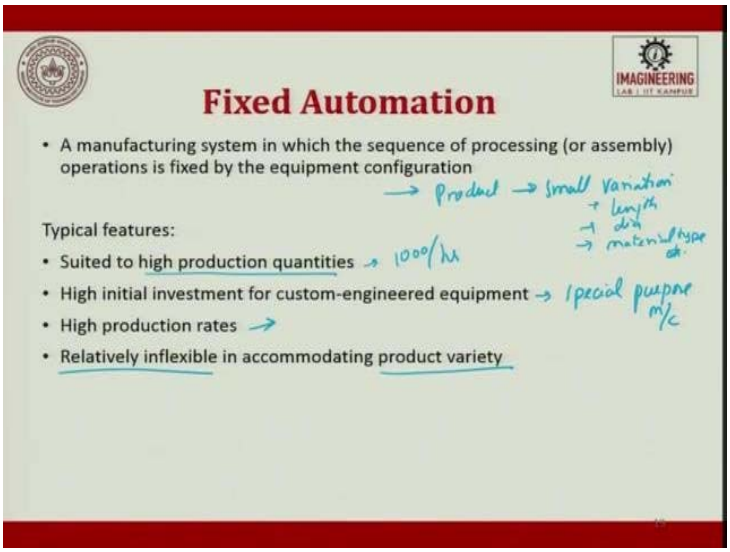

When I said fixed automation, so here the manufacturing system in which the sequence of processing or assembly operation is fixed by the equipment's configuration. So, day in and day out you can produce only a product you can have a small variation in the product which is accommodated by the manufacturing system. So, that is called as fixed automation. In fixed automation, we predominantly use mechanical systems like cams, springs, then we use leavers, so all those things in fixed automation.

So, here typically suited for very high production quantity, so there is no change. So, for example, nail manufacturing. Nail it has to undergo a sequence that the raw the wire is their wire has to be chopped then it has to be offset, forge has to be done so you produce a head and then you have to crimp the edge so that you produce a sharp one. So, four or five operations are there, all the operations will be done in a fixed automation machine and we produce it at higher quantities.

So, we talk about 10000 nails per hour. Generally, it is a very high investment cost, and it is more of customized machines are developed. So, we call it a special purpose machines or SPM. So, here in which these machines are custom built only for that product to produce it in bulk. The production rates are very high, it is relatively inflexible, in accommodating product variety I said small variation that means to say length, diameter material can be changed type.
So, all these things can be changed. This is part of fixed automation.

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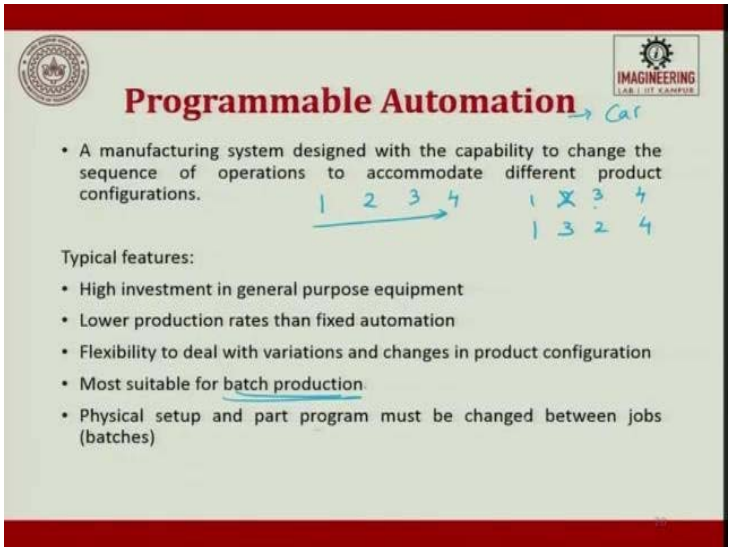

When we go to Programmable automation, the manufacturing system designed with the capability to change the sequence of operation to accommodate different product configuration. Say, for example, there is 1, 2, 3, 4 operations, in fixed automation it goes through 1,2,3,4 only. In programmable automation you have a small flexibility 1, 2, 3, 4 is there you can close 3 and then you can use 1, 3, 4 alone.

So, here with the capability to change the sequence or you can also make it as 1, 3, 2, 4. Here I use a program or a robo to change the sequence little bit and then still produce a different

product to my requirements. So, here it is high investment in general purpose occupants happen, in programmable automation, lower production rates than fixed automation, flexibility to deal with variation and change in product configuration is possible.

Generally car assembly, we always use programmable automation then most suitable for batch production. So, the first one was for mass, and this is for batch, again the sizes you have to watch out for it. Physical setup and part program must be changed between job to job.

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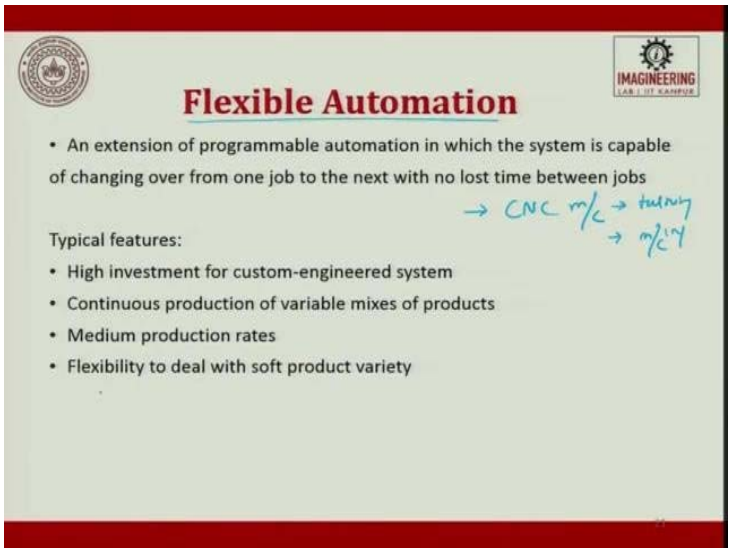

The final the higher end is flexible automation. So, the extension of programmable automation in which the system is capable of changing over from one job to the next with no loss of time between jobs is flexible automation. For example, a CNC machine. So, you can produce CNC machines for turning center, CNC machine for machining centre.

So, in machining centre what happens, within this variation of turning, you are able to produce parts such that there is a huge variation from one part to the other and the entire part is governed by a program what you write. Rest of the operations are set with or program changes, so you try to get, so this is called us flexible automation. High investment for customer engineer system, continuous production of variable mixes of products can happen here, medium production rate and flexibility to deal with soft product variety.

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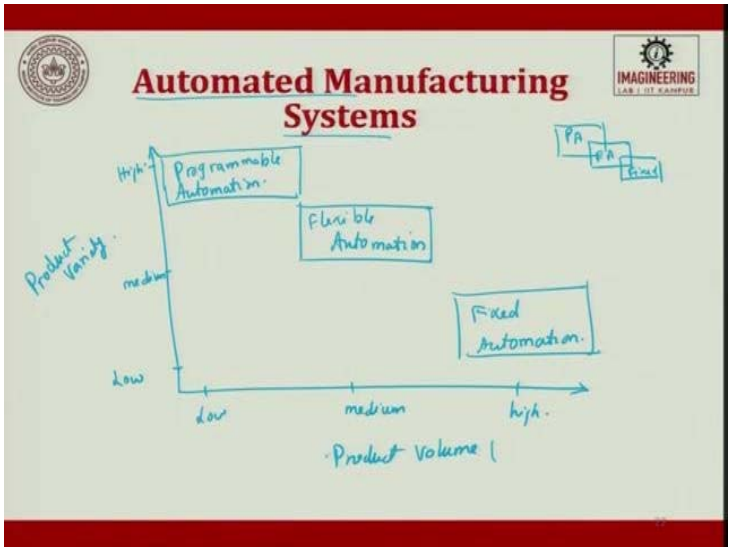

So, if we look at the diagram, wherein which we are talking about automated manufacturing systems, we are writing here product variety. Again, I would like to put as low, medium, high, and then I put here product volume, again I say low, medium, high. So, now what did we see? We see very high product variety, and very low production volume is going to be programmable automation.

Then product variety medium and product volume medium is going to be flexible automation and product volume high, product variety low it is going to be fixed automation. You will not see, this is only representation, so you will have even overlaps that means to say you will have overlaps like this also between the three. So, programmable automation, flexible automation and then you will have fixed automation you can have overlaps also.

And here the product volume, we are not saying in terms of numbers, for example, we are not talking ten thousand, twenty thousand, fifty thousand, it can be one, ten, fifteen or it can be ten fifteen, or it can be thousand, five thousand, ten thousand, one lakh, ten lakh, 15 lakhs whatever it is. So that is why we since we do not know the numbers here and here we just write it as low, medium, high. So, you can see here the automated manufacturing system falls in this category. So, by looking into this figure, you can quickly remember which automation to choose for your product.

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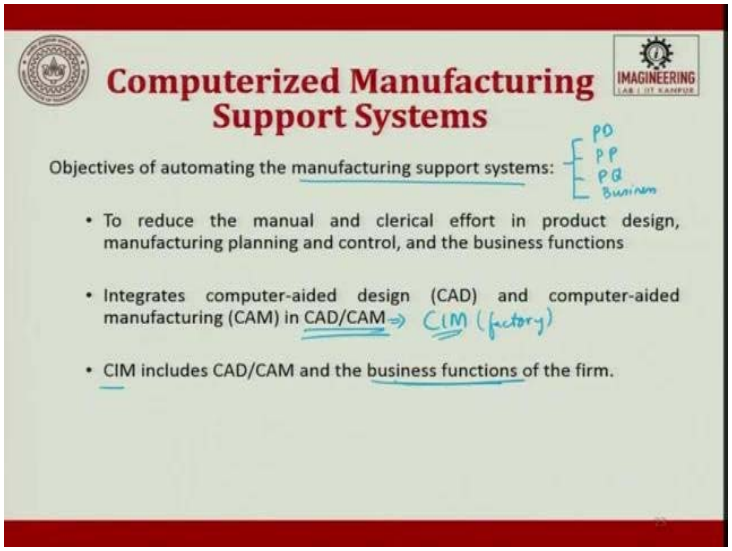

So, the computerized manufacturing support system, the objective of automating the manufacturing support system, what are the support system? I said product design, then process planning then process quality monitoring and then it is business. So now what are we trying to do? We are trying to automate this segment. So automating the manufacturing support system is basically to reduce the manual and the clerical efforts in product design, manufacturing planning, control and business function.

So, when we talk about product design, if we start doing it on your drawing board, so every time when there is an error, we start erasing it. And suppose if I wanted to do a small variation in the drawing, and if I have to regenerate the entire drawing, so then it becomes very difficult. So, today what has happened is every everything has become computerized.

So, you have a single server, where in which all the parts and products are stored and whenever there is a customer requirement, they pull out the library function, look out the existing parts and see how they can tweak which part to tweak such that they can make a requirement for a customer.

So, they make the tweak, and then they put it and store it inside the server, and then they release it as a new product. So that is what is to reduce the manual and clerical effort in product design, manufacturing planning control. Earlier they used to make a control chart which is by manual and every time holding those papers was a problem, today everything is digitized and automated. So, anytime you can pull and then see which part when was it produced? What was the quality variation? What was then status of the machine and the tool?

Integrating computer aided design and computer aided manufacturing, today it has become CAD, CAM together we call it as CIM environment, computer integrated manufacturing where in which you have both CAD and CAM that is what I written it in the next line. And the business function. So here CAD, CAM is at a factory level, so factory level alone is not the end in CIM, we add a business function to it so then only it becomes a CIMS.

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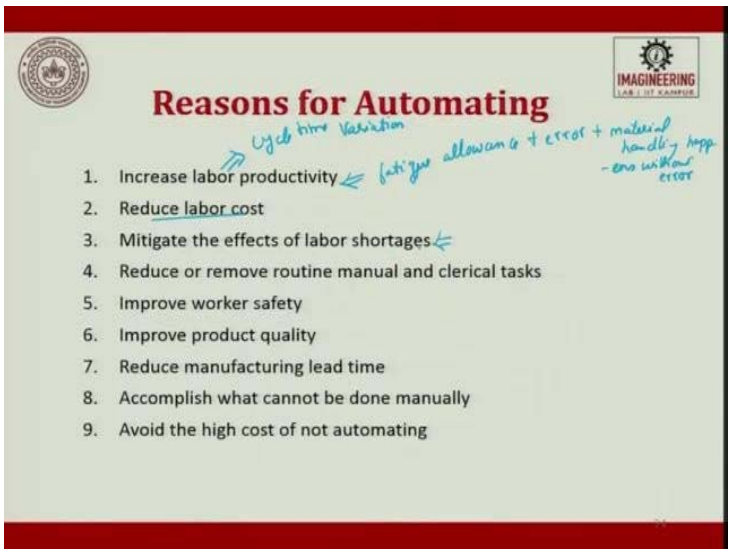

So why do we try to do automation? We wanted to increase the labor productivity. So that means to say that is no fatigue allowance, there is no error which is produced, the material is handled, material handling happens without error. So, no wastage to a large extent it is control. So, this increases the labour output basically what are we trying to say, when you try to automate you will not have cycle time variation. What is cycle time variation? Cycle time is nothing but for producing a part of what is that time required.

So, from part to part from a process to process, you will not have variation. So, when you automated the productivity of labour is increased. Then once you have automated it, then you can also see the labour cost is going down. Today, the labour cost is very high even in third world countries like India. So, then mitigate the effects of labour shortage. In many of the developed countries, the there is a shortage of labour and even today in a country like India and China where there are highly populated in certain skill levels, we still have a shortage of people, even in food processing, even in laddo making, we have a shortage, the skilled manpower is less.

And you can also say this, look at it like from for certain jobs, we like construction, where in which there is a huge shortage. That is why today, you see almost all the infrastructure construction, let it be road or building, it is completely getting automated, reduce or removing routine, manual or clerical tasks. Improving worker safety can happen when you do automate, improve product quality. Definitely, the errors are reduced, manufacturing lead time is reduced because the process computers are involved transferring of data is done fast, it is fast, it is also consistent.

Accomplished what cannot be done manual can be done by automating for example, wherever there is a safety hazardous thing, we can automate it and get it done by the machine and avoiding high costs of not automating all these things are the reasons which are leading to automation today.

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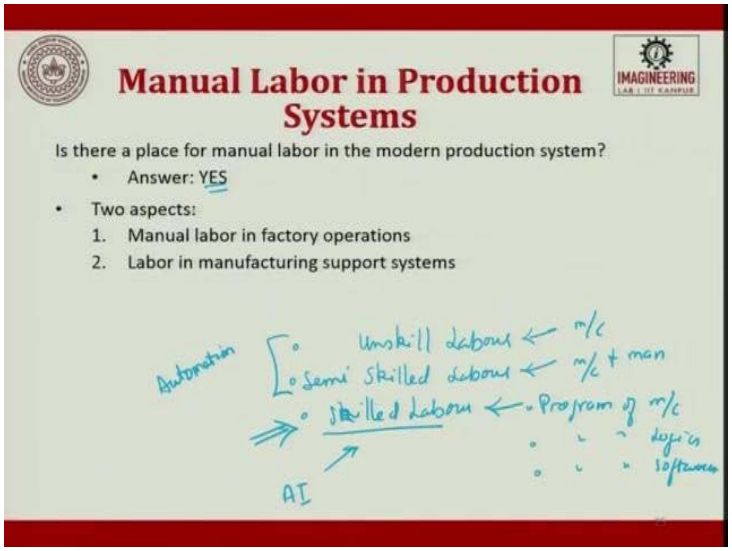

Is there a place for manual labour in the modern production system? Yes, today what human has been moved is, earlier human was doing unskilled labours. Today, they are being pushed to skilled labours. And unskilled machines have taken over skilled machine and man interact and then do. So, now there are something called as super skilled or if I want to change this I can write it as semi-skilled, unskilled, then it can be semi-skilled then it can be skilled, skilled labour.

So, here in which they are so much of knowledge, they can be used for programming of machines, they can be used for programming of logics, they can be used for programming of programming of softwares also. So, you can see there really skilled labour. So, today more and

more manpower is required in the skilled labour rather than unskilled and semi-skilled. When we try to automate we try to hit at this point, automation happens only between these two, even here we are struggling.

So, so today in the skilled, we are slowly trying to bring in artificial intelligence to automated, which is in the way world is moving but still a long way to go. So today we talk about driverless cars. These are all completely skilled artificial intelligence use and the skilled labours are used for programming such things. The two aspects are, manual labour and factory operations and labour in manufacturing support systems are the two aspects which even today people look forward.

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Manual labour in factory operation, the long term trend is towards greater use of automated systems to substitute the manual labour. So again, here we are talking about unskilled and semi-skilled labours. When is manual labour justified? Some countries where the labour rates are too low, we go for manual, where the task in technology is too difficult, we go for manual.

For example, if somebody wants to automate pharmaceutical or I would put this if they want to automate combing of hair or if they want to help in fixing buttons of a shirt where the task is very difficult you need two hands with single hand you can not mount or you have to modify it. So, if you want to do such operations, we is the automation becomes very difficult, then short product life cycle times wherever it is very short for example, it is a seasonal business, and the batch quantity is not so high, so we always go for manual labour, so, shorter product life cycle. So, then customized product requirement for human flexibility, see the most flexible

end effector arm robo arm is our human hand. So, depending upon the force depending upon the orientation, you try to balance the load by yourself and then start doing it. To cope up and down in demands, because today what is happening, if you try to automate, it is expected that the machine should run for one full year, but if you are requirements are only happening here, so or two months, no point in automating to reduce the risk of new product failure, we always use manual labor.

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So, the labour in manufacturing support system the labours are used to design the production equipments and tools and plan the production methods and routing. So, here manually they do, but when they do manually, they lose consistency. When I try to repeat that with the same slides, I give new new set of explanations. So, consistency is not there. So, when when we try to use labour, you will always go up and down, so there will be a small variation, but in products or in process you cannot allow that to happen.

So equipment maintenance where labours are used programming and computer operations labours are used in a big way. Engineering project works they are used and plant management. So, these are the areas where labours are used in manufacturing support systems. For example, going to a customer talking to a customer understanding his need has to be done in labour which is part of the business. So, manufacturing support system even today needs lot of skilled labours to understand the market customer and the convert it into engineering specification such that it can be produced.