INDIAN INSTITUTE OF TECHNOLOGY
KHARAGPUR

NPTEL
ONLINE CERTIFICATION COURSE

On Industrial Automation and Control

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Topic lecture – 02
Introduction
(Contd.)

Good morning now in all these cases what we were discussing is how to produce a particular product better, so that you can make profit out of it so as we have seen that this is typically related to what is known as sort of economy of scale that is if you can produce a product in a much larger volume by using very sophisticated machines then because of the blessings of automation you can gain lot of profit that is called the economy of scale.

But there is a totally different kind of economy which is becoming more and more important in which is first shown its significance in the latter half of the20th century and it is going to be all important in the 21st century and that is called the economy of scope. Now what is the economy of scope to be able to understand that we have to first see look at the look at the manufacturing environment.

So the manufacturing environment today is actually very dynamic now what do I mean by that to able to understand that you have to first understand that.

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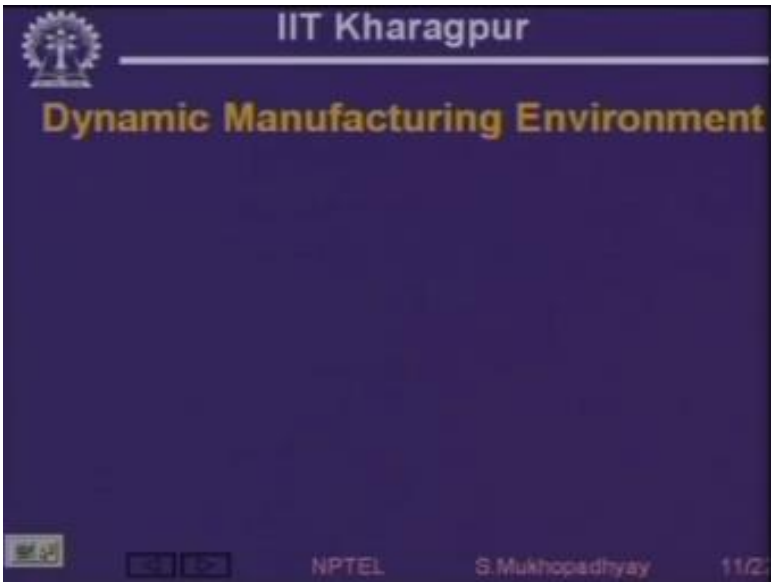

How a given product what is the what is the lifecycle of a given product that is right from the time of conception what are the phases through which it goes so that it finally is produced and sold in the market and eventually dies the life of natural death and another product comes into existence gets conceived gets designed gets manufactured and gets sold, so every given product actually has a has a particular lifetime. So to be able to understand that.

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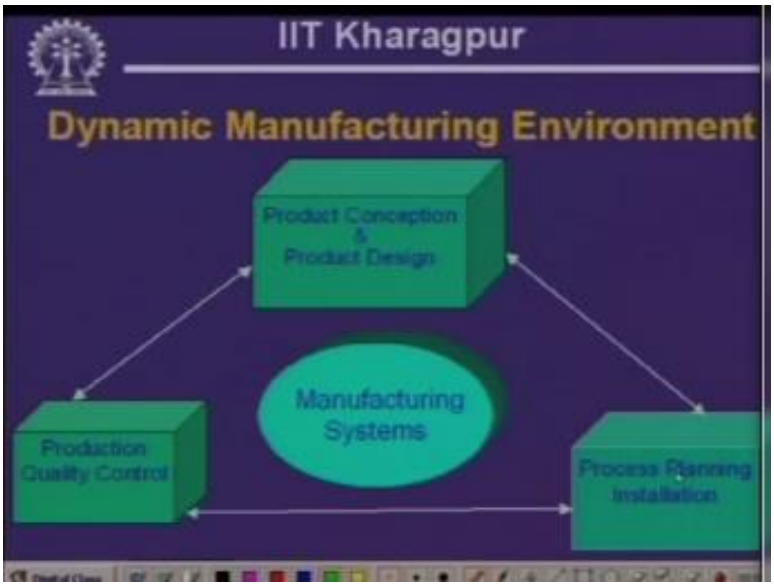

The first phase is product conception and product design right after that you have if you want to so at this stage you have conceived a product that you want to make this thing after that you want to and you have also designed it but once you have designed it you have to actually plan and you have to actually install equipment so that you can manufacture it so you have to set up your factory you have to you have to change your production facility right.

After that you have to actually do production that is when you have to actually do production and you have to do quality control and at this point of time it will go out of the factory into the marketplace and will get sold now in the marketplace from the marketplace you will get feedback you will get feedback of various kinds from consumer surveys plus there is continuous R&D is going on.

So people are going to come up with better material with better manufacturing processes with better controls which will enable you to do to conceive new products which are improved which will sell much larger probably cost preproduction will be less, so you again conceive a new product again you design it again you make process planning installation and again you produce it so you see this is a cycle that a product from its time off from its time of conception up to it up

to it a time of selling has a certain life. Now this life is crucially affected by manufacturing systems.

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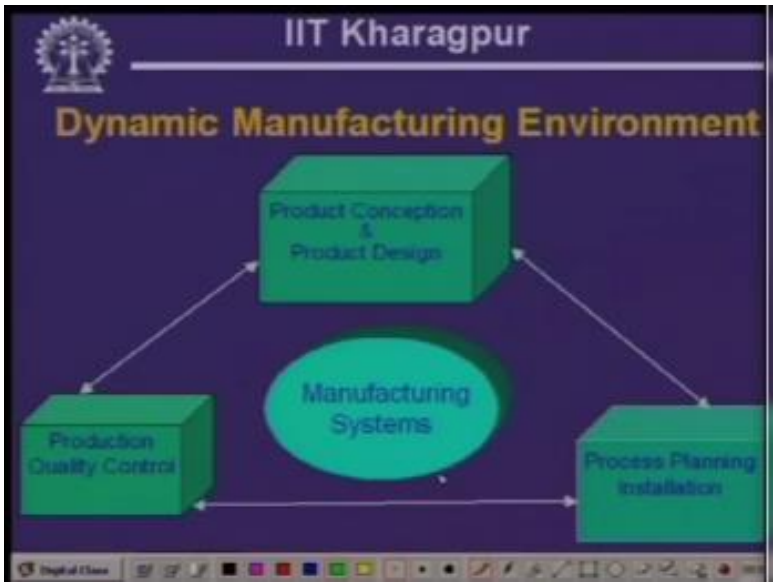

So now let us look at what is happening to this situation, so excuse me.

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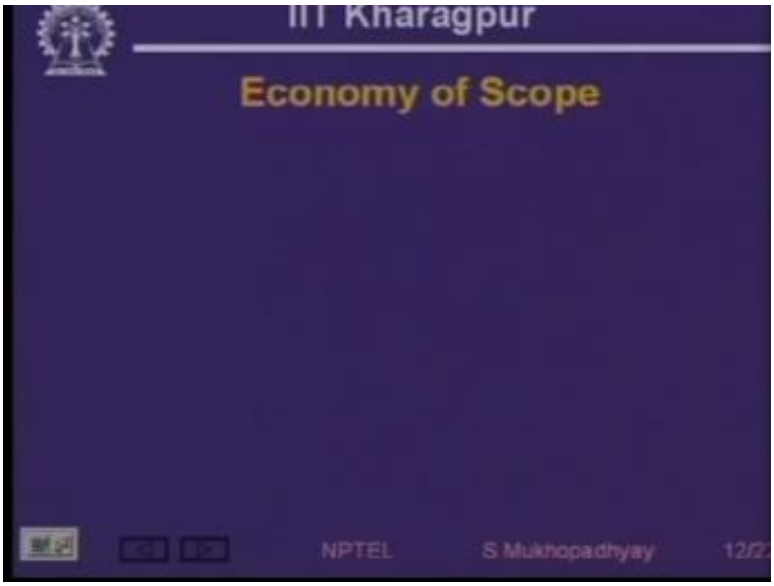

So here we have the economy of scope and what are its features see competition.

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And R&D are continuously causing product development continuous product development is going on so all old products are getting old products are getting replaced by new products and this is continuous right, which means that product for a given product.

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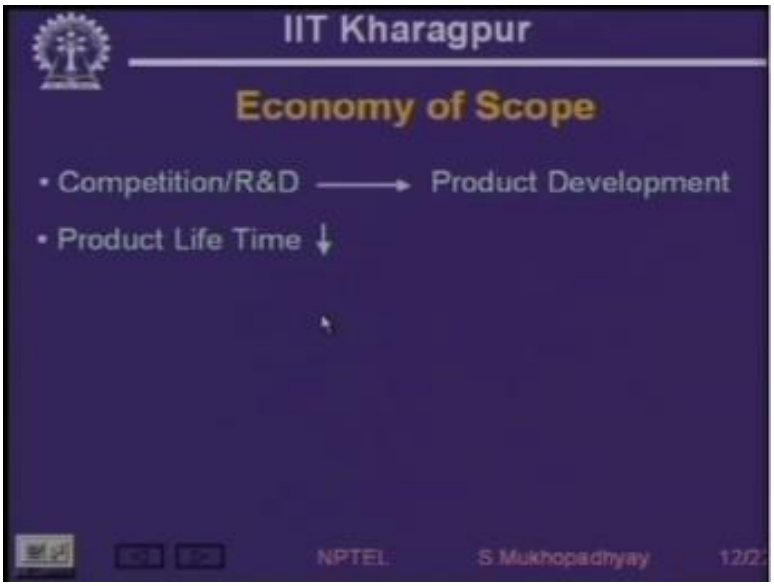

It is lifecycle is getting continuously reduced look at the pc market today roughly in six months time you are getting newer and newer versions of pc change is coming from the cabinet to power supply to motherboard to ram to displays to software every where there is change now these are very sophisticated equipment just imagine that an equipment as sophisticated as a motherboard has to be designed it has to be produced it has to be marketed sold and after six months it is going to be defunct it is going to be obsolete to be replaced by another product.

So within six months it is everything will have to be done product will have to be sold and profit will have to be made so the product lifetime has shrunk dramatically what it means.

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It means that product lifecycle is in product lifetime is less so the whole product lifecycle of conception design process planning installation production everything will have to be accelerated how can you accelerate it you cannot accelerate it you cannot make new and new designs very fast you cannot produce them fast without having without having manufacturing systems.

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Which are rapidly reconfigurable so you have to have machines which will which can today make PCBs like this tomorrow make PCBs totally entirely different PCB s right, so they have to be rapidly reconfigurable and therefore you need so this all these how can I manufacturing system be racket the rapidly reconfigurable it can be rapidly reconfigurable only with the help of what I wish.

So unless you have that is one aspect second aspect is that unless suppose you have built a machine now if the machine is machine very good fantastic absolutely efficient for a product X now you if it is only meant for Product X then you will always think in this volatile market that suppose product X goes out of fashion what is going to happen to my machine I am spending so many so much money on it.

Secondly using this machine if there is not enough demand of product takes can I also manufacture product Y from the same machine so can I explore other markets so can I rapidly reconfigure my manufacturing system so that sometimes I manufactured product X sometimes I manufactured product Y and sometimes I manufactured product Z if I can do that then I can utilize my machine and I can take the benefit of three different markets.

So for this also continue configuration is necessary so this is what is the economy of scope and 21st century automation systems will enhance this economy of scope significantly now let us look at the kinds of the production systems that typically exist there is a broad categorization of production systems.

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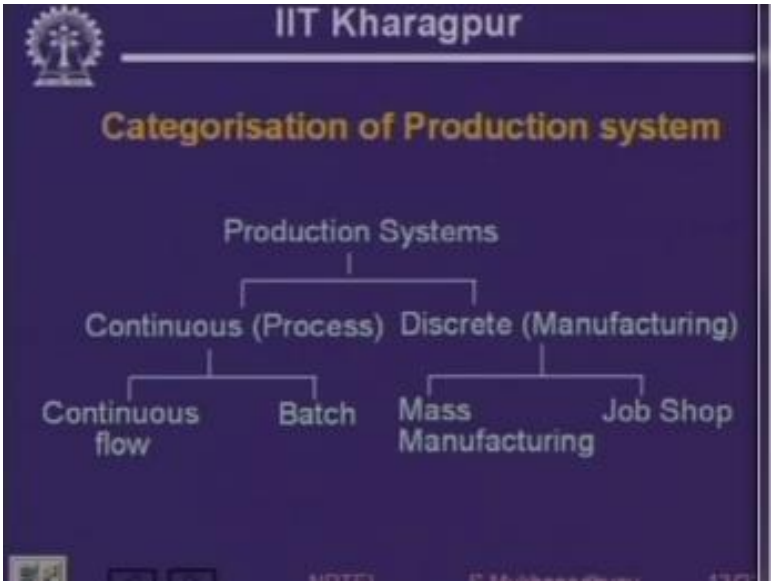

So typically production systems are categorized broadly into continuous processes and so continuous manufacturing and discrete manufacturing so things which you can count as one two three so you have watches you have bicycles this is manufactured discrete manufacturing on the other hand things which you generally measure not as numbers what does quantities like oil steel cement that is a continuous process right.

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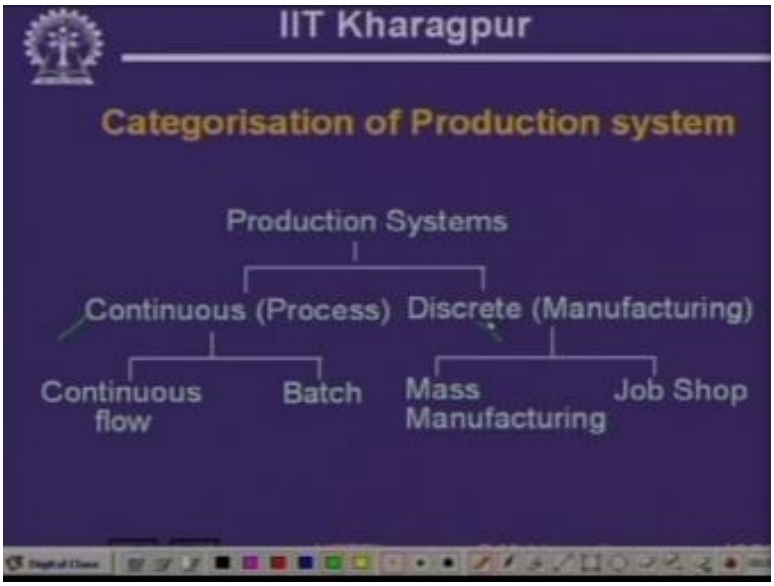

So again continuous processes could be divided into two kinds one are called continuous flow processes typically means that a product is manufactured for a considerable amount of time and continuously a the product manufacturing goes on like the case of let us say oil refineries or the case of steel plants very big factories manufacture maybe four or five kinds of products may be let us say gasoline petrol kerosene these are typical product types of a refinery. Similarly you could have a batch.

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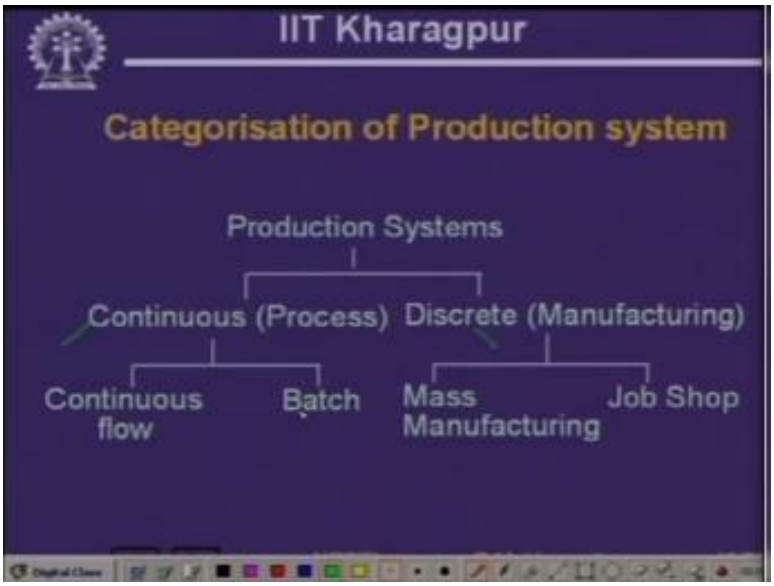

A batch process where the product quantities are more in move when the product varieties are more in number but the product quantities are less typically is pharmaceuticals or let us say pains so you have a large number of products there they are still continuous processes but each gets manufactured in smaller quantities exactly similar categorization exists for discrete manufacturing.

One kind is that where there is less number of variety gets produced in huge numbers let us say by cycles or some appliances some factory produces mixers or produces televisions or produces so on the other hand contrasted to that there is a kind of factorial job shops for example let us say let us say machining factory so every customer comes with a drawing so with a new drawing so every piece that you are manufacturing probably every customer gives an order of 100 pieces 2000 pieces like that.

But every customer comes with unique products which not only involve different geometries but also might involve different manufacturing processes like turning drilling grinding milling and they may be applied indifferent sequences so every job is new so this is the categorization of production systems.

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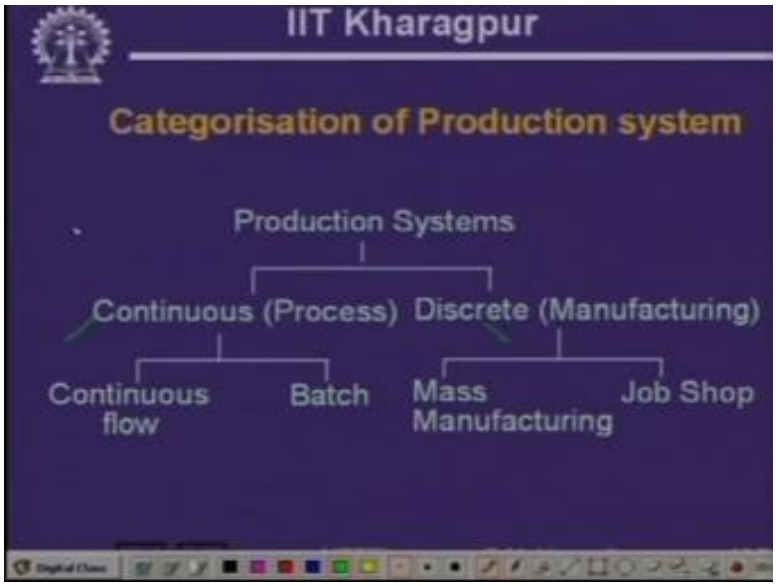

And if you if you organize them then you will see that you will see how they look on the quantity variety chart.

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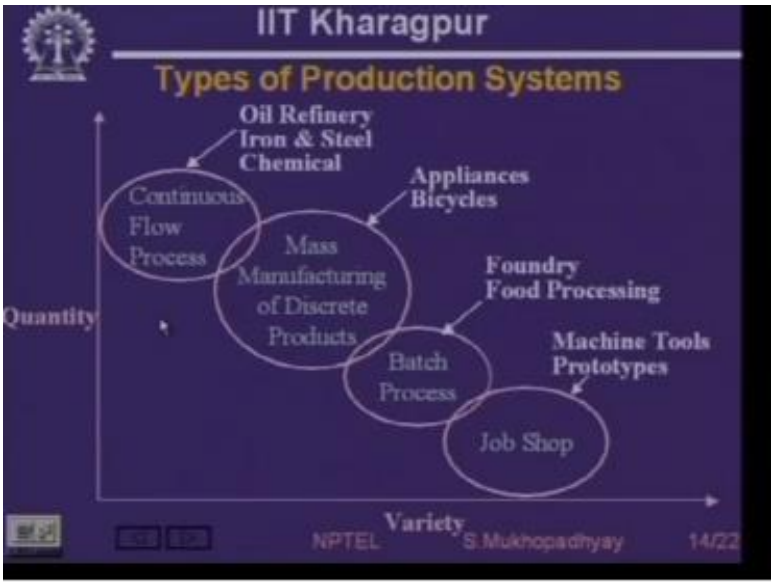

Right so on this side this is there is a graph and on this side you have the quantity for each given type of product and on this side you have variety of the types of product that that factory produces so on the these are so these are these are continuous flow processes where the product variety is probably lowest 3 4 5 but huge quantities of that of each product gets produced so some basic industries like oil refinery error and steal some chemical cement paper fertilizer these are typically continuous flow process on the other hand discrete manufacturing is the.

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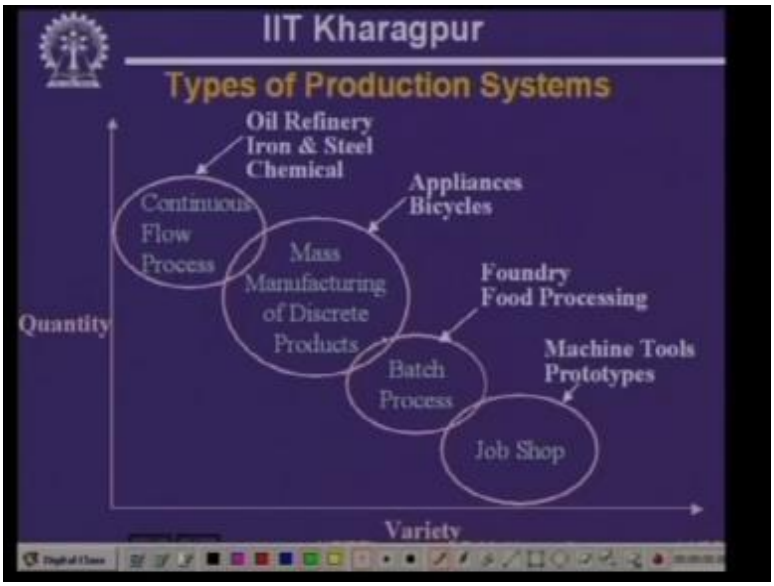

The counterpart of continuous flow processes there you have mass manufacturing of discrete product so appliances by cycles as we have discussed in continuous processing you have foundry shops where you know molten metal gets becomes casting and then casting each casting is actually different casting metals could be different so food processing so various kinds of various kinds of foods get it prepared so here again variety is more each variety production quantity is less and at the extreme you have job shops.

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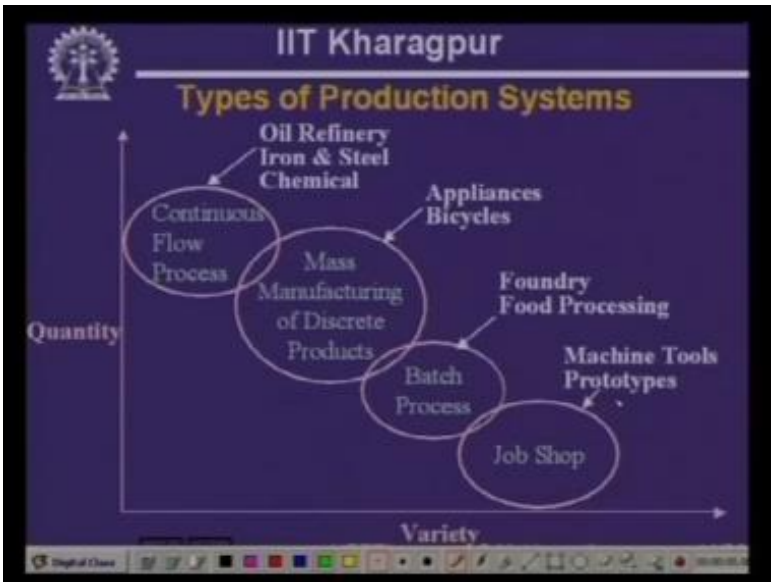

Where every product that you are getting is likely to be a new product right so these are so basically what we are trying to categorize these production systems into are firstly in terms of the quantity that is produced so and secondly in terms of the types of product so the so the flexibility required in manufacture right so now we will see that for these various types of production systems how the various types of automation systems they are each one will be no suitable for given types of industries so. So we have let us see the various types of automation systems again categorized into four types.

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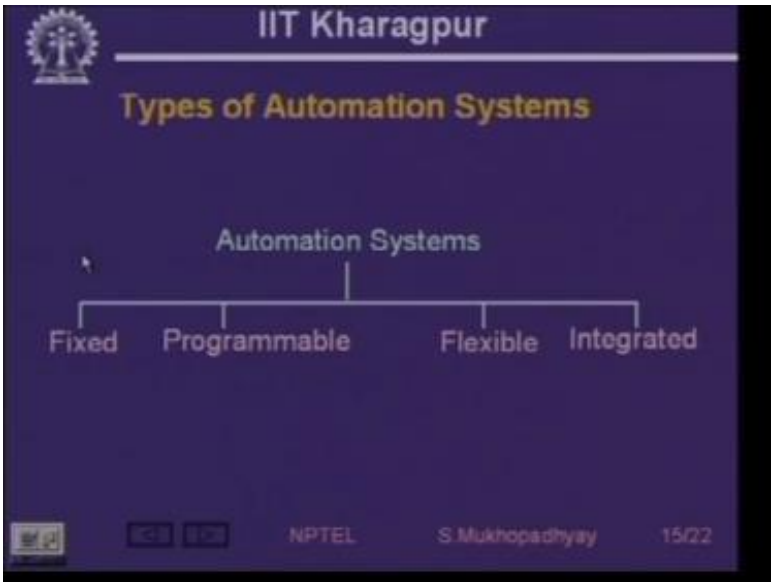

So the first so they are fixed automation programmable automation flexible automation and integrated automation right so let us see what each are so if you go to flexible automation now rather fixed automation first so infixed automation you have what are the features.

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The features are that you have generally used for very high volume of production so you need to really tune your automation to that particular production equipment is very dedicated products.

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Are not likely to change for example the iron steel industry cannot really I mean the product variations is still is there because of metallurgical research etcetera but it is much slower process and generally products life lifetimes are much larger so there you can you can and the volume is so large that by building dedicated equipment you gain so much money that it makes sense to have dedicated equipment which is low inflexibility but very high efficient for that manufacturing process so you have basically you have a very fixed and efficient operation.

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So for example the LSA the blast furnace or the steel melting furnace or the continuous caster these are equipment which are likely to have a long life so and they handled so much of equipment so much of it so much of material so much of energy that it makes sense to make them very tuned for efficient production so factory types are typically.

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Continuous flow and discrete mass productions okay cycles most part of the cycle are likely to live for a much longer time than let us say let us say a fancy watch so examples are process.

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Automation controls for these kind of you know steel oil refinery kind of things for example there are parts of automation which do not need to be changed when there is not much to change it for example conveyors main nearly same always so that is the fixed automation paint shops generally painting is that you need to put the object at one place and you not be you need to jet spray it the paint so the operation itself is simple does not is not likely.

To change very much transfer lines so for example the Maruti800 stays the Maruti 800 for a long time keeps changing but changes are not very significant changes so each part remains unchanged for reasonable lengths of time to make the will make the investment on dedicated equipment meaningful now gradually if you go for let us go for programmable automation programmable automation is one where you need.

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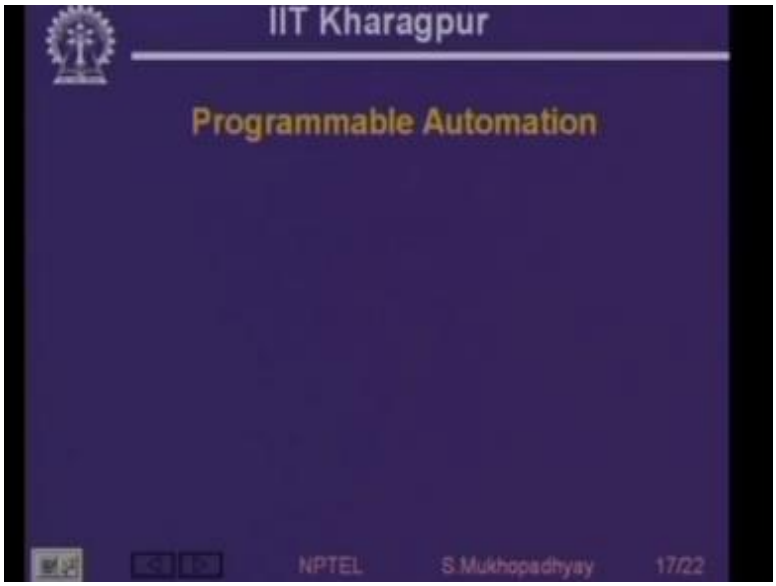

To make changes more frequently may not be everyday may not be every hour but you still need to make change perhaps once in a week or once in a month so since the basic equipment life is going to be much more than a than a month so you need to make it programmable so that reasonably easily you can change these changes sequence of operations.

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So that is so it has changeable sequence of operation and it has electronic controls so that is why it came.

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First it came into existence in numerical controls for discrete production so again you have batch process you have mass production where you still have mass production but you but now your product variety has increased so you need to make changes so it should be reasonably fast probably need not be done by operators but it can be done by in within let us say if you want to change it every month then probably for changing you need to take less than a day that kind of automation so examples will be.

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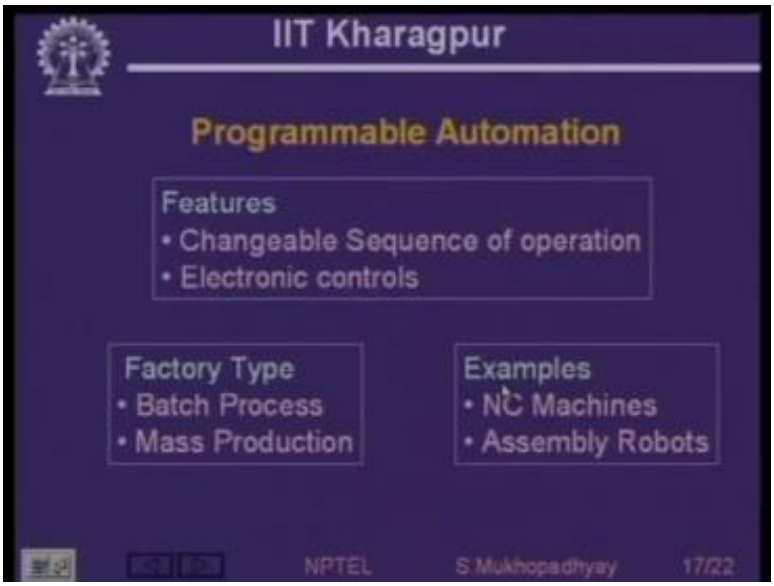

Let us say numerically controlled machines various kinds of assembly logo which will pick apart and put it at a different place so if the sequence changes then this assembly logo also needs to be changed so that it can now pick parts from a different place and place them at a different place perhaps contrasted to this as the economy of scope increases we have various kinds of industries where things will change very fast right so there we have flexible automation so now changes will be made several times in a day and changes will have to be made by operators.

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So and after we made fast because if the change takes time then you are going to lose out on idle time you have to you want to maximize production right so machines are now computer-controlled maybe with graphical user interfaces so that the operators know how to how to operate it and can give very you know many of these changes should be pre-programmed so that he operation just so the operator typically you know chooses certain configurations from a mix makes a choice probably adjust some parameters and the rest is done automatically similarly material handling.

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Should be also programmed because if the sequence changes then parts will have to travel from one place to another and so if you use material handling equipment for which is fixed then you cannot transfer parts from one place to another very flexibly that is why you need programmable material handling so factory types are job shops .

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Where you know every part requires a different sequence and also could be batch processes were depending on you know back sighs the sequence of process operations will change.

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So the examples are CNC machining centers and guided vehicles automatic guided vehicles now still all these that is fixed programmable and flexible they are mainly concerned with automation over a limited special range so you are talking about local automation maybe within a shop or maybe within parts of a shop or maybe involving just one or two machines, now if you want to really control the whole factory in a in a very integrated manner and in a very optimal manner.

Then he then what you need is that you need to exercise this automation you need to integrate all the automation systems and make them coordinated and make them talk to each other so that is called integrated automation .

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Where you have whole factories under automation systems so what are these features first feature these are these are actually this they are the most expensive variety of automation and they are there they are firstly characterized by advanced optimizing algorithms that is there is a lot of knowledge built into these machines they actually do lot of mathematical calculations based on very sophisticated models and there are very few vendors who are who have got that knowledge and they generally do international business.

So international companies like less safe waste alpine they are they are still making consultants and they make they give their consultancies to factories the world over right, so they use very advanced knowledge and algorithms obviously based on computers.

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Then one of the essence of these factories is that they have come a lot of communication so you have to integrate various parts so you have computer communication and here gradually the trend in automation is that production and management must be integrated that is right from these the order bookings at the marketing offices they must be they must be quickly I mean very you know whole all aspects of the business must be harmonically operated.

And so if you have suddenly get more orders immediately material procurement maybe go on maybe going on production facility augmentation go on inventory capacity will be changed so things are tuned and just operate like an orchestra right. So there this is what gives the name of integrated automation so typically this could be applied to.

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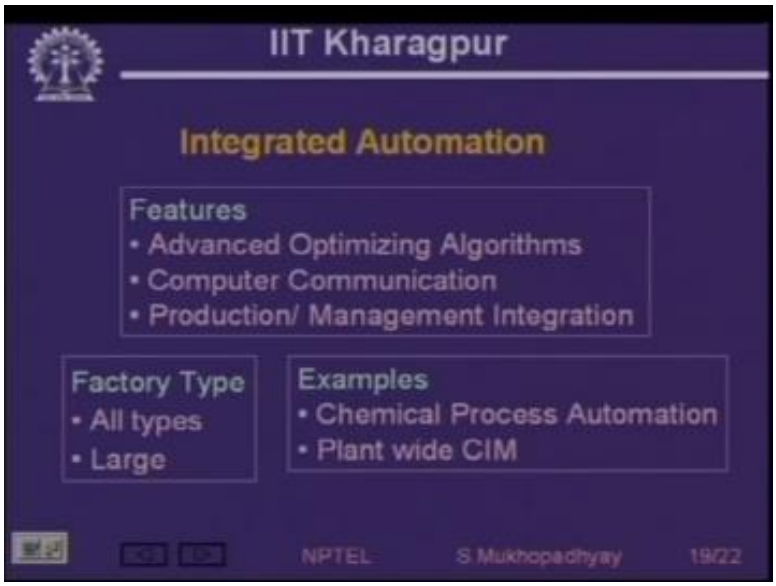

To all types of factories but since they are so expensive so it generally they are they are actually applied to very large factories because otherwise the cost cannot be justified and typical example are let us say chemical process automation big chemical process automations and or otherwise plant-wide CIM which stands for computer integrated manufacturing. So now we have seen that as we go for go from for various kinds of factories you also need various kinds of automation for them.

So for machines in steel plants you may be requiring very fixed type of automation locally but for coordination for example coordination between the steel melting shop and the continuous caster you see in the steel melting shop you are pouring out hot steel so this hot steel has to be taken by a material handling system to the continuous caster where it has to be cast now if for some reason this continuous caster and steel melting shop are not synchronized.

Then you're your ladle in which you are carrying the hot metal and you take into the caster that may have to wait at various places due to various problems and in this process it may get cold and in the continuous caster if there are certain conditions I mean you can only pour this steel into the continuous caster when this feel has a certain temperature so if due to coordination lack

you cannot ensure effective coordination that it may happen that you can suffer very large losses because a particular ladle could not be put into the continuous caster and had to be say put into the slab caster where this steel will sell at a much lower price.

So for steel factories you need one kind of combination on the other hand you nowadays if you have a if you have a bicycle factory there are people are thinking that people will book orders on the net people will assemble their own parts on the on the web and give an order for a customized cycle for that customer so you will choose a particular type of seat a particular type of handlebar a particular type of gear ratio wheel diameter tire type what not.

So every order now becomes a customized order so you see a factory which was essentially mass manufacturing has it is trying to manufacture the same volume but it is trying to increase the variety just to capture markets, so and this is being made possible by very advanced automation so this brings us to the end of our lecture and before we end let us review our lessons so what have we done today we have seen a definition of industrial automation and well we have discussed about automation control .

We most of us know because we have already had a course in control actually got control is actually a part of automation and actually talks about only the day-to-day I mean minute to minute operation giving input getting output that is called control while automation is much larger in scope both geographically and over time and over functionality so we have seen that definition.

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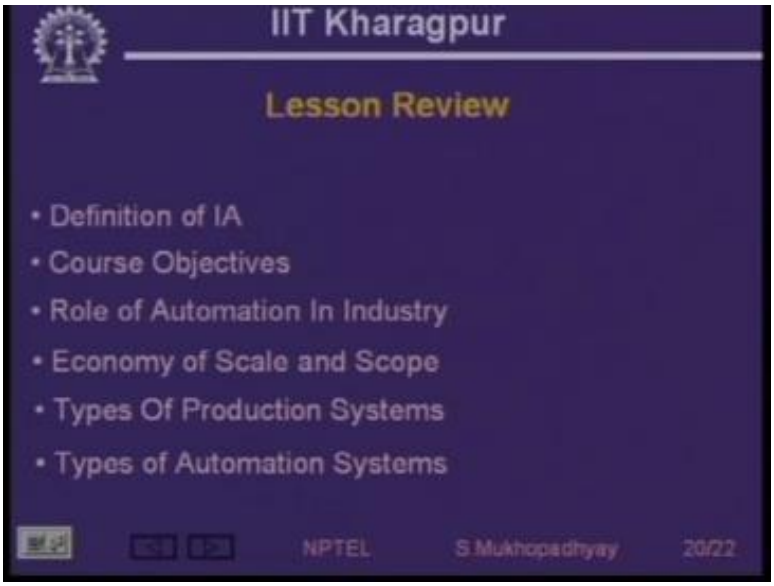

Then we have defined our course objectives we have underlined the role of automation industry and how it can help you on profits we have distinguish between economy of scale and scope we have shown the various types of production systems and they are different types of automation systems so this is what we have done in brief.

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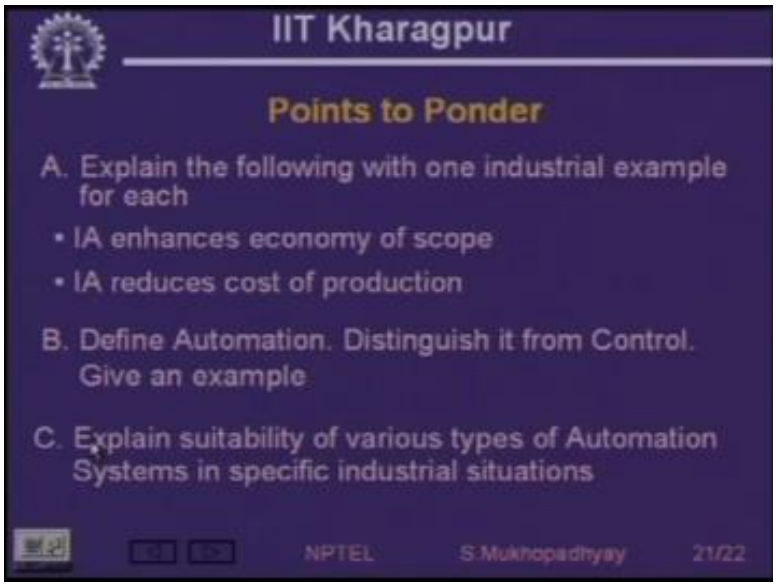

And here are some questions which you can look at for example you can you could try to give examples of how industrial automation enhances economy of scope you can give an example from a particular type of industry you can also enhance in a given industrial context how it reduces cost of production you can define automation and distinguish it from control give it an example or explain suitability of various types of automation systems in specific industrial situations.

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So that is all for today thank you very much in, we will see the architecture of industrial automation systems in our next lesson, thank you very much.