Project and Production Management
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Lecture - 21
Life Cycle of a Production System

Good morning friends, in the last lecture we have talked about the general notion of production and we talked about generalized model of a production system. Today we are going to be talking about the life cycle of a production system. As we aware, the term life cycle implies particular system or a particular entity that undergoes changes throughout its life and therefore you can characterize different kinds of performance characteristic of the system at different stages of its life. In this particular lecture we are going to talk about the various stages of the production system and we will see the kinds of decisions involved at different stages of the production system. Let us broadly try to recapitulate what we did in the last lecture.

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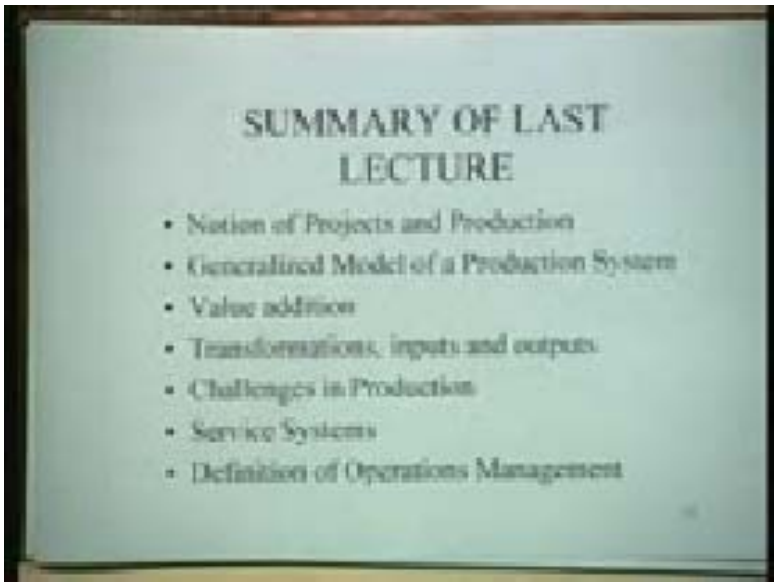

We talked about the notion of projects and production. We tried to distinguish between the two and we found that the projects and production are (Refer Slide Time: 02:36) with each other in real life. Even as you are talking about production systems, you have to carry out many projects like improvements or modifications in the system, and then we talk about the general notion of a generalized model of a production system. I think the key aspect was that the production system is not just conversion of raw material to finish products. It is in fact much more than that and we try to identify some of the other important variables in the context of a production system. Some of these variables, you would recall like the notion of feedback, were governed to a very large extent by consumer behavior, fluctuating fashions. Of course the most important variable was the

environment with its social economic and political components which would influence the production system to great extent. Another thing that we show was that value addition was the central concept in all production systems and in fact production system was designed or is designed to basically add values to inputs and is therefore something very important. We also talked about the notion of inputs outputs and various kinds of transformations. We talked about the challenges in production. Primarily**,** with regard to price, quality, delivery time and various other things coming up as a consequence of global competitiveness. You also looked at service systems, how they differed from manufacturing system and therefore required different kinds of treatment, different kinds of designs and also different kinds of operations. We then ultimately defined the formal definition of operations management system. So with the perspective in mind, let us now talk about the life cycle of a production system.

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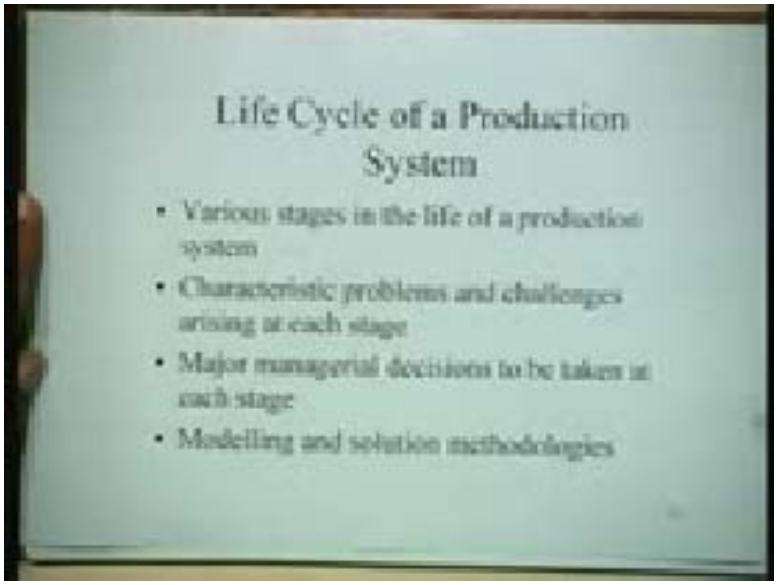

When we talk about the life cycle of a production system basically we are going to be talking about these 4 aspects. We are going to first of all, talk about the various stages that are present in the life cycle of a production system. I think it is important for you to understand as to why we divide the various stages in the life of a production system. Why do we divide them into these stages? What are the specific advantages to manage this division? We know that if you look philosophically at science, it is basically a process of classifying knowledge. You talk about the physical sciences, chemical sciences, we talk about biological sciences, and you talk about the various divisions. So classification helps us actually to understand knowledge to a very large extent. Even great poets like Shakespeare, have divided the life of a man into seven stages and there is a very famous poem called the seven stages of the man, where a particular character in Shakespeare plays describes how a child who is mewling and puking ultimately becomes a lover. He then becomes old and dies. So there are those kinds of classifications. Even in a Hindu mythology or in our Asian scriptures, we essentially talk about 4 stages of life, childhood, youth, middle age, old age. The basic idea is that we are talking about the householder.

We are talking about the householder that is when person is looking after the house is the crusty in the sense of the term. At each stage the problems and priorities are different. As a child you consume a lot of butter and become stronger by playing and we do not have many responsibilities. So your domain of activity is defined by these. When you are a young man entering college, you are more responsible. You have your carrier to look forward too and therefore your priorities have changed. Then you are a householder, your priorities are totally different because you are raising a family. That becomes the major priority and finally once we are through with these stages, the last stage is supposed to be the stage where you are looking after your own self and are trying to discover their reality of life. To do this you take renunciation. Renunciation in the sense, you are basically not bound to the objects of senses. Therefore you are contemplating about the reality of life and trying to determine it. This was in some sense a division of the life cycle of a man and the idea was, you have different stages in life and you require different stages to do different things. That is the important issue that we are talking about. We will first talk about the various stages in the life cycle of a production system.

We will talk about the characteristic problems and challenges that arise at each stage. We will talk about the major managerial decisions to be taken at each stage and of course we will then indicate that once you know the problems, what could possibly be the modeling and solution methodologies that could be adopted for dealing with these kinds of product. You need a specialist to deal with each problem. If you are dealing with a child, you need a pediatrician to deal with related problem. If you are dealing with an old man you need a geriatrician to deal with related problems because of the needs. You have entire disciplines based on these stages. So I think in the similar way, one we can understand that the problems of production systems are going to be different at different stages, we must understand these stages and see what kind of problems are present. This would provide you a perspective of what all is involved in the production system at large. Let us take for instance, the first stage of the production system; a stage which we say is the birth of the system. How does a production system take birth?

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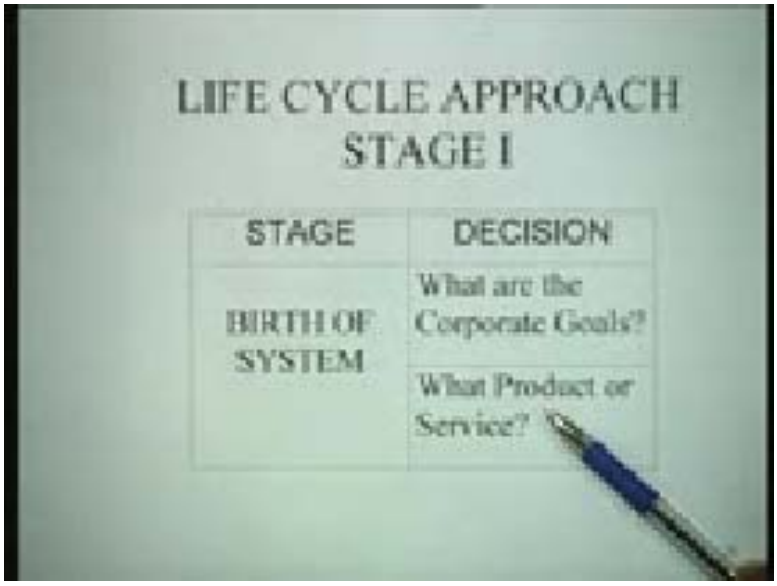

Basically the birth of a production system is determined by some crucial management decisions and these decisions are what are the corporate goals and what product or service you intend to produce? These are the 2 important aspects that we are talking about. The corporate could be entirely different. They could be an organization whose corporate goal is to make money. Most of the organization have this is an objective. If the objective is to make money, they would probably like to for a product or a project, which would probably get the base written in terms of whatever they do. The choice of the product or service is then going to be depended on this objective similarly there could be other service organizations or touristic organizations which are not interested in making money.

They need money. Every organization would need some money but their primary goal might be to provide free service to travelers. To travel haridwar for instance, you will not open a 'Dharmashala'. This is the kind of project or production system that you want to set up. The goal is entirely different and this kind of a goal, the nature of the product, the design of the product, the kind of service that you want to provide would be entirely different. So, one must realize that the birth of the system is something which is intimately linked to the corporate goals. You have to recognize what your goals are and based on the goals you have to decide what products or services you like to produce and that is the major activity that takes place the first stage. While performing this activity, some of the major considerations that management has to go through at this stage are, firstly you have to get future long term trends of growth of various products, is it worthwhile for me to enter into cellular phone technology or is it better to consider entering into housing project. Whatever it is, this kind of a decision is dependent on a very large extent upon the feature term, trends of growth. Growth in terms of which are the new products that enters the market, the new technologies which are prevalent which are going to be dominating this scene. How are consumer preference pattern going to change? This is something very important. Consumer preference, patterns to a very large

extent depends or governs the sales or the demand for any particular product. So unless you are keeping close with the consumer preference patterns, you would not be able to get the wave and therefore it is very important that you determine consumer preference patterns. The industrial climate, its life, kinds of government policies involved, what is the trend of the government in future, which kinds of products and services are likely to be favored, which ones are not likely to be favored, the decisions are not easy.

But the basic data you require for doing this is something of this kind and what you require here is long term forecasting of different types of products, technologies, consumer preference, patterns, and industrial climate. Now if you are able to make a decision, this is how products are growing, the second basic thing that you need in the product is what is the basic desire of the company in setting up this project ? What is the commitment and what is the experience, for instance, there is a company in the software business today. Manufacturing in terms of aluminum is picking up in a great way but the question is because of the expertise in software, it might not like to get into that particular area or it might like to go in particular area. We can pick up specialist in that area and then try to diversify. So the question of whether a company would like to diversify or whether a particular company would like to continue and excel in the field in which it has the experience, itself is a decision.

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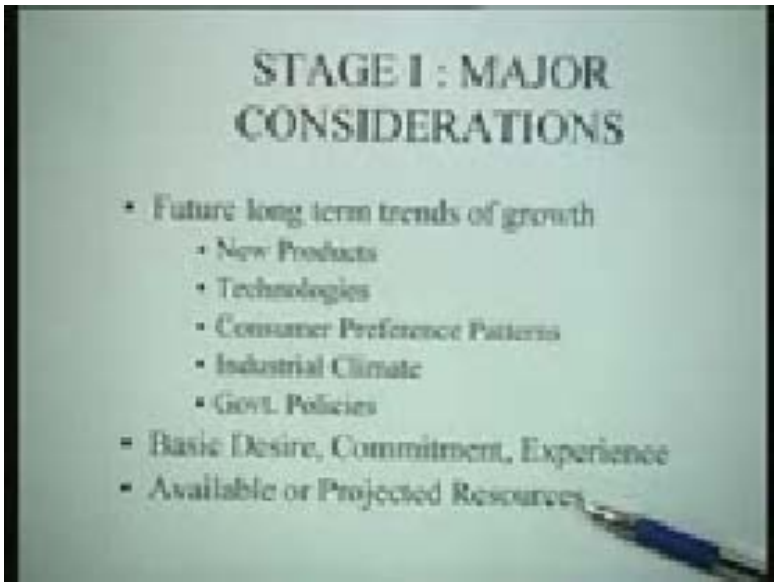

The third major issue is what is the availability of projected resources? How much money can the company rise to set up this new product? When you are talking about rising resources, normally you are talking about not only your homely sources but you are also talking about the amount of resources that you can raise, as a consequence of your own reputation. For instance I am a robber and I go to a bank and I ask a loan of 5 crore. They will shoo me away. However if I belong to the Ambani family, I go to the bank say give me 2 crore now the bank will give me 10 crores. To a very large extent your capacity to raise funds depends on your past performance behavior and also reputation in the market

to a very large extent. So these are important considerations when you talk about setting up a new system. These are the considerations that we will have to be careful about when you select a new product or a service and I think this is the first stage of setting up the production system, giving birth to the production system. Suppose at the first stage, you have decided that you want to set up a cellular phone technology and you want to compete with Reliance or Bharathi or you want to compete with any of these cellular phone providers, you will not set up a new company. The next stage would be a very important stage of what we can call product and process design.

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In this stage, the issues are really designing of the product or service and this design has to be based on the technological design of the product. That is you want to talk about the form and appearance of the product and also, you want to talk about the process which we are going to use in manufacturing these. This would involve production of the appropriate manufacturing technology and the appropriate sequence operations. Normally the decision comes from what you have to make and how you have to make depending on the quantity which we want to produce, the quality that you like to have and on these parameters. You make a choice between the design and the process selection for the new product.

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Some of the major considerations of the product during the design of the any product are, it all begins when customer demands you to have to establish the need for that particular product and what is likely to be the clientele for that customer and for this; you might have to do very appropriate and detailed marketing research studies. To identify who the customer is, what are the specific needs, how he is geographically distributed in this space, and after doing this you have to talk about the product characteristics, what kinds of materials would be needed for the kind of application that you intend the customer to have. Is the product going to be used and in a typical Indian kitchen, where it is going to be wet all the time, you have to find out the appropriate material that you use. You invariably find that in the kitchen many products that are designed at typically low cost product, tend to go back with all kinds of with rough usage. Also with exposure to water they get crowded. If you are designing a product, you have to talk about behavior of materials. You also need to talk about the available processes of manufacture for dealing with that particular material and then you have to clear about the economics.

You have to find out for instances what is going to be your fixed cost, what is going to be your variable cost for different levels of production and how to determine a break even analysis. How to do the NPV calculation; how to find out the IRR etc? So they are all relevant but remember everything goes down from the customer. One of the major problems with typically engineering orientation is that people tend to lose site of the customer and they keep on refining the product that they have done very good surface generation using the latest CST machine and therefore it is very good without talking about the customers. In the design methodology, these days we talk about things like QFD, quality function deployment which means if you talk specifically about customer needs and what you want, you translate them to the product specifications systematically and then design your product, keeping those specifications in mind. So this happens at the stage of designing the product during process selection. You have to be aware of the available technologies and when you talk about these available technologies, we have to

also be talking about the economics of these technologies and also to be talking about the required specifications. That means specifications that the customer wants on your product should comply with these specifications. So the customer gets the right kind of performances from the product in the sets. So this was a broad idea. What happens at stage 2 in the life cycle of a production system is product design and process design. As it is, we said that every stage is special and you would have specialist product design and specialist process design. You would actually be doing these activities for the particular organization. Let us talk about the third stage. Third is the design of the system. So we have talked only about the design of the product and how it has to be made. This was the basic design involved in stage 2.

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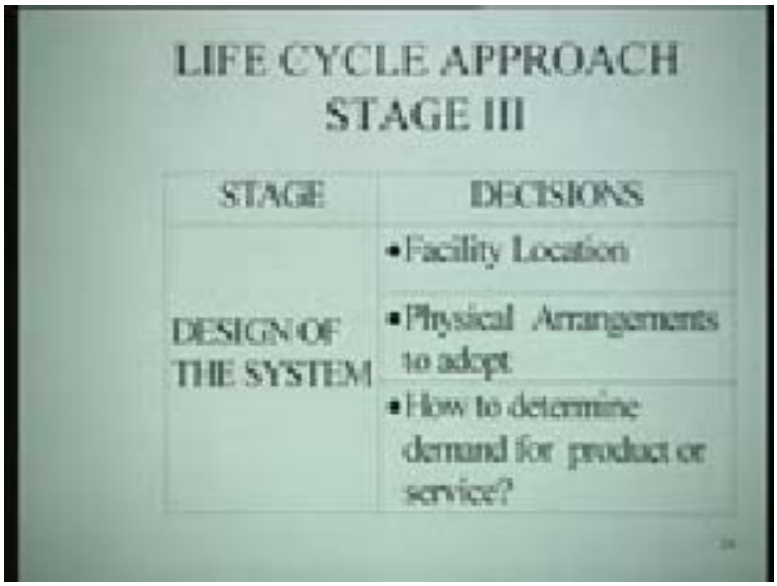

In stage 3; we want to set up a system which will accomplish what we wanted to do in stage 2. So this is the design of the system that shows how to set up the factory. In stage three, setting up the factory talks about various crucial decisions. Some of them are facility location where should the manufacturing plant be located? Where should the ware house be located? Where should the retail center be located? These are optimization decisions which come under the domain of facility location problems. What should be the physical arrangement to adopt? What we are trying to say here is simply that should we set up an assembly line. We set up an assembly line and then there could be various types of configurations we could follow. You could have one machine followed by the next machine, followed by the next machine or in a straight line.

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This could be done in a straight line. What we mean here is essentially that it could be a situation where it could be a flow system where the product comes here and you have one machine here and the next machine here the next machine here (Refer Slide Time: 25:22) and so on and the final products comes out here. Of course you could have variations in the spacing, the same assembly line could also be a use structure where product flows in the u shape and ultimately the final product comes out here. You could also have an L shaped flow, product flowing here. All these could depend up on the constraint the space that you may have. U shaped configuration is obviously more efficient because within the same space you have been able to accommodate more machines. So these are decisions which we have to take with regard to physical arrangements, to adopt and they are what we call as mass production.

We might decide on a process layout or a job shop which would mean that you could have different departments and these departments could be grinding ABCDEF etc. What would happen in layout of this kind is product? You could manufacture a variety of product and each product would follow its own path through the system. So these kinds of decisions on whether we should have mass manufacture or whether we should have a process layout or whether we should go for job manufacture. This is what we mean when we decided on which physical arrangements to adopt and there are different procedures and different algorithms for designing each of these systems. At the moment we are talking about the decisions. Another factor is once you decide the system, then how do we go about determining the demand for product? Suppose you have designed your factory to produce 100 cars a day, but you are not necessarily going to produce 100 cars per day. If your demand for cars on a particular day is 50, next day 62, third day is 150 and so on. There is a fluctuating demand for the product. So you would first of all require a system by means of which we should able to determine the demand for the product or service.

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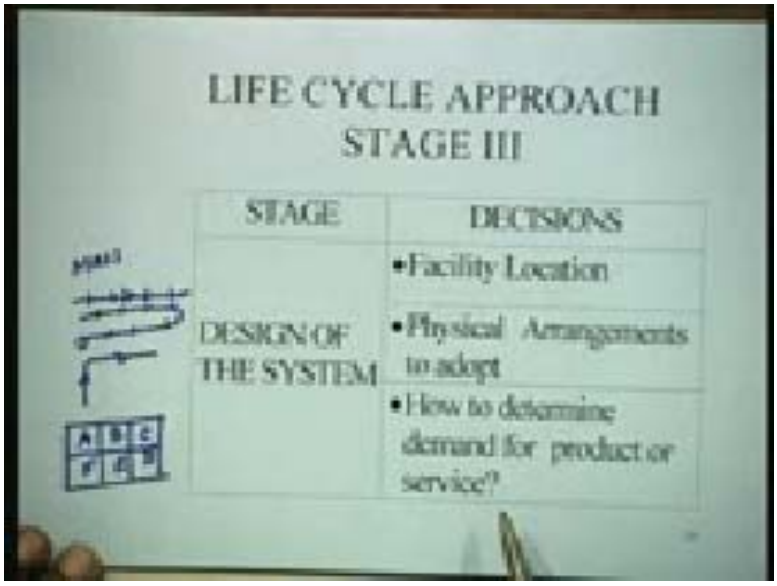

Only when you do this, you can actually plan for this variable demand. So the design of the system talks about some of the major issues and some of the major considerations here. What you have to do is you have already hinted some of them. You normally begin with this stage with surveys and feasibility service to establish the demand of different products, different technologies and so on. Then you would work out the economics of different types of production systems, whether it is using mass production or batch production or job production or project production.

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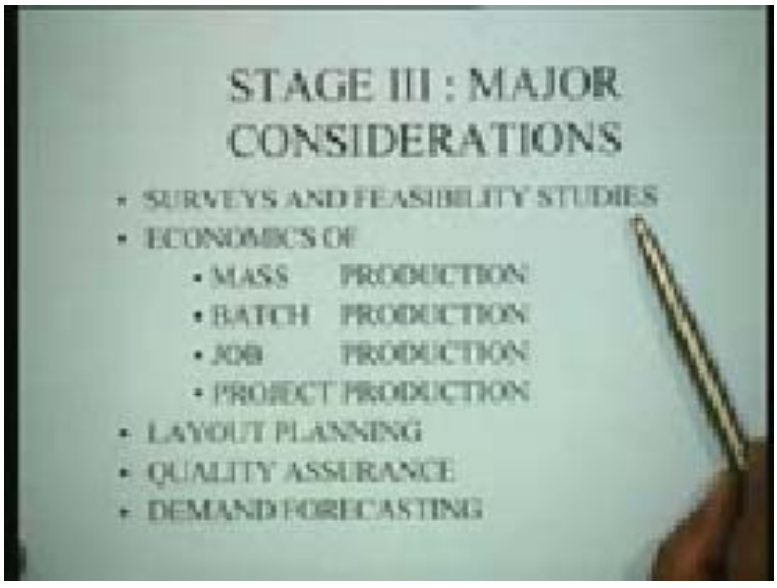

I hope now you understand the distinction between job production and project production. In a project production, the quantity is 1and 1/2 and when you are producing a just the individual quantity, you have to actually plan out the individual jobs and activity and that has to be done to make that particular one. For instance if you are building a flyover at a particular intersection, it is a project. You have to decide up on which are the various activities that have to be done, what is the sequence that has to be followed and then based on that you would determine a schedule which is generally based on a network of when which activity would be performed. Whereas in job production, you have manufacturing facilities for dealing with a variety of situations and the job which come simply and goes the way it likes and it would be quite a chaotic and a confusing material flow, when you are talking of a job production or even a batch production. However when you talk about mass production, the flow would be very smooth. These are the kinds of decisions that you would take.

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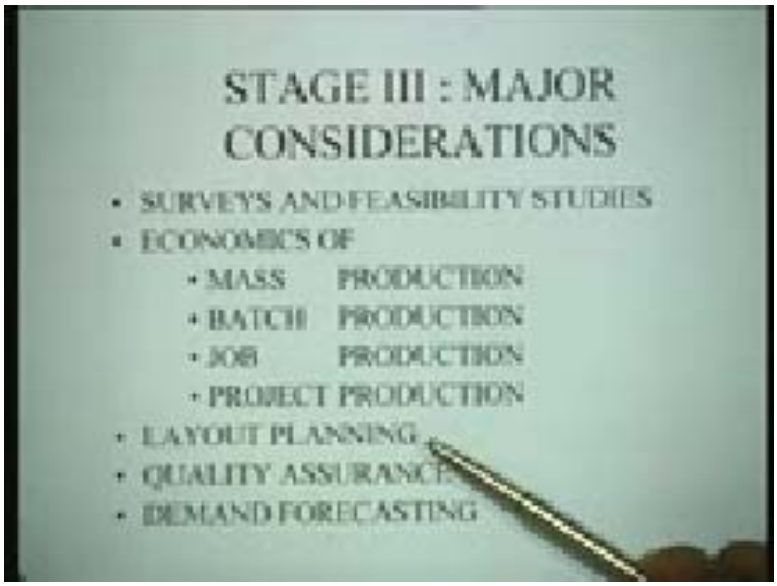

Based on the economics and these features, you do the layout planning. The layout planning is in terms of determining which kind of system to have and how exactly you are going to layout your machines and other facilities within the planning. You talk about quality assurance, how to set up procedure for quality assurance, at what stage do you decide to inspect the product or project and what kind of systems you set up in place and finally no design of a factory would be completed without system of demand for forecasting. This will actually tell you what all needs to be done, how the demand has been varying and once you know the variable demand, you should then be able to think of ways of coping with these.

We have come to the end of the third stage of the life cycle of a production system. Until now we have not produced a single product. We talked about the birth of the system, and then we talked about product design and followed by the process selection. We then

talked about setting up the facility of the factory so the product has not actually flown out so far and it could be considerably leave time there.

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The fourth stage in this entire exercise is the stage of manning the system. It is a very crucial stage because if you are now designing the factory, you must know how different operators and supervisors man that factory. You have to work out the requirements of man power needed at different points, in the factory. So some of the major decisions involved in manning the system are, what job each worker has to perform. So this is job decision. You would know what exactly you are expected to do within the factory. So basically you are designing jobs for everyone who is going to occupy the factory right from the operator who might be assembling some product on a table to the security guard who would be manning your gate to the engineer to someone who would be supervising the various people. You know exactly what each person is supposed to perform. So this is the crucial stage of what we call manning the system. Then once you design the job for each worker you have to worry about how the job will be performed. After all, there is an operator who has to take up some raw material from here, pick up some other raw material from here, assembles the two and then may be put the finished product here. There could be various ways this could be done. Especially as far as your system is concerned, you have to standardize the method by which the process has to take place. As you know, when we are talking about system like ISO9000, the basic job of ISO9000 is to specify or write down exactly how the process performs, from which stage to what stage and what different people are supposed to do unless you document that is as the first step towards quality.

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How will the job be performed? You are probably aware of discipline known as method study, which is the part of industrial engineering. Here you establish the best method for doing a job which means you would specify, the person picks up something with the left hand, he picks up net with right hand, he assembles the net then he tightens it with right hand and places the whole assemble on the bin available in the right side. This is the specification of a method. You could actually be experimenting different methods and find out what are the times and workers for the team that they lead to and then specify an ideal method for doing each job. That is what we mean by method study and there are ways of doing this job. How can it be measured? We talked about primarily, work measurement here. We are talking about time studies, establishment of the time that you observe and the allowances that are there the rating for the operator and then you specify the standard time for each operation.

This is very important because based on these standard times of each operations, you can you actually determine the rated capacity of manufacturing plant. So the issue determining this is basically the domain of work measurement and then a very tricky issue for workers is how will workers be compensated if we have designed a certain specific method? Given that the workers specify time, and suppose it is required to make 50 pieces per day of certain assembly which is subsequently used in the major assembly, what would happen if you make 50 pieces instead of 70 pieces? How will you compensate 70 pieces on a particular day? Or will you not be able to compensate? Naturally you would expect some compensation because you know there is a heavy union behind things. This is one of the very tricky issues involved. So you have to develop what is known as wage incentive schemes. What kind of incentives will be given to workers if they perform at a particular level? All these domains of dealing with human being in the context of the production system is in fact extremely important. The difference between the successful manager and unsuccessful manager in a company is primarily because he is not able to handle the work force properly.

Besides other decisions or other qualities like leadership, motivation and an MBA degree from Harvard that are involved, what is really more important is the true understanding of the problem of the workers and an ability to sympathize with them. But at the same time communicate to them and know what is expected from them and they are paid accordingly. So this is the stage of the manning of the system.

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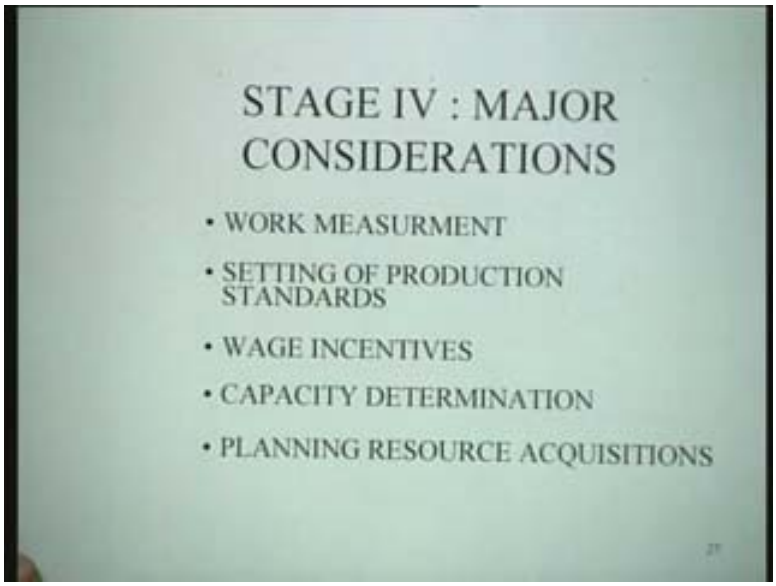

This is stage 4, where we talk about many of these problems which would occur here and of course we have summarized most of these major considerations where work measurement is important, setting of production standards is important, designing of wage incentives is important. The determination of the capacity of the plant is actually a natural corollary of this particular calculation and planning resource acquisitions. There are different kinds of decisions. Managerial decisions are involved at this stage of manning the plant. Let us now go over to stage 5.

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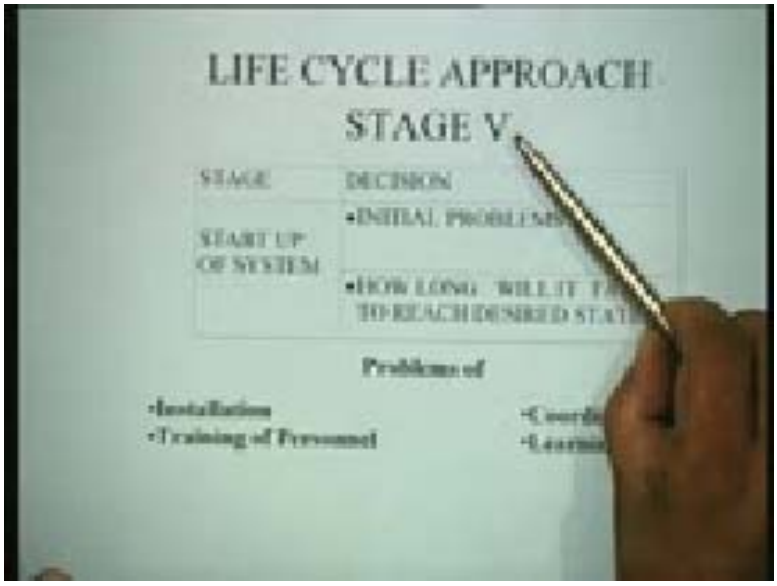

Until stage 4, as I said our factory has not produced anything, we were designing the factory. It took time to set up the factory and so on. This is the stage when actually things starts moving and here we are talking about start up of the system. This stage is start up of the system. Normally this would be the stage, where your factory is ready and you give out the first product.

You then probably call the Chief Minister or Prime Minister to come and inaugurate the plant for you. So it is a stage where we talk about plant of study. At this stage generally, there are 2 major concerns for managements. The first major concern is talking about the initial problem. There are always some initial problems when you set up a new system. You might have noticed when you buy a new computer or you are trying to set up something there are always some problems. Either you have to call the installation guy or you have to call a friend who is an expert at installation. There are always some initial problems.

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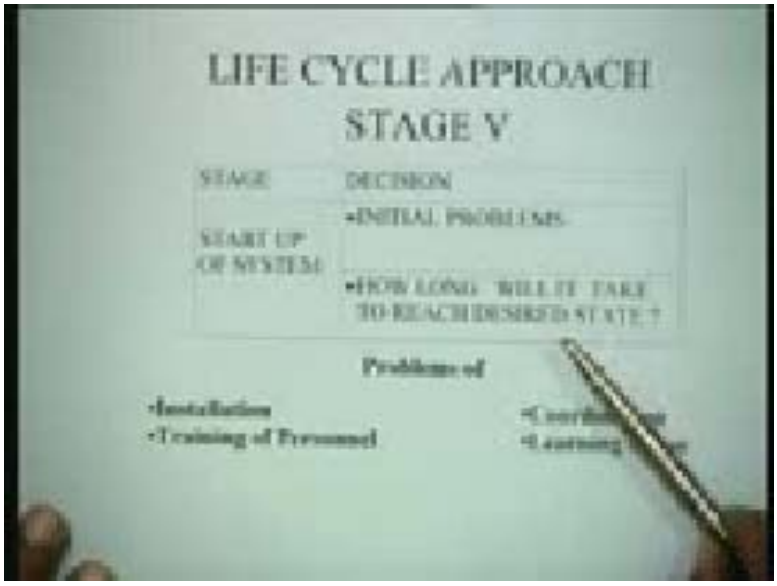

The second issue is that we are talking about in startup is the amount of time it will take to reach the desired state. You see it is a very simple activity that happens invariably. Is it that your plant is designed for a certain capacity? This is the capacity. When you start for production, your capacity does not suddenly reach this regional value, so it might be something like this (Refer Slide Time: 41: 12). What we talking about is this time. This is the time required to reach the desired production capacity and you have probably heard that most companies open up in phases. They have not reached the entire thing. So at this amount of time and this is obvious. How long will take to reach the desired state? This is important because of its economic implications. Soon you start producing more and the higher would be the NPV of returns. Therefore you are very keen to minimize this particular term that senses some of the problems that occur at this stage. You have installed a new machine and at the time of installation here are some problems, either it is not fully operational. The person who was called for installation will have to look into it. Probably there is a faulty connection. These kinds of problems arise commonly and another major problem that arises at this stage is training of personnel.

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We see that in the stage 5, the problems could be installation, on the one hand followed by training of personnel. Co ordination could be a third major problem and the learning phase, of course is an important aspect. Learning phase is when you are introduced to a new system. It takes time for you to understand the new system and therefore there is this problem of learning initial stage. So training, learning, coordination are the problems faced. Various problems are sorted out to some extent and it could be there at a particular stage. These are the problems associated with start up that means if you want to get the factory into operation, you would encounter these kinds of problems.

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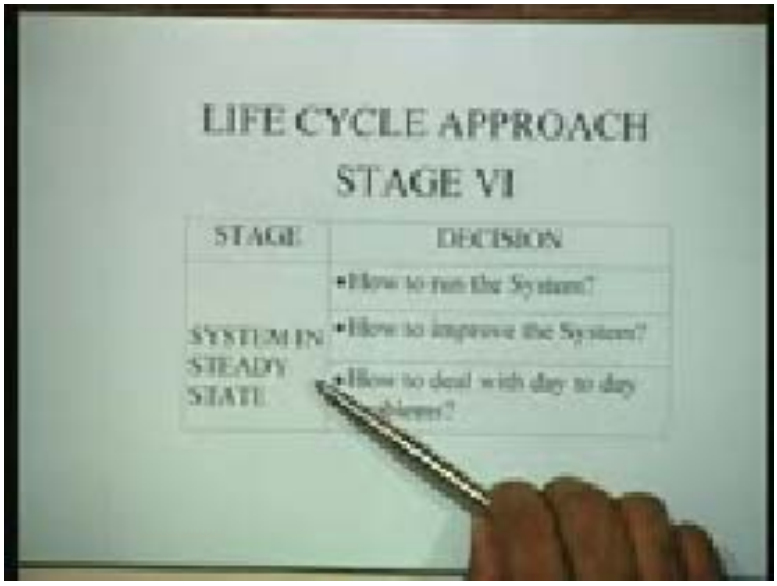

The next stage is the 6th stage of the system, is when the system goes to the steady state. When you join a factory or a production system which is already in the steady state, you might continue to work in the system in the steady state and never get an opportunity to see any of the problems that we have talked about because you spend a life time only in the system which is the steady state. Most of you join companies which are running. What do they do? What are the kinds of problems or what are the kinds of decisions that managers have to take in the context. The major problem is how to run the system? You have to first learn how to run the system which is a major issue. Who are the raw material suppliers? How do you place orders with them and you have to clear the procedures out which are to be followed by them. So, most of the people spend their life doing that. How to improve the system is another issue, for instance if you are an enthusiastic engineer and you join a company. You may be able to find out that everyday there are a lots of accidents taking place at certain location because all is dripping from certain overhead conveyor and everyday you find that 1 or 2 workers have slept or trolleys are slept and they are prone to accidents. What do you do? When the system is in steady state, you have an opportunity to improve the system by may be changing the conveyor or trying to put a better design. Thus, there is no leakage and accidents can be prevented. This is an example of improving the system. Most young engineers, when they join companies after they have learnt to run the system, would actually be improving the system by using their creativity at different places in the system or suggesting some improved design or something similar.

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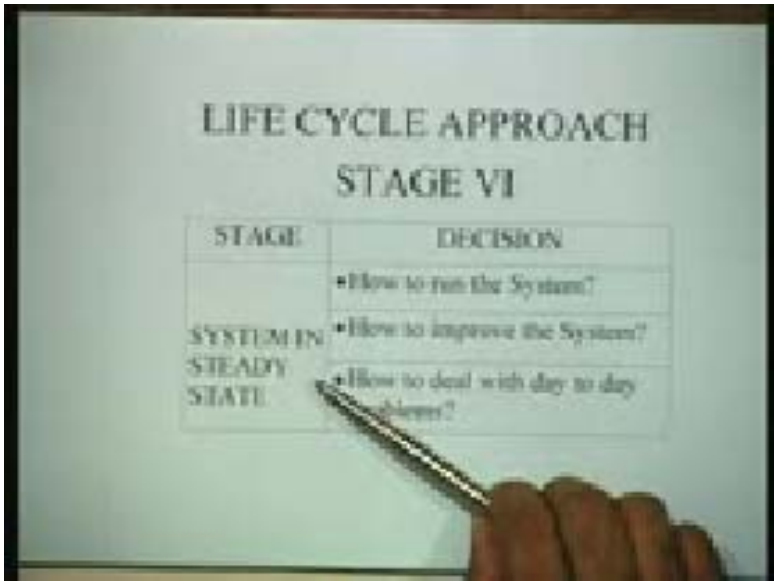

Of course the major issue here is how to deal with day today problems? Day today problems mean that the problems are actually running the system. You are the time that is concerned about issues like running after suppliers, phoning up a particular vendor and trying to get the material sometime or if there are complaints then you are lodging complaints, most of the times. These are typical day to day problems. You are really in this domain of the system, in the steady state, involved with these problems and when you are doing these problems, you can be helped with things like statistical quality control to maintain quality and do various things.

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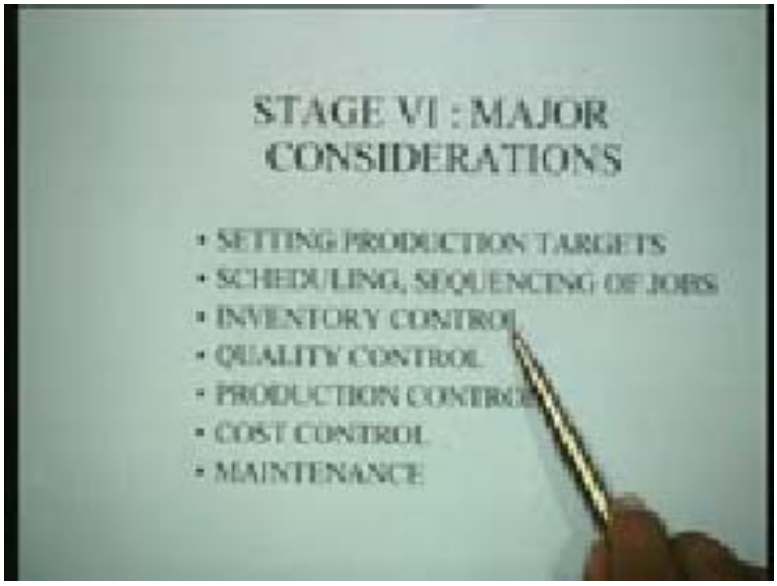

Some of the major decisions here are day today setting of production targets. Everyday setting up a production target depends upon the demand which you probably have as the forecasting system and it also depends upon the capacity which is available. Then you are dealing with decisions like scheduling sequencings of jobs, number of jobs have to be done within the factory. How do you schedule them? Which job to be done, when and what is the sequence in which these jobs need to be done. This is a very versatile area for mathematicians. You can use a lot of models and lot of heuristics. Similarly inventory control, you would like to minimize the amount of inventory that we would have at the raw material stage, at the finish stage and also in the process. **S**o you can talk about what would be the realistic ways of setting your production batches or procurement quantities. You can use economic order quantities and so on. So you find that a lot of mathematical models, tools are available for dealing with day today decisions which are required. Quality control is another area. You can maintain control chards, you can try to determine what exactly has to be done and keep on doing various things.

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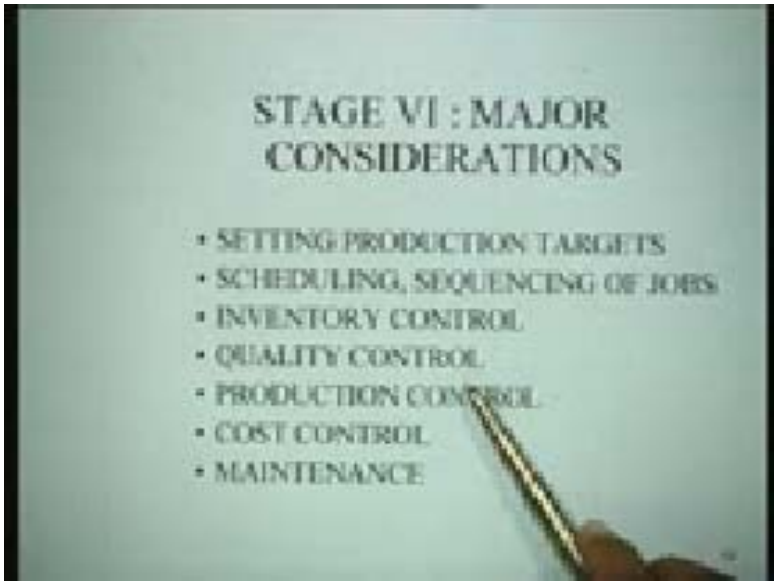

We talk about production control. Production is actually the activity where you are trying to ensure that your operation as per the target, essentially that that what it is. Similarly cost control and maintenance which are major activities at this stage, because when the plant is running, maintenance is one of the major activities. When you talk of maintenance, there should be predictive maintenance or whether it should be to preventive maintenance and whether you are going to do condition monitoring of jobs and use crucial machines to determine the optical frequency of opening. These are some of the major decisions which are involved at this stage, the 6^{th} stage of the production system.

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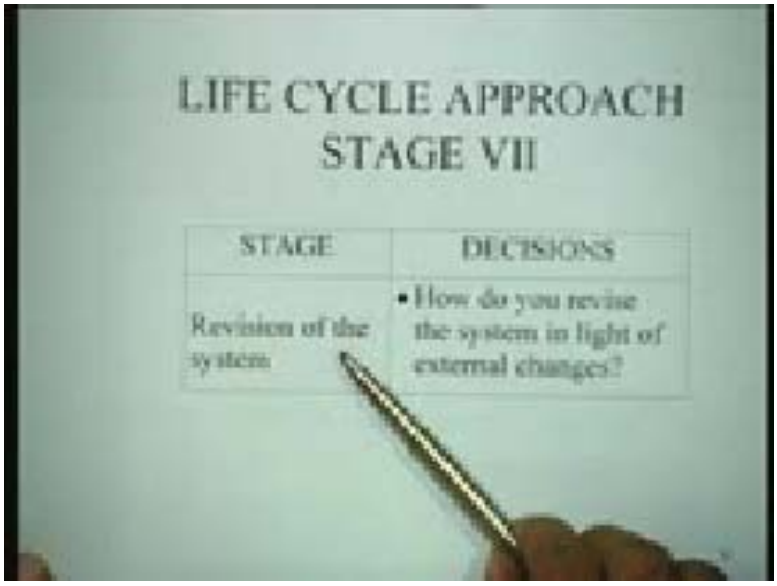

Stage 7 of the production system is what we call revision of the system. The decision here is, how do you revise the system in the light of external changes? We have seen that even when the system is running in the steady state, there are small suggestions which you can do for improvement. Revision is doing something totally different. The kinds of changes that you are talking about in the steady state were actually kyson or day today improvements. Here we are talking about BPR, Business process engineering. We are talking about some significance changes on how to revise the system in the light of external changes. What might happen for instance here is that if you take a company like ITI, Indian telephone industries, previously it was making only the conventional land line phones then it showed that the markets for cellular phones are really growing and this could be a perceived threat to the company.

So what would the company do? One option could be there it could continue to specialize in this landline phones and die a natural death as the case may be. It could diversify and try to make cellular phones along with the system and do both these. This is what is meant by system revision in the context of the term. An important thing to note here is that companies do not make this decision often and for instance, the Swiss watch industry is famous for its watches, is now gradually dying a death because there are very good electronic watches available, very cheap Japanese cigo and others which do all the jobs that you do not have to, that is the situation. We are not revising the system. Of course there could be advantage in antiquity, I mean it can become antique therefore sell your product price. But at the final stage, when we are talking about the 7^{th} stage, we have therefore talked about like technological threats and opportunities, revision of market demand, newer product, technological innovations and newer methods and manufactures. All these have to be considered when you are thinking in terms of revising the system.

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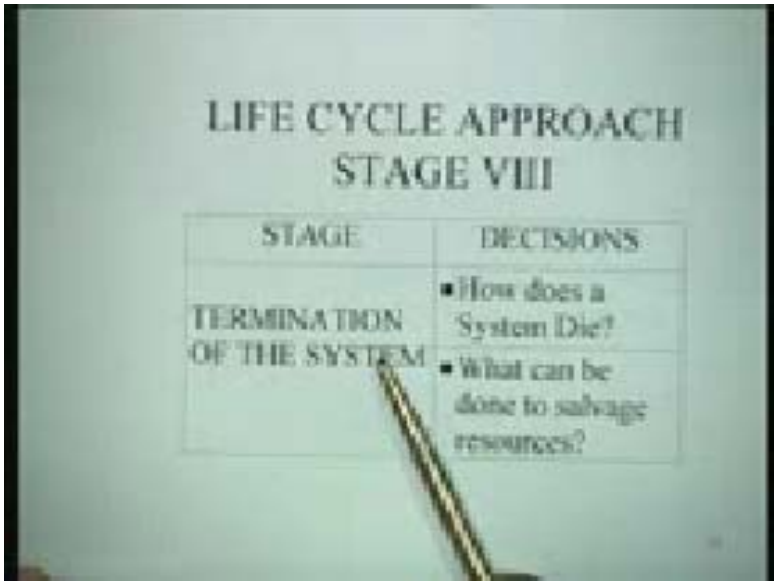

The final stage of the life cycle is the stage 8, which is the termination of the system. At every stage any factory has something to be dumped. So here again the difference is very obvious in the sense that just as a human being, you do not decide when you are going to die, it is pre decided. End of your life could be sudden. In the case of manufacturing system, how the system does dies is a managerial decision and what can be done to salvage resources is also managerial decision.

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When we are saying how a system dies, there could be different ways dying. You could think of manner of phase out over the next two years we are going to phase out the

product and therefore the system will die. You can work out the economics of this and do it. Second thing it could totally sell out to another company or merge with a company. Camp a cola of India died by merger with coca cola. It was the economic decision based on the part of the CEO of that company. You could also start a new product in same thing and the old product automatically dies. So in that sense remember even the death of the system is basically the economic decision and you have to work out what is the best way of dying for the manufacturing system and adopt it.

Finally I would like to summarize what we have tried to talk in this session. We have looked at various stages in the life of the production system and we have identified 8 different stages. We have tried to identify characteristic problems and challenges which arise at every stage so that you know that at this particular stage, these are the kinds of problems that you will be facing. We have seen the managerial decisions to be taken at each stage. The courses of production management is the study of managerial decisions to be taken at different stages and what helps you take the decision is modeling and solution methodologies available for modeling the problems at different stages, followed by developing the solutions for the various kinds of problems. In our next lecture we will try to have a glimpse on the role of model in production management and see different kinds of models would be helpful for different kinds of production systems.

Thank you