Project and Production Management
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Lecture - 26
Economic evaluation of new products and services

In the last lecture we were talking about introduction of new products and services and we had identified various aspects that should be considered in that analysis. For instance you would recall that we looked at the marketing aspects, the product characteristic, the aesthetics aspect, the production aspect and we had indicated that as perhaps the most important aspect. The evaluation of the economic aspect in introducing new products and services is the theme of today. In this lecture we shall look at a particular financial criteria relevant for evaluating new product and service launch decision and we shall also see how different kinds of economic analysis can be conducted to find out the best from amongst various products and also to find out what could be done with reference to individual products to improve their profitability. One can broadly talk about two kinds of economic analysis. The first kind of economic analysis we have already talked about which is gross measures of cash flows these are extremely important because what we try to do here is we look at the entire life cycle of product and estimate the cash flows over the entire life span and then measure the worthiness of the cash flows in terms of computations like the net present value, the internal rate of return or the payback which are all essentially measures of return or the performances of the cash flows over time. Another important thing that can be done with the cash flow analysis is finding out the loan disbursement capability which means essentially to find out whether the cash flows are adequate to return a particular loan.

So financial institutions typically are interested in this kind of analysis and a figure called death service coverage ratio is something which can be computed on from the cash flows to determine the loan paying capability of a particular investment. Then apart from this we can be talking about risk evaluation in probability terms. This is something for instance that we did with our decision tree analysis, where you can identify the quantum of risk involved through subjective probabilities with various options and with various outcomes of a particular decision. Now apart from these, one is talking about economic analysis. One can talk about annual measure of performance and in this category things that are important are the characterization of costs into fixed and variable cost. Fixed and variable cost essentially depends up on a bifurcation of cost into the category that do not depend up on the production capacity and a category that depends up on the production capacity.

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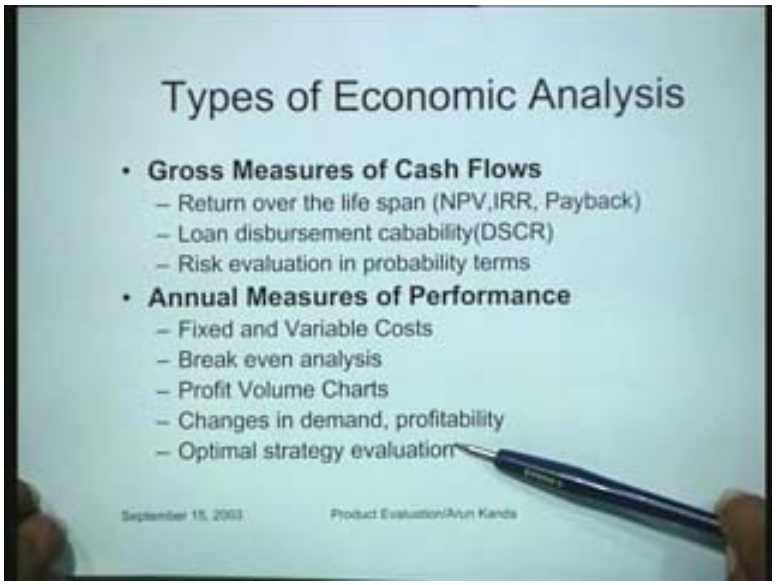

So if you can do this then you can do some very useful analysis. You can talk about breakeven analysis; you can talk about profit volume charts for products because profit is one of the major parameters that the management may be interested in. You can also investigate the fact on the profit of changes in demand, changes in profitability and all this analysis can help us in determining the optimal strategy evaluation. So essentially in this lecture our focus is going to be on these measures of return or performance for new product and service appraisal. Just to recapitulate, when we are talking about gross performance measures our input is essentially the stream of cash flows. So we know what is the investment what is likely to be the return in the first year, the second year and so on over the entire planning horizon of the product or the service and this stream of cash flows is generally used to derive a number of important financial parameters like the net present value the payback period, the internal rate of return and a variety of financial ratios, like typically we might have a benefit to cost ratio or we might have a death service coverage ratio.

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So a benefit to cost ratio would tell us the quantum of benefit over the entire life span divided by the overall cost, so if this ratio is greater than 1 only then would a project be worthwhile. Similarly we are talking about the death service coverage ratio which measures to a very large extent the capacity of the cash flow streams to return the installment on the loan. Financial institutions are very concerned about this and they normally sanction loans only when the death service coverage ratio is greater than 1.5 or close to 2. Similarly when you talk about risk evaluation in products what really happens in risk is that there is uncertainty as far as cash flows are concerned. You do not know exactly whether your investment is going to 5 lakhs or 6 lakhs, but you know it could be within this range. Similarly you know that your returns in the first year could be 2 lakhs or 2.5 lakhs as the case may be. Similarly you have ranges for each of the cash flows and various years. So you have essentially uncertain cash flows with some estimate of the degree of the uncertainty that is likely to arise in each of these cash flows. Normally what is done is that this kind of a situation is typically projected in terms of two or three different scenarios. You can talk about an optimistic scenario obviously the most optimistic scenario would be when you have the least of cost the maximum of returns throughout. Similarly you can talk about most likely scenario which would be somewhere between the extremes and then you can talk about pessimistic scenario in which the cost would be high the returns would be relatively low and you can do the analysis on this basis.

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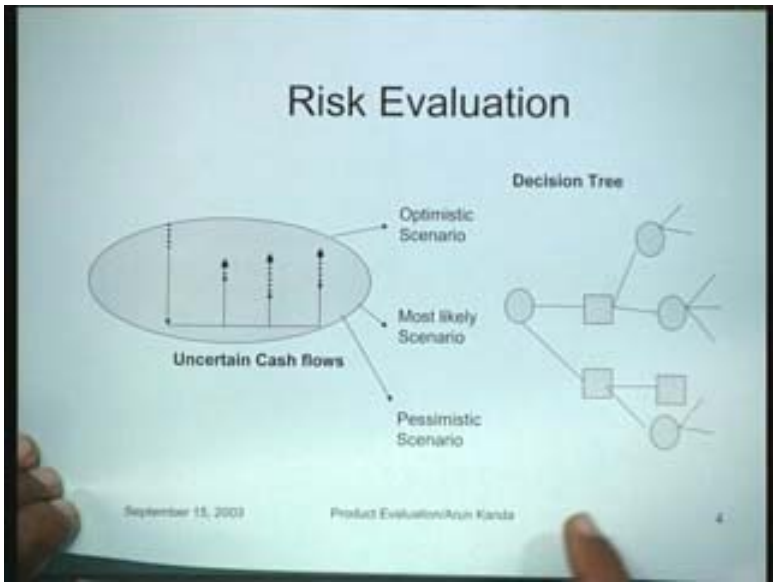

Quite often this kind of analysis once it made in terms of these scenarios can be analyzed in terms of a decision tree and a decision would have decision nodes where you can choose your course of action and ultimately when you encounter a square node or probabilistic node, you would face this uncertain option, so you would know the probabilities that you land up on this branch or this branch and so on for the tree. The tree could then be evaluated in order to determine the best strategy and also to quantify the risk because the risk is nothing but complete consideration of the probability distributions of outcomes corresponding to a particular strategy. So this is the manner in which we could completely talk about risk evaluation which is a very major concern in the introduction of new products and services.

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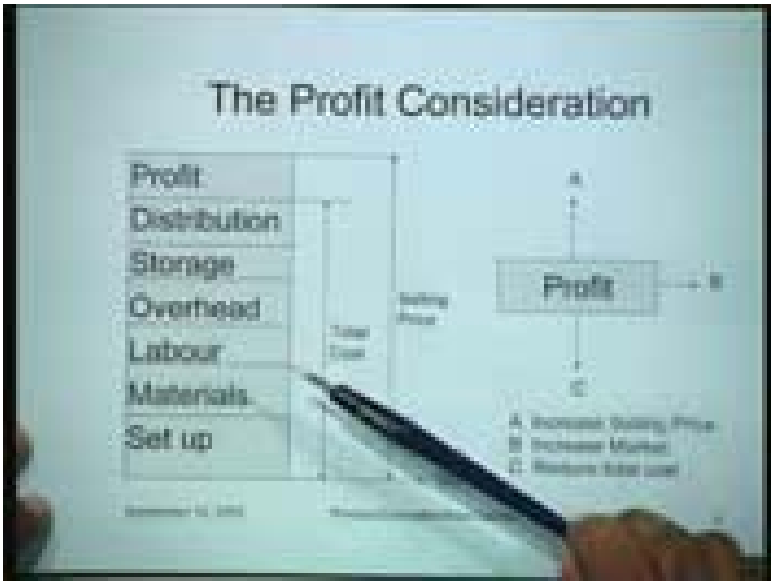

Now if we come to the topic of annual cost within a project typically what happens in the profit consideration for any company is that the costs are typically built up of a number of layers and these layers are for instance you might have set up cost. Set up for various machines you might have a cost of materials which you procure for production you have a cost of labor then you have overheads on these costs, then you have cost of storage, then you have cost of distribution these are the various layers which are there. So the total cost up to here is the total cost of the product assuming for the time being that I am plotting quantity this side and the cost of profit on this axis. What really happens is that this is my selling price in terms of this product that I am trying to sell the difference between the selling price and the total cost will in fact give the profit margin per piece. Let us look at this profit rectangle in greater detail.

Let us look at this profit rectangle here. In fact the objective of most companies is to increase the area of this rectangle and is not it quite surprising that most production managers and others CEO's of the company are actually hired to basically maximize the area of this particular profit rectangle? Let us see if were to maximize the profit because that is one of the major concerns of the organizations. What are the strategies that it can follow? You can think of basically three pure strategies. You can talk about strategy A which means increase the selling price, if you increase the selling price the top line would go up and therefore you expect the area that is the total profit would go up. But this is not a very good strategy. Why? It is not a good strategy because if it is a competitive world like it is today, the chances are that you would lose out on sales. Your market share would tend to drop if you increase the selling price. So what will happen is that this side of the profit rectangle will tend to fall so what may happen, what started out as an exercise in increasing profits may in fact land up into an exercise in reducing profits and therefore this is not a good strategy. Although this strategy would work well in the situation where there is a monopoly, people are forced to buy your products. Then you can keep on increasing the selling prices which is what you want and there is no

competition and therefore this kind of movement of the side line to the left would not take place. But in general it would not be a good strategy.

Let us look at the case B if we try to increase the market how do you typically try to increase the market? One way can be to reduce the selling price, advertisement could be another way. You put in greater advertisements, you offer greater incentives, if you are talking about variety, it could be variety. But if we are talking about let us a say a particular product, if you introduce variety may be the property would be shared between the two products. So that also may not work well. So this will be a costly proposition to some extent. All this would lead to is if this could be done in isolation, it would be good strategy but what happens is the cost set various levels. The cost of distribution the overheads the other things the account that you offer will tend to increase the cost and this portion will try to move up and therefore this strategy would be worthwhile only if the increase in sales, more than compensates for the increase in additional cost of advertisement and offering discount and things of that kind. Mergers and acquisition could be there but here we are talking about a particular product merger and acquisition would essentially help in reducing competition that is what will happen. Take strategy C that says reduces the total cost.

That means if you look into your own operations and try to cut down cost wherever there is flap cut down make distribution more effective, make storage more effective, make overheads reduce the overheads, cut down cost of labor providing better methods, cut down cost of materials by better design cut down the set up with better machines and things of that kind if you do that then you would definitely have a situation where the cost would go down. If costs go down, there is no negative effect on either the selling price or the market force. So whatever you gain in terms of the selling price tends to be bigger rectangle here and you are directly heading for let us say riskless strategy which will need to increase profit. In fact if you look at the situation of the American auto market and you see how Toyota entered the American auto market. What did they do? They actually played with this strategy C. What did they find? They found that they could reduce the prices by virtue of their better quality control and another thing and bring down costs.

So there were much more comparative as compared to the American auto manufactures so a lot of people started shifting to the Japanese cars that is Toyota in that sense. When they shifted like this the profit went up now. Toyota did another interesting thing they said that when this profit margin was increased, they passed on the benefits of increase profit margin to the customer that means they lowered the selling price of the cost. If it is gone down by 100 percent they would bring it down let us say by fifty percent something like that so as a consequence their market went up even further and there came a time dominated the American market and general motors and ford motor company were at loss because they did not know what to do so it was basically the operation of this kind of a strategy is c followed by passing on the benefits to the customer that is reducing the selling price reducing selling price if you cut down your cost and in that manner the sales increased tremendously and could increase their profit, So some interesting strategy to increase the profit depending up on the situation at hand could be thought out by looking

at this profit rectangle and seen what could be done under the various circumstances in that sense of the term.

We can define the term called the competitiveness of a product any product we define competitiveness and competitiveness is nothing but the fraction of the market captured by the product. If this is the total market for a certain product which is denoted by a volume P, the small p is the value that the product captures. Then P/p will be a ratio which will lie between 0 and 1 which will give you an idea of the fraction of the market that is being captured by the product and this is defined there is competitiveness of the product.

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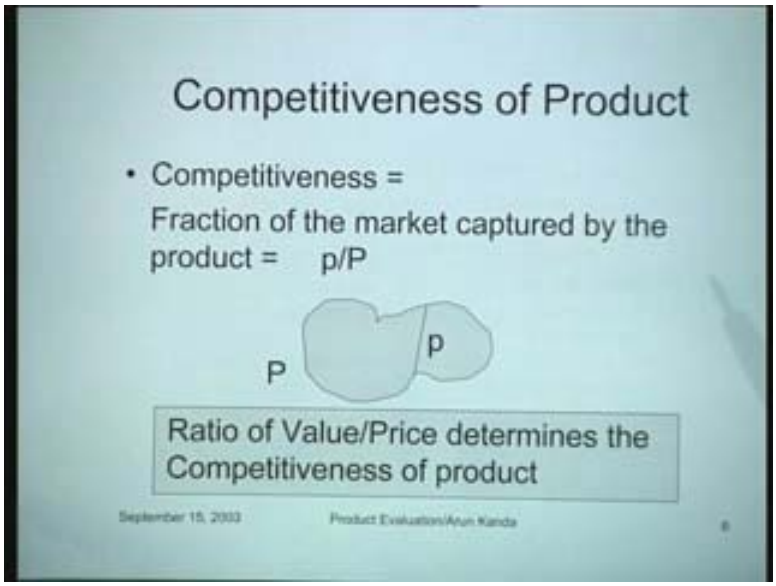

How do you increase the competitiveness of a product? The major thing is you want your products to compete in the market and do very well. How does that happen? In fact it is the ratio of value to price that determines the competitiveness of product. So if a product has a lower price and higher value, what is value? Value is the subjective estimate of a worth of a product that the consumers perceives for your product. If your product offers greater value for a lesser price, this ratio to very large extent, then determines the competitiveness so they are the major parameters that can play in order to capture markets. In order to introduce products and try to make sure that the value has increased, we already talked about in the last lecture the various tools at the disposal of a product designer. We talked about QFT, we talked about value engineering. All these two would in fact design to increase the value of the product and of course the price. How do you reduce the price of the product? By making sure that there is a less of waste, there is better quality and things of this kind, so constantly examine yourself to lower down your prices. That is what you are trying to do and that is becoming more and more important in today's competitive world. If you have to survive in the market of today you have to increase your value and cut down your prices some how and that is what is important every day. This is happening in every field. For instance in today's newspaper I was

looking at advertisement for a trip tours about 10 days ago, this trip tour was being offered by a company called SOTC for about 1700 dollars for 15 day trip and advertisement in today's paper was this would be a trip for about 1300 dollars for a 15 day trip with an overnight stay in Dubai and 5 days stay in Switzerland. What is this they are doing? We are talking in this class about designing products and services. I have given you an example of a design of a service by SOTC which is a package for tourism, also based on this concept of increasing value and reducing price to capture volume or customers that sense.

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Let us now talk about a very fundamental concept of fixed and variable costs in the context of new products and new services. The distinction between fixed costs and variable costs I think is obvious. The fixed costs are generally those cost which do not depend up on production volume. So it is like saying the basic infrastructure of a factory, the cost that you have for maintaining that infrastructure, the rental that you pay for buildings the other expenses that you have to incur for just maintaining the building, those cost you will incur no matter whether the factory produces any item or not. Those are the cost which you call fixed cost and these cost which must be incurred no matter whether we produce or not.

Some typical examples of these cost rental or cost of land, the initial machinery cost, the management and indirect salaries the warehouse factory and office space cost for these will typically depend up on what we call fixed cost. When you talk about variable cost, you are talking about costs which directly depend up on production volumes such as raw materials. If you are talking about Maruthi udyog limited, the cost of steel which goes as raw material for their stamping division to make the bodies is directly dependent upon the number of cars produced. Next coming to utilities direct labor, like saying that five man hour needed to make one car and therefore for two cars you require ten man hour. So that is the variable cost in that sense. Packing cost, shipment cost all is essential. In fact what

would happen is typically various cost would have a fixed component and a variable component and to some extent the manner in which the company defines fixed cost could be arbitrary. But you must understand that this is defined depending on the purpose. For instance it may so happen that a company spends 80.000 rupees on a certain machine today. It might decide that the 80,000 rupees is to be recovered in this very year. Then 80,000 rupees will be a fixed cost in this very year for this particular machine. On the contrary the company might say that you would like 80,000 rupees, to be recovered over two years and say 40,000 rupees each. In that case the fixed cost that would be allocated would be 40,000 rupees each year for two years in that sense. That is the way that fixed cost and variable cost could be considered and to some extent the allocation of the total fixed cost to the number of years is a decision which is taken by the company depending up on its own circumstances and its whole objectives. A very useful and a very simple analysis which can lead to a lot of useful insides into about how the company is operating can be done through what is called breakeven analysis.

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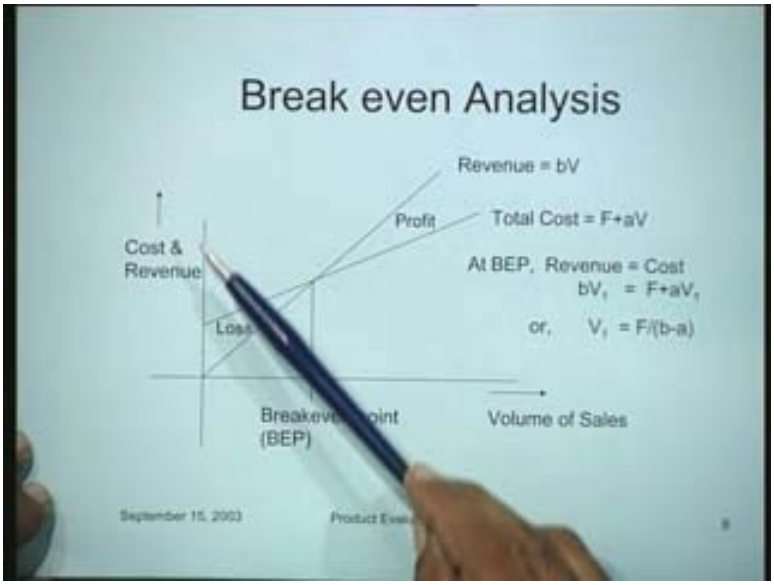

A breakeven analysis is nothing but a plot of the cost or revenue on the y axis and the volume of sales on the x axis. What may happen really is that my fixed costs are F. I would put the fixed cost F here and the total cost would be this line here, so the total cost is the fixed cost plus aV. a is the unit variable cost. So the way we have defined it, a would be nothing but the slope of this line. This is a, so F + aV is the total cost line and as we have as a function of volume, as the volume keeps on increasing, the cost would keep on increasing. Let us look at the revenue function. The revenue function is typically given by bV, where b is the selling price per piece and V is the volume of sales so in this particular situation. We would have this particular slope of line b which is the unit selling price and we now have here from this diagram the point of intersection of the total cost in the revenue. That means at this point, the point V_1 the total cost is equal to the total revenues. There is no profit or no loss. If you operate in this region, you are actually

incurring this much loss and if you operate in this region you are incurring a profit in this region. Obviously any company would have a desire to operate only to the right of the breakeven point and not to the left of the breakeven point. So, one can easily determine the breakeven point by equating the revenue and the cost. The revenue is bV_1 and the cost is $f + aV_1$ which is actually V_1. This is the breakeven point, so we can see that V_1 is equal to F upon b – a. This gives us some good insides into how we can manipulate our breakeven point. What would happen if our intention is to lower the breakeven point which is V_1. What are the strategies that a company can adopt to lower the breakeven point? Companies would like to operate at lowest breakeven point as possible so that the range of operation as far as profits are concerned is increased. This expression simply tells you there are only three ways to reduce the breakeven point. You can reduce the fixed cost or you can increase the unit selling price or you can reduce the unit variable cost so in that sense you can find out what the breakeven point is going to be. Now breakeven analysis can answer a number of questions. For instance what may happen is that if this is the breakeven point for a company, for a product and suppose, I am operating at a point V_2 what would be the implication of this? The implication is further to the right I am of the breakeven point; the better it is for me. We define a concept called the Margin of safety.

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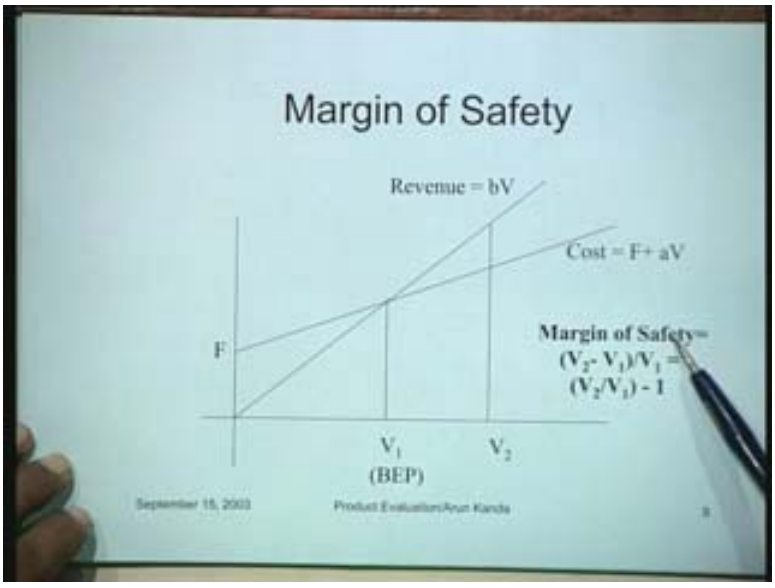

The margin of safety of operation if you are operating at V_2 is just $V_2 – V_1$ divided by V_1 which is nothing but $V_2 /V_1 – 1$ so in fact at any point of operation you can calculate a margin of safety. This would give you an idea of how safe you are in terms of operations because what happens in real life is these volumes of sales are highly dynamic in nature and there could be fluctuating up and down so on. The higher the margin of safety, the safer you are from such violations or such disturbances which tend to take place in these kinds of systems.

In the breakeven analysis we talked only about the cost and revenues. Quite often a manager is concerned with his profits right so an alternate variation or alternate representation of the same information can be made through a profit volume chart.

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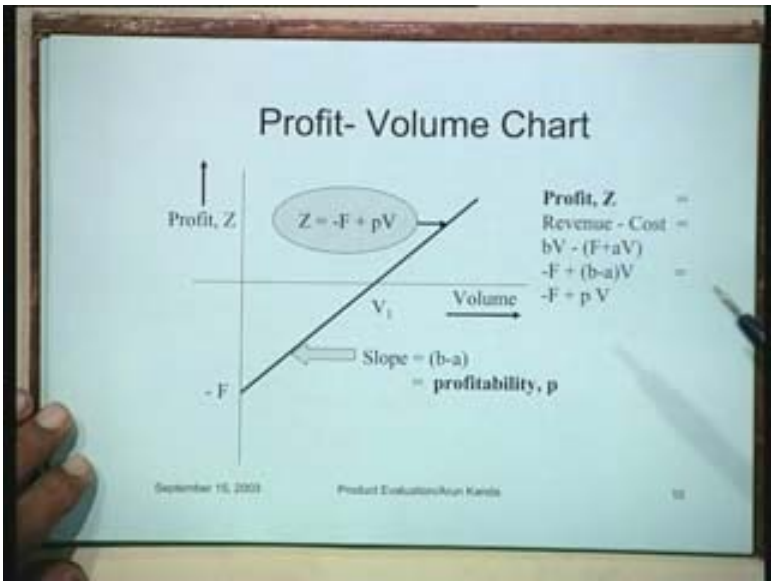

So we are going to see here what a profit volume chart looks like and how it is derived. The profit Z at any particular point of time is nothing but the difference between the revenue and cost and we have seen that the revenue is bV for any volume of sales minus the fixed cost which is F + Av. So this can be directly written as – F + b – a into V. Now this is nothing but the equation of the straight line and this equation of the straight line if is denoted as b – a/a constant p, we can simply say – F + pV where p is the slope of the line and – F is the intercept on the y axis. So if you plot the profit versus the volume, the same information that we had in the breakeven analysis, would show that the profit function is the straight line with the intercept of – F here or the slope of this line is equal to b – a which is p often known as the profitability. This is how we formally define probability of the product and we would see this particular point where the volume corresponding to which the profit is 0 is defined as the breakeven point so that point is V_1 here. V_1 is the volume of sales and this is equation of the profit volume chart. So we are relating the profit directly to the volume of sales. This is the constant and this is the constant, this is the fixed cost, the negative of the fixed cost has to be recovered, that is why up to this volume you have no profit because you are recovering the fixed cost essentially and this point of time onwards you have profits which are positive and in this sense.

Now why do you think this difference between b – a is called the profitability? What is the physical or the managerial significance of profitability? Profitability here is the slope of the profit volume curve the profit volume line. So the interpretation of profitability is the increase in profit per unit increase in volume of sales. In that sense that is why it is

called profitability and what does it depend up on? Suppose the company wants to do an exercise in improving its profitability, what are the kinds of things that need to be done? It has to basically increase b and reduce a. What does that mean in physical terms? If a product has to improve in terms of its profitability, V means selling price. Selling price has to increase, you could increase, you could keep it constant and still reduce a and thereby increase the profitability which is the better option in many instances. But b increases and a reduces so reduction of a is reduction of all your cost. We bring about cost reduction, so that the total unit variable cost comes down.

It will help in improving the profitability and therefore all kinds of projects may be undertaken in companies which are looking at waste reduction improval processes and so on. We are all basically aimed at reducing the total cost. How do you increase b? How would you naturally like to increase b? You are selling your products. You would have to add some feature to the product so what would that mean? It would increase the value of the product to some extent. You have better features so you can you are willing to pay more for those features. What our friend is pointing out here is that for unnecessary products which essentially have tremendous amount of margin in terms of their pricing, you could increase b to such an extent that it may be belong to a different category but that again is possible only if you add some features to it, if you know better. For instance if you are talking about marketing towels for the Goa beach, something of that kind, what would be required of those towel?

Basically it would be the same Hindustan lever towel or some other towel, but some features would have to be added like maybe you have a small picture of the beach or something written on the towel, that says this is exclusive club of Bombay or something like that, whatever it is you have to do something to it. The point really is you have to improve profitability. But to even take it from one level to another, you have to do something and what is that something? Increasing value by providing some additional features and what can happen is that you can put in those features which appeal best to certain class of people than for that class of people you have enhanced the value of the product and therefore gone up much more. So the point that we are simply trying to look at here is the profitability is a very important concept and normally companies are striving to improve profitability and what we are trying to see is what could be the possible mechanisms that could be there for increasing profitability? I think what is important and what would happen if you increase profitability is the slope of the line would increase; the slope of this line would increase that is what it is.

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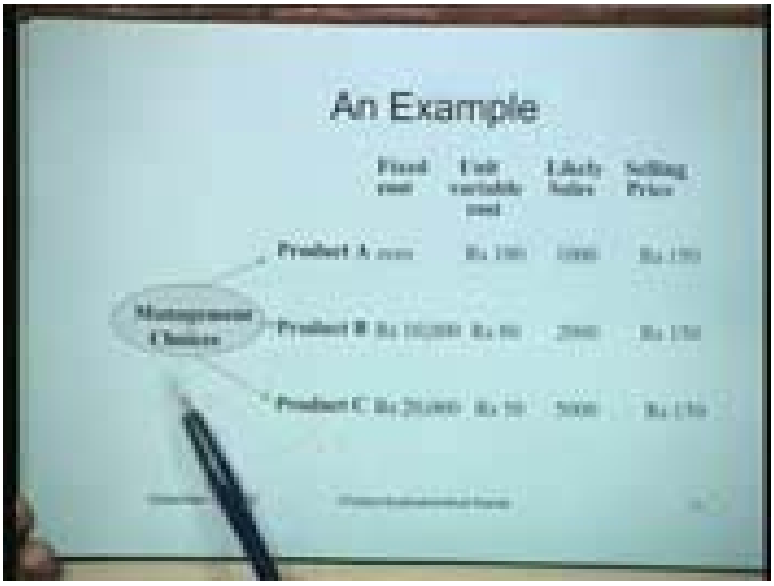

Let us now take an example and this is an example of a situation where the management can choose between three products. The management choices have to choose either product A or product B or product C and for the sake of simplicity we are assuming here that the fixed cost for the various products, the unit variable cost for these products are the likely sales for these products and the selling price for these products. What is being assumed here is the selling price for each of these products is the same. That means we are essentially buying or procuring these products from different sources and we are able earn the same amount of revenue from each of them but our cost and the capacities of the individual suppliers vary considerably as far as these three products are concerned. So what we like to do is to an analysis and find out what particular choice the management should make and how should we go about making these choices. What you find here is that the product A there is no fixed cost.

It is like directly buying the product per piece and you can buy the product for 100 rupees of piece and the vendor for this particular product is capable of supplying to you only 1000 pieces in a particular period and you can sell the product for 150 in that case. Similarly product B requires that you set up something required to make an investment to the tune of 10,000 rupees and the unit variable cost has come down from 180 rupees and you can go up to the volume of 2000 likely. The sales are 2000 which means essentially the implicit assumption is that we can go up to this particular level because beyond this we are not likely to sell off this particular item. In Product C, the investment gets doubled and the unit variable cost comes down considerably. It is now only 50 rupees a piece. We can go up to 5000 rupees and the selling price is 150,000. What we will try to do is we will try to draw for this particular situation, the profit volume charts for individual products and see how different ranges give us opportunities and how exactly we can determine the best opportunity for different types of products.

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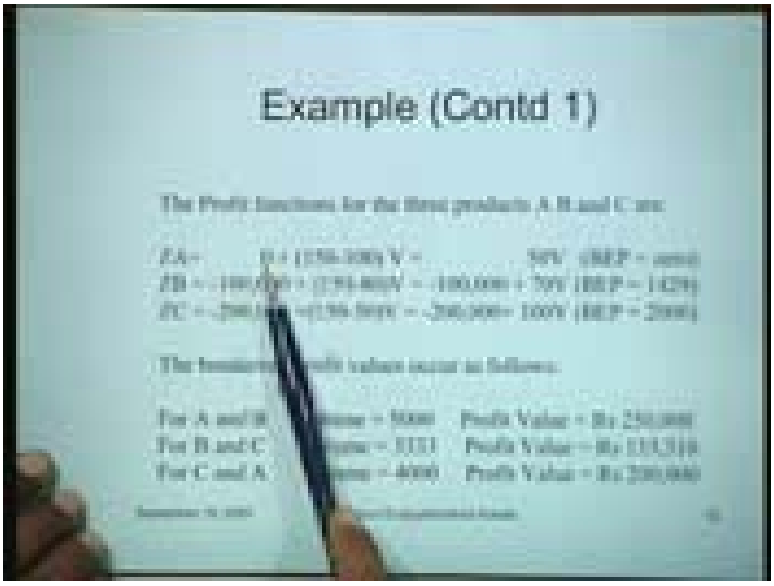

The first thing that could possibly be done in this example is that one can compute the profit functions of the three products A, B and C. It is very simple. The profit function is – F + b – a into v. So if you write that down for the individual product, this had 0 fixed costs. b was 150 unit, selling price 100 rupees. So this is just 50 V that is what it is. So it is a straight line passing through the origin with a slope equal to 50. The profitability is 50 for this particular product and obviously the breakeven point for this product is 0. Similarly for the second product – 100,000 + 150 – 80 into V. We develop the profit function for the second product which is – 100,000 + 70V and this has the breakeven point of 1429. You know if you recall the breakeven point is simply F over b – a. So we are given F which is 1 lakh and b – a is this volume. So we directly get the breakeven point. Similarly for ZC we have – 200,000, – 150 – 50 into V and the equation for the profit function is – 200,000 + 100V and the breakeven point for this particular product will be 2000. Just to draw the graph more conveniently, we can perform these computations. We can find out the breakeven profit values, there are only three products A, B and C, the intersection of two lines. There can be at most 3 possible intersections. So between A and B, B and C and C and A, we know the profit functions. We create the profit functions and we find that A and B at profit value of 250,000 rupees. The volume is 5000 for volume of 3333 the profit value is 3310 and for C and A, the break even will be volume of 4000 and a profit value of 2 lakh rupees as shown here.

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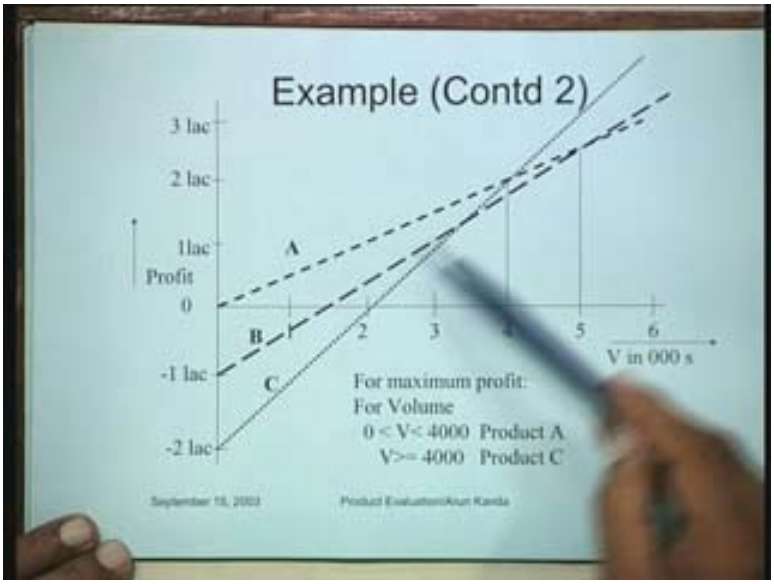

Now all with these information, it is very easy for us now to draw the profit volume charts to scale and the profit volume charts. For the three products as shown here this is for A this is for B and this is for C product A had no fixed cost product B had a fixed cost of one lakh of rupees product C has the fixed cost of 2 lakh rupees and correspondingly all these breakeven points have been computed and these are not drawn to scale in this particular graph. What is our overall objective? Our overall objective is that if this is volume of sales and thousands of units and these are profits. We want to maximize the profit that means we want to take that top most envelope of these curves which will maximize the profit function that is what we are interested in. So for this particular situation what you find is that for volumes up to 4,000, clearly product a is the dominant product. It is the highest product as compared to the others up to 4000 and beyond 4000 the best is going for product C and as far as product B is concerned, it is being dominated by either A or C as the case may be. Our situation is that the product A will yield a maximum profit if you go up to 4000. I will address the question after I finish. I show you second chart, may be your question is answered there.

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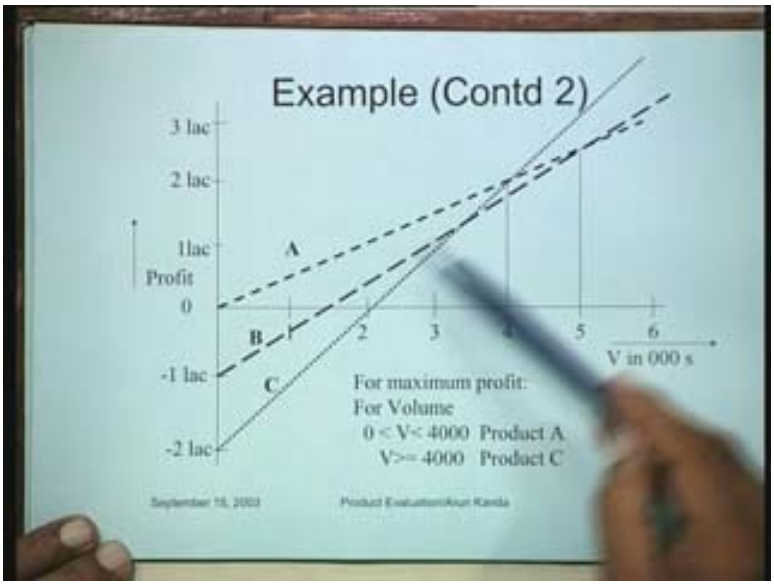

Then beyond that what you find that beyond 4000 so A is the best option if you are in this range and v is the best option if you are in this range obviously so this is the global objective in this case we had not taken into consideration the various constraints on quantities that we said we could do.

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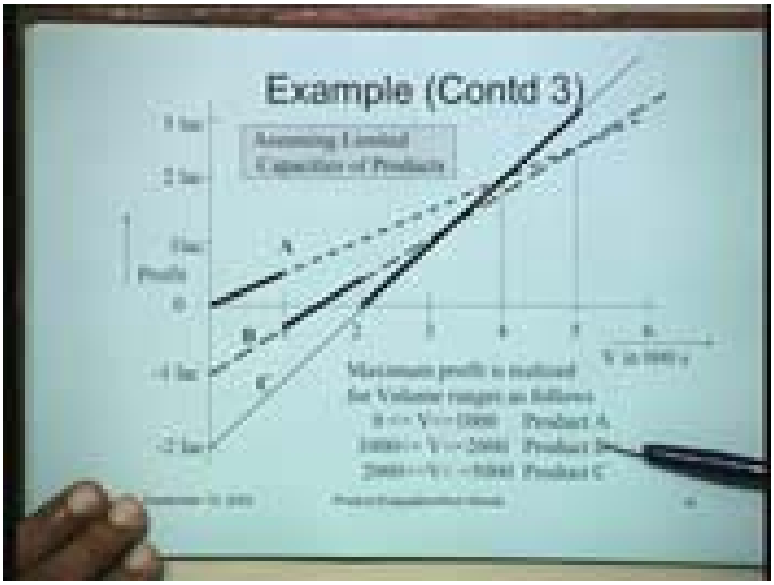

Let us try to take the constraints on quantities what you find here is that A and then B and then C what is happened is that product A, if you look at the data, product A likely go up to 1000.

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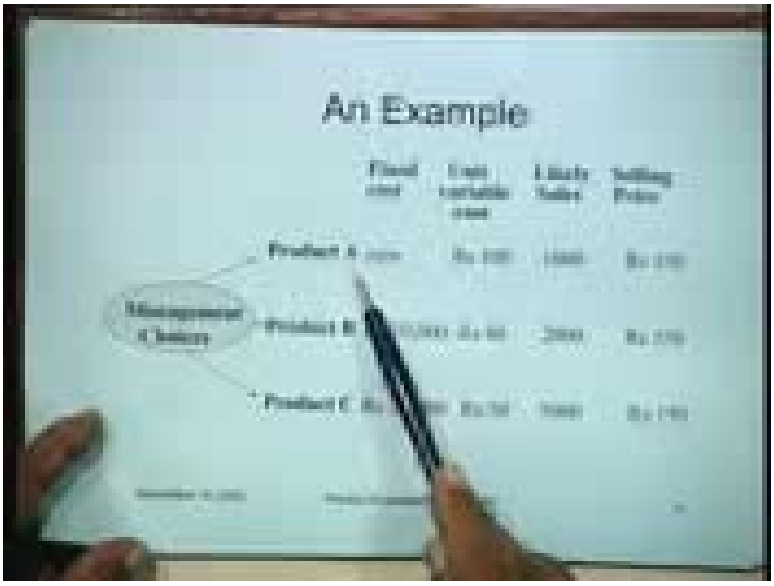

If we assume that this particular option is available from 0 to 1000. This option is available from 0 to 2000 and this option is available from 0 to 5000 only then what is going to happen so what you find is in this case since A is available only up to 1000 so this option available only by the dark line here only up to this particular point and thereafter the maximum profit would occur corresponding to the option of the product B so this product B would go up to only 2000 because this option is not available after 2000 and then the third product which is product C is lower here. But it is still lower than this and is not available now. From 2000 onwards up to 5000 that means here now what is happening is if we assume the limited capacities for the various products, our decision situation for the optimal product is this. That product A lies between 0 to 1000. If we want the best, we have to use option A between 1000 and 2000, use product B and between 2000 to 5000, use product C. So this decision obviously is different from the decision that we had earlier about the global situation. 48:04 where we have not considered, does that answer your question please? What you see is that simple breakeven analysis or a simple analysis of the profit volume chart is actually the same thing in different words. It can answer very important decisions regarding the optimal choice of strategy for introducing different types of products in different ranges of volumes of sales. I think this is a very important contribution of these whole concepts of breakeven analysis and profit volume charts.

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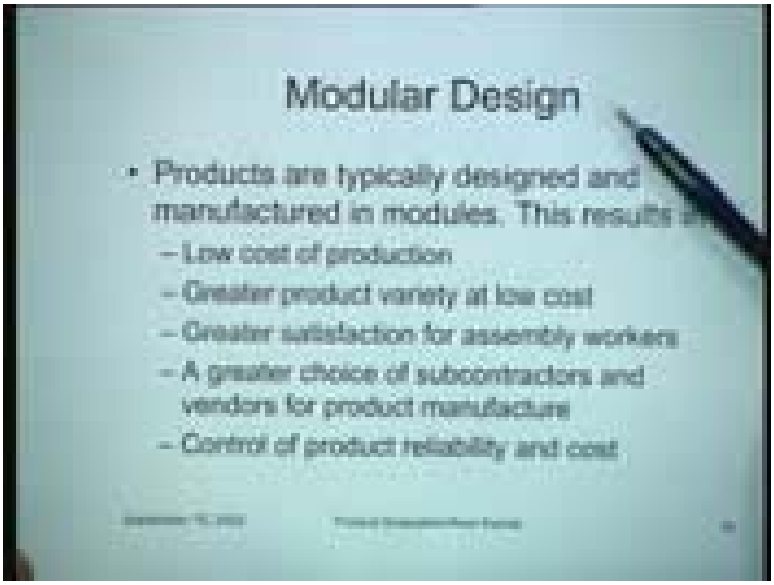

Another important concept which occurs in product design is the notion of modular design when you talk about the modular design, we say that products are typically designed and manufactured in modules why this results in various advantages. Some of the advantages are low cost of production. If products are produced in modules, modules would be like for a car, you have the engine you have the carburetor, you have the break assembly and so on. These are actually individual modules and the whole production takes place module wise, there could be greater product variety at low cost. This is one of the major advantages of modular designs. There could be greater satisfaction for assembly workers. Why should there be greater satisfaction for assembly workers simply because a worker now assembles the entire module so he has the satisfaction of producing the entire carburetor. It is not like saying that they say when man retires on the Ford assembly line. He will ask what you did. He says a tighten blot number 999 on the ford assembly line for my entire life. What a boring life it would have been? For at least now he has the option of telling his wife that I have assembled the carburetor that you see on the Mercedes. That is the idea.

There is a greater choice of subcontractors and vendors for product manufacture and control of product reliability and cost can be made easier. So we will take a small example of modular design and see how we work with modular design. Suppose there is a component which has two subcomponents A and B and we are assuming that for component two functions both A and B must function. If any one fail or both fails then the product is a failure. If there are three designs for A and three designs for B what would happen is there is a total of 9 designs for the product. So just by taking the limited number of designs for one module and certain number of design for another module you can generate a large number of product varieties.

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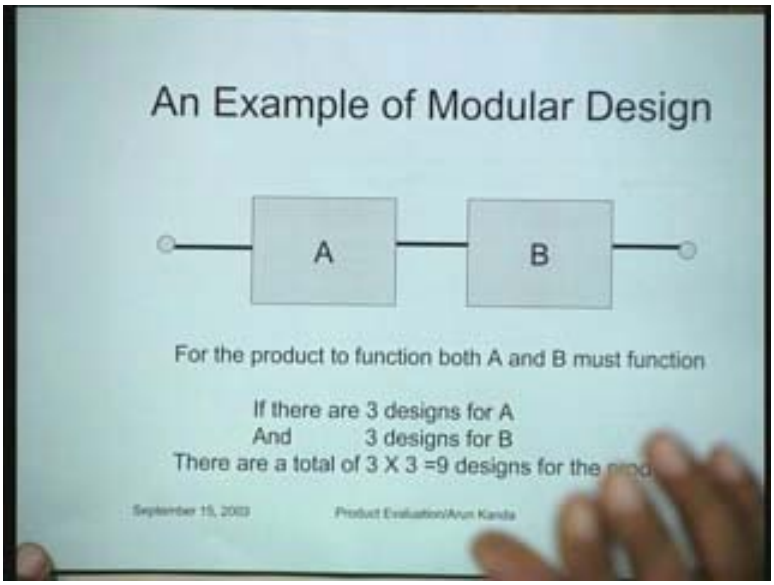

So this is how typically the Japanese cycle manufacturing companies operate because what they do is a person goes and gets a personalized bicycle. They take its dimensions like you stitching a shot and then you make a bicycle to your dimensions and give you after 36 hours or whatever it is. How this happens is that each of these modules has the frame module. They have the wheel module and so on. All they have to do is to put together the various modules and generate the size which they want to generate for that particular individual. This is basically the concept of modular design. Let us look at a small example. This is an example where there are two components A and B.

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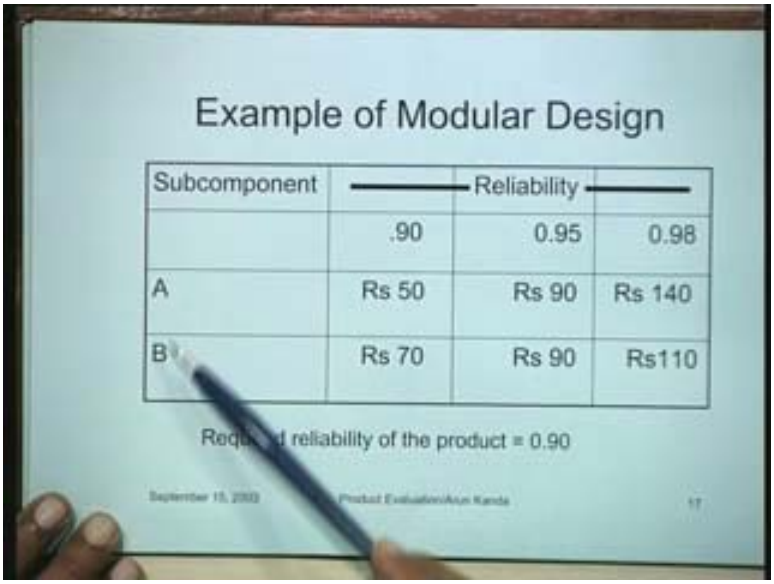

Let us say that the reliabilities of these components can vary from 0.9 to 0.95 to 0.98. So increasing reliability is like you get it at a better quality you are getting and the cost that are being available for these things. You can imagine that this is like a vendor one, this is like a vendor two, this is like vendor three who is providing these compounds A and B. So vendor one gives you this reliability for 50 rupees and this particular reliability for component for 70 rupees, for 95 percent reliability. he same information is that 90 rupees will be the cost of A and 90 for B. He is supplying the both the product of the same cost and this one is providing a reliability of 0.98 for 140 and 110. Suppose the required reliability of the product is 90 percent, this is the requirement of the design or it could be a requirement of the market place whatever it is you want to do this. The question is how you would buy this component from different vendors so that you can attain this reliability at a minimum cost. This is a small example. We can do the whole thing by enumeration.

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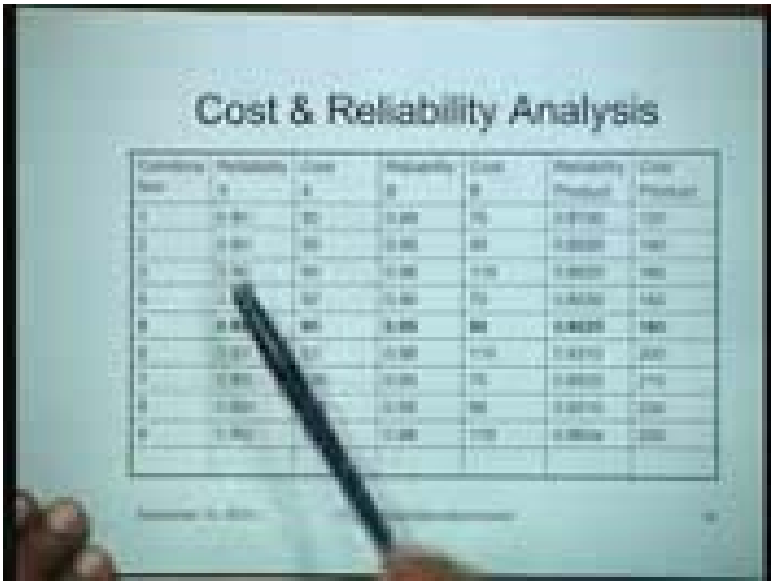

What would happen is that there are 9 combinations in all and you can have 0.9 reliability, 0.9 five reliability, 0.98 reliability for the sub component A and the corresponding costs are listed here. Similarly for B you can have reliability for each of them 0.9, 0.95, 0.98, so you have all the combinations. Similarly you have all these probabilities here and the costs are here what we can do is we can calculate the reliability of the product the reliability is multiplicative. So the reliability of the product is 0.9 into 0.9 which is 0.81 and the cost are additive. This is 120 and this is the cost. We can do the whole thing and for the entire thing we are interested in a product reliability of 0.90 obviously these are not feasible - all these design. This is the first feasible design 0.9025. There are higher values of reliability available but we get this and this particular value gives me total cost of 180. So all the possible designs is a combination of five which is shown in bold here is the optimal one because I can now generate the new products at a total cost of 180 and get a required product reliability of 0.9025. This kind of analysis is very easily possible when one is thinking in terms of modular design. You can work out the reliability and cost implications of individual designs and try to determine the best design in that particular context. Finally let us try to summarize what we have tried to do in this particular lecture. We have seen for instance that as far as the financial evaluation of products which is generally carried out in two phases.

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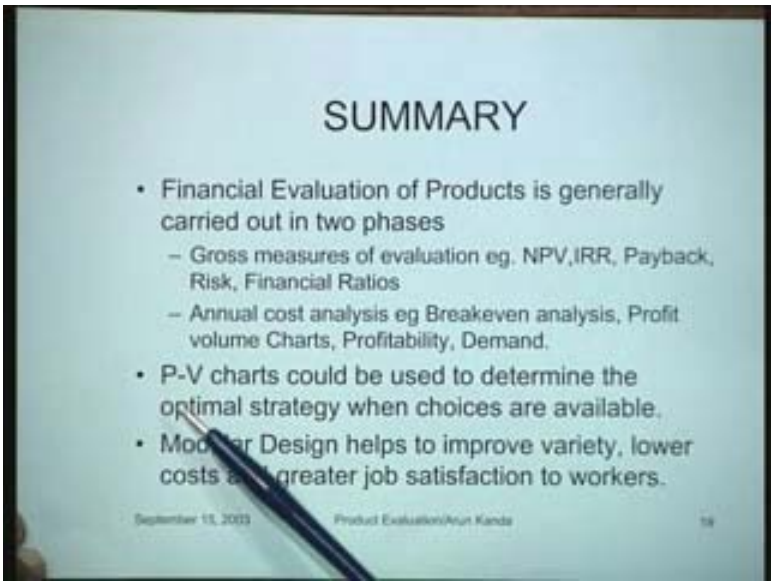

The first phase is the phase where we talk about gross measures of evaluations and here we are talking about the net present value determination, the internal rate of return, the payback, the risk and the financial ratios. These are something that we had already discussed when we were talking about the financial evaluation of capital investments in the previous lecture. In this particular lecture we have tended to focus more on the annual cost analysis such as breakeven analysis, profit volume charts, profitability and the effect of fluctuation in demands and profitability on the product. So what we saw was the profit volume chart could be used to determine the optimal strategy when choices are available that was one interesting thing and secondly we had looked at the notion of modular design. Design which helps to improve variety lower costs and results in greater job satisfaction to workers. In fact we have taken an example in which we are seeing how different combinations could be evaluated and ultimately you could determine the best possible design in our next lecture. We shall be talking about the aspects of the optimal product mix that means the company generally manufactures not only single product but a combination of products. What should be the possible mix of these products so as to maximize profits and there are many mathematical models available for dealing with this problem depending up on the situation. So we look at the deterministic as well as stochastic aspects of this particular problem next time.

Thank you!