

Business Analysis for Engineers
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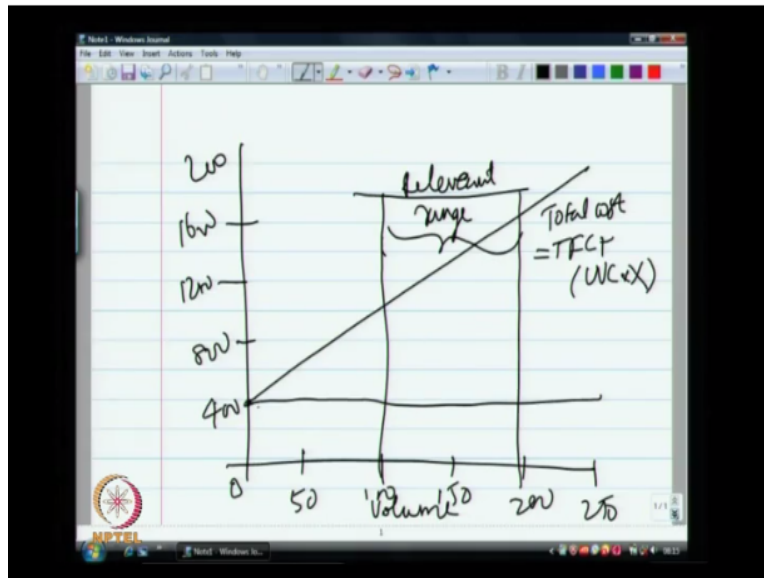
Lecture-17
Cost-Volume Relationship

Good morning class last time we, last class we had a quick introduction to management accounting and then we started off with fundamental concepts of cost beginning with the cost volume relationship and that is when we discussed the various types of cost namely the fix cost, the variable cost and the semi variable cost and how these behaves with volume and we constructed the cost volume graph to understand the behaviour of each of these costs with volume.

Now this behaviour also has some assumptions that are inherent to understand the behaviour of all these types of cost with volume. Now we saw that how the total cost which is some of the total fixed cost and the variable cost that changes with volume and we saw how the unit cost drops down with volume. The reason being that when the volume increases there is more base for the fixed cost to be spread as a result of which the total cost per unit comes down.

And if you look at this behaviour then it is easy to assume that as volume keeps on increasing, because remember when we did the diagram.

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Actually the cost volume relationship if you look at the cost volume relationship if this is the volume and then in our example last class we had 400 was the fix cost. And let us say this represents the total cost line and as per our definition the total cost line will be our total fixed cost+the unit variable cost times the volume, this is the total fixed cost. Now you know that the total cost follows as straight line right from volume 0 up to a given volume.

Now the question that we need to ask ourselves is that is this behaviour valid for whatever is the volume range which means as long as the volume keeps on increasing and we know that the unit total cost it is on decreasing there will be a certain volume where the entire fixed cost can be spread over that and that the it is so high that the volume is so high. That it will happen that the cost approaches to the variable cost itself.

Now for example if I say that this total cost line the behaviour of this line if we follow this graph traces backwards to some cost which is 400 in this case at a volume of 0. Now does that mean that when there is no activity which means when there is no volume that the fixed cost is 400 always, technically by definition yes. But since we are talking about management accounting there might be some decisions that managers might take.

That at 0 volume it is quite possible that we can reduce the fixed cost by eliminating certain fixed cost component consciously which means the management decision might be that at 0 volumes

we need not incur these fixed cost which is 400 in this case. That again ask the question is then is it in alignment with the definition of fixed cost, no way we are saying that the definition of fixed cost is getting changed.

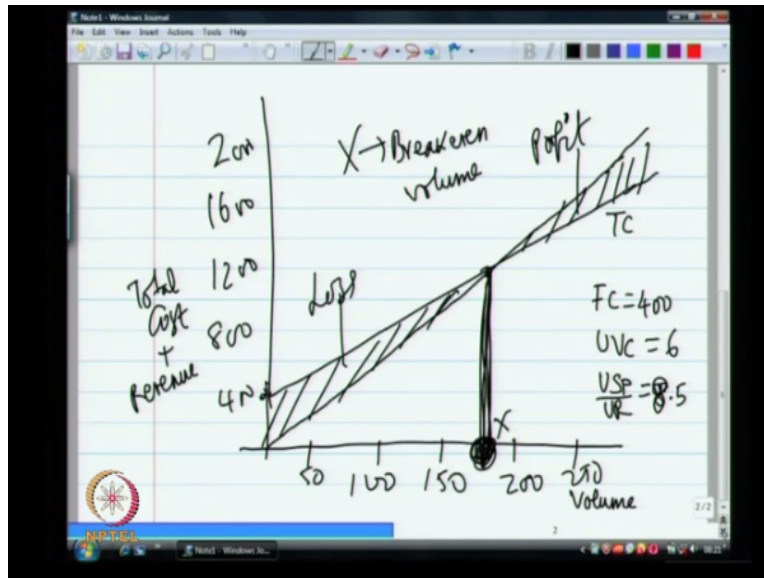
But then we are introducing another concept that assumes that the behaviour of cost is within a relevant volume range. So, let us say in this case I say that the relevant volume is this, so if this is the relevant range which means that the total cost behaviour with volume holds good as long as the volume is within this relevant range of 100 to 200. And it makes sense to make an assumption of this type, because the characteristic of the cost involved changes either if the volume drops drastically lower than this relevant range.

Or it keeps on increasing to a certain extent which is much beyond the relevant where the total at the fixed cost changes, because the volume has exceeded this relevant range. For example if the fixed cost of operating let us say a machinery whose maximum capacity is to generate only a limited volume and if the volume changes the fixed cost will also change because we need to add one more machinery to meet that volume.

And the addition of that machinery itself will add to your fixed cost component as result of which the total fixed cost is no longer the same when the volume was within the relevant range. But now it will be different because the volume as exceeded the relevant range, but that does not alter the behaviour of the cost line except that we are moving the fix cost from a predetermined value to some $X + \Delta X$ if the volume is beyond the relevant range

Or possibly $X - \Delta X$, if the volume is less than the relevant range that we have considered to be the most let us say the relevant range is something that is very common that happens in a business side. So, this is 1 fundamental assumption that we make when we understand the cost volume behaviour. Now just us we have the cost volume behaviour it is also important for us to understand that just us cost behaves with volume that is also something that we need to understand in terms of the revenue that a unit generates, a business generates.

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Now why are we discussing about this revenue, remember the entire concept of understanding management accounting is to have some sense of internal control and one of the big decisions or one of the big indicators that we need to take before we take business decision is to understand what would be the minimum business or what would be the minimum volume that we need to generate as a business.

If you are talking a business that is engaged in producing some units, so, what will be the minimum number of units that we need to produce. So, that it is a viable proposition, now for that we need to understand what would be the revenue that would be generated by selling these units that are being produced. So, just as we had a cost volume relationship we also have a revenue volume relationship and it is a mere extrapolation.

Because just as cost changes with volume the revenue will change with volume and it is a direct relationship you have a unit selling price and you have certain number of units that are being sold. The total revenue will be your total I mean you are selling price, unit selling price times the total number of units that are being sold. Now we are just going to juxtapose both of this, the revenue as well as cost.

And why we do this we need to understand what will be the minimum number of units that is required. So, that that the revenue that we generate by selling that minimum number of units is

enough to meet the total cost that we incur for producing that minimum number of units. Now if we put it graphically we will be able to understand this better and let me just retain this same example of let us say now this was your volume.

And similarly your fix cost remains the same 400 and we know that this is the total cost line. And now we are introducing another relationship between revenue and volume, now this one was cost we can also add revenue, total cost revenue. Now let us say in our example that we took the fix cost was 400, the unit variable cost is 6, now the units selling price or the unit revenue let us say is 8.5 which means for every unit that I sell I get 8.5.

Now if this is the basic data that we are using then it is possible to construct a relationship between the total revenue and volume and the relationship is very straight forwardly near the more number of units that you sell the more you will earn as revenue, let us say it goes like this. Now why is this relationship it is important for us to understand, because we need to understand what is the minimum number of units that we need to sell.

So, that we neither make profit nor loss but that is not the objective of doing business we always need to make profit. But at least we need to know where what the minimum is now if you look at this graph the total cost line exceeds the revenue line till this point. So, this could be your loss and then beyond this point this keeps on increasing. So, this one is some relevant volume this volume is called the break even volume.

This volume x let say this x is called the break even volume add break volume the total cost is equal to the total revenue. At break even volume the total cost is equal to the total revenue now what is the total revenue.

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The image shows a digital whiteboard with handwritten mathematical formulas. The formulas are as follows:

$$TR = UR \times X$$
$$TC = TFC + (UVC \times X)$$

at Break even volume

$$TR = TC$$
$$UR \times X_{BV} = TFC + (UVC \times X_{BV})$$
$$X_{BV} = \frac{TFC}{UR - UVC}$$

The whiteboard interface includes a menu bar (File, Edit, View, Insert, Actions, Tools, Help), a toolbar with drawing tools, and a status bar at the bottom with the NPTEL logo and system icons.

Total revenue is our unit revenue times let say the total number of unit sold is x or total cost is or total fixed cost+unit variable cost times x. Now at break even volume total revenue is equal to total cost which means or x break even let say this is break even x break even is the total fix cost/the unit revenue –unit variable cost. Now this is a very simple mathematical equation which just gives you the relationship to calculate the break even volume which is that volume at which the total cost is equal to the total revenue.

And for any volume beyond that you are making profit and for any volume less than the break even volume the unit is making loss which means we are not selling enough units to cover the fix cost at the variable cost. Now just as we had the cost per unit we also need to understand the average profit per unit. This is important from the point of view of understanding what operational leverage is especially when businesses have a lot of fix cost component.

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Average profit per unit

200 units Revenue = 1700
 Total cost = 1600
 Profit = 100
 average unit profit = $\frac{100}{200} = 0.50$

250 units
 average profit = $\frac{225}{250} = 0.9$

This relationship is very important for us to understand the average profit per unit remember last class we talked about the cost per unit and how when the volume keeps on increasing the cost per unit keeps falling down. The average cost per unit will be the total fix cost/the total volume now in this case in this example let say we the same example unit selling price is 8.5, the variable cost unit variable cost is 6 and the fix cost is 400.

Now suppose we are selling 200 units so, the revenue is 1700 the cost is the total cost 1600. So, the profit is 100 and the unit profit or average profit is 0.5. Now let say instead of 200 units I am selling 250 units then average profit will be the total profit that I make for 250 units is 225. So, the average profit will be 225/250 which is 0.9 look that is any increase in the unit profit. Now why is this unit profit increasing with volume it is the same relationship.

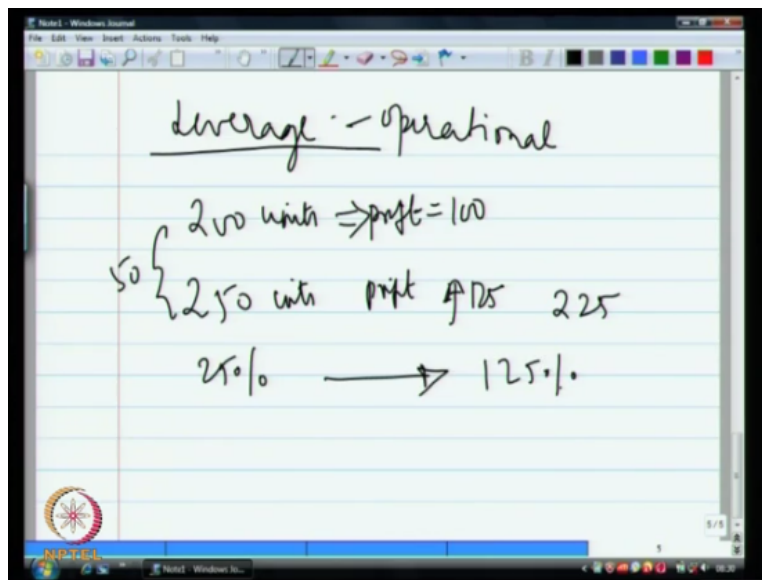
That we saw in the previous class that explained how unit cost decreases with volume it is that relationship that still holds good. When we see why unit profit increases with volume the reason is there is more days for the fix cost to be spread out. As a result of which the unit profit keeps increasing with volume and this phenomenon of spreading the fixed cost over a higher volume is called operating leverage.

So, when you say that a firm has a high degree of operational leverage it means that the fix cost component is very high. And typically firms that are extensively capital intensive which means

the fix cost is very high. These firms that should be very very careful in doing in understanding this behaviour. Because it is very sensitive to changes in volume if the business is good the volume keeps on increasing then it is good.

Because the unit profit keeps increasing with volume and considering that it is very sensitive. The more volume that you are able to generate the more profit that you will be able to get but in the other hand any drop in volume and remember this is very sensitive to volume this relationship say any drop in volume just as any increase in volume increases the unit profit. Any drop in volume will reduce the unit profit to understand that let me just take you through a small example. Now let say because this will make you understand why this term leverage is being used.

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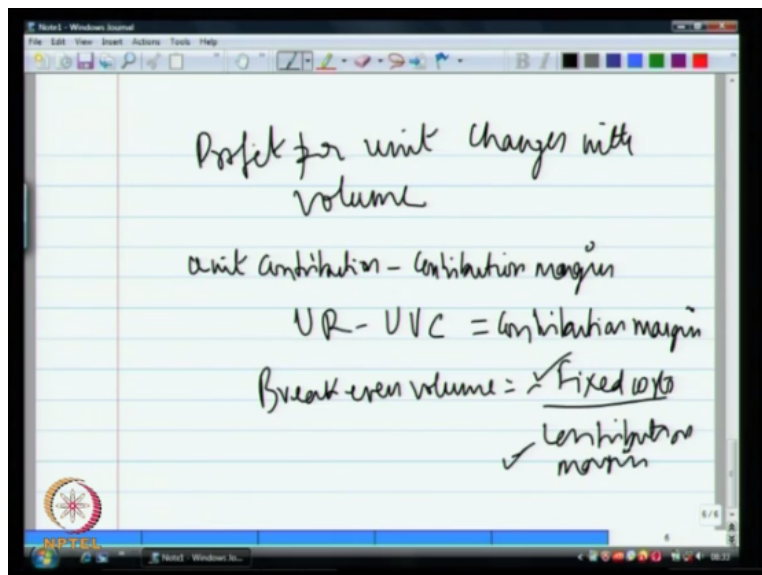
This is operational leverage by the way financial leverage is something different that as we saw in the accounting it talks about the debt equity in the capital structure. Now let say when the volume was 200 units. The volume was 200 units the profit was 100 now when the volume went up by 250 that is the incremental volume was 50 units profit went to 125 now you see that the increment in volume is just 50 units that is from 200 to 250 which is 25%.

So, when the volume increase from 200 to 250 the profit goes up by 125 so, profit is increase by 125 to 225. Now what is the increase in the profit as a % the increase in profit is a % is 125%

now this explains the leverage factor. In this case the leverage factor is a factor of 5 for a 25% increase in volume there is a 125% increase in the profit. So, a business will be very concerned in understanding this leverage.

Because on one hand if the volume increases it is good news but if the volume decreases the impact on the profitability is also very critical. If businesses have a higher leverage factor in this case the factor is 5. So, operational leverage from a fix cost point of view is an important parameter that you need to understand when understanding the behaviour of fix cost. And how it changes with volume and how when volume changes the profit per unit also keeps changing and how that is sensitive to increase or decreases in volume now

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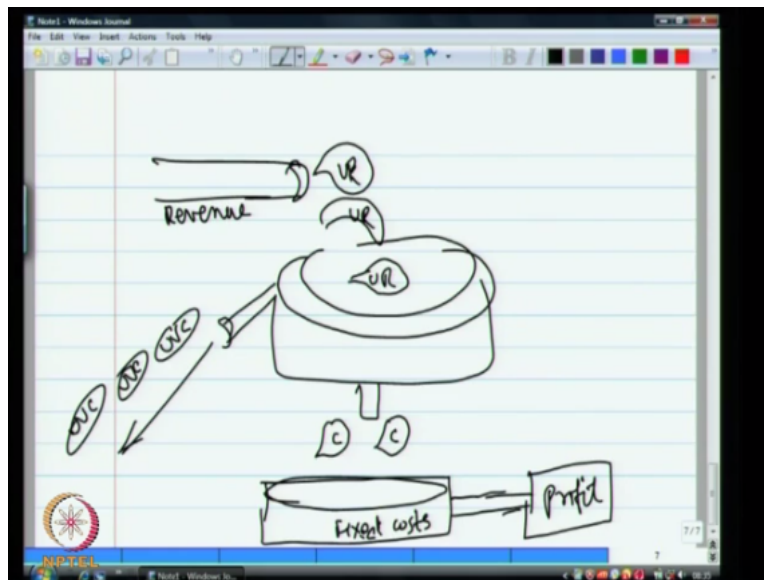
The profit per unit as we saw before changes with volume but there is an other measure of profit that remains constant whatever be the volume. That we usually call it as unit contribution or the contribution margin in simple terms the contribution margin is your unit selling price-your unit variable cost. It tells you that for each change of 1 unit of volume the profit will change by that contribution margin by that unit contribution.

So, if you again rearrange your break even volume calculation your break even volume is nothing but your fix cost/contribution margin or unit contribution. So, this unit contribution remains the same for whatever be the volume. Because these two parameters or volume

independent fix cost is volume independent of course I am talking about the relevant range here. And contribution margin also volume independent.

Because it is unit revenue-the unit selling price now why is this important for you to understand if you just understand it through a schematic.

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Let say this is the revenue pike and let say UR unit revenue this is **spurt** comes out of the revenue pike. And here the neat accommodate for the unit variable cost UVC so, this unit revenue goes into this and from here drops the contribution margin unit contribution that is unit revenue-your unit variable cost what remains here is here unit contribution. And let say this is the fixed cost so this diagram is just to give you a pictorial understanding of the concept.

And if you are understand this well then you will be able to get the bigger picture in place. So, when you generate revenues the total revenue is this aggregate of this unit revenues. So, the unit each unit revenue component contributes with the total revenue. And it has to compensate for the unit variable cost so, what remains after this stage is what you have in hand after you meet the unit variable cost.

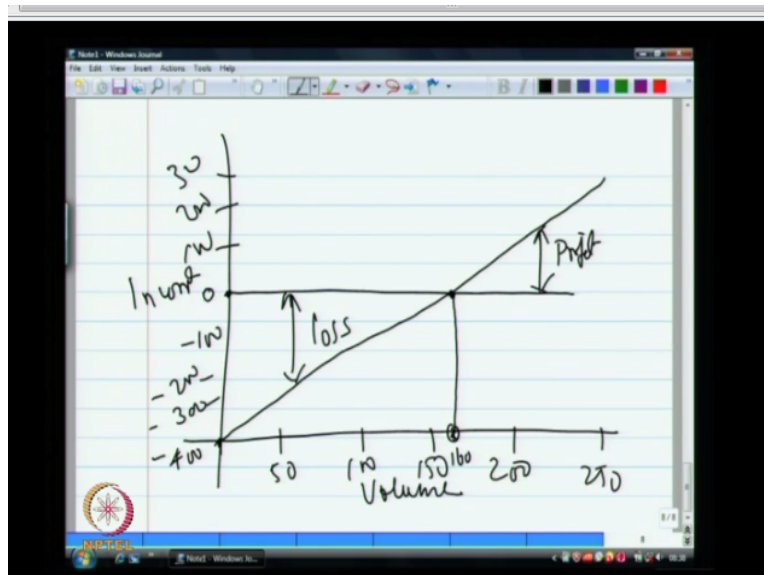
And that is your contribution margin as I defined before it is your unit revenue-unit variable cost. Now when will say that you are making profit let say if say this is the profit part. This is the

profit part when will say that some profit moves from here to here. It is only if you have enough unit contribution to fill this fixed cost part and anything beyond that goes to the profit parts. Let say the fix cost part the volume of that is broken into units of contribution margin.

That is the capacity of fix cost/ the size of each of the unit contribution then it has to fill this part to an extent that is required. We depends on what the fix cost is bigger is the fix parts uhhh fix parts size the more number of spurts that have to so smaller is the fix parts size will lesser number of contribution margin spurts that meet to fall into these an anything over and above this will get into the profit.

So, if this is filled anything that excess is your profit so, you can understand that the new make revenue part of the revenue goes to meet your unit variable cost the remaining comes. And you have to make sure that the fix cost component is compensated for and after meeting you need to variable cost and fix cost it is then you start making your profit. Now this if I am just representing it graphically.

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So, this is the volume line let say I am talking about income this is -400 and then 100, 200, 300 so, we found in example that we took the brake even volume was 160. So, add brake even volume and neither making profit nor loss. So, my income is 0 so, this my profit this is my loss

so, if you get the overall picture. Then you will begin to understand that the business should not focus on just the profit per unit.

Because it keeps changing at the different volumes but rather we should be focussing on the total fix cost and the contribution margin to see how much fix cost. We can spread over a bigger volume range or when we talk about the contribution margin how much we can increase the selling price or how much can we reduce the unit, variable, cost which means that there are four basic ways by which that profit a business can make by selling a product can we increase.

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Factor	Revenue	Cost
1) ↑ Selling price	↑	
2) ↓ UVC		↓
3) ↓ TFC		↓
4) ↑ volume	↑	↑

One increase selling price, two decrease unit variable cost, three decrease total fix cost, four just increase volume that you sell. And where assuming that all these four are independent of each other which is not a correct assumption to make. Because if you increase the selling price it might happen that even the volume that you are selling will decrease. But then as a standalone basis if you do one of these it is possible that your profit will increase.

Now just as for the purpose of understanding you can probably take this as your home work for an assignment. Let say if these four factors are increase by a factor of 10%. So we are selling price increase by 10% where unit variable cost is decrease by 10% total fix cost is decrease by 10% or volume is increase by 10%. This will have an effect on two things revenue, cost the selling price is increases by 10%.

Your revenue increase unit variable cost and total fix cost is decreases by 10% to some extent your cost is increase. If your volume increases by 10% there will be a change in the revenue as well as your volume increases by 10% there is also your change in your cost. Now you can probably take the example that we discuss before a mathematically do this to see how revenue and cost increases or decreases.

We changes in selling price unit variable cost fix cost are the volume. Now all the discussions we have done so for we are making the assumptions that the business is making only a single product. But then in reality that should not the case because businesses are involved in making several products. So, the cost volume profit relationship that is the previous graph that we saw, it will be the same let say if you are taking an business that has multiple products still I would say the cost volume and the profit relationship will hold good.

If each of the product as the same contribution margin then the same relationship will still hold good even if they are different products or if will hold good if the product mix that is the relative the proportion of each products sales to the total sale. If that also relatively remains constant then still this single cost volume profit relationship holds good. But if the contribution margin across the products and the product mix also keeps changing.

Then this one graph does not best represent the total cost volume profit relationship of the business. Then what we do is we treat each product as separate entity each product will be treated as a separate entity and for each product you will have this cost volume profit relationship and to understand how the behaviour of business as hold changes. Each products CVP the cost volume profit of graph is being constructed.

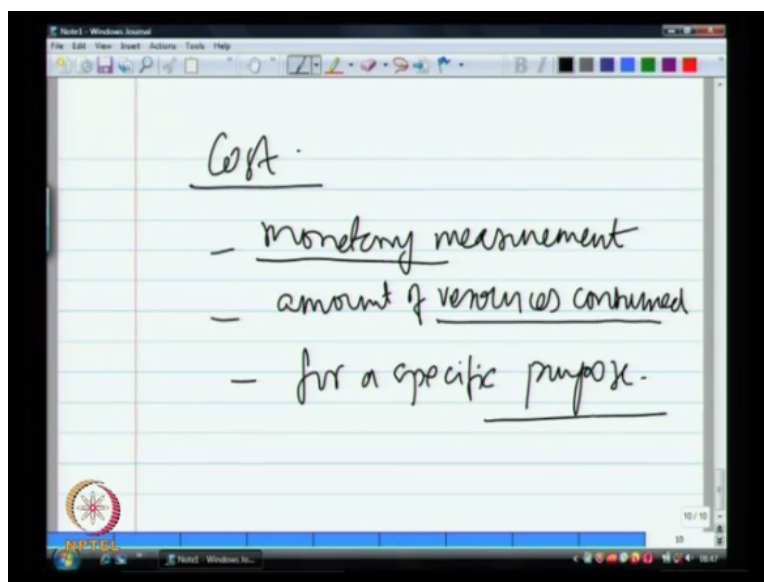
And then the aggregate of all these relationship will best represent the total cost volume profit relationship of the business itself. Now to do this we need to understand all the cost that are involved in the business which can be individually allocated to the multiple products that are involved in this business. So, that is why before we go an understand the behaviour of these different cost components in the final product at the broad level.

We just understood the cost volume relationship assuming that the business manufactures only one product. Now if the same relationship will hold good for a business which has different products except that each product will have its own cost volume profit relationship. And the aggregate of all of this is the representative of the businesses cost volume profit relationship. And as I told before to understand this we need to understand the cost that can be directly identified to a particular product.

And likewise diff cost for different products the very term cost itself is a slippery definition. When somebody says the something cost me 100 rupees you do not know what the actually means because cost is very generic and a very slippery terminology that is used in accounting. It will become more meaningful only if I am able to add a modifier or a qualifier to this cost. And say that the cost that I am talking about is the products full cost for differential cost or joint cost or opportunity cost or whatever the cost may be.

Because each of this as definition on it is own by it own, so unless we know what cost we are talking about simply saying cost of this is 20 rupees or 100 rupees. Though it conveys some sense it does not convey the real sense. So, we need to understand cost from a very broad perspective to begin with that let me first give you the broad definition of cost.

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The definition of cost and when we did accounting we did learn about how cost is being measured in an entity. It is a monetary measurement of the amount of resources that are being consumed amount of resources consumed for as specific purpose. This is a very broad definition of cost and remember there are 3 key elements in this that it has to be monetary measurement. And it has to be of those resources that are consumed for a give a specific purpose.

So, cost as a broad definition is a measurement in monetary terms the amount of resources that are being consumed for a specific purpose which means let say I am going to produce a product. Then the cost of the product is the monetary measure of all the economic resources that will be consumed in the process of making this product. So, it satisfies these 3 it is monetary, it is resources and that it is purpose of making this product that time using this.

The resources that can be consumed will be in different types typically when you make a product you consume tangible as well as intangible resources. And the tangible once that can be quantify let us say is raw material that is being consumed or the labour hours that is being consumed. These are resources that are consumed 5 tons of steel 100 hours of labour these are resources that are being consumed.

But then 5 tons steel+100 hours of labour put together does not make any sense, because it is not expressed to monitory terms. So, the second part is how much is this 5 tons of steel that is been consumed. So, we multiply that with some value to bring it to monitory terms and how much is this under hours of labour worth. Again we convert that it monitory term, so the second element of the expressed in monitory term is also satisfied.

Now if you running a factory and you are utilising man power you are consuming raw material and you are **use** utilising all this for a specific purpose to let say the end product is hour. So, you need to only take into account those economic resources and the monitory value of those economic resources that are involved in producing this end product hour, because that is the specific purpose.

The cost of another activity which is not related to this end product, let us say in the same business there is some cost that is involved for a different end objective. The cost of that should not be involved in this, because the money spend for a different objective is for a different purpose and not for the purpose of making this hour. So, you need to understand that the costs need to satisfy these 3 basic criteria it has to consume some economic resource which has to be expressed in monetary terms.

And the reason for consuming this economic resource is for a specific purpose and it is for that purpose we are calculating the cost involved. This is a very broad definition of what cost is then we will have to split this cost to understand what are the different elements that get into in the making of the cost I told you cost is a very generic term there are different components that are added up to finally give the cost of a product.

Now what are those different concepts I mean what are those different components that add up to the costs. And how those are being calculated to arrive at an expected cost of making a product and actually when a product is being manufactured what is the actual value of the economic resources that are being consumed and whether the expected and the actual are same or different and what will happen if the expected is more than actual or less than actual.

And of what uses that information to us, how decision making changes we understanding this behaviour of cost something that we need to understand at length and for that I will give you inputs on different cost components and then how to calculate standard cost an actual cost and how to understand the difference between standard or budgeted cost and the actual cost and how based on that decisions are being taken.

Because that is the trust of management accounting, because it is more internal, we need to understand whether the individual cost elements are well within control and if not what decisions needs to be taken. This as we said before is the essence of management accounting, so next class when we meet I will be giving you some introduction on the basic first components what makes the total cost and how it changes the behaviour of cost.

These are the standard cost to assist the actual cost what sense can we make out of this difference something that we will see in next class thank you.