Decision Making with Spreadsheet
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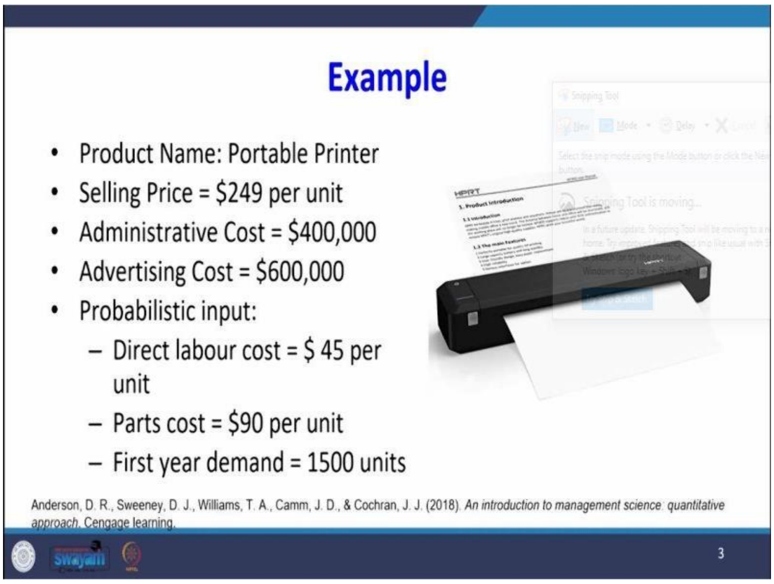
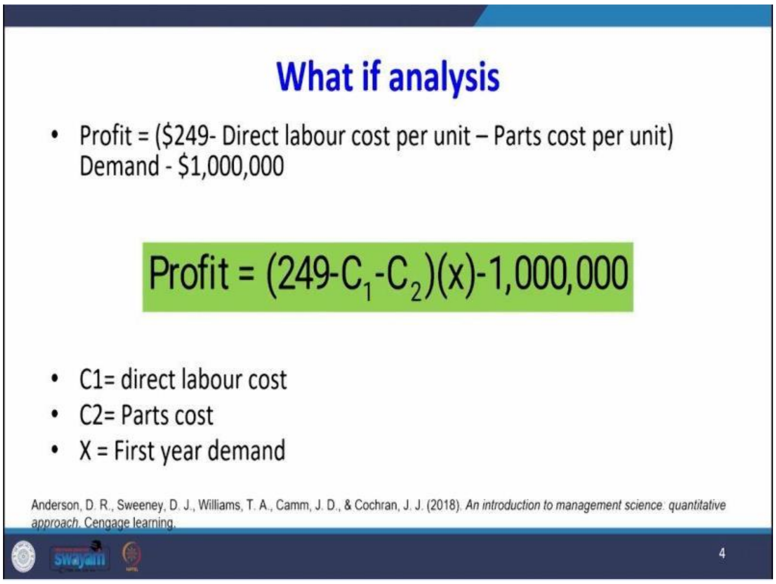
Lecture - 42
Financial Risks Associated with the Development of a New Product - II

Dear students, in the previous lecture, we discussed the basic concepts of simulation. Then, we started to solve a problem of risk analysis while introducing a new product. In this lecture we will continue the same example and also solve another problem of risk analysis while introducing a new product with small variation. So, the agenda for this lecture is a risk analysis example of a new product introduction, which we are going to continue from the previous lecture.

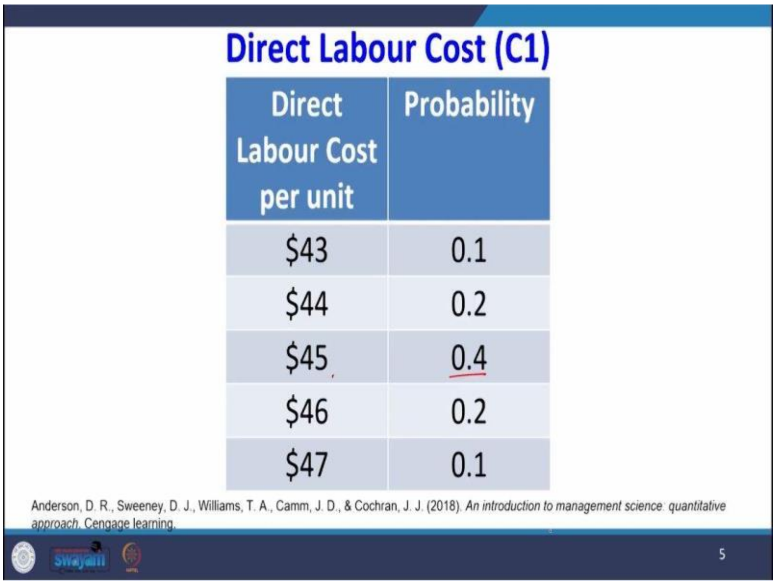
We are going to solve another problem of risk analysis while introducing a new product with a small variation.



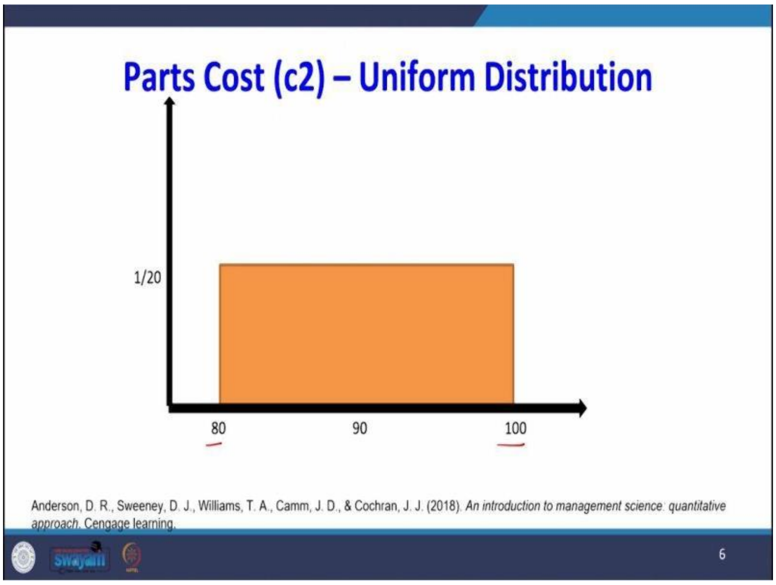
I am just recollecting what you did in the previous lecture. That company is looking to introduce a new product whose product name is a portable printer; The selling price is given, administrative cost and advertising cost are given, and the probabilistic input labor cost, parts cost, and first-year demand.



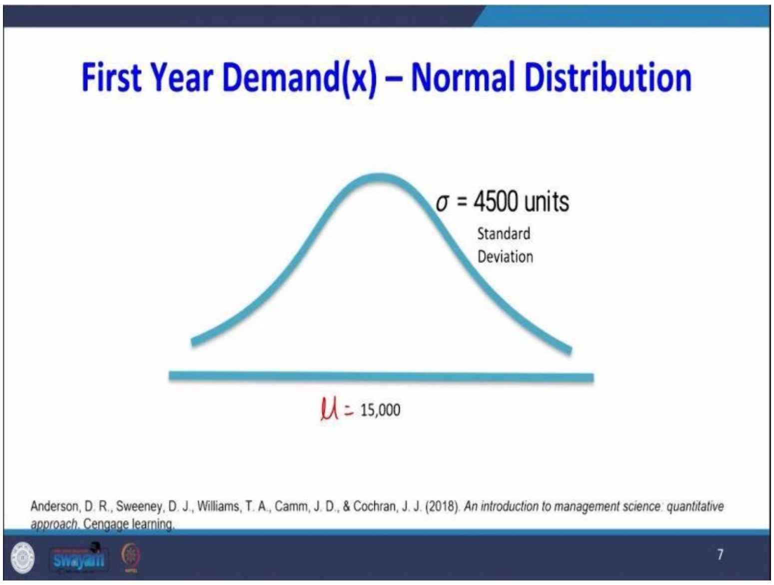
So, the profit function is, which I have seen with what-if analysis, there is a 249 - C_1 - C_2 multiplied by demand - subtracting the overhead charges.



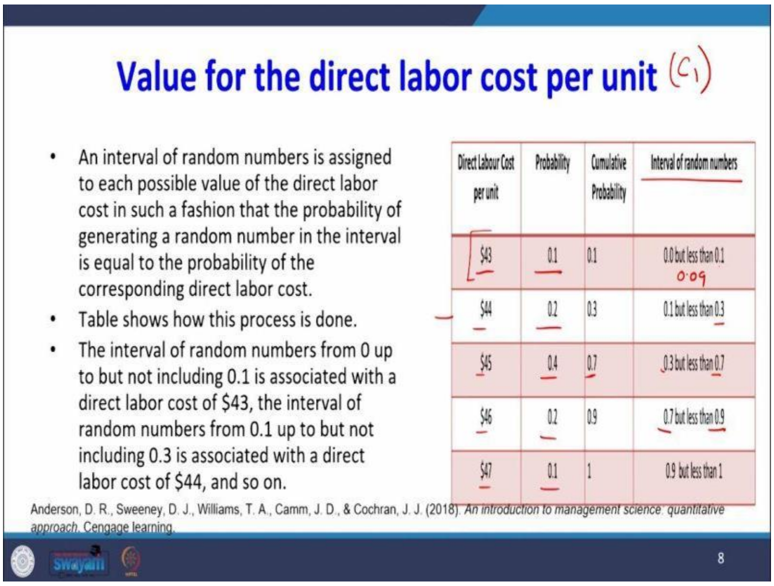
Because the labor cost is an uncertain input, that follows a probability distribution. So, the input for labor cost is which follows an empirical distribution like this.



The cost of the parts follows a uniform distribution.



And the first year demand follows normal distribution.

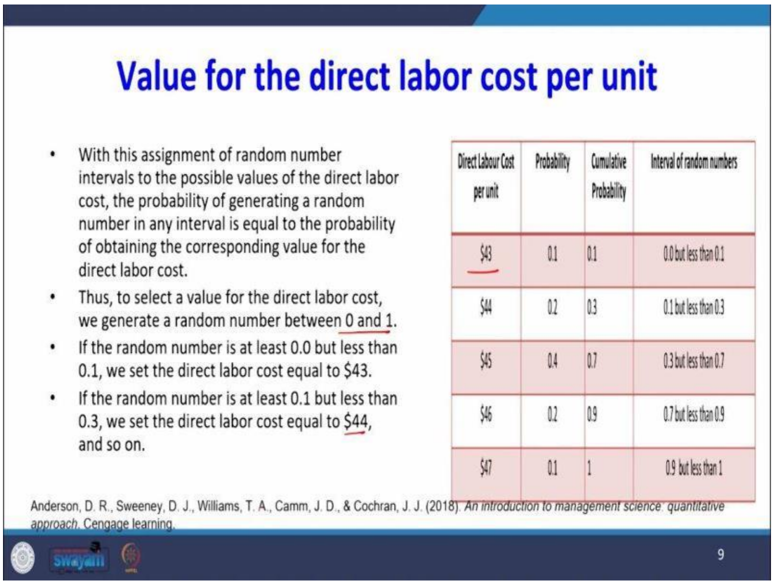


Now how to find out the values for the direct labour cost that is for your C 1? First, what we are going to do? An interval of the random numbers is assigned to each possible value of the direct labor cost in such a fashion that the probability of generating a random number in the interval is equal to the probability of the corresponding direct labor cost. For example, you see the table which is on the right-hand side.

This empirical distribution is given to us at 43, 0.1, 44, 0.2, 45, 0.4, 46, 0.2, and 47, 0.1. Now, we are going to find out the cumulative probability 0.1 + 0.2= 0.3, 0.3 + 0.4= 0.7, 0.7 + 0.2 = 0.9, and 1. So, here we are working we are going to make an interval for random numbers; what is that? 0 but less than point 1, then start from 0.1 but less than 0.3 start from 0.3 less than 1.7; why do you get this 0.7 from the cumulative probability 0.7 but less than 0.9, 0.9 less than 1.

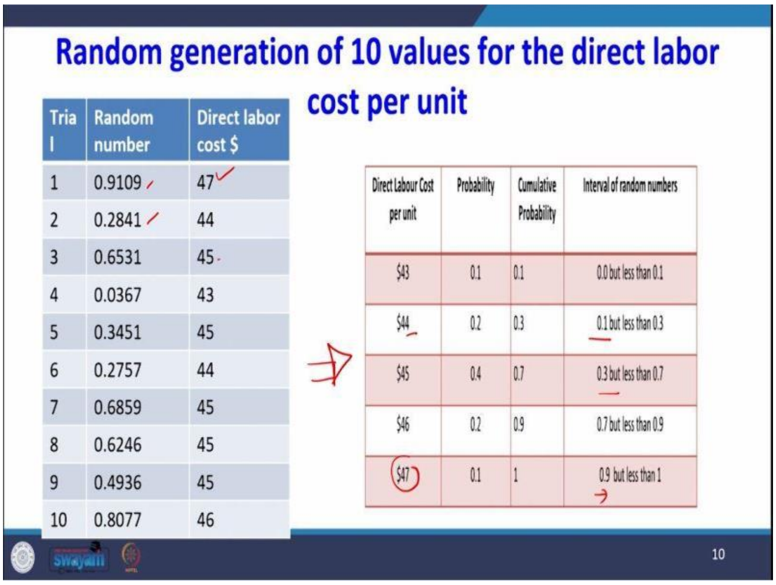
So, we have formed an interval; why are we forming this interval? Suppose what we are doing is randomly generating a number. Suppose that a random number, says, follows between, say, 0.09. So, 0.09 will be here, which means that we will be capturing the direct labor cost as 43. So, the interval of random numbers from 0 up to but not including 0.1 is associated with the direct labor cost of 43 dollars.

The interval of random numbers from 0.1 up to but not including 0.3, this one is associated with the direct labor cost of 44 dollars and so on.



So, with this assignment of random number intervals to the possible values of direct labor cost, the probability of generating a random number in any interval is equal to the probability of obtaining the corresponding value for the direct labor cost. So, any probability between 0.0 and 0.1 will have an equal chance of getting the direct labor cost of 43; thus, to select the value for the direct labor cost, we generate random numbers between 0 and 1.

If the random number is at least 0.0 but less than 0.1, we say the direct labor cost is 43, the randomly generated number, if the random number is at least 0.1 but less than 0.3, we say the direct labor cost is 44 dollars, and so on.

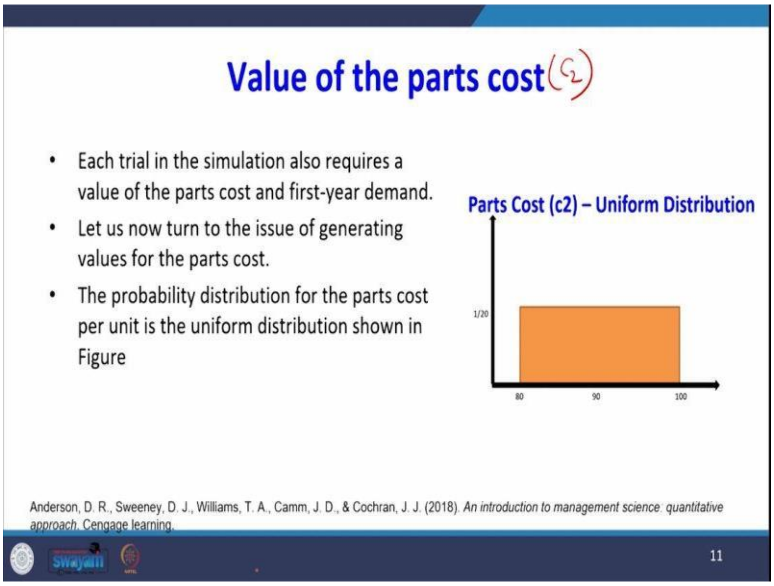


So, for example, look at the table which is on the left-hand side; I have randomly generated a number, say 0.91. So, in the table, which is on the right-hand side, I have formulated an interval of random numbers, say 0.91. So, I will look at the table on the right-hand side where the 0.91

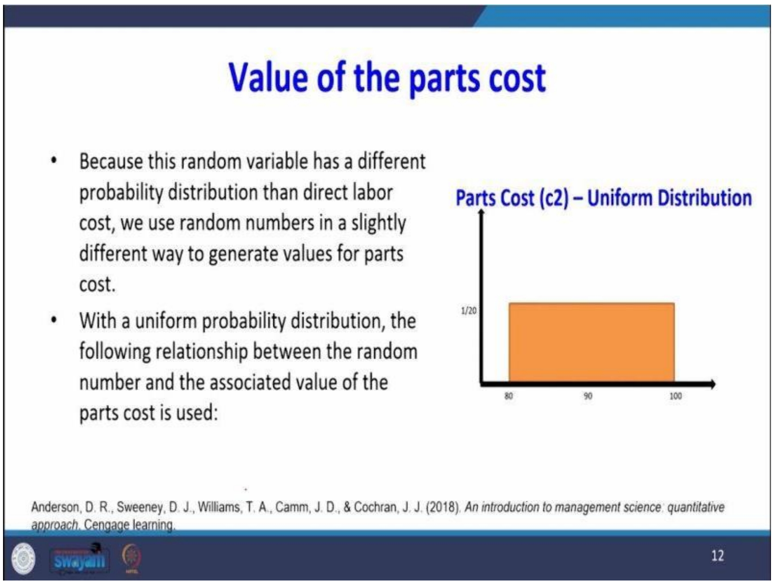
is this interval. So, the value for direct labor cost is 47, which is why 47. So, this next random number 0.28, this random number I got with the help of Excel.

Or we can get it with the help of a calculator, but here we are. This course is on a spreadsheet. So, we are going to use Excel for generating random numbers. So, using a RAND function so RAND = RAND when I type I will get this random. So, 0.28 if it is a 0.28 where that will lie point 0.28, so 0.28 is here, so it will be 44. If it is a 0.65, there is a 0.65; 0.65 will be here. So, it is 45 like these 10 random numbers I have generated.

Then, I assigned the direct labor cost with the help of this interval of random numbers. How did I find this interval of random numbers? I know the lower limit, but I found the cumulative probability will be the upper limit for each interval, like that I have extended up to all the direct labor cost values.

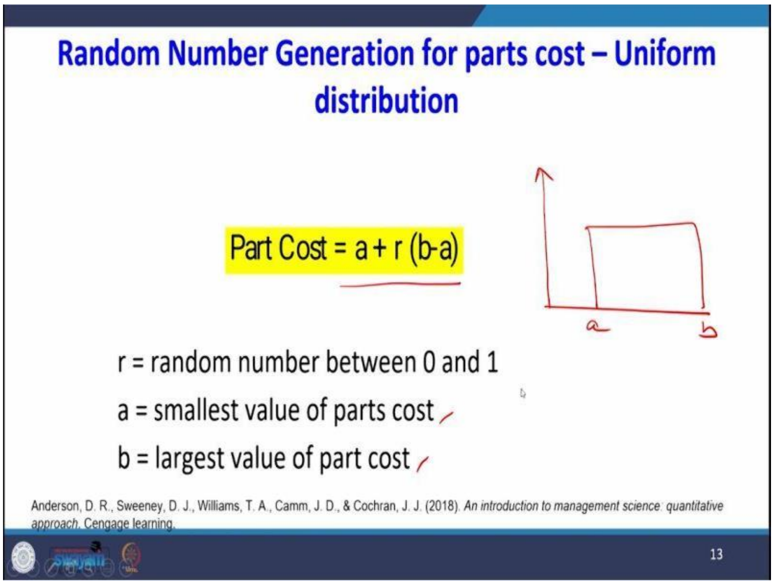


Now, we will generate the value for the part cost, which is our c2. Each trial in the simulation also requires a value for part cost and the demand for the first year. Let us now turn to the issue of generating values for parts cost. The probability distribution for the parts cost per unit is the uniform distribution, as shown in the figure.



Because this random variable has a different probability distribution than the direct labor cost, the direct labor cost followed an empirical distribution. If it follows empirical distribution, we have found the random number interval, then we randomly generated a number, then we have seen where that randomly generated number falls on that interval, and then we captured the corresponding direct labor cost.

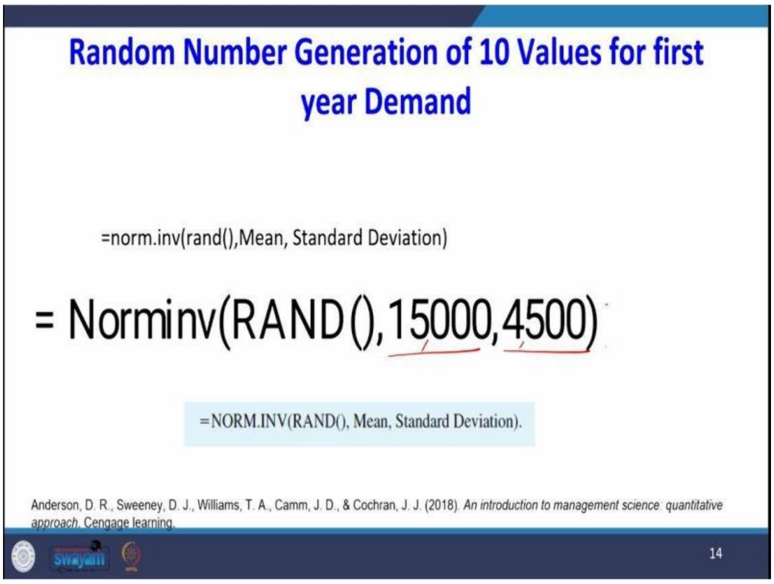
But here, the part cost follows a uniform distribution. So, with the uniform probability distribution, the following relationship between the random numbers and the associated value of the parts cost is used. So, what point we need to say is that the way we are generating random numbers is slightly different for finding the value for part cost because this follows a uniform distribution.



So, here is what we are going to see. To get the part cost, we are going to use the expression a + r multiplied by (b – a); a is the smallest value of parts cost, b is the largest value of parts cost, r is the random number between 0 and 1. So, this expression is used for generating random numbers that follow uniform distribution, where the lower limit is a and the upper limit is b, so if this is a this is b.

$$\text{Part Cost} = a + r\,(b-a)$$

So, this is the expression used to get a random number that follows a uniform distribution whose mean value is lower, and the upper value is b. This number is called a pseudo-random number. It is not valid between 0 and 1.



The third input is the demand, first year demand. So, how we can get values for first-year demand? So, in Excel, we can use this function norm.inv rand mean value and standard deviation value.

=NORM.INV(RAND(), Mean, Standard Deviation).

So, the naming here is rand asset, the mean is 15000, and the standard deviation is 4500. This is given in advance. So, this is a format for entering into the Excel. So, what we will do?

If we use this function, we will get a set of random numbers that follow normal distribution whose mean is 15000 and standard deviation is 4500. So, now we have learned how to generate values for your labor cost, part cost, and demand. These inputs are used to get your profit. So, these examples I am going to explain with the help of excel. I will go back to Excel.

Dear students, now I am going to explain how to use excel for the simulation. So, here I have entered the values. The values selling price per unit is 249 dollars, the administrative cost is

4,00,000, and the advertisement cost is 6,00,000. In this problem, there are three inputs: The three inputs are the labor cost. So, look at this highlighted cell here, direct labor cost per unit. Please look at this, this is given to us 43 44, and the probability is also given.

So, in between, I have entered the probability upper limit. So, that is nothing but the random number interval. So, for any value between 0 to 0 and 1, the value of a rand value for c1, that is, the labor cost, is 43. For any random numbers between 0.1 and 0.3, the value for labor cost is 44. This is another input. Look at the next input, c2, which is a part cost that follows a uniform distribution.

So, the lower limit is 80, the upper limit is 100, and another variable input is demand. The mean of demand, which follows the normal distribution mean, is 15000, and the standard deviation is 4500. So, what have I done? First, I have entered 500 trials. Look at this up to 500 trials. So, after entering 500 trials, so I need the value for labor cost. You see, I am using a function called VLOOKUP.

So, VLOOKUP and B21 keeper cursor and B21 = VLOOKUP RAND, then you have to select the table A10 to C14 this table A10 to C14 this table. In this table, you have to select; after that, you see comma 3; what is the 3? Because the values in the third column have to appear in B21, that is why there is a syntax for VLOOKUP; randomly, it will generate a number that number will be searched into the table between A10 to C14.

If those randomly generated numbers follow in a particular interval, the corresponding values in the C3 column, that is, the third column in the table, will be captured. For example, here, see that 45 because what is the 45? 45 is the random value of the randomly generated number, which is between 0.3 and 0.7. That is why I got 45. So, 44, how I get here? You can press the F9 function. You see that now it is a 46. The trial one, the value of labour cost is 46; why is it 46?

Because the RAND function generated a random number, the number was between 0.7 to 0.9, which is why we are getting 46. So, we got the labor cost. The next one is this labor cost I have dragged up to 500. The next one is the cost of the parts. We know that the part cost follows uniform distribution, and then we know the expression for generating random numbers that follow uniform distribution; what is that?

A is the A, A is E8, E8 is the A; A is your lower limit + random numbers RAND, then the difference between your E9 and E8 that is b - a so that I got here 91, then I have dragged up to all 500. The next one is the demand; we know the demand follows which distribution normal distribution. So, we need to have a set of random numbers that follow normal distribution whose mean is 15000, standard deviation is 4500 = norm.inv RAND function, mean.

The mean is your E13 15000, standard deviation of E14. So, you see that I got the value of demand, so if I press F9, see there, it keeps changing. So, I have also dragged up to all 500, and then I wrote expression for the profit. What is the expression for profit? Your selling price - labor cost that is your B21 - parts cost C21 then multiplied by the demand is a per unit cost.

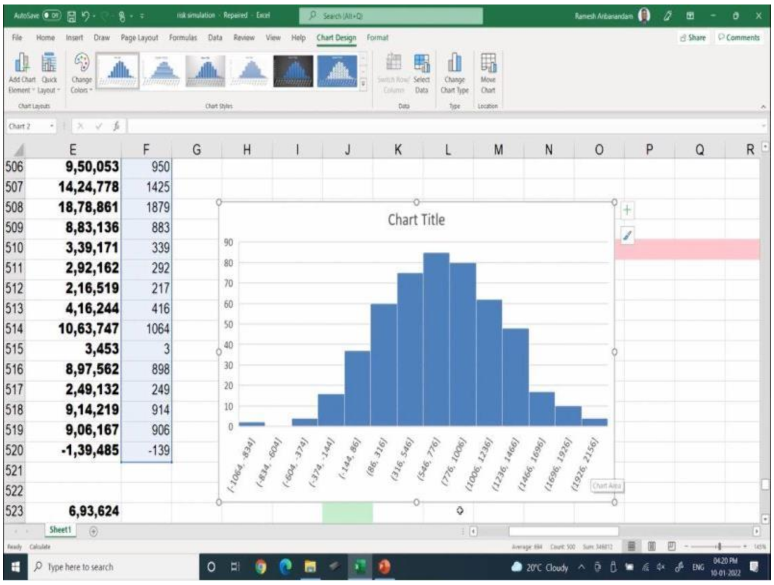
So, when you multiply by the demand that is a D21, you will get the overall profit - your C4 - C5. What is the C4 and C5? Our administrative expenses and advertising expenses. So, in E21, I am getting an expression for the profit. So, I have also dragged up to all 500. Next we need to have the statistics of the simulation model. First the mean profit, what is the mean profit?

So, the mean profit is the average value of the profit column, then the standard deviation, then the minimum profit. We have the function minimum of profit column, then maximum profit then max in the profit column function. The number of losses, you see that here is how I am defining losses. Count if in the profit column if any value is less than 0. So, wherever that means, wherever there is a negative profit, I am counting that scenario so that iteration is a loss.

So, now we have 41. So, out of 500, 41 times, we got the negative value, which is the number of losses. Then how am I defining the probability of loss? The probability of loss is number of losses divided by total number of iterations. Here, 41 upon 500, so the probability of loss is 8%. So, what we will do is look at this E500 and 28 when I keep on when I keep on pressing F9 when you look at the probability of loss.

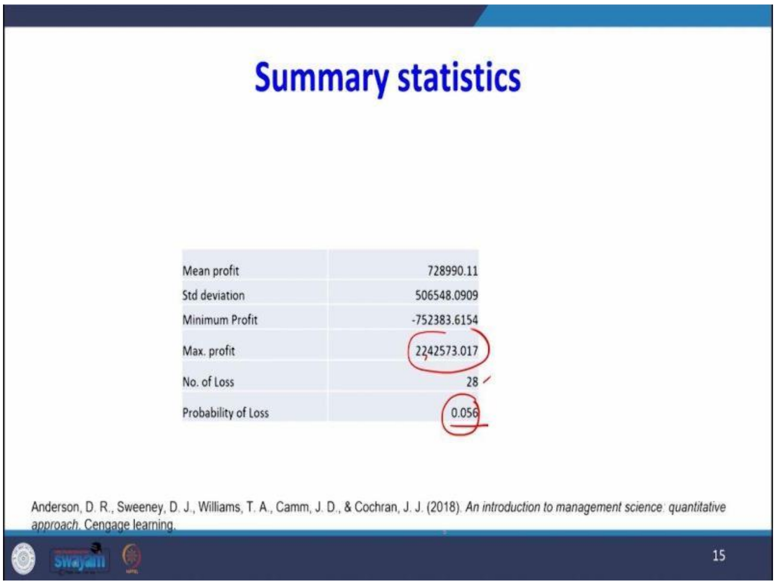
Most of the time, the probability loss is below 10%, 6%, 9%, 8%, 9%, and 10%. But most of the time, when I press F9, the probability of loss is below 10%. So, the risk of introducing this new product is 10%. But when you look at the mean profit you see that this is 6, 93, 624 dollar mean profit. So, now, what am I going to do? I am going to plot the profit function. So, I have converted it into the F column. I have converted the profit in terms of 1000.

So, after I convert it into 1000, I am going to draw a, so this is my profit function. I am going to select this. Now, I am going to draw a histogram and insert the recommended chart. Then there is an option for a histogram.

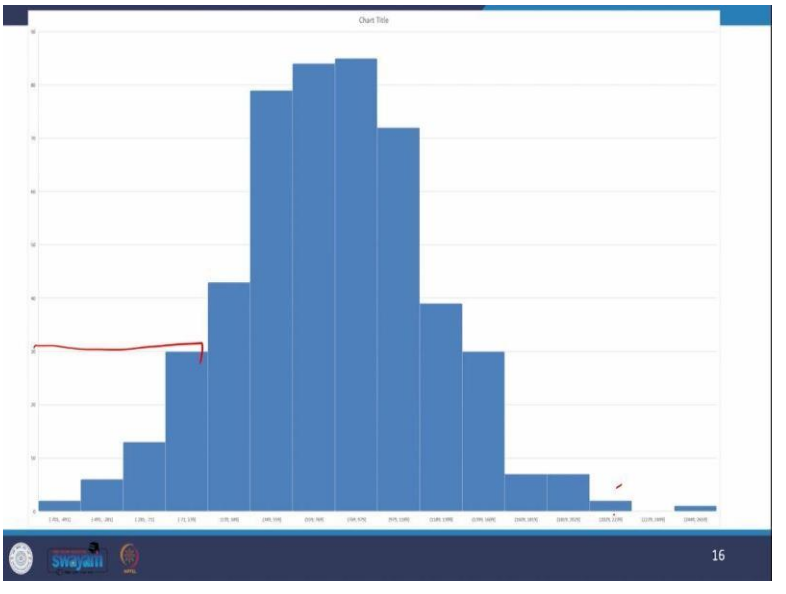


Look at this histogram chart if you see that in the y-axis of frequency. You see that the highest extreme right has the highest profit because all the values are in terms of thousands. So, it will be 2,156,000. So, even though the risk is below 10% there is a chance of getting higher profit. So, the conclusion that we are learning from this Excel model is the risk of introducing a new product is only 10%.

But looking at our maximum profit we can take the 10% risk, so that is my conclusion now. I will go back to my percentage now.

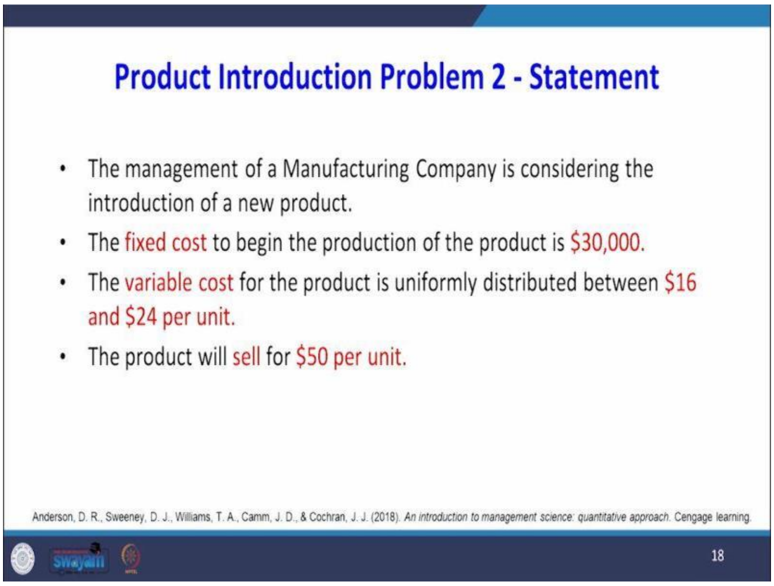


Here, I brought the summary statistics. What are the summary statistics I found? This is not because it is a simulation, or this value may change. So, the mean profit is 7,28,000, the standard deviation is 5,06,000, the minimum loss is 7,52,000, the maximum profit is 22,42,000 for that particular set of random numbers, and the number of losses is 28. So, the probability of loss is only 5%. By looking at this 5% and the maximum profit, so we are concluding that we can take the risk of introducing this new product.



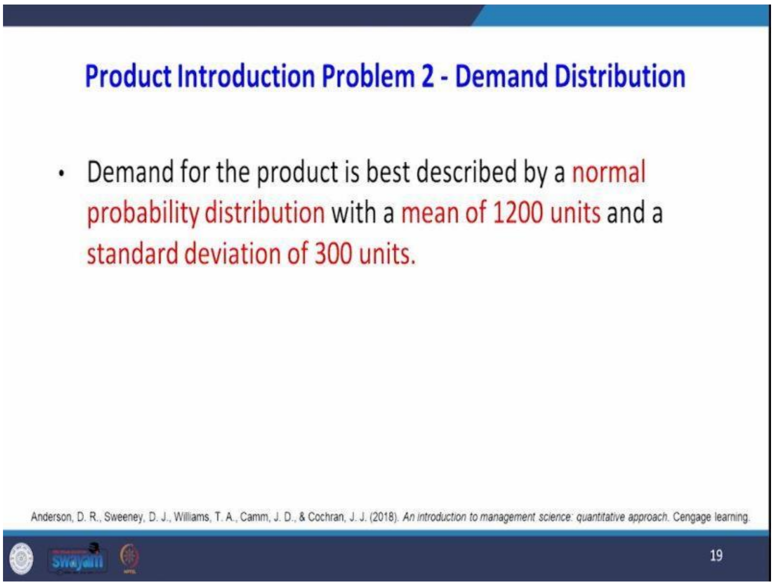
So, this shows the probability distribution of our profit function. Look at this; this follows a normal distribution. Look at this in the highest value. So, it is 2029 to 2239, and all the values are in terms of thousand. So, there is the highest chance for profit where we are getting losses here, we are getting lost up to this, see that up to get up to this we are getting losses. But we notice that the loss is, most of the time, below 10%.

By looking at the extreme possibility of getting higher profit. We can conclude that since the loss is below 10%, we can conclude that there is no risk for the introduction of this new product.

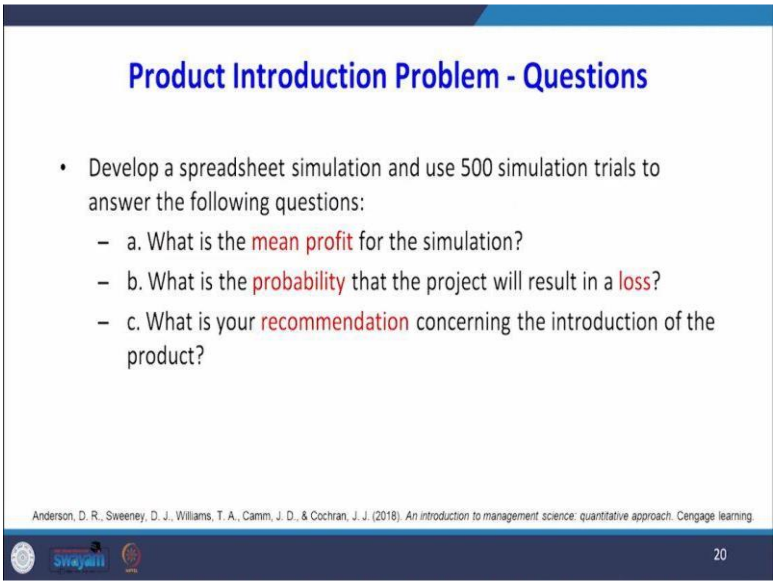


Now, we are going to solve another problem, which is the introduction of a new product. What is the problem statement? So, the management of a manufacturing company is considering the introduction of a new product. The fixed cost to begin the production of the product is 30,000 dollars, and the variable cost for the product is uniformly distributed between 16 dollars and 24 dollars per unit.

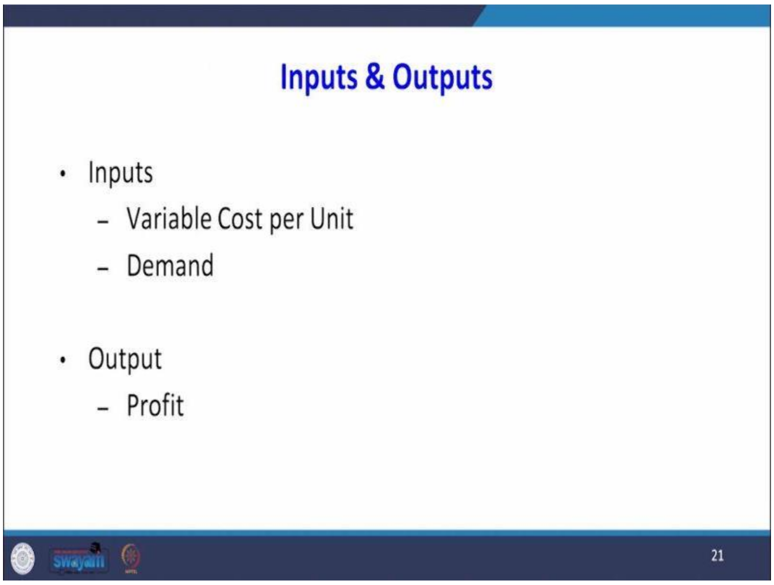
Here, the variable cost follows a uniform distribution. The product will sell for 50 dollars per unit.



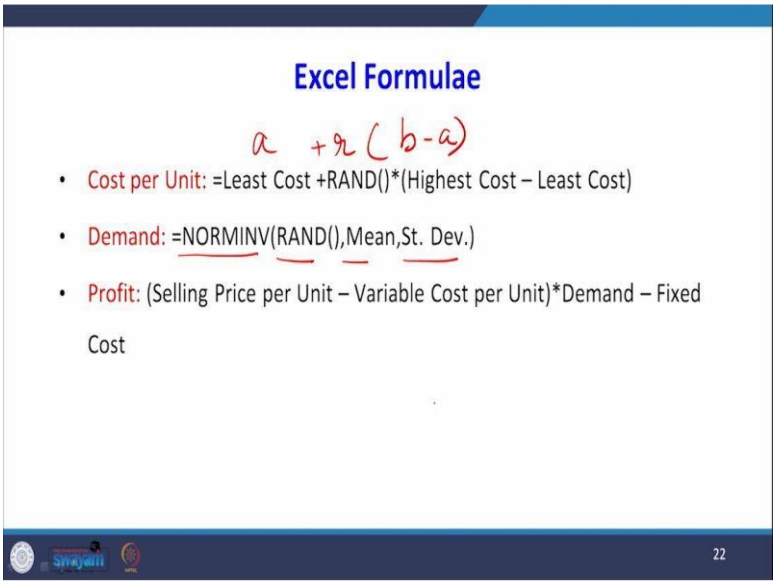
Then, we talk about the demand for that product. The demand for the product is best described by a normal probability distribution with a mean of 1200 units and a standard deviation of 300 units.



What are the questions that need to be answered? So, first develop a spreadsheet simulation and use 500 simulation trials to answer the following questions: a. What is the mean profit for the simulation? Then, what is the probability that the project will result in a loss indirectly? What is the risk of introducing the new product? Then what is your recommendation concerning the introduction of the product?



Now, we will discuss the inputs and outputs for the simulation model. There are two inputs; the first input is the variable cost per unit, which follows a uniform distribution. The second input is demand, which follows normal distribution. The output of the model is profit.



So, what are the different Excel formulas that you are going to use? The first one is that we have to find out the variable cost per unit; it is given that variable costs follow a uniform distribution. So, we have to generate a set of random numbers which follow a uniform distribution. So, we have seen the formula for generating random numbers which follow a uniform distribution. What is the formula? The least cost is the + RAND, the highest cost is b and the least cost.

So, this will be a. This will be our random number. This is (b – a). What is the b? Highest cost - least cost. So, another input is demand, which follows a normal distribution. The formula which is used for generating numbers that follow normal distribution is NORMINV RAND mean and standard deviation. So, the profit function is selling price per unit - variable cost per unit; then, when you multiply, you will get the overall profit - fixed cost. So, we will get the net profit.

=NORM.INV(RAND(), Mean, Standard Deviation).

So, I will solve this problem now with the help of Excel. So, now I will open the Excel model, and then I will explain it to you.

Now, I am going to explain these 500 trials of simulation with the help of Excel. So, what are the information is given to us? One is the selling price per unit is 50 dollars, and the fixed cost is 30,000 dollars. So, another important input is the variable cost following uniform distribution. The smallest value is 16 dollars, and the largest value is 24 dollars. Another input is the demand for the product. So, which follows a normal distribution?

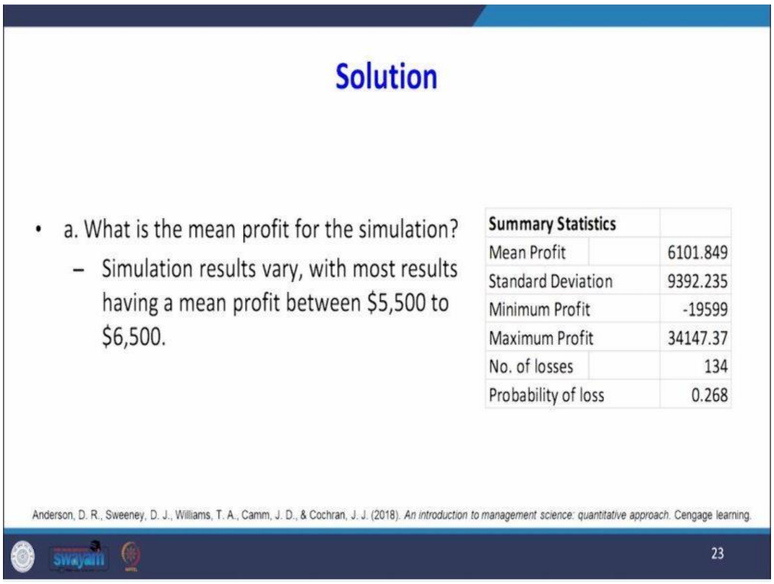
So, the mean of the normal distribution is 1200, and the standard deviation is 300 units. First, we are going to generate the variable cost per unit using the following formula. So, what is C7? C7 has the smallest value + RAND, and C8 has the largest value - smallest value. So, I generated this variable cost for 500 trials. For the next one, we have to generate random numbers that follow a normal distribution.

So, we use this formula equal to norm inv RAND, so the mean is your G7, and the standard deviation is G8. You see that I have frozen to that cell so that because I am going to drag it while dragging, the cell value should not change. So, I have randomly generated the demand. So, I have extended up to 500 iterations. Now, look at the profit formula. The profit is the selling price, which is a 50-dollar C3 - variable cost per unit.

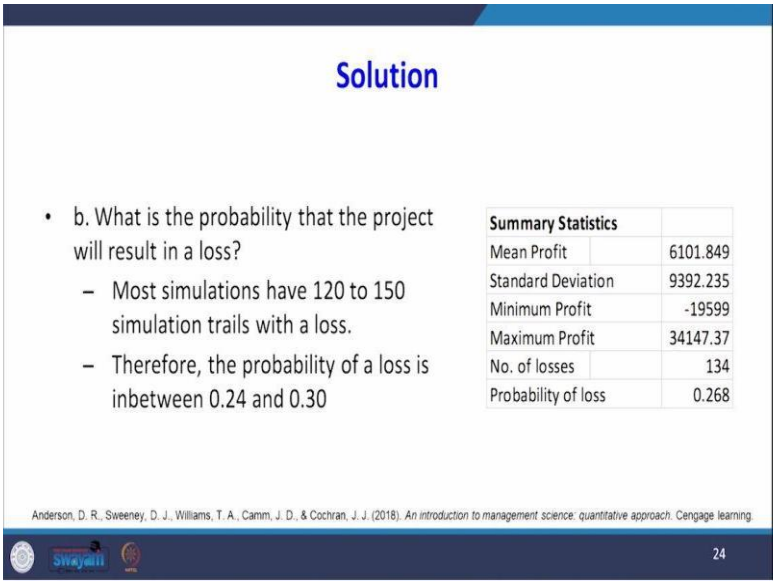
So, we will get the per unit product that we multiplied by the demand, which is C13. So, we will get the overall profit from that by subtracting the fixed cost. So, we will get the net profit, so I have extended it to 500 trials. When I go back, see that I dragged this formula for 500 trials. Now, you see the summary statistics. The first one is the mean profit. So, I have the profit column there I have used the formula of average.

Then, the standard deviation was D13 to D512. Then, for minimum profit, I used the minimum formula, and for maximum profit, I used the maximum formula, which is the number of losses. So, whenever the profit becomes negative, I consider the loss. So, I have counted out of 500 how many times we have incurred the last. So, if the percentage shows 132, then the probability of loss is. So, the probability of loss is the number of losses dealers by 500.

When I keep on pressing F9, you see that the probability loss is now 26.4%. Most of the time, the probability loss is about 20, 20%. So, what we are concluding overall from this model is that, for this problem with this product, if you introduce this product, there is a 20% or more probability of loss. This is the inference from the problem. Now, I will go back to the presentation.

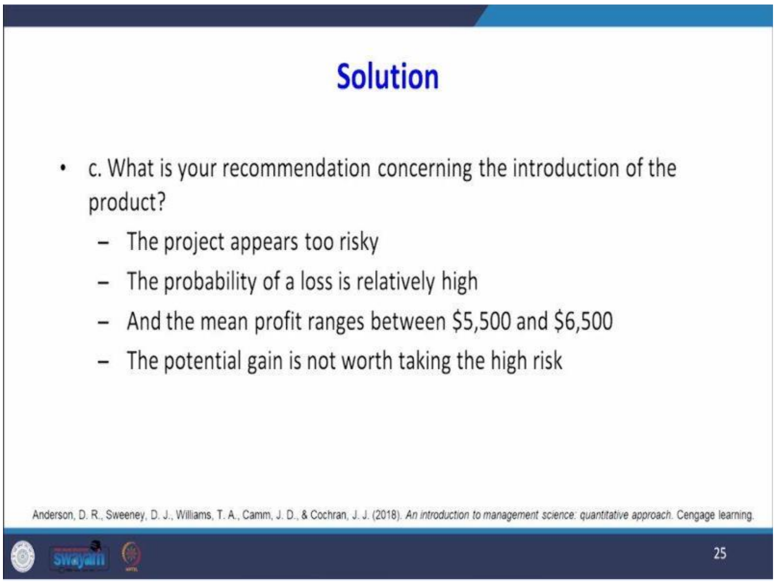


So, what is the first question? What is the mean profit for the simulation? I have just taken a snapshot of the summary statistics. So, simulation results vary, with most results having a mean profit between 5500 dollars to 6500 dollars.



The next question is, what is the probability that the project will result in a loss? So, this is a very important question because we are introducing a new product. We have to know the risk of introducing this product. When you look at this the number of losses, most simulations have 120 to 150 simulation trials with a loss. Therefore, the probability of loss is between 0.24 and 0.30.

So, what we are inferring from here is that there is a 24 to 30% chance that there will be a loss if you introduce this product.



So, for part c, what is your recommendation concerning the introduction of the product? Because the last percentage is very high. So, we are concluding the project appears to be too risky. The probability of loss is relatively high, and the mean profit ranges between 5500 dollars and 6500 dollars. The potential gain is not worth taking the high risk. So, we conclude that the introduction of this product is not advisable.

Because there is more chance that you may incur a loss, in this lecture, we have completed the problem of risk analysis of the introduction of a new product that we have begun in the previous lecture. Then, we have taken another problem and analysed the financial risk associated with the development of the new product. In the next lecture, we shall discuss how to use simulation to solve inventory problems. Thank you very much.