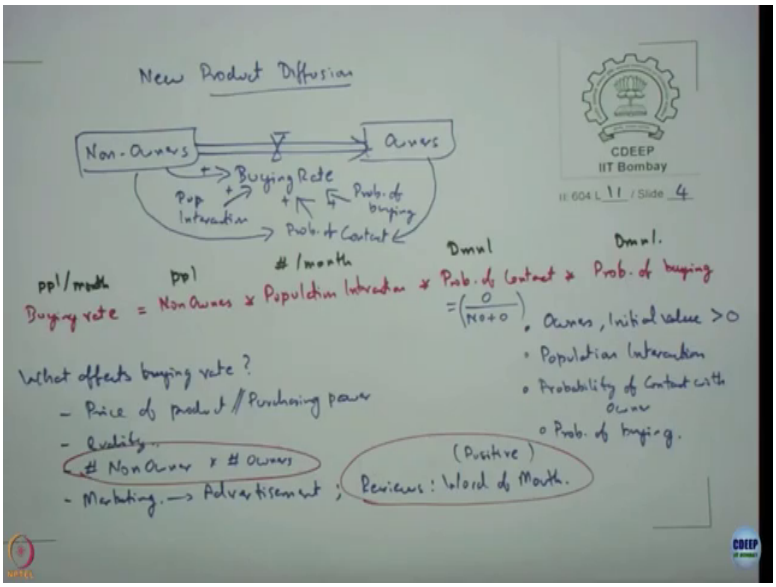
Introduction to System Dynamics Modeling
Prof. Jayendran Venkateswaran
Department of Industrial Engineering and Operations Research
Indian Institute of Technology, Bombay

Dynamics of Simple Structure: S - Shaped Growth (Contd.)
Lecture – 11.3
Dynamics of Simple Structure: SFD of New Products

(Refer Slide Time: 00:19)



So, let us figure out how non- owners, owners are going to be influence through this word of mouth in our model. So, let us try to achieve that. So, if for the word of mouth you spread initially there has to be some, but he was actually owned it, let us assume there not advertisement only the red circles are available.

So, we will make an assumption that owners whatever Initial value is strictly greater than 0, it means that at least some owner, right. And only the people who own it can actually give a

positive or some feedback on that, ok. And till then is nobody owns it there is nobody to give the feedback on because nobody knows that product even exists. So, we will assume that there is some owners already available.

Now, we are assume the population to be homogeneous, you can imagine this entire class room and people are going to be interacting with each other. So, let us assume that some amount of population you are going to be interacting with. So, let us introduce a term called as population interaction, imagine yourself as a non owner, ok.

So, you are going to be interacting many people, right. So, among the many people you interact there has to be some chance that you are going to be interacting with the people are going to own the product, right. If you are only going to talk to friends who do not have the product and you do not get the information. So, when you interact imagine your again as a non owner then interacting with say ten people per day, let us assume.

So, and population homogeneous so, it can be any ten people. So, this population interaction you may get convert you may be tempted to buy or maybe come aware of the product. If you by chance meet a person who owns a product then we will have a thing called as probability of contact with owner. What is the probability you are going to actually meet a person who has the product. And even if you meet the person with the product you are not going to immediately go and buy it, you may think of other factors like price or quality or current cash in hand and your own inclination to buy the product, etcetera.

So, let us just capture all of that there is simple parameters are called as probability of buying. So, with these few let me try to define the buying rate. So, now, if we are going to look at a systems view for a individual person I am I know, I am going to interact with some amount of people and what is it probably that I am going to meet the person who is actually going to own the product and even if I meet them what is my probability of buying it.

So, when you think logically. So, that gets affected by the population interaction multiplied by the probably of contact multiplied by the probability of buying. So, that is for one person.

So, now, if I have lot of non owners then I had to do it for everyone, right. So, I have to multiply by total number of non owners just pretty much what you are going to do.

So, here I am going to define buying rate as non owners multiplied by population interaction multiplied by probability of contact multiplied by probability of buying that is write out the units here. So, we assume we already know the product, ok. So, the buying rate is number of people who are buying the product per time unit. So, buying rate can be people per month say number of non owners are people, I am just using ppl.

For people the population interaction is number of number per month, probability is dimension less values write here. So, how do we get the probability of contact again remember total population is conserved, right. See if we know how many of owners are there the probability I am going to meet owner is number of owners divided by total population, correct. So, the probability of contact will be nothing, but owners divided by non owners plus owner, right.

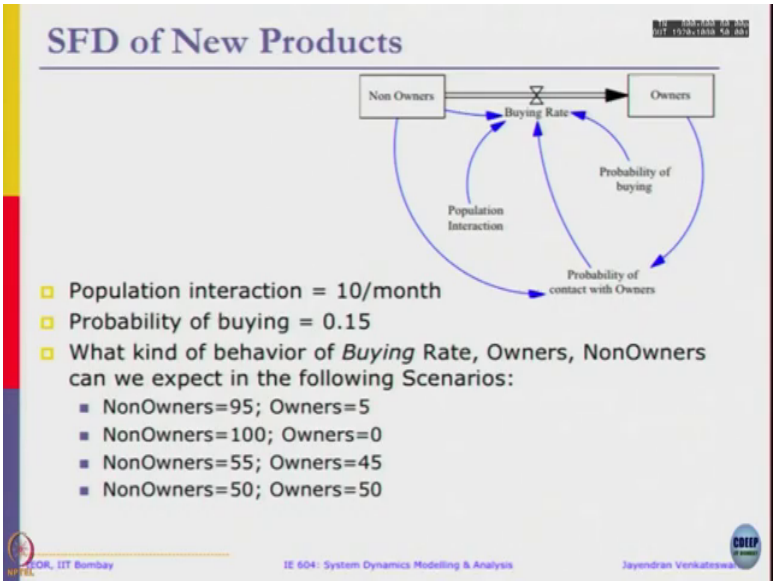
That should be the probability I am going to meet a owner think the proportion of the owners that are there in the group. And probability of buying will assume we know some value there. So, this I need to represent in my as a model. So, let us just do that we will define population interaction, we will define probability of buying if I am probability of contact. So, non owners affects buying rate directly. So, let us link it here.

Population interaction affects it directly let us link it probability of contact probability of buying as each of them increases, I am going to have larger buying rate at the probability of contact is ratio of owners by non owners plus owners. So, I can I need to connect it like this, right here. This is the model we have and complete the model by including population interaction probability of contract and probability of buying on connect with the arrows.

So, the model you would have downloaded it will have just non owners buying rate and owners is this stock and flow will be represented create the new variables and complete this

model. Then we will simulate and see what kind of behavior we get for different input parameter.

(Refer Slide Time: 08:03)



So, this is a model this now, it should look the value should be enterer also given there or give to go had a buy this model. And we can start with the first scenario. As we can see now all the scenario the total population is 100, total population is 100 new product diffusion class that is the name of the file download it and open in Vensim.

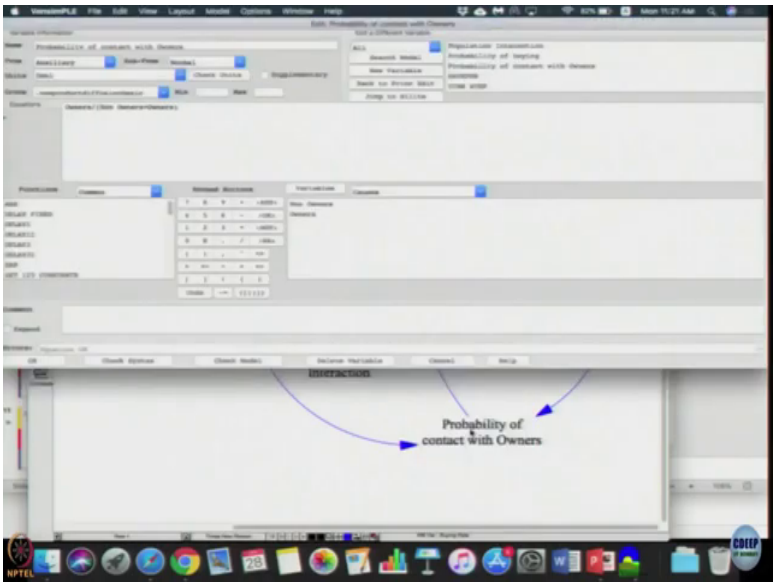
You should see only the stock and flows we can open it to see what is there nothing would be written except the initial values. We can set the initial value of non owners as 95 and owners as 5, we can create these three variables connect them with arrows and population interaction we have to write the value 10 probability of buying 0.15 and probability of contact with owners the equation I showed, probability of contact with owners is nothing, but owners

divided by non owners plus owners; that is only equation you have to write for this. And quickly make note of the parameter values so that I can open Vensim and show the model there.

Population interaction keep it 10 probability of buying point one 515 percent chance to buy. So, interesting thing happens is this probability of contact initially is very is going to vary along with the number of as a number of owners increases that is also expected to increase, correct because that denominator is constant only thing affects this is the owners as a number of owners increases it will keep increasing.

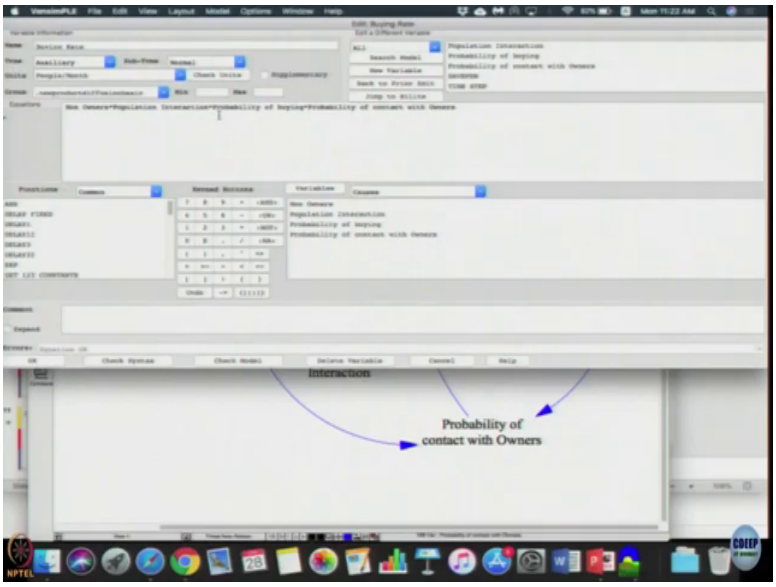
But overall this buying rate itself is nothing, but a product of all these buying rate is equation is product of non owners multiplied by population interaction multiplied by probability of contact multiplied by probability of buying, but the total number of non owners keep falling down which acts as a limiting factor constraining and leading the model into a shape behavior. See, note it some of the parameters the equation for buying rate is just a product of all the arrows are going in, equation for probability of contact is owners divided by non owner plus owner have let me open my Vensim, ok.

(Refer Slide Time: 10:41)



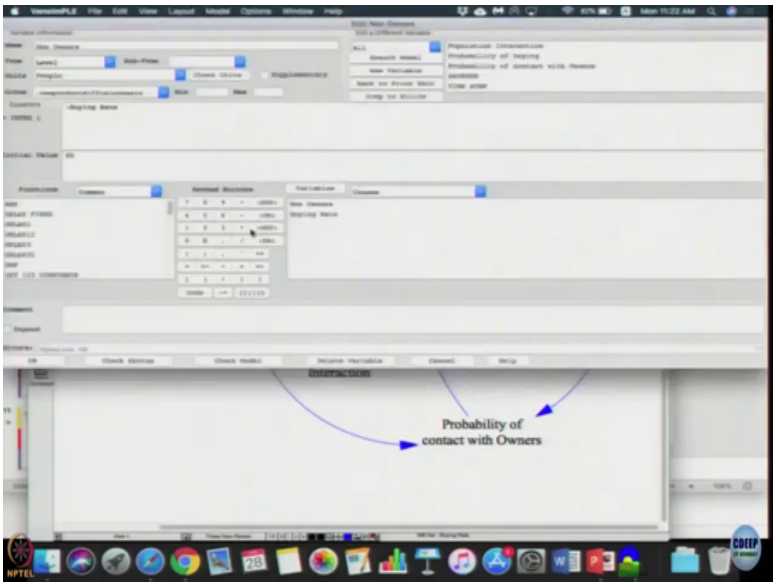
This what will have now see the equation for probability of contact with owners divided by some of non owners plus owners use parentheses to ensure division happens properly.

(Refer Slide Time: 11:01)



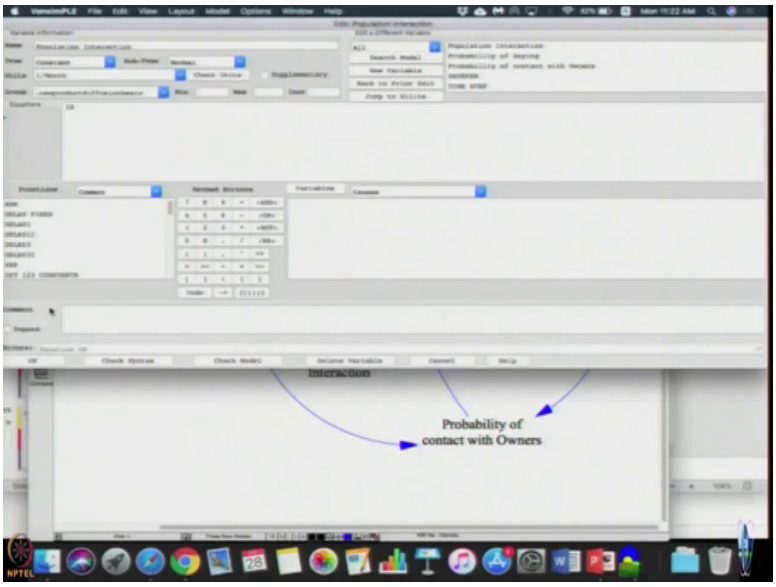
Buying rate is nothing, but probably the product of all the parameters, all the variables it is linking into the rate is multiply everything. Non owners multiplied by population interaction multiplied by probability of contact multiplied by probability of buying.

(Refer Slide Time: 11:25)



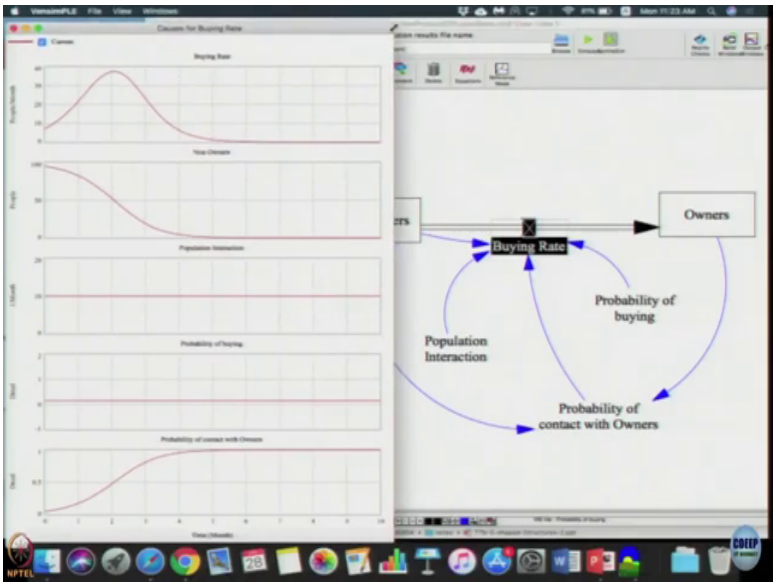
And check the initial values non owners is 95, owners is 5 let us not change it non owners 95, owners 5.

(Refer Slide Time: 11:37)



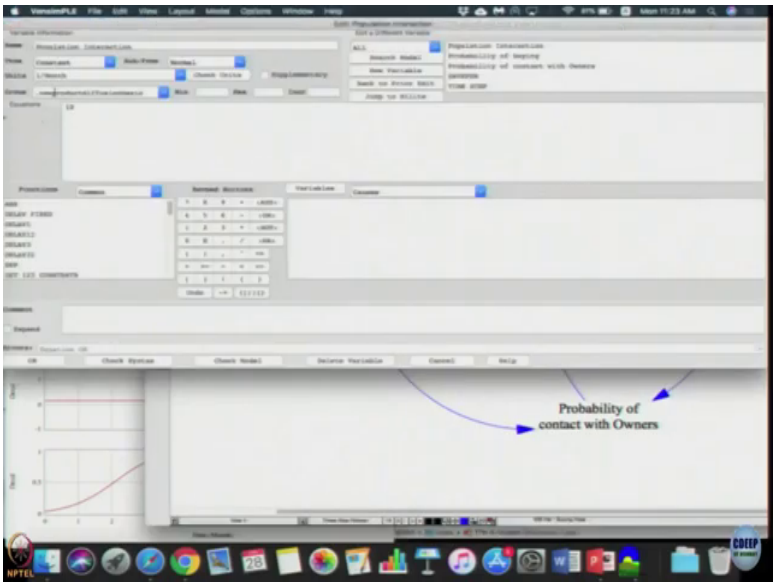
Population interaction is 10, probability of buying is 0.15. If you run the model click buying rate click causes strip after you run the model.

(Refer Slide Time: 11:55)



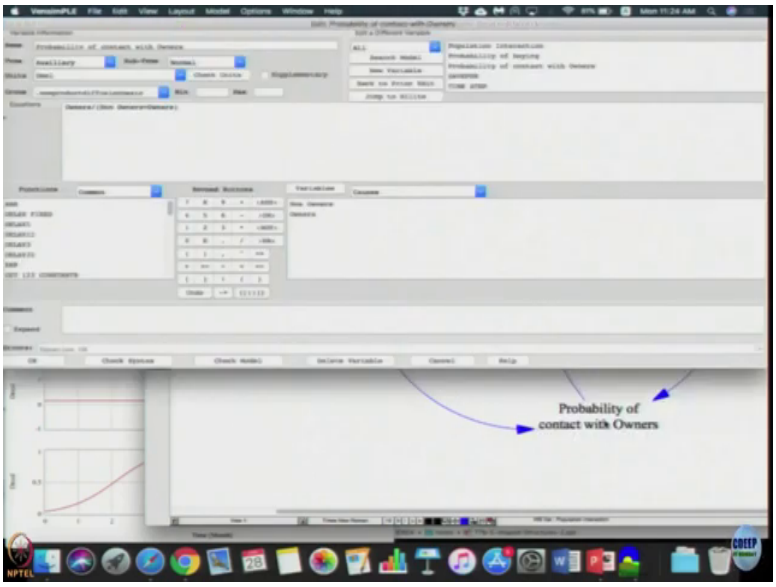
Once you do that you should get a graph like this.

(Refer Slide Time: 12:19)



One over month is the units per population interaction value is 10.

(Refer Slide Time: 12:27)

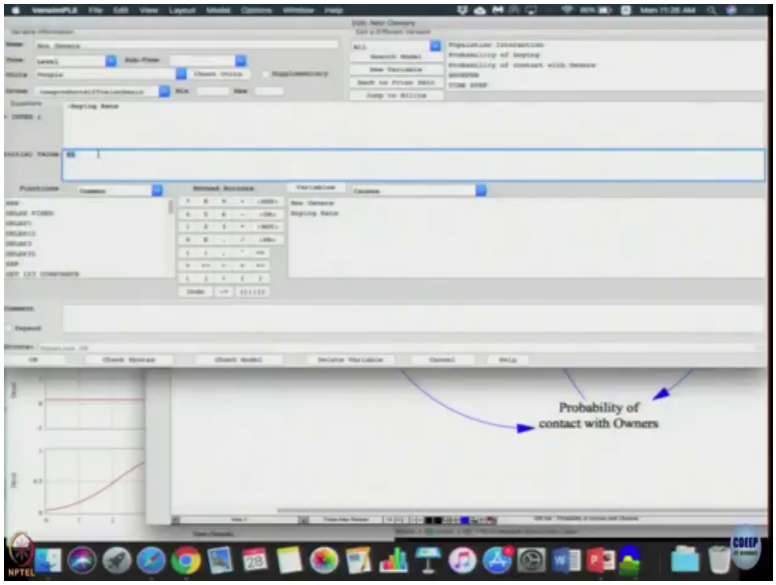


Probability of contact to the owners is here you can see it unit is dimension less dmnl here is equation owners divided by non owners plus owners. If you got this you can play with other values make owners as 0 and non owners as 100. Since, non owners are 0 and we are multiplying it should not be any behavior that is a unstable equilibrium, we need at least one owner for the entire system to start.

So, instead of buying it you can assume things like it is say spread of some infectious disease, one gay gets it and then everybody gets it. If the everybody is healthy then nobody gets it, it will be a similar model. You can try it if larger values ensure the sum of owners and no owners initial value is 100. Suppose we have non owners has 95 or rather non owners has just 5, owners has 95; that means, only 5 people are not bought it, we can see what will happen, see just reverse it.

The expected behavior in that cases should just asymptotically converts you may not get a growth it will just increment it will asymptotically converts to the value, we can try that. How may got it? Same number of hands, I hope there will be more hands every time I ask. You can play with it let us take the non owners as say a 60, owners as 40 again we can run the model.

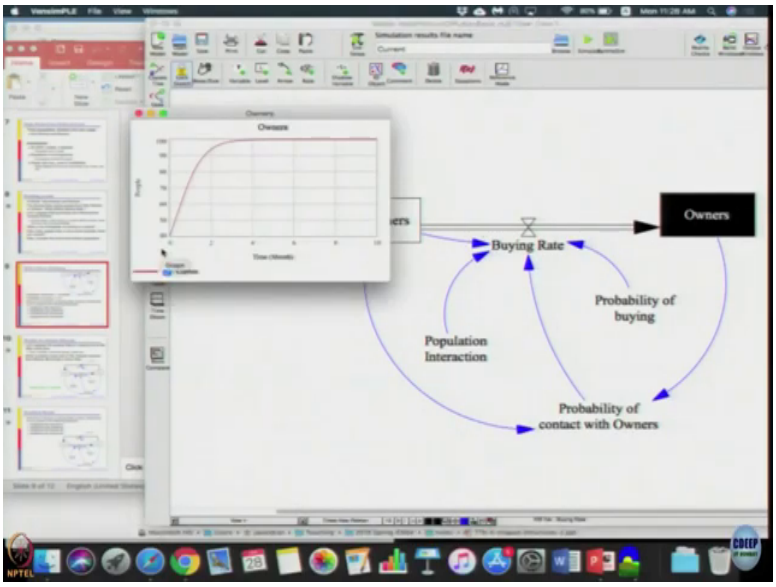
(Refer Slide Time: 14:17)



So, you can see the owners here s shaped is not that pronounce within this model for obvious reasons.

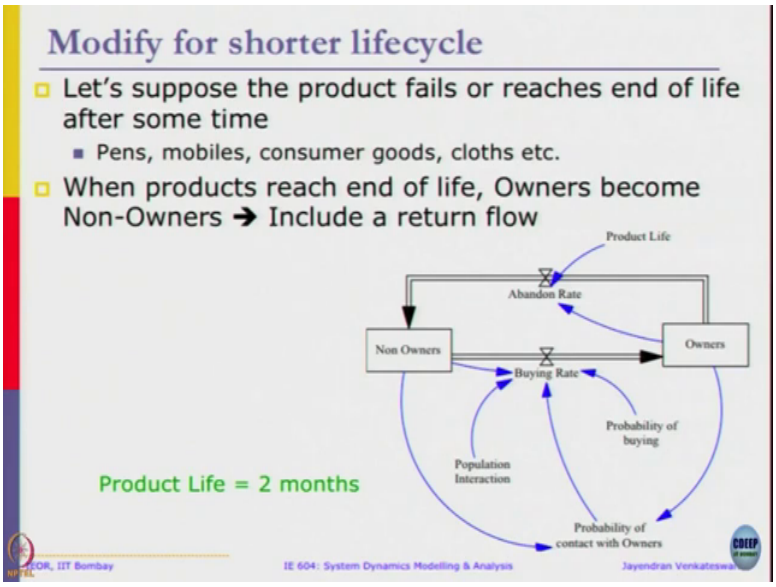
(Refer Slide Time: 14:35)

(Refer Slide Time: 14:53)



Again note that the S shape is to be seen in the owners the s shape that we are looking at should be whatever is pronounced at the owners only. The others need not exhibit S shape, the S shape that we are talking about is you are solving for the owners buying rate usually increases and then decreases, right. The S shaped we can find at the owners and non owners we expect inverted S on need not other mirror image of it.

(Refer Slide Time: 15:29)



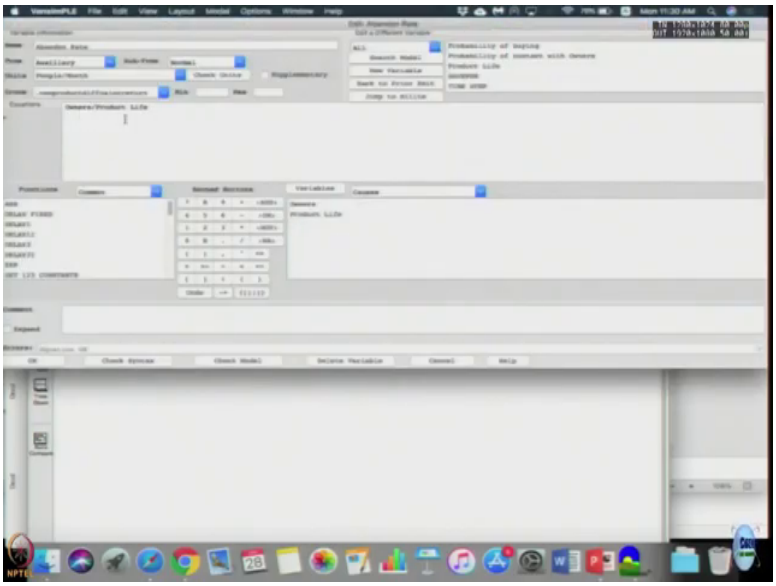
This case you will get a S in owners, ok. One small thing, we can make very simple modification this. Let suppose a product fails or reaches end of life after some time pens mobiles consumer goods whatever it is then products reach end of life owners become non owners then the again by the product. So, let us modify the model that you have build by including this reverse flow again.

As you can see here there are two rate that is effecting non owners and owners, we are not having a we are not doing any extra calculation for it, all we are saying is owners will abandon the product after some time and then become non owners and again ones we are again contact with other owners again they end up buying the product. So, we can include this in the model here.

The equation for abandoned rate is owners divided by product life again it is very intuitive when you, but you need to now pay attention sense owners is connected to abandon rate. And here the arrows you see the owners is going in into abandon rate product life is going to abandon rate, product life units is two months that after a couple of months here going to abandon it.

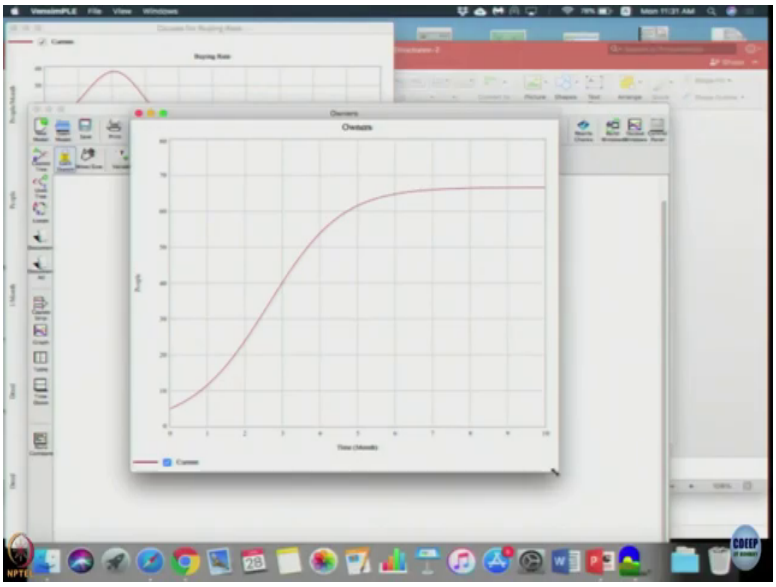
So, then the only equation abandon it has to be rate means it has to be people divided by time, I do not have the time. So; that means, this equation has to be owners divided by product life. We can try similar scenarios in this one also let us.

(Refer Slide Time: 17:15)



So, the abandon rate here is owners divided by product life owners initial value is 5, non owners initial value is 95, then it's simulates this model once you finish it, we can do it.

(Refer Slide Time: 17:29)



You click owners you will find that the owners saturate at a much lower value of may be 67 or something, but in the previous case the owners would saturated at 100. When there is no return rate the owners would have saturated at 100, you can check that; that means, all non owners will eventually become owners non owners will drop the 0, owners will drop will peak at 100, but we have any external flow; that means, reaches the stated capacity some people always come back that value is stops at 67. Let me just stop here and any questions you can ask. Please, tryout this model and complete it.