Introduction to System Dynamics Modeling
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Lecture – 15.1
Information Delays
Delays: Information Delay

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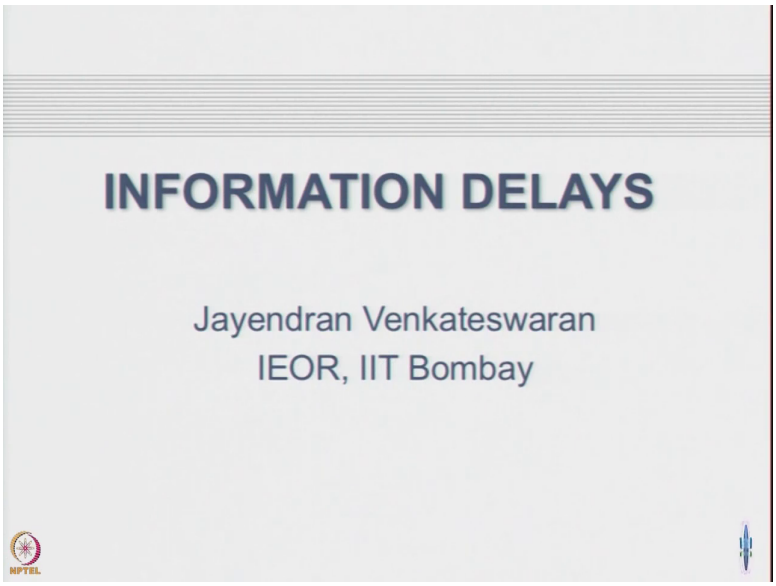

So, today's class, we look at how to model Information Delays in a System Dynamics Model.

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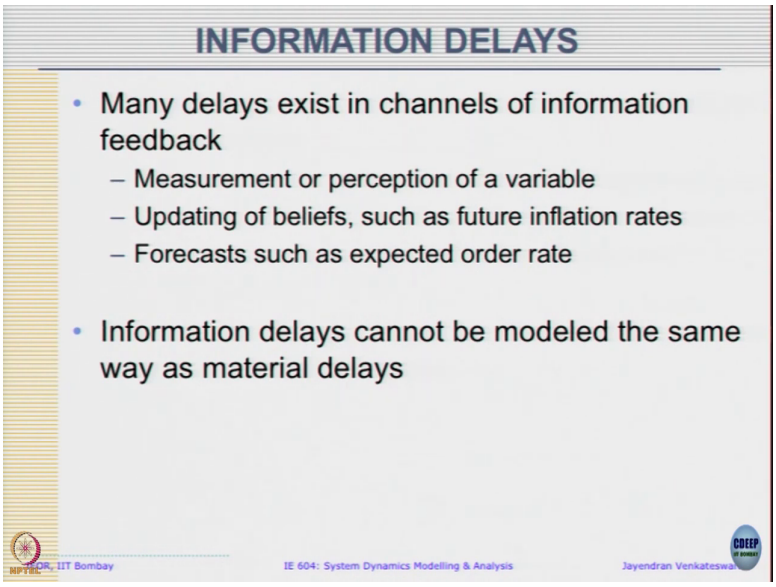

See when you want to make decisions, it involves the use of information and you see getting the information their entire feedback mechanism to get the information and based on that make your decision is fraught with a lot of delays. The delays could be in the form of measurement or perception of variable, updating of beliefs such as future inflation rates or forecast such as expected order rates, these are some examples where information is being used.

So, whenever decision maker has to make a decision, he use a some information about some perceived value or some reported value right. That means, he is going to use information based on the past; the information on the past is being used and it takes in time to gather all this information, process information and then finally, use it for making whatever decisions that we want.

Sometimes we have formal process of processing the information, like when we imagine say like a demand forecast, you may think of a process where you know the actual sales data is collected and based on that I am going to estimate what is the forecasted demand and then, upcoming week or upcoming month or upcoming quarter and use it to make our decisions. But most often it may not even result in such a formal structure. The sales, regional sales manager may just go with his gut feeling to figure out what is going to be sales next month right.

But even then, he has to update it or kind of you know though even though he made a formal process, he does have a process through which the sales manager is going to estimate what is going to be the expected sales next month. So, we are trying to capture that kind of a process in this kind of information delay. But information delays cannot be modeled the same way as we did for material delays. So, reading materials; for example, if let us say when you post letters, it goes through the system, it is in a trucks and vans and planes etcetera before it reach a destination.

Suppose there is an additional delay that happened, may be trucks got canceled maybe there is a worker strike, then, what happens? The letters will get piled up right, it gets piled up at different points before the strike it gets resolved or maybe the you know congestion gets relieved and then again, the letters get delivered. So, in that sense they think of systems such as the lead posted, postal delivery system, the letters are conserved. Just because there is delay, people do not just throw away the letters.

However, after sub delay, it eventually gets delivered. But information delays are not like that. An information delay, the material is not conserved that is a key thing. Information delay does not involve conserved flows that is whatever goes in does not necessarily make it out after a particular delay right. We keep updating it based on the current information and then so that is how the information delay or information processing works.

So, let us take up a very just like we did with material delay. Let us take up some simple cases of how to model information delay and look at higher order models. There are some parallels

like similar to material delay, we have a first order information delay and higher order information delays. So, we will be looking at that in today's class.

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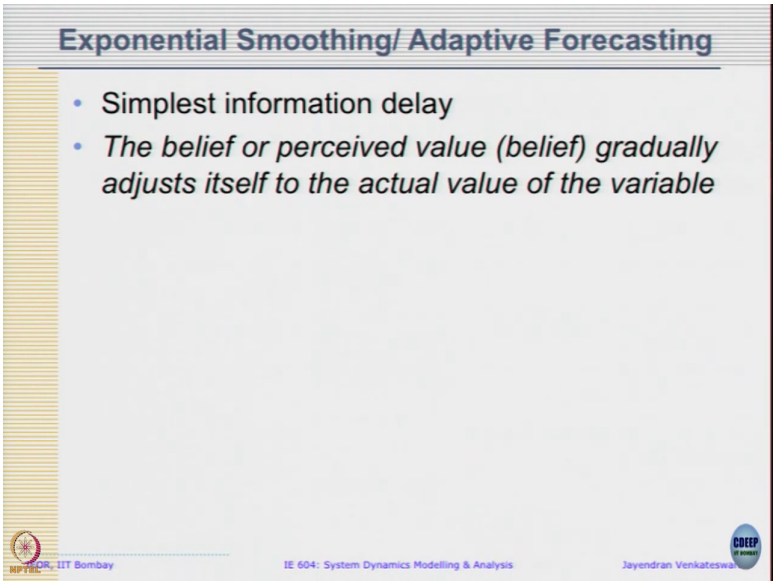

Now, simplest form of information delay is called as exponential smoothing or first order exponential smoothing or adaptive forecasting or first order adaptive forecasting. Those of you who have done a course on say basic course on operation management or something must have come across this forecasting method called exponential smoothing.

That is nothing but updating their information about the forecast based on the present value of the actual sales or demand, that structure is called as a first order exponential smoothing and that is one of the first basic models of information delay as we will. That is a belief or perceived value gradually adjusts itself to the actual value of the variable. Once the variable holds constant, after some time it reaches that particular value.

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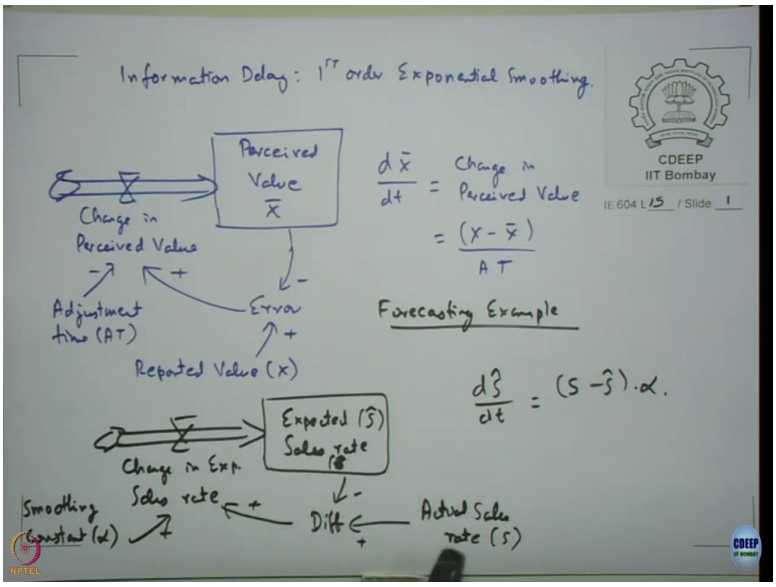

So, let us see what is a basic stock flow diagram of that is, informational delay, first order exponential smoothing is what we are going to do. It is nothing but or I will just write it change in perceived value. So, it is nothing but x minus x bar by a adjustment time. This is a first order exponential delay or first order exponential delay or first order adaptive smoothing. These are various terminologies that is used to represent the same thing. Let us take up a simple example of a forecasting example.

So, in this forecasting example, let us map it similar to this. Let us say we are going to forecast the expected demand rate or expected order rate of a particular inventory stock item. Let us call it as a expected say sales rate, change in expected sales rate. Let us define it as a actual sales rate. Let us call it as s; let this be s hat. Let us calculate the difference. In sales

lingo, similar to exponential smoothing forecasting, we can call it as a smoothing constant say alpha.

So, in this case we define the change in expected sales rate or d s hat by dt, as simply as s minus s hat into alpha, where alpha is your smoothing constant. So, if we take a time difference equation of the same which will be similar to your exponential smoothing forecasting. So, what this model is doing is I have a let us assume a current sales rate and the expected sales rate is the same; say let us say 100 units. It is been selling consistently 100 units and I am forecasting also saying expected sales of next week is also 100 units.

Now, suddenly the sales rate jumped to 120, I may not immediately change from expected sales rate to 120. I may just say ok, sales has increased 120, let me wait and watch here what happens in the following week and following week and so on. Only if the sales is consistently 120 for many weeks together, then it is ok, looks like sales has stabilized at 120 now.

So, now, I will move towards this 120, but I do not just remain idle at 100. I keep adjusting towards the actual sales to a small fraction, alpha; alpha fraction of the difference, I keep adjusting towards a new target. So, if the alpha is very small; that means, I am not giving too much weightage to the new value of sales. I keep closer to the old value of sales; if alpha is say 1; that means, whatever the difference I am going to immediately react to the new value of sales. If sales jump to 120, I want immediately adjust for that and keep reacting.

So, that is what this model is going to do, initially s and s hat say equal at 100. Now, if s became 120, so, 100 minus 120, that is 20 units. So, I have to adjust for 20 units, my expected sales let us increase towards the actual sales to it. So, this is actual information that is happening. This is what I expect to be. Say I wanted to become as close to the actual sales as possible.