Simulation of Business Systems
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Lecture – 01
What is Simulation?

A very good morning to all of you. Today, we are going to start the first lecture on the course of Simulation of Business Systems. And this is a specialized course as you might have seen and it is a course that is mostly meant towards people who are interested in learning a very versatile and useful operation research technique called Simulation, to solve complicated or unstructured problems, which are normally not solvable by typical analytical and mathematical methods.

So, what we are doing going to do today is we are going to take a jump into this complicated or most advanced topic and we will start looking into the basics of it from one end and then slowly we will get the into the more complex ideas and concepts. And we will also substantiate most of these concepts with appropriate examples, so that you are able to obtain a working knowledge out of it.

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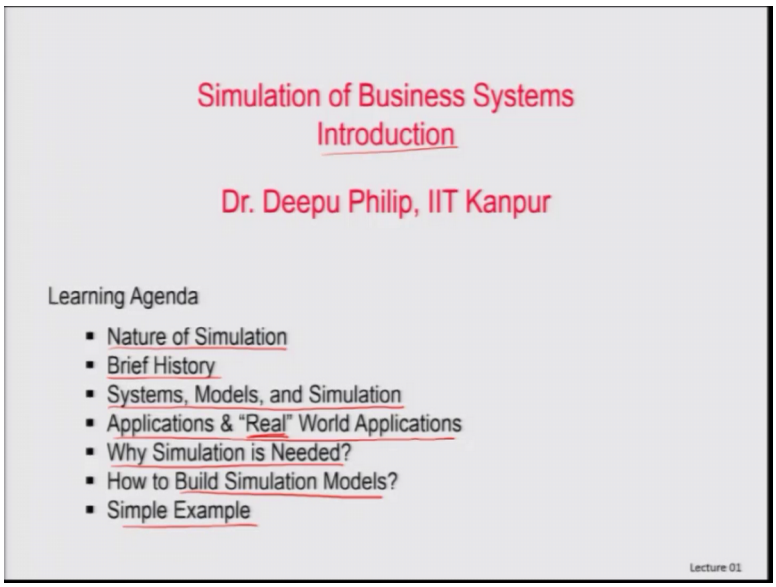

So, today's topic if you look into it, the introduction part of the lecture the first lecture the learning agenda includes the nature of simulation will be the first one a small history, then we will look into systems models and simulation, then there is a applications and

what are the real world applications and why do we need simulation and how can we build the simulation models and few simple examples. So, this is the order in which we will do the lecture, but the most important part will be that, we will be doing this as and when our concepts comes in we will try to substantiate with examples that will make the concepts clear.

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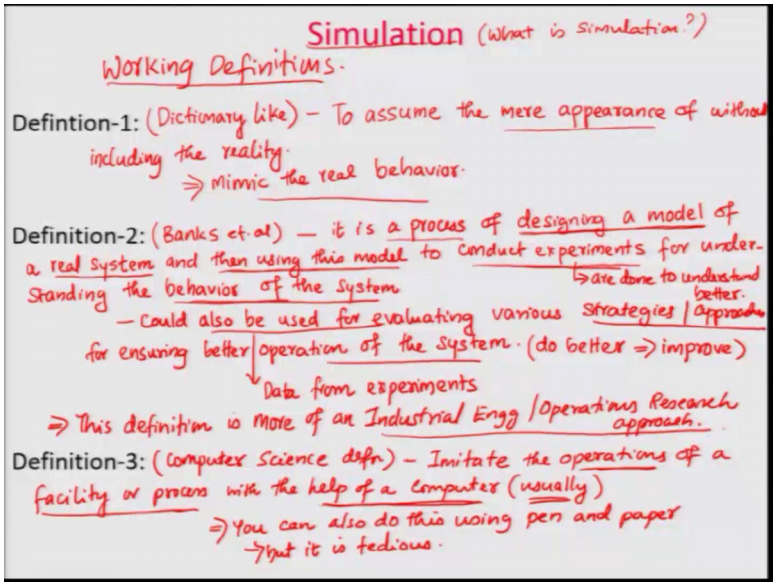

So, if we try to define simulation, we ask the question people usually ask, what is simulation? So, if you ask this question and there are so many definitions of this available, but the three, ones that I prefer or I like is number one this is typically made by the dictionary like definition, this is a dictionary like definition and what does it says is that, to assume the mere appearance of you assume the mere appearance of without including the reality.

So, what does this definition says is that you this is like mimic the real behavior, ok. So, it is like a mimicry, you try to mimic the real behavior of something, could be a system, it could be a phenomena, it could be a vehicle it could be a bird, does not matters, ok. So, you are trying to do is you are trying to mimic the real behavior or assume the real appearance of without including the reality.

Then Jerry Banks et al who are also very popular in the simulation field banks et al they have defined simulation in a much more broader sense and that definition is they define it as a process. It is a process ok is a process of designing a model of a real system of a

real system and then using this model to conduct experiments experiments for understanding the behavior of the system the behavior of the system. So, that is one part of the definition the other part we will also add here after soon. So, they define Banks et. al define it as a process simulation they define it as a process. Process of what? Process of designing a model we have to try to design a model of a real system, or can be real phenomena does not matter so, real system.

And, then this model is being used to conduct experiments. So, using this model you are conducting various experiments. Experiments are in another way to do is you can think about it as trying to do different things or you conduct experiments are done to understand better,. So, we conduct experiments to understand the behavior of the system. So, you first design a model of a real system. So, it is a process that designs a model of a real system, then use this model and then we conduct experiments for what for understanding this system behavior, ok.

It could also be used for evaluating various strategies or approaches for ensuring better operation of the system one is to conduct experiments for understanding the behavior of the system. In addition you could also use these experiments. So, could also be used. What could also be used the data from experiments this can also be used for evaluating various strategies or approaches for ensuring better operation of the system. So, how can you do better or a better way to say it is improve, how can you improve the performance of the system or how can you ensure that system operates better with this particular strategy, or what particular approach.

So, this is the definition this is more like a this definition you can think about it as this definition is more of an industrial engineering or operations research approach. So, what we are thinking about here is this is more of a so, as you know a simulation is an over tool. So, it actually came from the industrial engineering and operation research field. So, this approach this definition literally looks into that aspect.

Then the third is the; this is more of a computer science definition, computer science definition is what it says is it says imitate, it is like mimic imitate the operations imitate the operations of a facility or process with the help of a computer usually, ok. So, you are trying to imitate the operations of a facility or a computer or a process facility or a process using a computer, most of the time you use a computer we can also do it without

a computer we can use it with pen and paper. You can also do this using pen and paper, but it is tedious, ok. So, that is the major aspect of third definition.

So, imitate the operations of a facility or a process particular factory or insulation or a process with the help of a computer or most of the time usually you use a computer to imitate the operations. So, these are the three major definitions of the simulation that is what I usually called these are or these are the way, I usually call this as the working definitions. So, you should be able to understand that if you understand these definitions to a large extent you will have a broad overview of what are we going to do in this simulation.

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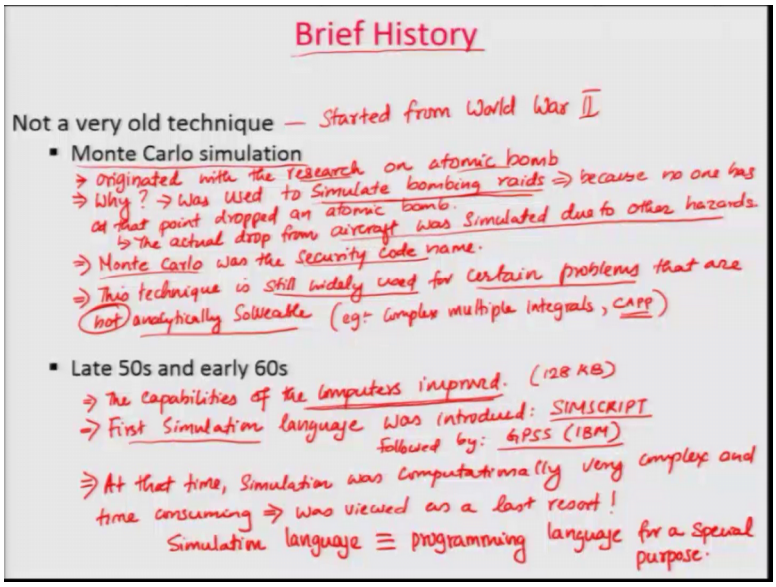

So, anything that you study you also need to know how this system evolved or how this particular branch of simulation evolved through the history and it does not happen overnight it had a long history, it originated from as usual originated from the war side actually the military side and the later being started using for the civilian applications quite commonly.

So, the brief history of this simulation field the area of simulation is not a very old technique at all. Actually where does it started? It started from the World War II from World War II. So, World War II is as you know forties little bit forties ok. So, the first technique that you come out was called as Monte Carlo simulation, and this one

originated with the research on atomic bomb then also why this was designed. So, why was used to simulate bombing raids.

So, up to that point nobody has built an atomic bomb and since you have never built an atomic bomb because no one has at that point dropped an atomic bomb and it was very unsafe to drop the bomb just freely. So, instead of dropping the actually dropping the bomb so, the actual drop from aircraft was simulated due to other hazards when nobody in say in mind will drop an atomic bomb in your own land because of the radiations and all other things. So, instead of trying it on they actually you created the Monte Carlo simulation which will simulate the bombing rights. So, it will simulate the scenario how we can use the a simulation to do the bombing rights.

So, actually the Monte Carlo was the code name security code name, ok. So, hence it is known as Monte Carlo simulation, right and still this technique this technique is still widely used for certain problems that are not analytically solvable, ok. So, still certain problems that are analytically not solvable. An example of this would be complex multiple integrals, then also some certain aspects of capacity process planning is also being done using Monte Carlo simulation. We will see this later in the course how to do this.

So, Monte Carlo simulation was the first one which originated with the research on atomic bomb. It was used to simulate the bombing raids and Monte because the recent it was used to simulate it because actual dropping of the bomb from an aircraft was very dangerous, ok. Then Monte Carlo was the security code name for the system for the a particular thing, so and so name stuck with it and it is still widely used for problems that are analytically that are not analytically solvable. These problems are analytically not solvable like complex multiple integrals and hence you know we are using that still now.

Then in early fifties and sixties, I mean late fifties and sixties the capabilities it is of the computers improved, ok. So, the computer capability is improved. So, then the first simulation language, like a programming language was introduced, that is called SIMSCRIPT, ok, then followed by GPSS general purpose simulation software made by IBM, alright and at that time simulation was computationally very complex and time consuming hence what was viewed as a last resort.

So as the computers slowly started to improve and the first simulation language; simulation language is like a programming language. So, you can think about it as simulation language is equivalent to like a programming language for a special purpose, like MATLAB and other thing, ok. So, the first simulation language SIMSCRIPT was introduced, then GPSS was also introduced almost same time by IBM, then at that time still because the computers were not very big we were talking about systems which are 128 kilobytes of RAM, KB RAM. So, hence those computers was very expensive, memory was expensive, storage was very difficult.

So, hence simulation was viewed as a last resort you would only do simulation when all other methods fail, ok. So, because it was still a very complex and it is still a complex option, but the capabilities of the computers have improved very significantly.

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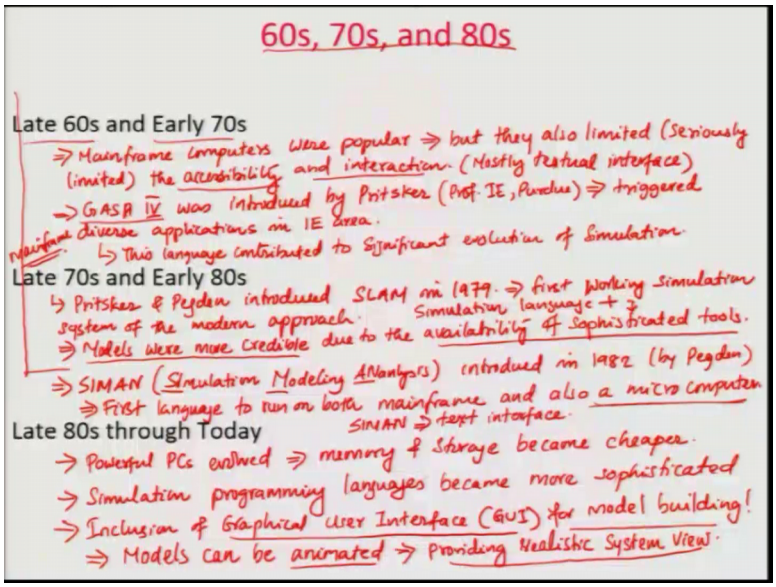

So, then from fifties, now let us move to sixties, seventies and eighties. So, in the late sixties an early seventies the major thing is the mainframe computers were popular, ok. So, which means the, but they also limited or seriously limited the accessibility and interaction, ok. So, mainframe computers were getting popular that time and, but because it is mainframe you have to be specifically in a terminal that is right next to the mainframe. So, you have to move to where the computer was, and then so, that seriously restricted the accessibility in interactive approach because it was still mostly textual interface, ok. There was really no GUI at the time or Graphical User Interface, ok.

Then what happened, then later was that GASP. GASP IV was introduced by Pritsker. Pritsker is a he is the professor in Industrial Engineering from Purdue University, he was kind of considered as the father of simulation to an extent by lot of the IE people because he was the one who did their pioneering work in it and this graph for it triggered diverse applications in IE area applications in IE area industrial engineering area, and to a large extent this language contributed to significant evolution of simulation.

The simulation that we use today, the next event stochastic simulation which is to simulate the most complicated systems like production systems, military systems, communication systems, transportation systems all those things the fore runner is the GASP IV which was introduced by Pritsker in where late 8 sixties and early seventies,.

Then when we come to seventies and early eighties then Pritsker continuous his work and Pritsker and Pegden they both join together introduced SLAM another simulation language, in 1979. This SLAM is the first working not prototype first working simulation system of the modern approach, ok. So, whatever the simulation softwares and other things that we see today they all kind of a derivative software large extent you know of SLAM the main approach is that models were more credible due to the availability of sophisticated tools, ok. So, what happened was the SLAM introduced the concept of sophisticated tools embedded into the rather than just a simulation programming language.

So, it was like a simulation language embedded with sophisticated tools. So, that we can build more credible models the end result was the models became more credible, ok. Then comes the language that revolutionized the simulation which is called as SIMAN, it stands for simulation modeling analysis, ok. So, this is SIMAN simulation modeling and analysis introduced in 1982 by Pegdon, ok. So, Pegdon was the one who took this SLAM approach which Pritsker has come up and then Pegdon introduced the SIMON.

And, this was the first language up to this point everything is you can think about all up to here is mainframe, ok. It is a mainframe system. So, in this case this is the SIMAN was the first language first simulation language to run on both mainframe and microcomputer and also a microcomputer, ok. So, this way when the current simulation languages that are personal computer PC based simulation languages, SIMAN is the forefather because it also created scenario that can also be run on the microcomputer.

Then, in eighties major change was powerful PCs. PCs evolved they are the personal computer were evolved, then memory and storage became cheaper. So, things that we are running on 512 KB, 1 megabyte of RAM now you have gigabytes of RAM available at the same price, ok. So, simulation programming languages became more sophisticated, ok. What happens is, you can think about it as the major difference the major inclusion is; inclusion of graphical user interface GUI for model building, ok.

So, this is the major advantage of the in eighties that happened is GUI. Even SIMAN is a textual software, ok. SIMAN text interface ok. In eighties is when we started seeing the GUI based systems, ok. Then because of the GUI models can be animated now or the concept of animation have paved the way of, providing realistic system view, ok. So, in this case what has happened is the invention of the animation, the concept of animation provide a realistic system used to the current simulation languages.

So, currently the simulation languages that we see are heavily GUI dependent or GUI based graphical user interface that people rarely do programming in the backend. Earlier days it used to be text interface we have to program a lot of things, but in the GUI process you have lost some flexibility in the programming approach. Because, the logics lot of the logics are inbuilt, but then we want to really do a specialized system you still have to do the programming, but most of the major simple routine trans can be very well taken care of by the GUI based systems, which is significantly improved the productivity and has also made the simulation system or simulation approach as a much more versatile and popular tool.

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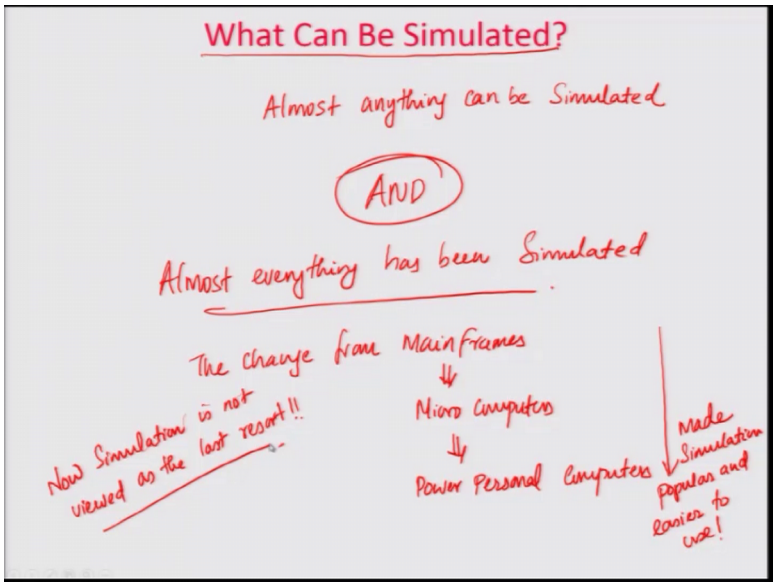

So, the next question obviously, is going to ask is what can be simulated? The people always ask this question, many of the students always ask me, sir what can be simulated? What can be studied and my answer to that is almost anything can be simulated, almost anything can be simulated and what is the big thing almost everything has been simulated, ok. So, this statement you should understand that simulation is now applicable all across different fields. It is not just limited to IE or tool; it is not just an optimization tool anymore.

It is used in studying very complicated things, so that you can take big things that are pretty hard to study things where and which time is a factor and you it is a very hard it is very hard to model time. Time is one of the hardest things to model. So, simulation provides you a way to study complex systems, in which time is an underlying factor, so that you can come up with better insights into the system and come up with better models. So, just to recap of this, we solve the major revolution. So, the change from mainframes to micro computers to powerful PCs, personal computers ok, this has resulted in the popularization of the, this has made simulation popular and easier to use.

So, I would say now simulation is not viewed as the last resort, it is no longer a last resort it is actually very much a front order tool now, ok.

So, with this today we will conclude the introduction aspects of the simulation and then in the next lecture, we will take a look into the new aspects of simulation. Thank you for

your patience listening, go ahead and start reading the notes and as well as the additional reading material as provided to you. I will see you in the next class.

Thank you.