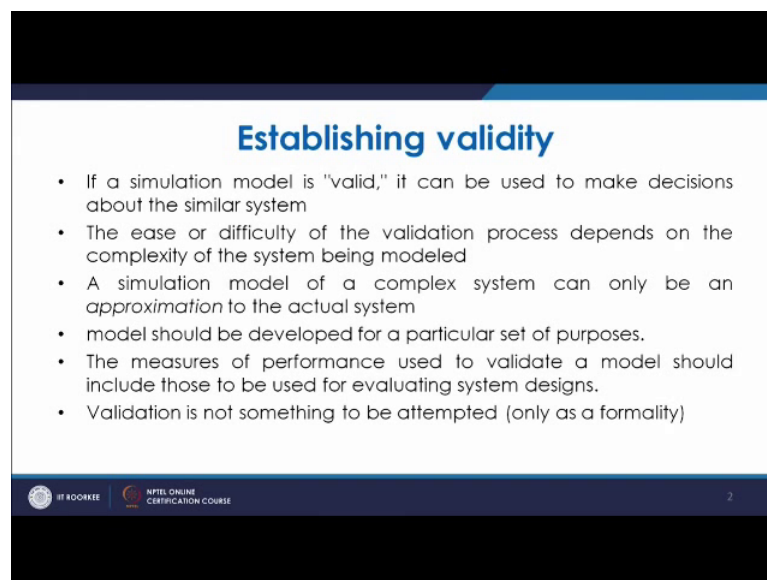


Modeling & Simulation of Discrete Event Systems
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Lecture - 35
Model Validity and Credibility

Welcome to the lecture on Model Validity and Credibility. So, we had in the last lecture discussed about the verification of Models. Now we will see that what are required for the model validity and credibility. Now we have already understood about the validity and credibility definition. So, if the simulation model “valid” it can be used to make decisions about similar system

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Establishing validity

- If a simulation model is "valid," it can be used to make decisions about the similar system
- The ease or difficulty of the validation process depends on the complexity of the system being modeled
- A simulation model of a complex system can only be an *approximation* to the actual system
- model should be developed for a particular set of purposes.
- The measures of performance used to validate a model should include those to be used for evaluating system designs.
- Validation is not something to be attempted (only as a formality)

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So, we say that if it is valid if you have a similar system and if you do the, I mean analysis if you do the run of the system, the results which you get you can use it very much for that particular system. So, for similar system like you have done for the simulation of a restaurant and if you are making another restaurant of even similar type of larger size, but then the same way of working goes on.

So, in that case once you have the valid simulation model which takes into account every assumption every input parameters of similar type. Then in those cases you can say that the same kind of simulation model same model simply you have to change the some of the parameters, like you have the arrays may be changing number of input parameters

that is put in that will be same, but then the arrays of these parameters may be changing. So, if the size changes, but then the algorithm will be same you will have similar kind of subroutines where at the program will be run and you will get the results. So, that basically is true for when it is decided that yes it is valid. So, then we say that the program has validity.

The ease or difficulty of the validation process depends on the complexity of the system being modelled. The thing is that how much complex you are modeling the system. So, as we discussed that when you have a complex system in those cases you will have the complex assumptions, you will have to have many assumptions, the assumptions are to be taken into account and you have to see that the way you take the assumptions they should simplify the process the program making. So, the ease or difficulty of the validation process will certainly depend on how much the system complex is.

So, whatever be I mean the simulation model of a complex system, actually it can be only an approximation to the expert system whatever complexity you arise by taking large amount of assumption make it complex, but it does not become the real system. It will only be the approximate to the actual system and it does not mean that if you are taking very complex assumptions you are going to very close many a times you are taking the assumptions which may deviate you from the actual systems performance. So, you will have to say and also at the same time if you are taking complex system with complex assumptions it takes a lot of time. So, it is time consuming resource consuming. So, that is also not advisable because if you are. So, you have the constraint of time also.

If any program takes a large amount of time you know because you have to give the results based on that you have to suggest what needs to be done. So, in that case you need to see that whatever you are getting the results, whether it is going in the right direction or not. So, it does not show you have to see that only do not think of making very complex assumptions because if you face any change at any stage you can further change certain parameters certain conditions.

Model should be developed for a particular set of purpose. So, the purpose or the objective should be clear in your mind for what you are making the model. So, before starting when you are simulating any model the objective should be clear in mind, then the model has to be made keeping that objectives in mind, because accordingly you will

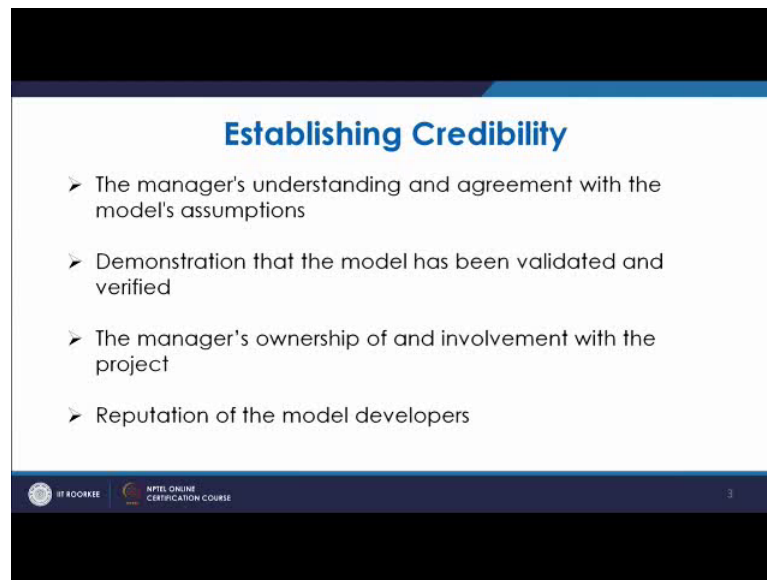
have to select the input parameters you will have to see the how the subroutine has to be made. So, that objective once it is clear that said because that is your performance measure what you are going to achieve.

So, once your objectives are clear you can think of having proper input parameters, measures of performance used to validate a model should include those to be used for evaluating system designs. So, it is same thing that your measures of performance should be the one which should tell that for what should be will be the capacity of this design, what it will do what will be the main objective of having this system, what are the parameters which you are going to evaluate, what are the confidence intervals you have been which of which parameter you are going to have the confidence intervals with certain confidence level. So, measures of performance it must include all those parameters.

Then the thing is that validation is not something which should be attempted only for a formality many a times we make the program run it will get the results and then we validate in the end. So, that is not the true way of validation or 2 way of going for simulation you should validate first against certain reported once reported results or experimental results.

So, validation is very important it should not be taken as if just simply for the sake of something to do you have done it, before that already program has run and then you can say that it has run it has come something which is though that is not a not a true spirit you will have to have this in mind that this is very important to validate the model. You have to see that whatever you are going to simulate, whatever you are going to present and you are getting that is basically the true representation of the work which you are doing.

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How to establish the credibility? Now for establishing the credibility it is required that manager's understanding and agreement is there with the model's assumptions. So, as we discussed earlier that managers have to be taken into confidence, he must be the one who always should feel that yes he has been consulted, he was not left alone because ultimately it is the one that manager himself who is going to use it use that simulation results for doing any necessary changes, for improving the system performance.

So, he must be agreeing with the models assumptions, he must have the full knowledge of what models assumptions are what way these assumptions are realistic, what way it is going to help and if he does not suppose many times he may say that no this assumption should be taken in somewhat more complex way, you have to convince him that we have this is the more realistic kind of assumption which will give us this result. So, ultimately he has to finalise give the credit of that because he will be looking at the final results. So, he is understanding an agreement with the models assumptions is important.

Demonstration that the model has been validated and verified so, you must have the demonstration proper that this is how the model is validated and verified. So, this way it will increase it is credibility then people will have the faith that yes this model works well.

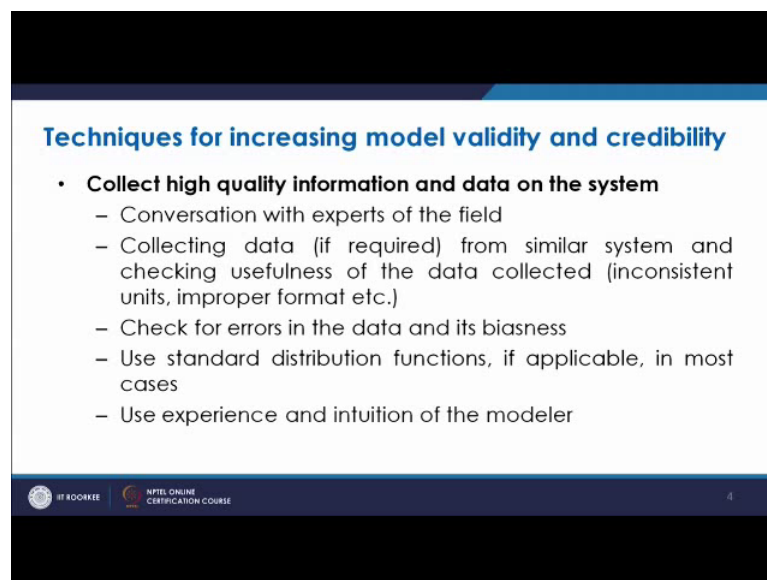
Managers ownership are involvement with the project, manager should always feel that he is involved with the project it is his work it is his organisation which is going to be

benefited and he is the key person to access this. So, he must have an ownership and accordingly he should be involved. So, every time he should be approached every time he is approached basically then he is very much helpful for the model developers whatever help the model developers required in terms of input or so, he is always available.

So, it will only come when he feels that this is going to be a good think for the organisation. So, the result which we will get it will be better. So, that ownership and involvement with the project for the manager has to be there. So, because in between he will bring few more ideas, few more assumptions, which will give even more realistic results.

Then reputation of the model developers what kind of reputation the model developer has so that has certainly the link with the credibility of the model because many a times the team which has worked for many years and which has a good track record. So, they is actually help I mean the person to be convinced that yes the model which is being made it will be credible enough. So, if that is so that helps.

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Techniques for increasing model validity and credibility

- **Collect high quality information and data on the system**
 - Conversation with experts of the field
 - Collecting data (if required) from similar system and checking usefulness of the data collected (inconsistent units, improper format etc.)
 - Check for errors in the data and its biasness
 - Use standard distribution functions, if applicable, in most cases
 - Use experience and intuition of the modeler

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Next is that what are the techniques for increasing the model validity and credibility. So, in that the important point is that you have to collect high quality information and data on the system. So, as you know that depending upon the quality of input you are going to have the output. So, you for that you have to have the conversation with experts of the

field, the experts in that particular field that is subject matter experts they can give you idea that what kind of information you require, what kind of data you require, what are the data's you require, which will help you to build the model. So, the conversation with them will be helpful in that.

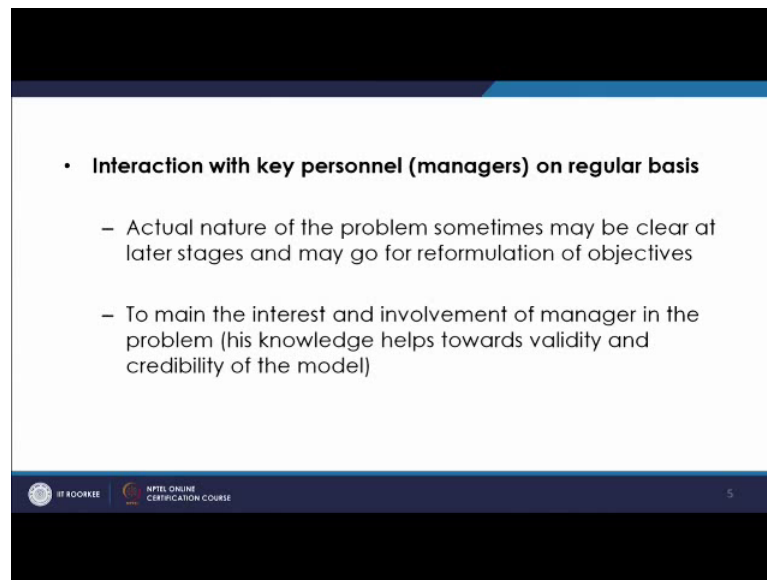
Then collecting data if required from similar system and checking the usefulness of the data. Now if there is another similar system working if you have some system which is the similar one which is there then you can get the data from there. So, that will help you in wasting time for getting the data from other sources because that is reliable data which is if any system is running, but then you have to be cautious how to use this data? The data may be may have some different units, data may be of different format file data is not of you know some of the data is super flows which is to be removed because many a times if you try to extract certain data from some system, then you may see that some of the data is having no you know at all relationship with others.

So, these things wherever you are copying something from some source or you are taking as it is from other source, you will have to have a proper you know check of the data which you are getting; like there is error in the data. Then there is it is not biased towards certain things it is not very much queued in certain direction because it biased for some other reasons. So, all these things are required to be checked when you are taking the data from some source.

Many a times so you should also practice that take the standard distribution function results in most of the cases. So, if they are the ones and if suppose for inter arrival rate or service rate or so you have some standard distribution functions if you know the mean you know the results what standard distribution function will give.

So, in most of the cases or to the maximum possible you should use this standard distribution function results, use the experience and intuition of the modeler many a times you do not have the data or you have the data which does not look. So, you know authentic and at many stages you feel to stuck at some place. So, at that time the modeller his experience and intuition should be used, he is only one who know that how his model is going to behave if he gets the data in certain form. So, experience and intuition of the modeler should be also used.

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- **Interaction with key personnel (managers) on regular basis**
 - Actual nature of the problem sometimes may be clear at later stages and may go for reformulation of objectives
 - To main the interest and involvement of manager in the problem (his knowledge helps towards validity and credibility of the model)

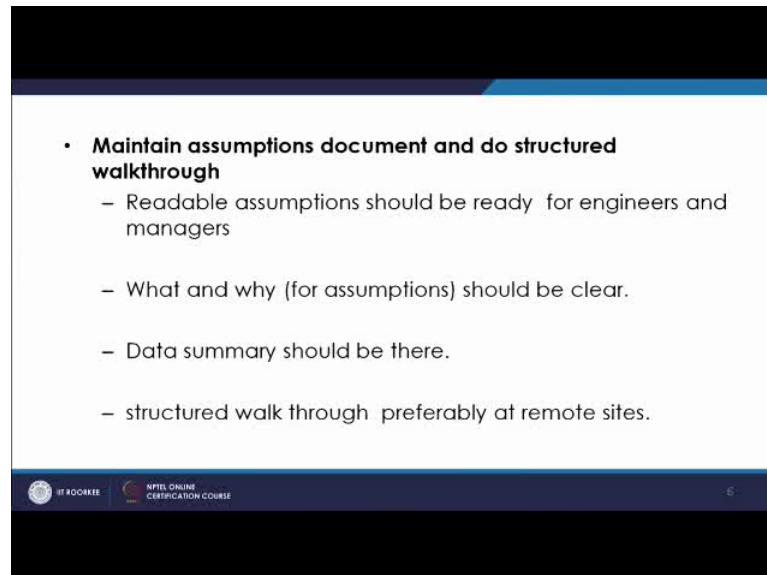
Interaction with key personal on regular basis, this is very important for establishing the validity and credibility of the model because if you do not interact at regular times then many a times what happens that your output results which you are getting that is something different. So, the thing is that the person should be involved in between also, during the program in the intermediate stages whenever you are getting some results there should be you know regular basis there should be interaction.

So, basically the advantage of this interaction is that during those discussions, we discuss about the ongoing assumptions ongoing result and the future results also. So, when we discuss that during that process during one to one discussion with many experts sitting on the round table.

We see that at many times we come with certain new assumptions which are going to be helpful or certain new objectives are basically coming in the end. So, your objectives are reformulated and that helps because that ultimately their objective is to have a good model which should give you the proper results. So, it is important that the interaction with key personnel should be there in between apart from that you have to do something. So, that the interest and involvement of manager in the problem is maintained as we discussed that he should be the he is the one who can give the maximum suggestions, he can give maximum inputs and he can only access the results which is going to come out.

So, you have to do necessary to maintain the interest and involvement of manager in the problem because his knowledge will help towards validity and credibility of the model.

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- **Maintain assumptions document and do structured walkthrough**
 - Readable assumptions should be ready for engineers and managers
 - What and why (for assumptions) should be clear.
 - Data summary should be there.
 - structured walk through preferably at remote sites.

Maintain assumptions documents and do the structured walkthrough. So, as we discussed that for increasing the validity and credibility there should be readable assumptions which should be ready for the engineers and managers. So, every time you are going to analyse any output performance measure any result you must be able to refer that what are the assumptions on which we got certain results.

What and why for any assumption should be clear any assumption which has been taken what are the assumptions, what for this assumption, I mean, mean to and why this assumption is required why it is necessary.

So, reason for them must be clear. So, it should be anytime whenever we have the structure walkthrough then that time the assumption document should be ready and at every stage you must have proper answer. So, that you are able to tell that why certain assumption has been taken, what is the basically purpose of taking that assumption if this assumption is not taken what way your model results are going to be suffering, what way your output performance measures are incomplete about certain assumption many a times we take certain assumption only to make the model simple. So, that should be clear. So, all that answer should be ready in front of the subject matter experts and if the

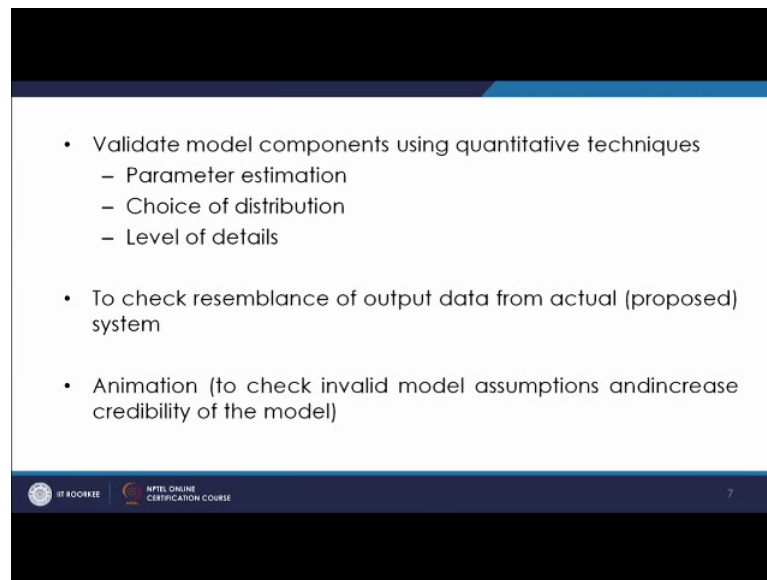
assumptions are taken what way it is going to you know effect what will be it is you know effect on the overall system behaviour.

Data summary should be there you must have the data summary we should always talk about the results. So, whenever people feel the need to discuss about the data that somebody should be there. So, after every you know some time passes after every stages the data which have we have got that can be analysed by the analyst statistical analyst, all the data types of counter statistical counters they should be computed they should tell that at this stage this is the result which is available. So, this will help towards the validity and credibility of the model.

Structured walkthrough normally should be done at remote sites. So, preferable it is thought of doing at some remote sites, may be in certain hotels at some distant places from the normal working sites. The purpose is that when you are doing that there should not be local disturbances. So, there are you can focus more on all the documents which are going you can discuss and deliberate on the results more and more. So, that if you feel that some of the assumptions were left out or certain results are unrealistic, there can be more and more deliberations on that many a times when people are preoccupied with lot of work at a parallel you know, at parallel you have they have lot of work, then because of the time constraint people are not able to concentrate on the aspects of simulation like assumptions or input parameters or so.

So, normally it is preferred that whenever you have to do this structured walkthrough you tried to locate a place which is at the remote site and this basically helps in more concentrating on the other affairs of the program. So, that helps basically towards improving the validity and credibility of the model.

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Then comes that the model validation and I mean model components validation should be done using the quantitative techniques. Now in basically we have come across the different types of statistical techniques and you must use the standard methods of comparison suppose you have to estimate the parameters you must have the proper you know ranges of the values at certain confidence level that should be mentioned.

So, rather than just looking at the behaviour in a microwave you must pin point this parameters estimate and then you should validate the model that, these are the performance measures which we are interested in and we are getting these results for these parameters.

So, that basically helps in coming to this conclusion that this model is valid and (Refer Time: 26:41). So, parameter estimation using different statistical techniques are basically that way helping you to realise that yes the model is basically standing at this point whenever we are trying to estimate these parameters.

Choice of distribution; now whenever we are doing the validate I mean modelling components are validated then the appropriate choice of this distribution function should be used for which parameters what kind of distribution functions are more stable we should be knowing about it.

Level of details what are the level of details at which we are interested in. So, that also should be there in the mind while doing the validation. We should check the resemblance of output data from actual system. So, basically we have to also see that how it looks the output data which we are getting from the simulation and from the actual data how much resemblance is there how much they are having the similarity. So, this is important because ultimately this is the data which are going to be used. So, the resemblance of this data is that way we must have that in mind.

Animation as we discussed that if you have this animation now these animations basically to check these invalid model assumptions and increase the credibility of the model. So, during the animation many a times it becomes clear that the certain type of model assumptions were invalid. So, you can from there you can think of changing the assumption and further get the results. So, that result will be more credible in the eyes of the model developer or the managers.

So, these are the ways by which you can increase the validity and credibility of the model developed.

Thank you.