OPERATIONS RESEARCH SOCIETY OF SOUTH AFRICA

OPERASIONELE NAVORSINGSVERENIGING VAN SUID-AFRIKA

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BULLETIN

September 1970

Cybernetics

The Sixth International Conference on Cybernetics will take place in Namur, Belgium, from 7th to 11th this month. Subjects will be divided into the groups -

1. Principles and methods of Cybernetics
2. Semantic machines
3. Automation
4. Cybernetics and human sciences
5. Cybernetics and life

Summaries of papers can be obtained for the payment of 500 Belgium francs (i.e. R7-14)

Johannesburg Chapter Meetings

Special Note

The chapter committee believes that members will find it more convenient to attend meetings soon after 5 p.m. than to travel back from the suburbs at 8 p.m.

However, as most of us are thirsty at this time the meetings have been scheduled to start with tea, talk, and biscuits at 5.30 p.m., followed by the normal OR program at 5.45 p.m.

Please diarise these times (5.30 p.m. to 7.00 p.m.)

Tea eill be served as usual on the ground floor in the south-east corner, of the geology block.

NEWS FROM THE JOHANNESBURG CHAPTER

J. Miller reported on the Joint Conference of the O.R. Society and of The Institute for Management Science (T.I.M.S.) held in London from the 29th June to 3rd July, 1970.

The main theme of the conference was involvement of management during the formulation and solution of O.R. problems. It was also apparent that the complexity of the situations to be studied requires a well co-ordinated team effort to arrive at useful results.

It was interesting to hear that a Study Group of the O.R. Society is active in applying a Systems Approach to Hospitals and their work has already produced good results.

The discussion was centered around a comparison of the O.R. situation in the U.K. and in S.A. It appears that it is difficult for O.R. men in S.A. to get management actively involved in the solution of problems. The main reason for this was given as the manpower shortage, which regrettably prevented management from dedicating part of their time to study and development.

Jonathan's lecture will be published in one of the next bulletins.

Next Meeting

Date	16th September, 1970
Venue	University of Witwatersrand Geology Building, Room G201
Time	5.30 p.m. for 5.45 p.m.
Speaker	Mr. B.H. James
Subject	Critical Path Planning in Practice.

Brian James is presently head of the O.R. division of M.I.T.A.C, and Critical Path planning is part of his departments stock in trade. At the present time the O.R. division is serving the needs of 5 companies on 7 projects where critical path planning is being used to control the project.

Topics to be covered in the talk are :

1. Features currently available with CPM packages
2. The usefullness of such features
3. The use made by project managers of CPM analysis
4. Future developments

IS SIMULATION THE LAST RESORT

(AN EDITED TRANSCRIPTION OF THE DISCUSSION)

The meeting was chaired by Professor Kerrich. The members of the panel were :

Dr. Brown, Mr. Cohen, Mr. Sankey, and Dr. Sichel.

Floor : I take the view that simulation is not the last resort but the first. It should be used to test whether you understand the situation before going on to mathematical analysis or more costly simulations.

Dr. Sichel : But you must understand the situation before you can simulate it - the computer has to be instructed.

Floor : Let me amplify. The systems analysis required for simulation leads to understanding.

Dr. Sichel : Dr. Brown said that simulation sometimes gave insight to help create a mathematical model.

Dr. Brown : You (the floor) imply that with simulation you can check the fit of the model, whereas with a mathematical model you can't. This is not so. In both cases the outputs or predictions of the model can be checked against the real situation.

Floor : What I mean't is that you should simulate and then choose a stochastic model.

Dr. Brown : If you are in a position to simulate it is implicit that you have already chosen a stochastic model. For both the mathematical analysis and the simulation approach, the first step is the choice of a model. In both cases it is important to test whether the model represents the true situation and in both cases this is achieved by comparing the results of the model (eg. average queue length which results from assumptions about inter-arrival times and service times) with the corresponding real situation.

Floor : Can you say something more about the criteria used when these comparisons are made.

Dr. Sichel : You use the theory of hypothesis testing. If there is a significant difference between the results of the model and the observations of the real situation, then the null hypothesis cannot be upheld.

Floor : How confident do you feel about using the model to predict events outside the range of the observations used to varify the model.

Dr. Sichel : I would take these predictions with a pinch of salt (outside the range) - but if you interpolate - ie. inside the range, and the model has passed the hypothesis testing, then I would rely on it. It is specially valuable when it predicts maxima or minima inside the range (After all, optimising or sub-optimising is the function of OR)

Chairman : With regard to hypothesis testing, I am 99.999% confident that no mathematical model is correct in real life. The problem is to choose a model that is accurate enough for the purposes in hand.

Dr. Sichel : If there are enough observations, say 100,000, no simple mathematical model will fit - but it may be so close that it is good enough. For

example, models used by insurance companies - in these cases, even though the null hypothesis is rejected, the model can obviously be used. This is where human judgement comes in

Chairman : You accept - you reject - surely there is room in between for proceeding cautiously - (laughter)

Dr. Sichel : I might just mention that you can never accept a hypothesis - you can only reject it - and that puts the cat among the pidgeons (more laughter)

Mr. Sankey : Concerning methodology, one should start with the simplest model; run it and discuss it with the people concerned with the process. They will point out missing elements. These should be put in one at a time, running the model after every change. This makes it easier to check that they are put into the model in the right way, and one can see their effects.

Chairman : The order in which you introduce the factors might be important, and if there are 10 factors that makes odds of nearly 4 million to 1 against hitting on the best sequence in which to introduce them.

Floor : I think the whole situation has to be studied in detail first, and analysis has to indicate what is important and what isn't - before you start any simulating.

Floor : How often in practice arn't you pushed into the last resort ? How many problems are solved without simulation.

Mr. Cohen : Not too many. Going back to the simple model, 1 ticket office - 1 queue - I don't think even this situation is so simple - you would measure the behaviour of people buying tickets at different times of the day and at different days eg. long weekends. In validation of your model you would also ask it to produce statistics under these different conditions. A word on optimization techniques - here simulation helps out, because I don't think any of the known optimization techniques optimizes for more than one variable. It is possible by playing around with your simulation to find compromise solutions.

Floor : It seems that in order to verify the correctness or accuracy of your stochastic model, you are having to use historical data which you've collected in your time studies etc. You then push this through your model and you get results out which must from sheer logic be the same results you put in. In other words, its all going through a very fancy machine - you start with ABCD - you put it through a mincer, a grinder, a turner, a lathe, and you come out with ABCD. Could I put it to the panel that you have no way of verifying the stochastic model because in order to verify it, you have to use the historical data to produce the historical data.

Mr. Cohen : Is it not rather that you start with data which is 3 to 1 years old, and you check against present events and then use the model to predict future situations ?

Floor : May I comment on the last question.? It seems to me that in a simulation you put in your independent variables but you get out your dependent variables, both of which are historical, ie. you put in ABCD but you don't get out ABCD; you get out EFG&H and this is how you verify.

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Floor : I'd like to ask a question about the effect of the random number generators. I recently had the experience that the numbers generated started cycling after 2000 (laughter) I wasn't experienced enough to realize that this would cause trouble, in fact it caused a tremendous amount of trouble (loud laughter). What I want to ask is - how important is it to apply tests to the numbers, and what tests to apply.

Dr. Brown : That I just can't answer because if you try enough tests you will always find some test which will show up a pseudo random number generator. The particular random number generators which were used 5 years ago, are now being shown to be unsatisfactory due to certain serial correlations etc. It will depend on the particular problem which you are investigating on how important this lack of true randomness - whatever this may be (laugh) is.

I think that it is better, after you have simulated, using random numbers and all, to check your results for goodness of fit with the real situation (goodness, in some sense or other)

Dr. Sichel : I am tremendously pleased that this case of randomness or non-randomness was brought up (it was not a planted question). I don't think enough attention is being given by people who use simulation, to test whether the random numbers which after all, are the primary input to start with, really were random - and in my whole experience with practical problems I have been several times lead up the garden path in a terrible way because the random generators didn't function properly. This is the case again where a mathematical study, if you can solve your problem in an analytical way, is so tremendously more powerful because on top of all the problems of simulation you have the nagging doubt that your numbers weren't random, and to such an extent that they gave you false answers. Now I have had several problems in conjunction with queues where we understood the theory, shall we say half way, not fully, and we had a test whether the random generator did its bit, and we got the results printed out under different conditions - I had the feeling there was something wrong and eventually we applied our theoretical knowledge and found that this type of distribution just could not have arisen out of truly random numbers. Then we went back to the original random numbers which we had stored and we applied tests and we found that they did not pass any tests. After a bit of trouble it was found that the random generator (package program) would not work on the computer we were using although it functioned correctly on a different computer. But I think this a very pertinent question and I would give an answer what tests I would use. The simplest test for all random numbers is the chi squared test - do the digits from 0 to 9 come up in the fashion of a uniform distribution. Now in my experience, that is the least powerful test. A very good test is the gap test where you specify runs of digits of say between 0 and 0 (so you count the number of non-zero digits between 0 and 0). My experience shows that to be a very very powerful test and also the test of correlation coefficients of successive pairs-that is very powerful too. If the numbers satisfy these three tests I would be quite happy-now as Dr. Brown says, if I use enough tests-say 10 or so-one or two will probably reject the numbers-I wouldn't be too unhappy about that. I have found the above three tests powerful in practice.

Chair : Do you wonder ladies, gentlement that to my first year students I say you have got to guess. No harm in guessing of course - we all guess with the aid of all the tools we have that will enable us to make some judgements.