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A GENERIC SIMULATION PACKAGE FOR ORGANISING OUTPATIENT CLINICS

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ABSTRACT

A computer based visual simulation model, made up of a complex data input component to define the clinic logistics, and an iconic visual simulation representation to show the effect of the policy has been built using a variety of commercial application packages. Visual simulation has made it possible to show interested parties in hospital outpatient clinics how the clinic appointment and operating policy can influence patient waiting time. The package has been tested at 20 tests sites in the United Kingdom (U.K.), and interest is such that further modifications to the system have been proposed. A user support centre has been set up to give advice to any outpatient clinic in the U.K.'s National Health Service.

1 INTRODUCTION

Hospital out-patient clinics are a typical example of the sorts of organisational problems that simulation modelling should be able to handle in health care. In this paper a visual simulation modelling approach to this problem is examined. Research by the Centre for Applied Simulation Modelling at Brunel University has led to the investigation of a variety of packages and languages, some of which have even been developed by the group itself (Balmer and Paul 1986, Paul 1992, Paul and Hlupic 1994). The research group is heavily oriented towards the use of program generators and towards the use of visual simulation. Visual simulation is an increasingly popular method of tackling simulation problems, but it has a variety of difficulties of its own as have been described by Paul (1989). Some idea of the variety of simulation packages and approaches that are available are given in the paper by Paul (1991).

In this paper we shall first of all, in the next section, look at the background to the problem which required the development of a visual simulation modelling package called CLINSIM. The following section describes the features of the CLINSIM package that were required by the customer for the system. The final section of the paper discusses the future of CLINSIM and the more widespread use of such systems in medicine.

2 THE NEED FOR CLINSIM

It has long been recognised that patient waiting times in outpatient clinics are infamously long. In the United Kingdom its recognition has taken place since the birth of the National Health Service in 1947, although it was undoubtedly a problem long before that. It is probably true to say that patient waiting time in clinics is a world wide problem, with perhaps one or two exceptional exceptions. The National Health Service in the United Kingdom recognises this as a recurring problem which has many political undertones (Thakar and Malin 1989). It is the sort of problem that is likely to generate questions by Members of Parliament in the House of Commons, and then to generate questions by the Minister concerned from his civil servants.

It is curious that this problem has existed for so long, given that there have first of all been many attempts at trying to solve it, and secondly, a fairly well known theory as to how the problem can be solved. The attempts that have been made to solve this problem consist of queuing theory, simulation modelling of a blackbox type, statistical analysis, and there have been many investigative studies of a general nature which by and large led to the same conclusions. The conclusions which can be generated by these mathematical techniques or common sense are, that if one assumes that doctors' time is more important than patient waiting times, then clinics will be loaded with patients to make sure that doctors do not wait. The second confounding factor is the assumption made in making these appointment schedules, that doctors will arrive on time in the clinic, and this historically has not been proved to be true. This combination of factors, overloading the clinic at the beginning of the clinic session and the irregular arrival times of doctors, in effect causes the problem that this paper is going to look at.

The model described in this paper is then, yet another attempt at solving a classical problem to which to some extent the solution is already known. Because we know the solution, this attempt is based around a general purpose Visual Simulation Model. The idea behind this approach, is that such a model could be used to show consultants and administrators why they have the problems they do have with waiting times, and how these problems might be resolved. In order to make this simulation model general purpose, so that it can be taken around, distributed and shown to as many people in the National Health Service in the UK as possible, the specification required that it be PC based, because this is the machine that is most likely to be available. Secondly, that the visual representation should be an iconic representation, so that non computer specialists could understand what the simulation modelling is trying to do. Thirdly, that the model should be of a general purpose, data driven construction, so that in theory any hospital clinic could be modelled by this general purpose model.

If one thinks about the structure of a hospital out-patient clinic it is in fact, in queuing or flow terms, fairly simple. Patients arrive, they check in with the receptionist, they may have some pre-consultation tests, they wait for a doctor, they have a consultation, they check out again to book their next appointment time, then they leave. This does not appear at first sight to be a very difficult problem and therefore at its inception it was handed to a student as a three month project. In a sense, this student discovered that the project had an iceberg hidden depth which he was not able to handle. The second attempt at this project was by a small software company who were Pascal experts, and who constructed a model in that language. This attempt failed because again, whilst it may appear that the problem to be modelled is relatively straight forward, the complexity of trying to build a general purpose structure inevitably meant that the development of the model by this company could not handle the changes of understanding that took place during model development. So several years after the project inception, a third attempt was made to build this model, and this attempt is what is being described in this paper. Whilst the development of this model was late, typical of many software developments you may think, one has to bear in mind that its lateness is not the lateness of the third attempt, but the lateness of the project overall, which was now some five to six years behind.

3 CLINSIM FEATURES

Whilst the model was designed to be general purpose in construction, one obviously had to limit to some extent the number of objects that might be in the system so that the screen could be designed to handle a range of clinics. It was decided that most clinics would have at most six doctors, so the model was designed to enable there to be between one and six doctors. It was decided that there would be up to two receptionists, and if there were a second receptionist, this second receptionist would specialise in handling missing case notes only. Missing case notes are a recurring problem in United Kingdom hospitals, and the specialist time in searching for them is considered to be an important design characteristic of a clinic. Pre-consultation tests, such as urine samples and blood tests, are handled by between zero and three test groups. In other words, there could be no pre-consultation tests or there could be up to three test rooms in parallel. Figure 1 shows a snapshot of the CLINSIM model, illustrating a typical hospital outpatient clinic configuration.

The clinic itself could be considered to have a variety of times related to the start, end and shutting of the clinic. But it has to be borne in mind that the start time is not the start time in the clinic, the end time is not the end time of the clinic, and the time when the clinic shuts is not when the clinic shuts. These remarkable descriptions are best understood by explaining that the clinic start time might be nine o'clock in the morning, for example, but that this does not stop patients who are eager to be on time arriving before the start time. It may be officially designated that the clinic will end at twelve o'clock, but of course the patients that are in the clinic will still be seen even if they are there after the official end time. It may be decided that the clinic will be physically locked at a certain time to stop more patients arriving, but still the clinic is not shut since there are still patients locked inside who are going to be served before the clinic can end.

Patient behaviour has a similar variable pattern about it. Appointment time in United Kingdom clinics is now defined as the time at which the patient is due to see the doctor. In order that the patient might know when to actually appear in the clinic, they are given a presentation time, which is some constant time in advance of the appointment time. This constant time is supposed to allow for delays in the system in queuing, seeing the receptionist and being handled by pre-consultation tests where these exist. In any event, there is another time to be considered when thinking of patients, which is the patient arrival time, which has nothing to do with the presentation time or appointment time, and more to do with patient anxiety about being sure they are on time at all. Patients themselves can be categorised in four different ways. They can either be new patients to the system or re-attenders, and they can also be either hospital transport patients or non-hospital transport patients who come by their own transport. There is a fifth unplanned category, the 'extras', who turn up with no appointment at all!

Doctor behaviour similarly has a variety of characteristics. The arrival time of the doctor in the system can have an official time, and then there is of course the time when the doctor actually turns up. The doctor will handle the patients in a variety of ways. One might anticipate that the chief consultant will be more likely to see most, if not all, of the new patients, and less senior doctors will see a decreasing proportion of new patients, so that the most junior doctor may only see the re-attenders. The consultation times for these doctors and patients could vary, therefore, according to the character of the patients and of the doctors. Queuing behaviour in the system is by and large the well known British first in first out system. This is true except for the queue of patients for consultation. First of all, the queue itself is sorted according to whether or not the patient has arrived on time for his or her appointment to see the doctor. There are a variety of ways of handling this in the clinic itself, so that the user of the model can penalise patients for being late in a variety of different ways. Even so, having sorted the queue in one way or another, the doctor does not have to select from the front of the queue. The doctors may elect to give some sort of priority to new patients over re-attenders, and therefore they may search the queue to a certain depth, looking for a new patient. If there are no new patients within a certain number of places in the queue, they may then take the first re-attender from the front of the queue. Another feature of this general feature package is that, since one cannot anticipate what question will be asked when the model has been run, it follows that the output from the model has to be very varied, to try and attempt to answer any sort of question.

The stochastic aspects of the model, as applied to all sampled times described above, can be handled by selecting one of six common statistical distributions with their parameters, or from histogram data supplied by the user.

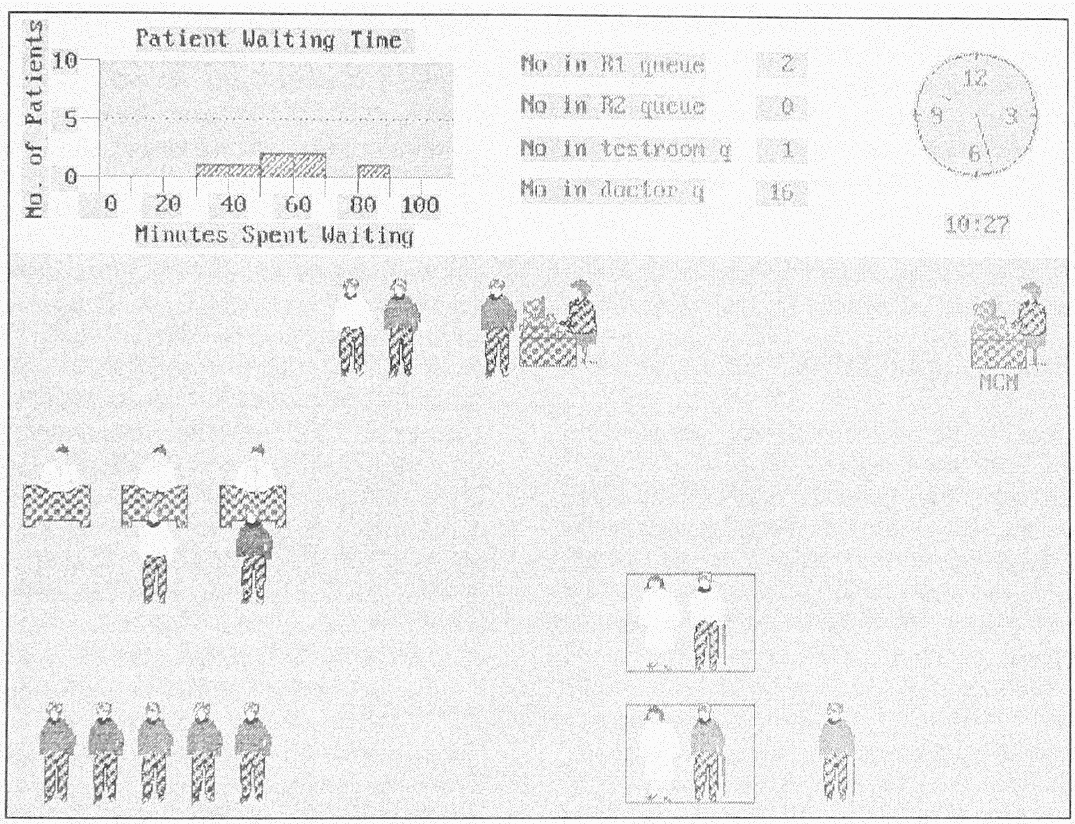

Figure 1: An Example of the Visual Running of the Model

The package, whose visual display is shown in Figure 1 was built using a dBase IV data input interface combined with Pascal routines for generating appointment schedules. The simulation part of the package was built using SIMSCRIPT II.5, primarily because of the excellent graphics of the simulation package. The two application packages, dBase IV and SIMSCRIPT II.5 were combined using a simple menuing environment known as Automenu, which gives the impression of a seamless package. The reasons for using this packaged approach to developing the model were several. First of all, in spite of the previous attempts to build this model, the documentation laying out the needs of the model were still more of a requirement than a specification. A specification would explain exactly what the model should do at any decision point, and exactly the sorts of output required and how it should be displayed. To some extent these specifications were going to be determined by trial and error during the development of the model. Therefore a package approach had been determined, because the environment in which the development was taking place was fairly dynamic. It was thought that a package approach would be more able to handle changes in the requirement, or changes in the specification, than trying to develop a suitable architecture in a high level programming language from scratch. dBase IV was selected for the data input part of the package because of the theoretically widely available expertise in this particular language. It turned out that our particular use of dBase IV, which was the Application Generator, was not widely used at all, and this caused a variety of problems in its own right. Further details concerning the development of CLINSIM are given by Kuljis et al. (1990) and Kuljis and Paul (1991).

4 THE FUTURE FOR CLINSIM

CLINSIM has been tested at 20 test sites throughout the UK. Results show that the model can be used to create current clinic conditions, a powerful validation test. There is sufficient enthusiasm for the system to suggest that modifications to the system are worthy of the expense (early results suggest that health service administrators see some benefits of the system). An independent report written for the Department of Health (Hall 1993) comes to the following conclusion. "In summary, CLINSIM is not the only method of assessing the effect of changes in outpatient clinic management, but it is probably the most appropriate." The system will be offered for general release with appropriate support from the CLINSIM Centre (Hall 1994). Examples of potential modifications are for doctors to have to leave the clinic during a session to attend an emergency, and for a doctor's clinic session to end at some predetermined time prior to the official clinic end time. Further details concerning the use of CLINSIM can be found from the Department of Health, whose address is given in the references. Further information concerning this form of modelling can be obtained from the authors.

One of the problems associated with the development of systems like CLINSIM is the development time. CLINSIM is designed to form a vehicle for debate amongst those responsible for running clinics. Therefore, the system has to second guess the nature of this debate prior to the debate having taken place. This meant that the contents of the system evolved with the development of the system, and could not be predetermined as one would like in order to make the process easier and quicker. The architecture of CLINSIM therefore had to be fairly robust to changing user requirements and to requirements interpretation whilst developing. Experience in this type of development does assist in making the exercise feasible.

Many business and policy matters suffer from a lack of common understanding by the stake-holders in a problem. The organisation of health care is no less afflicted by this problem. Visual modelling is one opportunity for providing some common ground for debate. As long as the participants in the debate do not confuse such modelling with decision making (the model does not give answers to problems, it merely reflects the possible outcome for the set of conditions and assumptions that are built into the model run), then the debate can progress to some conclusion drawn by, and acceptable to, the debaters.

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