AN APPROACH TO MODELING SIMULATION PROGRAMS

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ABSTRACT

There is a specific problem structure encountered in certain socioeconomic problems. The problem structure is characterized as a queuing network. By using certain concepts from activity network problems an efficient software system can be defined for the solution of queuing network problems. This paper discusses the conceptualization of the queuing network structure as a set of basic building blocks. The building blocks are the basis of a simulation software package designed to model queuing network problems.

I. INTRODUCTION

Many problems in vastly different problem areas exhibit a common structure. This common structure occurs frequently in socioeconomic problems. The structural aspects of these problems are characterized by flows of entities (transactions) through an environment consisting of a network of queues. The transactions compete for different facilities in the network, and this competition usually depends on the previous exposure of the transaction to the other facilities in the network and to certain attributes of the individual transactions. An additional problem characteristic is the distinct influence of the problem environment on the transactions' behavior which is usually stochastic. This stochastic characteristic is a consequence of the uncertainty principle of modeling; one version of this principle states that the more conscientiously developed model will be more likely stochastic in character (3). This problem structure can be conceptualized as a queuing network.

The simulation approach is an appropriate methodology for solving queuing network problems. To implement a efficient simulation methodology, a simulation software system that takes advantage of the queuing network structure is desirable. An additional useful feature of this system is that it utilizes a set of powerful but simple building blocks (instructions) that can be welded together to model complex problems.

The following paragraphs discuss the conceptualization of the queuing network structure as a set of basic building blocks, which are the basic set of building blocks in a software package designed to model queuing network problems.

II. OTHER NETWORK MODELING APPROACHES

One modeling approach similar in outlook to the approach proposed in this paper is offered by activity network problems (1). PERT and GERT are examples of techniques employed to solve activity network problems and both techniques have analytical foundations. However, operating experience with GERT demonstrated that a simulation approach was more efficient than the analytical approach. Consequently, GERT problems are modeled using GERT structure and then a simulation approach is used to solve the problem (4).

A central idea of the activity network approach is that problems can be represented (modeled) by a series of generalized nodes and paths between nodes. All nodes have similar behavior; all paths have similar behavior. The differences in behavior are represented by a set od distinct parameters. An example of a path parameter might be the travel time of each transaction using the path. A nodal parameter example might be a next node indication, i.e., a parameter indicating which other node immediately follows the current node. However, the most general activity network approach, GERT, is too restrictive in modeling stochastic behavior to be suitable for the kinds of problems encountered in a socioeconomic setting.

A second modeling approach is offered by the numerous computer simulation languages. The most common of these languages, GPSS, does not capitalize on the generalized node and path logic used by activity network approaches. Instead, to provide complete generality, a number of complex but specialized instructions are provided and the user is required to choose a set of instructions to represent his problem. For instance, using GPSS V, 56 separate instructions are provided and up to 8 parameter settings per instruction may be defined (5). This is an exceedingly complex arrangement requirement, and for many simulation problems computer simulation languages are cumbersome.

III. DESCRIPTION OF THE QUEUING NETWORK PROBLEM STRUCTURE

There are two entities that define the structure of queuing network problems: transactions and blocks. The unit traveling through the network is called the transaction (or customer). Each transaction consists of a set of descriptive attributes. A transaction is something that takes some path through an environment. The environment then does things to the transaction, i.e., it modifies the attributes of the transaction. The unit of the environment is the block. A block is a facility; it is comprised of four things:

1) A mechanism which creates brand-new transactions from time to time, if desired, and puts them in the queue,
2) A queue of transactions awaiting the attention of the processor,
3) A processor which services transactions, one at a time, taking a finite time to act.
4) A mechanism which sends processed transactions to other blocks and puts them in the queue at that block.

The above problem structure can now be described using an activity network approach with generalized node/path logic. Conceptually, the queue resides within the node and is referred to as a block. The block has four sections that are analogous to 1) through 4) above. These are:

1) An "originate" section or arrival mechanism which will generate a transaction if desired and put it in the queue at that block,
2) A "select" section which will take a transaction off the queue for processing (i.e., the queue discipline),
3) A "process" section or service mechanism which will service a transaction for a finite time period, and
4) A "disposal" section which determines the next block or path for a transaction.

Thus, each block can be defined by a set of four parameters. These parameters will determine how often transactions in that block occur, in what order they are selected off the queue, how long the transaction is disposed of ater the servicing is completed. Recall that each transaction consists of a number of attributes; the attributes may be used either to influence any of the four parameter values of the block or to collect statistics on a population of transactions.

IV. CONCLUDING REMARKS

Most, if not all, of the situations that require the features of a simulation language can be described by a language with a few powerful instructions with few rules to follow. The benefits of using a language with a small instruction set are substantial. Not only is such a language easy to use, it is easy to implement. The current version of a language embodying these principles was implemented in two man-weeks. The usefulness of this language in solving large "real-world" problems is demonstrated in other reports (2) and (6). It should be emphasized that simplicity not complexity is an important measure of good language design. In a simulation language simplicity can be achieved by generalizing certain characteristics of activity networks. The result is a flexible modeling technique for analyzing network, queuing and other simulation problems.

V. BIBLIOGRAPHY

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