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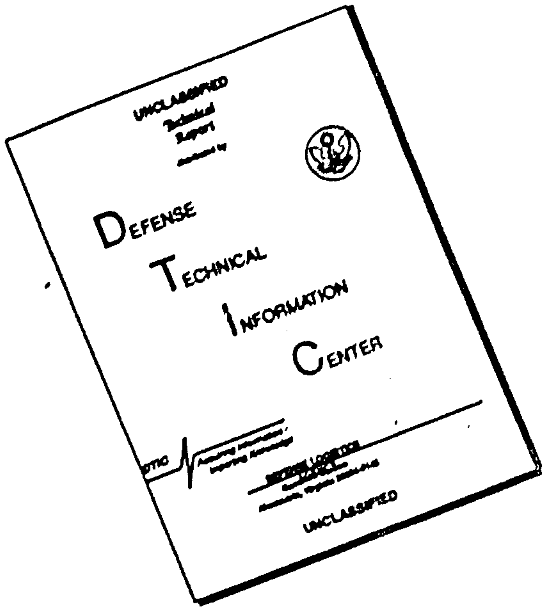

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A MONTE CARLO MODEL OF AN AIR FORCE TYPE SUPPLY SYSTEM

by

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INTRODUCTION

The so-called "Monte Carlo" method of solving complicated statistical problems by making repeated random trials has become, with the advent of high-speed electronic computers, a useful research tool both in studying scientific problems and more recently in studying business management problems. In the work at RAND on Air Force logistics, this tool of analysis has been applied to problems of Air Force inventory control and stock distribution using an IBM 701 computer. These problems are similar in many respects to the inventory and stocking problems in private industry and this ~~talk~~ is intended to give a very general description of one of these supply system models, in order to indicate the type of business inventory problems which can be studied by this method.

MODEL CONTEXT

The context or scope of the model includes, on the basis of a single spare part at a time, the supply relationships among a manufacturing plant, a supply depot, and several bases. It is a general-purpose model and is not limited to the study of any particular base-depot-factory system. The detailed specifications needed to describe a particular situation such as the number, size, and location of bases, etc., can be adjusted to fit almost any existing or contemplated situation. In fact, the model could, with minor modifications, probably be made to simulate many business distribution systems which have only three levels of distribution (plant, wholesale, and retail.)

STOCHASTIC ELEMENTS

The Monte Carlo method is usually employed to study problems which contain so large a number of interrelated stochastic variables that the problem is so complicated that straight forward analytical solutions are impossible or at least very difficult. Inventory control problems are frequently of this type, and the Air Force problem is an example.

In this particular model the following stochastic variables have been included:

1. The demands for spares which occur at each base supply.

2. The condition of the turn-in item, whether it is condemned, sent to base repair, or sent to depot repair (non-reparables are all condemned.)

3. The elapsed time between submission of a routine or priority requisition at a base until supply action is taken by the depot.

4. The elapsed time between establishing of a shipping order by the depot on a routine or priority requisition until the item is available in base supply.

5. Procurement lead times, both for normal and expedited procurements.

6. The time elapsed while a reparable item is processed through base or depot repair, and returned to serviceable stock.

7. The time elapsed between the decision to return surplus base stock until the items are placed in depot stock.

The values for each of these variables are generated randomly by the computer in accordance with their particular probability distributions. They represent the environment with which the system must cope.

SIMULATED SYSTEM

The simulated system is assumed to have no more information about the nature of the environmental variables it is facing than it can obtain from collecting samples from its own experience. In other words, it must not only deal with the variability of its environment, but it must estimate the underlying parameters from its own observations. Under these conditions the following operations are performed by the various parts of the modeled system:

At each base:

1. Computes any serviceable stock receipts from depot or from base repair every time period.

2. Computes the amount of stock on hand at the beginning of every time period.

3. Computes a new stock control level periodically.

4. Computes a new reorder point periodically.

5. Determines the number of due-outs that exist every time period.

6. Periodically determines if there is surplus stock to be returned to the depot.

7. Computes the quantity of stock due-in from the depot and from base repair.

8. Submits routine resupply requisitions to the depot

whenever stock falls to the reorder point.

9. Determines the disposition of every turn-in (whether it is condemned, or sent to base or to depot repair.)

10. Submits priority requisitions to the depot if the demand exceeds base stock.

11. Issues to demands and due-outs as stock is available.

At the depot:

1. Periodically computes system requirements and initiates procurement from the factory.

2. Initiates expedited procurement whenever depot stock falls to a specified level.

3. Periodically computes depot warning point and minimum reserve levels using past system-wide issues.

4. Computes the amount of stock on hand at depot at the beginning of every time period.

5. Computes the quantity due-in from expedited procurement every time period.

6. Maintains records, by base, of routine and priority requests which were backordered because of insufficient stock.

7. Ships items to the bases as stock is available and in accordance with the priority and backorder status of each request.

By varying the policies and rules by which the above operations are performed, and running them in the model for several thousand time periods, it is possible to obtain estimates of how the real system would perform under a similar set of policies.

MODEL OUTPUT

The output or answers obtained from this particular model consist of statistical summaries of several types of simulated performance data. It includes information on the number and size of routine and priority requisitions, the quantity and frequency of backorders at the depot, and the number of times the depot had to initiate expedited procurement and the quantity ordered.

USES OF A MODEL OF THIS TYPE

A Monte Carlo model of this type cannot be used to determine an "optimal" policy since all that can be done is to try alternative policies and to compare them. However, it can be used to select a "preferred" policy which is merely the best of those policies tried. It is also a valuable device for hypothesis hunting. Since a Monte Carlo model can usually include more detail than can analytical models, it can serve to indicate which variables and sets of variables are most important, and once these key variables have been identified, it is frequently possible to study them with more precise analytical methods.