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A MICROCOMPUTER BASED SIMULATION MODEL FOR A MILITARY SCHEDULING APPLICATION

Daniel G. Shimshak and Dean J. Saluti
Department of Management Sciences
University of Massachusetts at Boston
Harbor Campus
Boston, Massachusetts 02125

This study analyzes various design alternatives in determining the manpower requirements needed for an army orders processing operation. Specifically it will enable a National Guard Plans and Training orders. The analysis is performed by use of simulation modeling. Different manpower alternatives were evaluated that included varying numbers and arrangements of processes. Consideration was given to the total processing time objectives in order to determine these levels of manpower. It is intended that this model will ultimately reside in interactive software on a microcomputer.

1. INTRODUCTION

The determination of service processing requirements has always been a difficult problem to study. It has overwhelming importance in certain service sectors as hospitals or the military, where the need for proper service is extremely crucial. Administrators have turned to operations research techniques for the study of these problems. In particular, queueing theory has emerged as a useful decision making technique (e.g. Larson, 1975 or Gupta, Zoreda, and Kramer, 1971). Often times the use of simulation modeling has been required in the problem analysis (Shimshak, Damico, and Burden, 1981). Improvements in service processing operations have led to increases in overall organizational effectiveness.

It has become a priority for military organizations to increase organizational effectiveness through high performance. Berg (1983) outlines a profile of a high performance army organization and emphasizes attention to processes and procedures which are intrical parts of routine operations. This incudes particular emphasis on process blockages.

Organizational effectiveness is cited as extremely critical for military readiness and combat mobilization (Dohleman, 1982). Klein and Forsythe (1982) cite the importance of application of organizational effectiveness at all levels of military organization - both active and reserve components. They state that organizational effectiveness models have limitless applications.

The purpose of this paper is to present the design of a simulation model which assists in the management of an army orders processing operation. More specifically, this model will enable a National Guard Plans and Training Office to efficiently schedule clerks responsible for processing training orders. This model will reside in interactive software on a microcomputer. Similar orders processing operations can be found in all major military organizations. Thus, development of a simulation model which increases processing efficiency for such operations has widespread application.

2. ARMY NATIONAL GUARD OPERATIONS ENVIRONMENT

The Massachusetts Army National Guard State Headquarters, located in Boston, is responsible for the issuing/processing of training orders for 13,000 National Guard personnel. These training orders initiate an active duty status which

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officially obligates a civilian into an immediate military position. This position will always be combat readiness training oriented with the exception of the rare case of a local emergency or disaster. It should be noted that a member of the National Guard cannot enter an active status unless officially processed orders are in hand. Bottlenecks in the orders processing operation greatly affect the combat readiness state of the Massachusetts National Guard as a functioning military unit.

Initially, processing bottlenecks came to the attention of the Office of the Adjutant General and the State Chief of Staff. Subsequently an operations analysis of the existing orders processing system was authorized. This analysis provided an overview of the work flow involved in the orders processing and is summarized as follows:

1) The requests for active duty orders from various units throughout the State of Massachusetts are forwarded to the Plans and Training Office (PTO). These orders are batched and processed. The PTO has direct responsibility for managing and monitoring all orders processing procedures, to include the assignment of additional orders processing clerks to the process as needed. Figure 1 displays a flow diagram of the orders processing system at the Massachusetts PTO.

2) The orders processing clerks receive the batched requests and perform various manual and computer assisted functions to prepare these orders for review by the U.D. Property and Fiscal Office (USPFO).

3) Orders are sent by courier to the USPFO which is located over 20 miles away in Natick, MA. Here the orders are reviewed for pay allowance authorization, and are duplicated.

4) The orders are returned to the orders processing clerks at the PTO in Boston several days later to reenter the job processing stream. The orders are then distributed to the appropriate individuals and unit organizations, activating the need for various accounting functions to be performed by the orders processing clerks.

Because of probabalistic elements in the orders processing operations, queues tend to form. Orders arrive at random and the time required to process an order is random. When no clerk is available for service, orders must wait in line. This study analyzes the current orders processing system and evaluates manpower alternatives to reduce total processing time and eliminate bottlenecks.

3. MODEL DEVELOPMENT

The Massachusetts Army National Guard orders processing procedures was studied for 16 months of operation. This examination yielded information regarding the queue, arrivals, and services.

3.1 Arrivals

Order requests from the various National Guard units arrive in batches in a random fashion with an average of 1.4584 per day. They follow a general arrival distribution. The number of orders per batch remains relatively constant. Batches of orders are processed as received. Orders can be classified by their position in the system. Those that have yet to be sent to the USPFO are "pre-USPFO" orders and those that have returned from being processed by the USPFO are labeled "post-UAPFO" orders.

3.2 Service

Data were obtained for the time required to process both pre-and post-USPFO order requests. The total service process is comprised of several service activities that must be performed in sequence. Many of the times required for the order processing clerks to execute their activities are random variables that follow a general distribution. It was found that the average processing time for pre-USPFO orders was 45.4 minutes and post-USPFO orders took 80 minutes to process.

In addition to processing by the clerks at the PTO, orders must be sent to the USPFO. The USPFO is the remote link in the orders processing system. A courier from the USPFO arrives at noon each day to pick up orders ready for USPFO processing. On the same trip the courier drops off USPFO processed orders which reenter the orders processing stream. It is important to note that there is a constant 3 day lag as the courier picks up orders to be brought to the USPFO and returns them to the Boston PTO.

3.3 Queue

A single line forms for all orders waiting for processing. The sequence in which orders are filled is first-come, first-served. However, there is the need to complete orders that have returned from the USPFO as soon as possible so that they can be distributed to the appropriate individuals and unit organizations. As a result, orders returning from the USPFO reenter the system by preempting existing processing operations. The service of pre-USPFO order enters the queueing system, and resumes service from the point at which it was preempted when there are no more post-USPFO orders waiting to be processed. This creates a complex processing situation for the

clerks who are often faced with a backup of orders.

As orders build up in the processing queue and skilled orders processing clerks become unavailable, unaccepted delays occur. These delays prevent members of the National Guard from beginining active duty on a scheduled date. This is a matter of grave concern which affects all aspects of National Guard performance.

Manpower alternatives were evaluated by varying the number of processing clerks as a function of the queue size of orders. For each alternative the total expected order processing time was the characteristic of interest and decisions involving the number of processing clerks attempted to reduce this time.

4. FINDINGS

Because of the nature of the arrivals and services in this queueing system, it was necessary to use computer simulation in evaluating the manpower alternatives. The simulation model was written for use on a micro-computer so that the PTO has the ability to consider what effect the numbers and placement of additional clerks will have on the orders processing system.

Model 1 considers a single processing clerk who handles both pre-USPFO and post-USPFO orders. It was found that the effect of preempting pre-USPFO orders does not result in a large increase in the expected service time for these orders. A problem is encountered with the waiting time of the pre-USPFO orders. This quantity is particularly affected by preemption, and some pre-USPFO orders have to spend large amounts of time waiting to be processed. As a result, attempts were made to reduce the waiting time of orders and ultimately the overall processing time.

In Model 2, a second clerk was added to the process and preemption was eliminated. This, as expected, led to a decrease in the waiting time of pre-USPFO orders while post-USPFO orders, having given up the ability to preempt orders, showed little change in average waiting time. The utilization rate of the two clerks being so low suggested alternative designs that called for the use of additional clerks in only portions of the orders process.

Models 3 and 4 considered adding additional clerks to the process to handle post-USPFO orders that reenter the system. Various decision rules were evaluated which were based on the total number of orders in the queue (Model 3) or only the number of post-USPFO orders only in the queue (Model 4). When the number of orders in queue reached a particular level, clerks were added to process post-USPFO orders. These proved somewhat effective in reducing the size of the queue and the time spend waiting.

The most noticeable improvements were found by adding additional clerks to process the pre-USPFO orders. Model 5 considers introducing additional clerks when the total number of orders in the queue reaches a particular level, and Model 6 evaluates the number of pre-USPFO orders in queue to base the decision of adding clerks. The manipulation of queue level and number of clerks was effective in reducing overall processing time of the orders.

5. CONCLUSIONS

A simulation model of the army orders processing operation has been developed to enable a National Guard Plans and Training Office to schedule clerks responsible for processing training orders. The model has been designed to be run on the micro-computers available to the PTO. It is intended that thsi model will ultimately reside in interactive software on a micro-computer.

It has been found that overall processing time of orders can effectively be reduced by designing the processing system on the basis of the queue size of the orders and the number of clerks. As a result, clerks can be added to the orders processing system at certain critical times in the operation.

The model should be used by the National Guard Plans and Training office so that the arrival conditions can be inputted and the systems operations simulated for various designs. In this way, the PTO can evaluate the "what-if" questions based on the manpower available. In addition, critical bottleneck situations can be determined early enough to prevent serious problems from arising.

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ORDERS PROCESSING FLOW SYSTEM