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(c) A Simulation Model for the Commercial Fleet Operations

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TABLE OF CONTENTS

ABSTRACT

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A digital computer simulation model is built for the maritime transportation network that may contian transloading points of cargo. The model serves as a utility tool for testing certain designs, system configurations, or the implications of prespecified policies. A high degree of modularity, segmentation, and hence flexibility is achieved. The model was tested and validated on the ICL 1900. E computer and is presented here in considerable details.

SIMULATION MODELS

Model building is usually associated with the following two objectives :[42,43]

1- To be able to predict performances before the system is built.

2- To have assurance that the system design selected is optimal in terms of the design criteria adopted.

Thus,model building is oftenly carried out to provide inferences about the real system through experiments conducted with the model.

Representation of the system by a physical model, either in the form of scale or an analogue model is usually time consuming and expensive, and there is no assurance that other designs, not considered, would not be superior.

An alternative to physical models is mathematical models, which often permit the application of analytical techniques for determining optimal design, but mathematical models usually have the following limitations :-

1- They usually have implicit assumptions, normally tailored to fit certain specified applications. For example, linear programming formulations for transportation models are based on the assumption that only a single type of commodity is being shipped ([illegible]). This would restrict the applicability of linear programming in a multi-commodity flow environment such as the maritime transportation sector ([illegible]).

2- When an attempt is made to modify the underlying assumptions to incorporate more relevant factors, the model usually gets too complicated to be solvable with the available algorithms. For example certain attempts have been carried out to develop reliable algorithms for the case of multi-commodity non-linear concave cost function networks ([illegible]). Usually conclusions arrived at through complicated mathematical procedures are hardly conceivable by top management.

3- Furthermore, mathematical models cannot be relied upon in the design of information-feedback scheduling and operations rules. For example, the scheduling procedure for a freighter transport fleet prepared several months ahead, must take into account cargo demands at various ports, ship capacities and speeds, uncertainties due to delays and port congestion. Many shipping lines that own a large fleet of vessels must reschedule daily as they receive more accurate information about uncertain events.

In addition to these limitations and upon dealing with complex systems, mathematical models may become very difficult and can alternatively be replaced by numerical techniques to determine the changes in the system resulting from events. This technique is digital computer simulation and is particularly valuable for studying systems in which model relationships are stochastic.

System simulation has proved to be a powerful tool in dealing with and analysing complex transportation networks. Through simulation, it is possible to establish a model for shipping operations which permits feedback of dynamic parameters affecting the optimum requirements of design for future replacement vessels. A performance criterion could be introduced which might include physical, operational, human as well as economic factors.

The technique is most suitable for the maritime transportation sector. The diversity of problems encountering the sector and the relatively wide variation of routing, scheduling and allocation decisions to be taken requires an equally flexible tool to cope with these many facets problems when attempting to determine the consequencies in any specific case whatever reasonable assumptions required are made to get a reasonable answer from whatever description of the problem is at hand. In other words, the assumptions and techniques for solving the problem can be tailored to each case. When, however, this task is to be referred to an electronic computer, these assumptions have to be made beforehand, and they have to be reasonable for a sufficiently wide range of problems to justify the effort of coding and computations ([illegible]). Moreover, the format and description of the problem must be set forth beforehand, and again, must be flexible enough so that a reasonably large number of problems can be described and that every problem can be worked dozens of times.

In applying a simulation technique, an immage of the system is produced in the form of a set of numbers that represent the state of the system, and a complete program is written embodying the relationships controlling the changes of state in the system ([illegible]). The general operations of a simulation program are roughly the generation of inputs, the determination of the next event and whether it can be executed, the changes in state which occur from an event, and the generation of output.

The general programming tasks corresponding to these operations are the generation of data, scanning of events, logical testing, update and creation of tables, and the computation of statistics and their organization in a report. In constructing the model and program, efficient use of memory space and simulation processing time are very important.

Simulation models have been successfully applied in the maritime as well as in other modes of transportation. Variables such as : proposed vessels, ship characteristics, fleet replacements, route structures, level of service, cargo offerings, and seasonal variations are included and evaluated in the models. As an example a maritime simulation model was developed to serve three interrelated tasks :

1- Study selected trade routes to define operational features that might be incorporated into new ship system designs.

2- Use generated inputs to develop a mathematical simulation model of merchant fleet operations.

3- Analyzing world-wide maritime and connecting inland transportation links.

A second example is furnished by a medium range freighter fleet simulation model. The model is a deterministic one and has been used principally as a device for scheduling rather than long-range planning. The model was used with little modifications to assist in the study of the effects on profit of forcing ships to delay in port for additional cargo offerings, and thus increase voyage utilization. It has also been employed in the investigation of the fleet position against proposed large scale competition in the concerned trade.

In 1969, the U.S. Department of Commerce built a simulation model to analyze the traversal of defined trade routes by diversily designed vessels [112]. It was also used to appraise the effects of variations in speed on the profit margin.

In the following chapters, the simulation technique is applied in a novel development of a model for the Egyptian Fleet units operations. The model is rather a utility device intended to suit a wide variation of purposes.

CHAPTER 2

MODEL DESCRIPTION

2.1 - INTRODUCTION

In this chapter we shall be concerned with developing a model simulating the movement of cargo over a complex transportation network that may contain transloading points and in which several different types of transport ships may be used. As indicated in Chapter 3, the model is intended for rationalizing decisions concerning testing certain designs, system configurations, and the implications of prespecified policies. This entails decisions relating to growth, routing, fleet composition, ship capacity, ...etc. The attainment of the desired model flexibility is achieved by constructing a simulation model which is not oriented towards a specific corporate situation. For this reason the "format" of the description of the problem must be set in advance, and liable to accommodate a reasonably large number of problems that can be described and worked several times. Thus, the user will be able, under the necessary assumptions and good quality input data requirement, to undertake a series of experiments yielding quantifiable results amenable for statistical analysis and inferences.

2.2 - DESIRABLE FEATURES OF THE MODEL

Upon the development of a simulation model of this type, usually one is confronted with two factors, rather contradicting ; they are : the incorporation of much details to achieve the greatest possible deal of realism,and to keep the model fairly away from irrelevant complications. In the present model a compromise between the above two factors have been made in such a way that only those features of direct bearing on the problem are incorporated. Of the desired features, the two most important ones are: containerization and transshipment of cargo. The importance of these two features stem from the fact that the first is a possible development for the Egyptian fleet while the second has special significance to the integration of fleets of the Arab Confederation. Each of these two features is discussed in the following sections.

2.2.1 - Containerization

Containerization of commercial cargo is being now undertaken all-over the world on large scale and certainly it is timely for Egypt. A strong trend is now calling for the necessary measures to catch up with the new technique being hailed as the biggest thing in maritime affairs in the last 20 years [90,104]. Preliminary measures have already been taken at Alexandria port to deal with container ships.

The technique is developed to reduce the serious impediment to cargo handlings introduced by the heterogeneous nature of dry mixed cargo and increase their efficiency. The method acquires its greatest advantage from integrating several transportation modes including trucks and railroad cars. The actual discharge of the cargo takes place at the final destination of cargo. Containerization promises an increased rate of handling with consequent lower costs and a decreased turnaround time. Further, it significantly reduces the paper work which is, otherwise, required. Containers guard against pilferage and provide protection against damage and weather [90]. They are sufficiently sturdy to be used as temporary storage.

On the other hand there are several disadvantages which might handicap containerization advantages. Chief among these are costs of purchasing, maintenance, and returning the empties (when necessary). Other disadvantages are containers dead-weight and the inside lost cubic space due to imperfect fit. Special handling equipment may be required. Finally, present tarrifs and custom regulations pose special problems. However, efficient management, good scheduling and tight controls will be the deciding factors in the system.

Due to the fact that complete switching to container ships might not be feasible in Egypt at the early stages, provision has been made in the model for having some container holds among the ship holds. Entire container ships are, however, possible to be dealt with in the model.

Considering containerization, three major decisions have to be taken about :

1. The size of the container, relative to certain standards,
2. The number of the container inventory, and,
3. The allocation and scheduling scheme along the trade route.

In the developed model, no attempt has been made to impose a particular technique of scheduling and allocating containers to the system ports because such attempt will depend on the real conditions upon application and any assumption in this connection may impair the flexibility and generality of the model.

An input array INVCO(I) is provided to be read as system data giving the initial container inventory at port (I). Each time a container is filled or emptied, container inventory of the given port is updated. Container inventory is considered to be those empty containers ready for filling with cargo originating from this port. Transshipment containers whether loaded or discharged have nothing to do with container inventory. On the other hand any final destination container discharged from the current ship will increase the container inventory at this port. This is not done at once since discharged containers will need sometime to be emptied and ready for new shipments. Thus an assumption is made that discharged containers are accumulated during processing of a given ship and are piled up to the port's inventory at the end to be available for subsequent events. Container inventory at system ports is displayed on the monitor at specified simulation intervals in subroutine CARGO. No shipment of empty containers is considered by the model.

2.2.2 - Transshipment of Cargo

Shipment of cargo between the origin and destination ports may not occur in a single voyage. There may be one or more transshipment ports at which cargo is to be discharged for further shipments by other ships calling at such ports.