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THESIS

TOWARD AN ECONOMIC DISTRIBUTION MODEL
A MANAGEMENT CONTROL ANALOGUE

by

Willie Ray Bishoff, Jr.

March 1979

Thesis Advisor: R. A. McGonigal

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Toward an Economic Distribution Model
A Management Control Analogue

by

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Major, United States Marine Corps
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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1979

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ABSTRACT

Logistics functions within the military can be viewed as similar in operation to finished goods distribution within major manufacturing concerns. Based upon research conducted within the distribution departments of selected major manufacturing concerns, this thesis contains a predictive model created from an observed relationship between finished goods distribution and military logistics. Utilizing a descriptive format, this model is established through four major areas of comparison. First, financial aspects and cost-benefit analysis toward an economic utilization of all resources prevades the analogue. Second, material movement designs or processes are presented toward answering the question of how a manager can go into an organization with a critical eye at how better to perform his function. Third, the often under-emphasized area of human resources utilization also contributes significantly to the model's evolution. Fourth, concluding the analogue is a discussion of the interface of data processing, MIS, and evaluation aspects of the process.

TABLE OF CONTENTS

I. INTRODUCTION ---------- 9

A. THE GLOSSARY--A DEFINITIONAL BOUNDARY MECHANISM ---------- 10

B. THE MODEL ---------- 11

C. THE MANAGEMENT CONTROL ANALOGUE ------- 12

1. The Environment ---------- 13

2. Thesis Development ---------- 14

II. THE THEORETICAL UMBRELLA ---------- 22

A. MANAGEMENT THEORIES ---------- 23

1. Traditional Theory ---------- 23

2. Human Relations Theory ---------- 24

3. Human Resources Theory ---------- 25

B. THE MANAGEMENT CONTROL SYSTEM --------- 26

C. ORGANIZATIONAL ASPECTS ---------- 29

III. THE ANALOGUE MODEL ---------- 34

A. THE FINANCIAL ASPECTS ---------- 34

1. The Economics of Management ------- 35

a. Definition of Costs Functions - 35

b. The Input/Output Function ----- 40

2. Inflation--The Great Equalizer ---- 41

3. Economic Order Quantity/Economic Lot Size ---------- 42

4. Capital Investment Economics ------ 44

B. MATERIAL MOVEMENT ASPECTS ---------- 44

1. Inventory Classifications --------- 45

2. Inventory Management Systems (IMS) -- 47

a. Problem Statement ---------- 47

b. Objectives ---------- 49

c. Scope ---------- 50

d. Phase I--Control ---------- 51

(1) System Flow ---------- 51

(2) Major Features of the System ---------- 54

e. Phase II--Operation ---------- 56

(1) Forecasting ---------- 56

(2) Order Processing ---------- 57

(3) Master Scheduling ---------- 57

(4) Material Planning ---------- 58

3. The Materials Management Department - 58

C. *HUMAN RESOURCES ASPECTS* ---------- 61

1. Theoretical Approaches ---------- 62

2. Subordinate Responses ---------- 65

3. Productivity Standards ---------- 67

4. Employee Rebellion ---------- 68

5. Organizing for Change ---------- 69

6. Top Level Management Self-Image ----- 70

D. AUTOMATED DATA PROCESSING (ADP) ASPECTS - 72

1. Four Stages of Growth ---------- 73

a. Initiation ---------- 73

b. Expansion ---------- 74

c. Formalization ---------- 75

d. Maturity ---------- 76

2. The User Element ---------- 77

E. EVALUATION ASPECTS ---------- 77

1. Experimental Design ---------- 78

2. Non-Parametric Techniques --------- 79

3. Computational Procedures ---------- 79

IV. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH ---------- 81

V. GLOSSARY ---------- 85

BIBLIOGRAPHY ---------- 103

INITIAL DISTRIBUTION LIST ---------- 105

LIST OF FIGURES

Figure 1.	Cornerstones of the Model ----------	15
Figure 2.	Areas of Management Attention ---------	17
Figure 3.	Parallel Concerns ----------	19
Figure 4.	The Analogue Model ----------	21
Figure 5.	Typical Civilian Organizational Structure ----------	32
Figure 6.	Typical Military Organizational Structure ----------	33
Figure 7.	System Flow Diagram ----------	52

I. INTRODUCTION

> One man or a few may excel in virtue; but as the number increases it becomes more difficult for them to attain perfection in every kind of virtue, though they may in military virtue, for this is found in the masses. Hence in a constitutional government the fighting-men have the supreme power, and those who possess arms are the citizens.
>
> Aristotle: Politics,
> Book III, Ch 7 (1279^{a} 40-$^{b}3$)

> A wise prince ought to observe some such rules, and never in peaceful times stand idle, but increase his resources with industry in such a way that they may be available to him in adversity, so that if fortune changes it may find him prepared to resist her blows.
>
> Machiavelli: Prince,
> Ch XIV

Throughout the unity and continuity of western thought, the discussion of common themes and problems from one end of the tradition to the other, shows the many strands between the greatest minds of western civilization on the themes which have concerned men in every epoch. It is the task of every generation to reassess the tradition in which it lives, to discard what it cannot use, and to bring into context with the distant and intermediate past the most recent contributions to the furtherance of detailed problem solution. From Aristotle's discerning observation of the substantive relationship between the citizenry and its military through Machiavelli's systematic exposition of a

shrewd ruler's constant sheathing of political as well as military substance, history is rampant with analogues of the type postulated in this thesis. So why another analogue accentuating the importance of the vital link between problem solutions in the civilian society and those of the military?

Before significant strides can be made toward an answer to this question, a clear understanding of the central issue of this treatise must be obtained. Essentially a distribution problem, logistics functions within the military can be viewed as similar in operation to finished goods distribution within major manufacturing concerns. Throughout the evolution of this thesis the civilian distribution/military logistics analogue shall pervade. The supposition will explore management control systems* within the distribution departments of selected major manufacturing concerns toward building a model* of how a manager can go into an organization looking at how better to perform his primary function. Systematic analysis toward an economic utilization of all resources* will be the primary concern.

A. THE GLOSSARY--A DEFINITIONAL BOUNDARY MECHANISM

Information processing is a dominant activity in every endeavor. A significant portion of any person's behavior

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Words that are followed by this symbol are defined in the glossary on page 85.

within either a military organization or a civilian concern, involves the processing of information. Information, essentially intangible knowledge, is the content or meaning of a message. Effective information processing and managerial decision-making, vital for any organizational success, is often clouded or distorted through a lack of consonance on the meaning or definition of similar terms or concepts. For example, widely used throughout the military is the term ADP*. Essentially the same meaning is applied by civilian industry to the term EDP*. Agreement upon the intended tonicity of the content of this thesis is essential to the analogue it is intended to present. Therefore, to aid in the mental information processing, important terminology will be defined utilizing a combination of definitions drawn from both sides of the analogue.

In order to avoid unduly crowding the descriptive nature of this paper, a glossary of terms, unique to this exposition is provided. In some cases, terms will be defined exactly as they are in civilian industry; in some cases, as they are within the military; and in other cases, through a conjuncture of both environments, into a medium unique to this forum. In all cases, that terminology necessitating a unified understanding will be contained in the glossary.

B. THE MODEL

The basic methodology used in this thesis is much the same as that used in any other type of scientific analysis, the

basic procedure being the formulation of a model. To be useful, a model must in general simplify and abstract from the real situation. The purpose of this thesis will be to construct a model in such a way that irrelevant and unimportant considerations and variables are omitted, but the important factors--those that have an important effect on the phenomena the model is designed to predict--are included. To be effective a model must develop a meaningful set of relationships among its objectives, and accurately--at least to a believable extent--have a predictive ability of some magnitude. The analogue model to be developed herein will attempt to satisfy all these requirements.

C. THE MANAGEMENT CONTROL ANALOGUE

Increasing the resources of industry is suggested by Machiavelli, within the context of the more modern extension of the term, leads to the conclusion that a vast industrial resource in the nature of managerial approaches to problem solutions exists in the civilian environment. Returning to the question of why is it important to explore this resource, one needs only to review the broad gamut of diverse management approaches which exist both academically and practically to realize the need for continual revolution in this area. It is not intended that this descriptive thesis will solve all the problems associated with effective management, but it is intended that one should go away from this paper with a better understanding of the alternative methods of solving distributional type management problems.

1. The Environment

Before going into a summary of the plan for how the central issue of this thesis will be addressed it is important to establish the perimeters within which this exercise will be pursued. The civilian distribution model to be created involves research evaluation based upon the management control aspects of the distribution departments of major manufacturing concerns. Having its basis in a manufacturing process, this model involves the forecasting, planning, monitoring, classification, storage, order processing and packaging materials aspects of distributing goods to customers. The system begins with the receipt of raw-materials, includes physical inventory aspects, non-raw materials receiving, processing, packaging, storage and ultimately shipping of finished goods. The military logistics model to be developed involves the analogical evolution of a management thought process based on the inference that "if two or more aspects of each process agree in some respects they will probably agree in others." (Definition of analogue Webster's New World Dictionary)

For the purpose of this paper, the framing of a dichotomy so that a civilian distribution process can be classified as one type of endeavor and a military logistics process another type will be avoided. Some distinction between the two types of organizations, however, must necessarily exist. The dominant purpose of a civilian distribution process is earning profits. Decisions made by

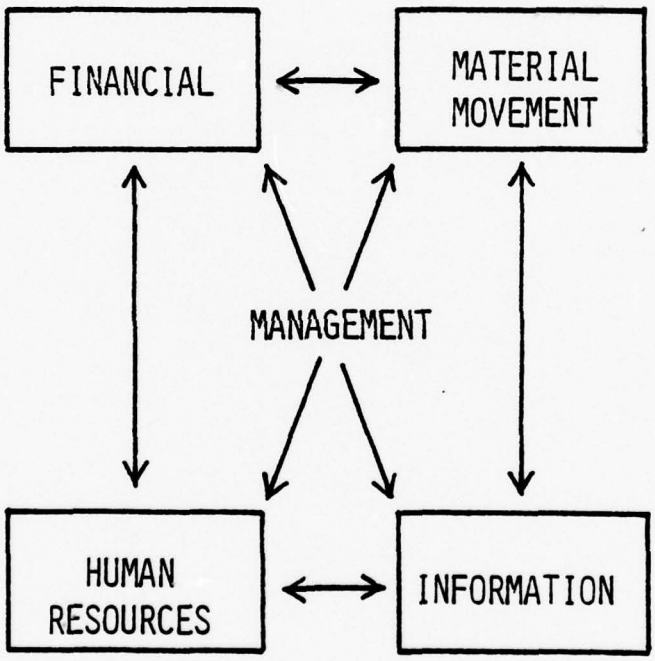
its management are intended to increase profits, and success is measured to a significant degree by the amount of profits that are contributed to the entire organization. By contrast, military logistics organizations exist primarily to render a service. Decisions made by military management are intended to result in the best possible service with the available resources. Their success is measured primarily by how much service they render and by how well they render it. It is an intention of this paper to disavow the myth of management control differences between public and private sectors--at least as pertains to this topic.

2 Thesis Development

Returning to a summary of the plan for how the central issue of this thesis will be answered, it remains necessary to outline the subsequent sections. Following a discussion of the theoretical umbrella under which the thesis will evolve, discussion and evaluation of four cornerstones of distribution/logistics management will be constructed. Figure 1 depicts the four cornerstones of the model and their constant inter-relation with both each other and all levels of management.

FIGURE 1

CORNERSTONES OF THE MODEL

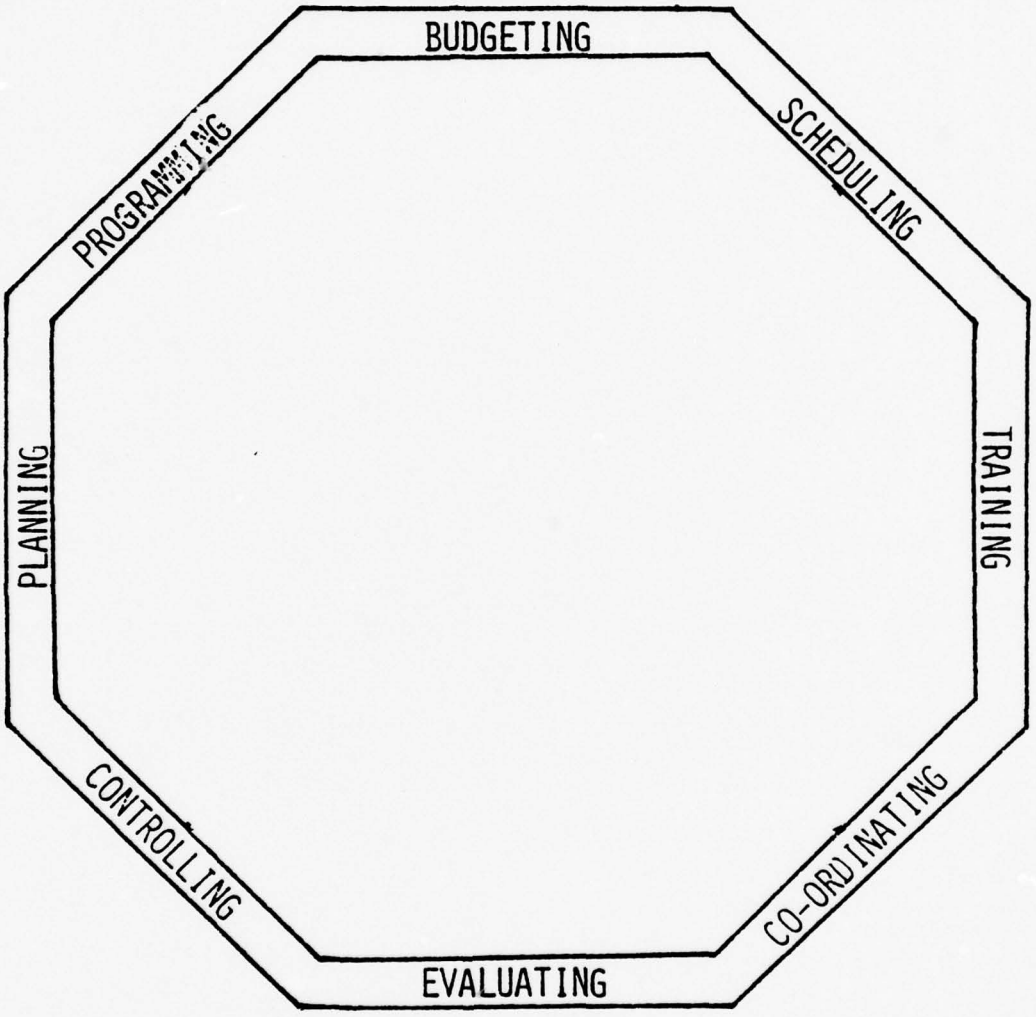


The first section begins with a discussion of the financial aspects of the analogue and will explore the economics of distribution from a benefit-cost analysis. Inflation can be seen as an equalizer between the two extremes of this analogue. The real heart of this development lies in the material movement aspects. Here an Inventory Management System* will be developed within which the Materials Management Department will be an integral part. The section following that will explore the greatly underemphasized importance of human resources management, and the employee rebellion to many of the real-world applications of theoretical management. Finally, the model will be concluded with a section on the interface of information systems, data processing and statistical aspects as an evaluation tool within this concern.

Admittedly it could easily be asserted that the four aspects of this model merely scratch the surface of possible areas for management attention in an economic distribution model. Research evaluation based on the management control aspects of the major manufacturing concerns studied, however, led to the conclusion that these areas stand out as those most often of immediate concern to management. Surrounding these cornerstones are several avenues of necessary management attention which were found to be present within both ends of the analogue. Figure 2 depicts these noted areas of attention.

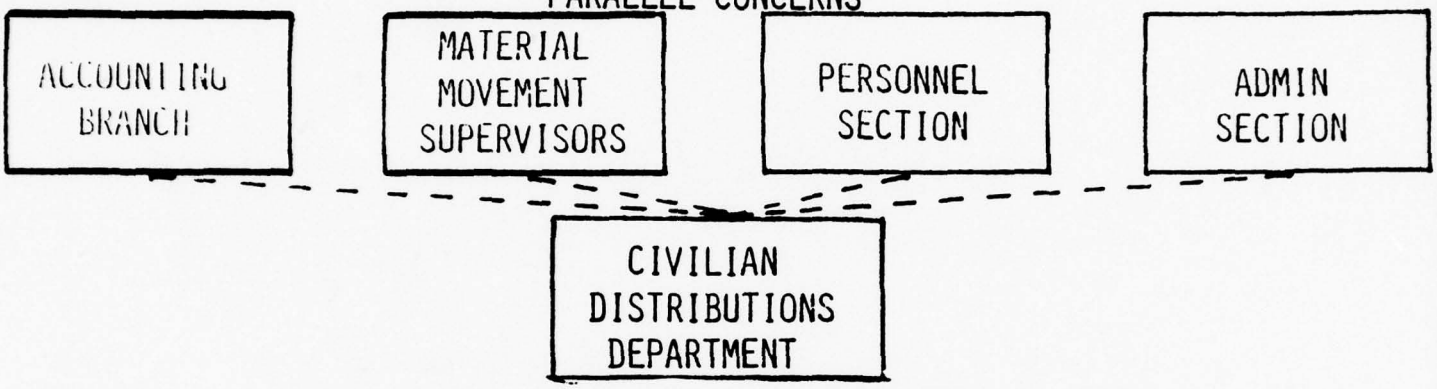
FIGURE 2

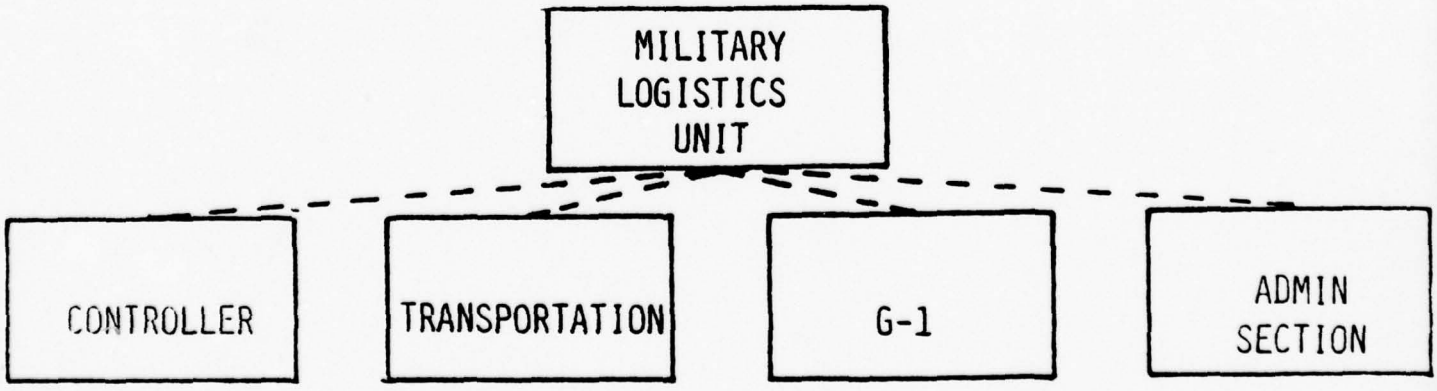
AREAS OF MANAGEMENT ATTENTION



Throughout the evolution of this thesis, it will be apparent that both civilian distributions departments and military logistics units have several parallel avenues of concern. Many aspects of how a manager would function within each organization could be described. The interactions depicted in Figure 3, stand out as the most obvious. An astute manager in the civilian or in the military environment will need to address the areas of attention mentioned in Figure 2 with each of the departments noted in Figure 3 on a continuing basis.

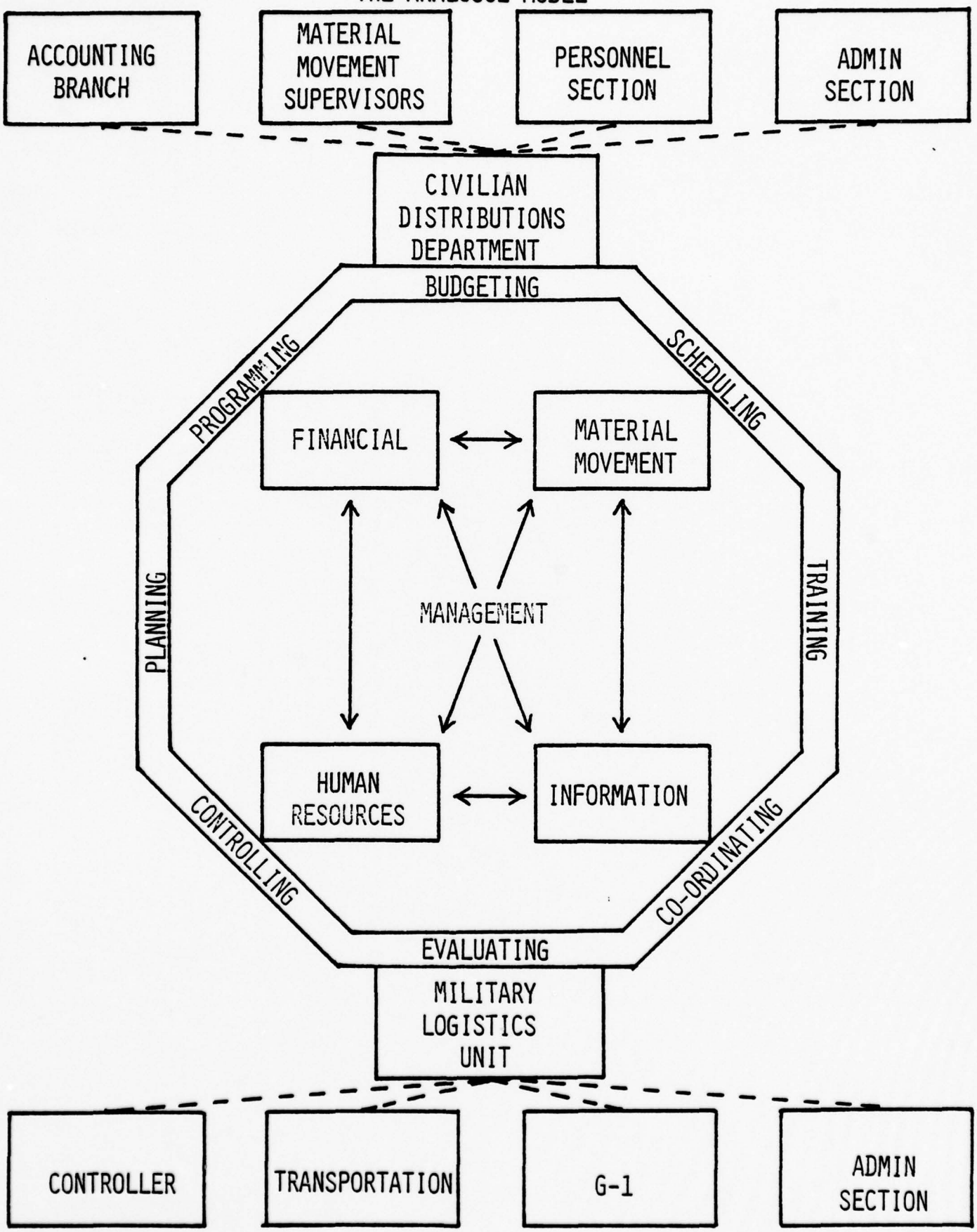
FIGURE 3
PARALLEL CONCERNS





Upon completion of the narrative portion of this paper, one should better understand the alternative methods of solving distribution type management control problems. The similarities between a civilian distribution department with its intra-departmental dependencies and a military logistics unit with many of the same motivations will be apparent. Figure 4 depicts the relationships the thesis will develop.

FIGURE 4
THE ANALOGUE MODEL



II. THE THEORETICAL UMBRELLA

Establishing the appropriate theoretical umbrella for this analogue will be supported by the glossary. However, it is important that a few basic conceptual aspects of the model to be developed be discussed at the onset. Some of the ideas expressed in the subsequent section are derived from academics, some from DoD publications, and some from concepts formulated during the research design and information gathering done in connection with this study. All are important to keep in mind throughout the remaining sections.

Agreement upon not only the definitions that shall form the basis of this transcript, but also the general application of basic concepts is essential. It seems inappropriate to attempt to construct an analogue of any importance without first describing in theoretical terms the basic conceptual foundation upon which this research was based. An important question appropriate at this point might be, does the typical manager actually have a theory* of management? Extensive data gathering and observation of managers in action during the preparation of this work indicates unequivocally--yes. Although most managers have never attempted to develop a carefully worked through, "logical" description of why they

---

*Words that are followed by this symbol * are defined in glossary on page 85 .

manage in a given fashion, the typical manager has a set of views and concepts which influence his behavior and affect his decisions. Often an outside observer can infer a manager's theory by watching the manager's behaviors.

A. MANAGEMENT THEORIES

Based upon observation, it does indeed appear that management theories--from a practical standpoint--fall into three approaches. (Miles Chapter 2) The following descriptions of these three approaches to management--albeit a theoretical description--will become even more important and shall be referred to in later sections as they affect and actually alter the total output of the model being developed. Based upon assumptions about human attitudes and behaviors these three approaches are described as the (1) traditional, (2) human relations, and (3) human resources theories of management.

1. Traditional Theory

Under the traditional theory man is drawn out of leisure and into work by the payment of money which he requires to meet his needs. The substitution of money for leisure will continue up to some point of marginal satisfaction. Management exercises direction on the basis of its superior scientific knowledge acquired through reading, training, and observation. To be able to discharge his responsibility for the work of subordinates, each manager has authority over them. A system of standards is designed

to assure uniformity in the performance of every task regardless of the number of persons engaged in it, and the coordination of different tasks. Explicit rules and regulations define the responsibility of each member of the organization and the relationships among them. It was the work of Frederick Taylor and his associates in the scientific management movement that brought about widespread acceptance of this concept [Dale p. 129]. This approach also resembles quite significantly Likert's System I design [Dale p. 207].

2. Human Relations Theory

Merely incorporating and extending the traditional theory, the human relations theory exhorts management to deal with the "whole man" rather than with just his skills and aptitudes, for people want to be treated as human beings with at least some recognition given to their individual needs, wants, and desires. Based to a notable degree on Maslow's hierarchy of needs, this approach attempts to bring management concerns to bear on motivating individuals to their next higher needs [Dale p. 437]. Douglas McGregor believed that much of the failure of this human relations approach stemmed from the fact that most managers worked on the theory that human beings just naturally dislike work and must be coerced into putting forth adequate effort on the job. Called "Theory X" regarding human nature in general and employee nature in particular, McGregor proposed that managers adopt what he called "Theory Y" (for a more complete discussion of his approach see Dale p. 438ff).

3. Human Resources Theory

Extending these assumptions about people, the human resources theory argues that people want opportunities to develop and apply their full range of abilities and to gain satisfaction from achieving demanding, worthwhile objectives. The main thrust of the assumptions of the human resources theory is an emphasis on abundance rather than scarcity in the area of human capabilities, which in turn indicates that the manager's role is not so much one of controlling organization members as it is of facilitating their performance. Blake and Mouton have shown that the most effective managers are neither human relations oriented nor scientific-management oriented. Rather the best managers are people-and production oriented [Hicks p. 377]. Leavitt and others have extended the human resources concepts into the exploration of the significant organizational changes that would occur when the computer and new-planning technqiues take effect in many firms [Fox p. 235]. Criticizing the human relations approach as it is practiced and making suggestions regarding the organization of planning and doing, Peter Drucker, has insisted that management must be creative and innovative with regard to the development of human resources [Dale p. 455].

Under the traditional theory, the manager's role is essentially that of a controller. Under the human relations theory, the role of the manager is modified to include responsibility for maintenance of the human system. Under

the human resources theory, the manager's basic role is as a developer and facilitator of the performance of the socio-technical system to which he is assigned. The application of these various approaches shall evolve into real world problem solutions in later sections.

B. THE MANAGEMENT CONTROL SYSTEM

Strategic planning*, as conducted by organizations of every size and scope, is a process having to do with the formulation of long-range, strategic, policy-type plans that change the character or direction of the organization [Anthony & Herzlinger pp. 183-184]. In the civilian manufacturing industrial concern, this includes planning that affects the goals* of the company; policies of all types; the markets to be served and distribution channels for serving them; the organization structure; sources of new permanent capital; dividend policy, and so on. Strategic planning decisions affect the physical, financial, and organizational framework within which operations are carried on. Strategic planning relies heavily on external information. The importance of data collected from outside the company, such as market analyses, estimates of costs and other factors involved in building a plant in a new location, technological development and so on, will become apparent as later sections develop.

Management control* is a process for the use of managers involving the interaction of one manager with another. A

management control system within either a civilian or military organization is general in concept and structurally the same. It consists of the process of actions that take place and the structure of organizational arrangements both formal and informal that facilitate this process. Line managers*, the focal points in management control, are the persons whose judgments are incorporated in the approved plans, and they are the persons who must influence others and whose perofrmance is measured. Staff managers* collect, summarize, and present information that is used in the management process, and they make calculations that translate management judgments into the format of the system. Relying heavily on external information--that is data collected from outside the company--strategic planning usually relates to some part of the company rather than as the whole. Management control, on the other hand, is intended to influence managers to take actions that will lead to desired results.

As a distinctive subset of management control, operational control* is focused on individual tasks or transactions. Operational control involves such things as scheduling and controlling individual jobs through a shop, procuring specific items for inventory, or specific personnel actions. Involving activities that are capable of being programmed, operational control is intricately interwoven with the input/output functions* of the organization. Every organization has outputs, even though they may not be readily measurable or even clearly definable; just as every organization requires

some type of input in order to function. This concept, introduced here in order to facilitate an understanding of operatinal control, will be discussed more fully and more specifically in the next section.

Operational control involves those activities such as the direct production operations of most manufacturing plants; production scheduling; inventory control; the order-taking type of selling activity; and order processing, payroll accounting, check handling and similar paperwork activities.

With the forgoing introduction of the various forms of control mechanisms apparent in civilian organizations it is now important to express the military approach couched in Planning, Programming, and Budgeting System (PPBS)* terms. The cornerstone to all planning and the real foundation of the PPBS is the collection and evaluation of strategic intelligence. At the national level the planning phase evolves into an appraisal of the overall threat to the security of the United States and a national strategy to counter that threat. On the individual organization level, this phase corresponds very similarly to the strategic planning phase in civilian organizations. Although during the planning phase, technological constraints are realized and fiscal constraints may be implicitly considered, it is within the programming phase of the system that fiscal constraints are explicitly introduced. The basic purpose of the programming phase is to translate approved concepts and objectives into a definitive structure expressed in terms of

time-phased resource requirements including men, monies, and material. The budgeting phase, which has essentially become the military's management control system is the processes resulting from the formulation of the budget in terms of appropriations and the execution of the budget by means of the obligation and expenditure of funds for specific purposes as appropriated by the Congress.

The close interrelationship existing between the various phases of the PPBS process is the most consistent aspect of the entire system. Even though in its most strictly applied setting it is an extremely comprehensive, intricate, and interdependent system, the focus within the context of this examination is upon the application of the PPBS process as a management control mechanism within military logistics organizations. Both the civilian and military approaches, as briefly introduced here, toward management control processes, will provide the umbrella under which the text of this analysis will mature.

C. ORGANIZATIONAL ASPECTS

Before concluding this section, an examination of the ways in which positions, units, and departments are theoretically structured to form organizations, is essential. The problems of both formal and informal relationships between any given set of positions within an organization enormously affect both the unit as a whole, and the output of that organization. In theory, organizational design can proceed from the top

down or from the botom up [Miles, Ch 5]. In the top-down procedure, broad organizational goals would be translated into specific objectives. The objectives might become the focal point around which a series of departments could be organized. Positions within such departments would then be established to serve as the means of attaining the objectives. In the bottom up approach, the basic processes of the organization would be established. As positions were formulated to operate the process, the requirement of a superstructure would emerge. Middle-managerial positions are needed to coordinate activities, and these in turn require coordination by higher levels. The evolution of both kinds of organizations are seen in both military and civilian environments.

The traditional organizational structure is a hierarchical combination of modules based on concepts of basic superior-subordinate relationships. Positions at the same level within a given unit or department are not linked together directly. They are joined by their common attachment to their superior's position. The formal arrangement is essential to the concept of accountability. The human resources model, on the other hand, argues that people are capable of exercising more creative self-direction and self-control than their present jobs allow and that they can contribute up to their capacities. The prim implication is that management must design an organizational structure which, in contrast to the traditional hierarchy, is aimed more at facilitating positive contributions than at controlling deviant performance.

Unfortunately, many modern firms still adhere to a traditional structure. Combining the organizational structures of the various civilian units researched, Figure 5 displays the basic traditional model upon which organizational structure matters were based. Figure 6 depicts the typical military organization within which logistics functions are performed. As with many theoretical approaches to real world situations, data collected for this thesis revealed that organizational design is more a function of reaction to necessity than a well thought-out pre-conceived plan. When organizational changes became necessary, informal relationships and power centers became the key aspects of design. Management innovations, as suggested by many explorers in the field, become increasingly difficult under circumstances where traditionalist type organizational structures existed.

FIGURE 5

TYPICAL CIVILIAN ORGANIZATIONAL STRUCTURE

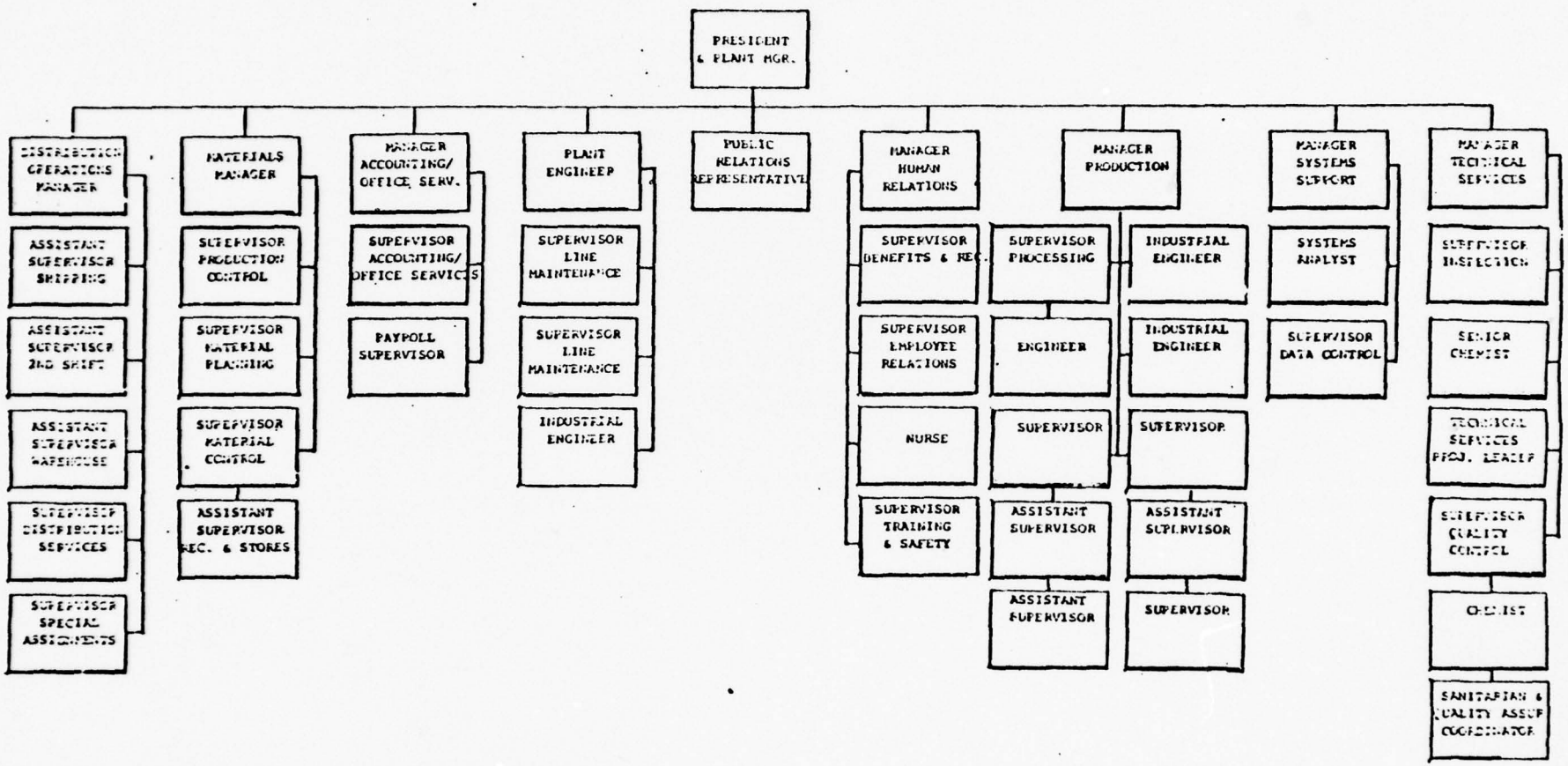
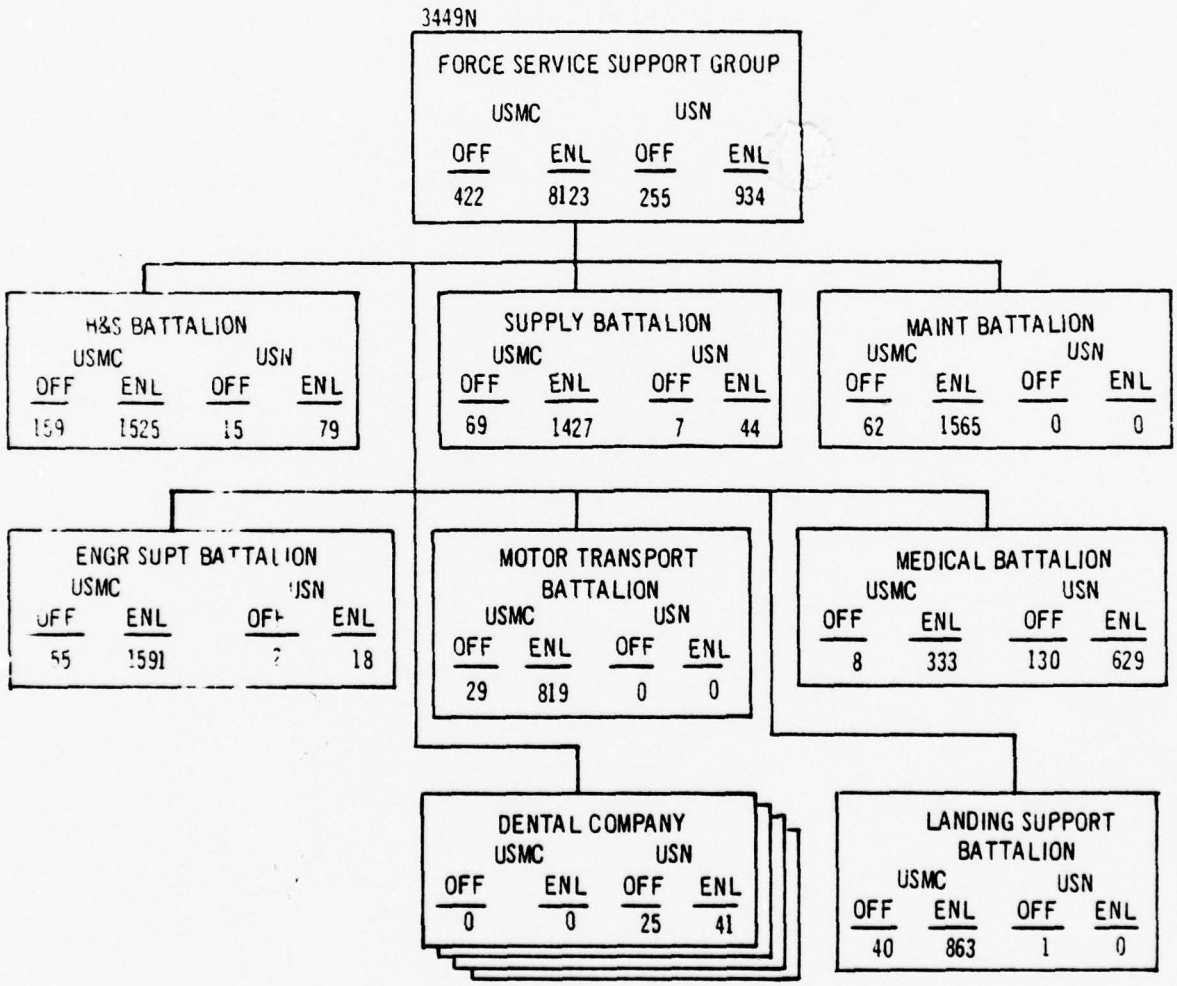


FIGURE 6
TYPICAL MILITARY ORGANIZATIONAL STRUCTURE



III. THE ANALOGUE MODEL

A. THE FINANCIAL ASPECTS

> The White Rabbit put on his spectacles. "Where shall I begin, please your Majesty?" he asked.
> "Begin at the beginning," the King said, very gravely, "and go on till you come to the end; then stop."
>
> Alice's Adventures in Wonderland
> Lewis Carroll

Unlike Alice's White Rabbit who found a ready reply to his question, where to begin an endeavor of the type postulated in this thesis is not so readily available. As pointed out earlier, it might be argued that civilian distribution operations and military logistics units are totally dissimilar because of the fiscal nature of their structure. In actuality it is possible to determine the financial aspects of either type of operation in one of two ways. The profits generated by a manufacturing firm in relation to the contribution made by the distribution department constitute one type of measure. The other lies in the identification, measurement, and control of the various costs* aspects of maintaining operations in either realm. In order to better understand the function played by the all pervasive financial aspects of this analogue, this section seeks to accomplish three

---

*Words that are followed by this symbol * are defined in the glossary on page 85 .

things. First, through an identification of the various cost functions common to both types of operations, a boundary establishing mechanism will be created. Secondly, costs analysis by way of a real-world example will be shown to be an all too often ignored, but important exercise. And, thirdly, inflation will be shown to have significantly altered management control approaches to real world problem solutions.

1. The Economics of Management

Measuring the costs of operating a responsibility center* in terms of expenses, profit-oriented operations as well as service-oriented operations must understand--from a managerial point of view--the various aspects of the concept of costs. Since it is not the intention of this paper to review the field of cost accounting, and since the scope of its content is based on the assumption that the intended audience has a basic understanding of the financial and managerial aspects of accounting, only those concepts necessary for a comprehension of the economics of management applicable to this model will be discussed.

a. Definition of Costs Functions

Following specified accounting procedures, military logistics organizations instead of measuring the cost of operations, as will be specified herein, measure inputs in terms of commitments*, obligations*, and expenditures*. The costs of operating a responsibility center, such as the distributions department, are the expenses of

that responsibility center. The full cost of any such department is the sum of its direct costs plus an equitable share of its indirect costs. The allocation of indirect costs, unlike the relatively simple process of assigning costs directly traceable to a single function*, must be done on a basis not only consistent with the goals* and objectives of the individual department but also a mutually agreeable method throughout the entire company or organization.

For all practical purposes, it can be thought that direct expenses are substantially synonymous with controllable* expenses. This concept of controllability must include all expenses which the manager of a responsibility center can directly or indirectly influence. The distinction between variable* and fixed* cost, on the other hand, are as easily confused or interchanged in meaning as are goals and objectives*. Personnel costs are the most immediate aspect of this problem that come to mind when attempting to gain a control mechanism on this aspect of any operation. Managers should understand that they will pay for some expenses for which they are actually not responsible and over which they have no direct control. Expenses incurred throughout the development of any management control system will contain a mixture of costs functions the significance of which can not be overlooked in analyzing performance or directing change.

When one responsibility center receives goods or services from another, a charge must be allocated, the amount of the charge is called a transfer price. The convolution of management control processes necessary to sort out all the above mentioned aspects of costs when tied into the concept of transfer pricing, often-times created inter-departmental conflict resulting in absorption of overhead costs into the company wide operation which should never have occurred. The primary purposes of a transfer pricing mechanism are to encourage the best use of the resources subject to transfer and to facilitate use of the resources subject to transfer. The transfer price should be the market price, when available. If a market price is not available, the transfer price should be based on the standard direct costs of the center providing the goods or service.

An example of the convoluted nature of this problem encountered during the course of this study involved a typical situation the implications of which are not immediately available to even an astute manager. Custom pricing, by definition, the providing of manufactured goods to the wholesale customer with the price the customer desires marked on the item, created an interesting cost analysis in one firm. Normally printed on the merchandise during the manufacturing process, different prices of goods in the inventoy were hopefully held to a minimum by marketing policy. Even with perfect market forecasting, however, the costs of this program were viewed as having several dimensions.

The cost to the Materials Management Department for planning and ordering custom priced goods in response to marketing demands when added to the costs of separately coding each priced item as if it were a separate product, constituted the majority of the costs. Although extra costs to manufacturing were considered minimal, additional costs due to increased inventory to maintain an optimum quantity of each price in stock were substantial. Set up as a separate cost center, the custom price room--a department tasked with repricing goods either non-priced during manufacturing or priced differently than ordered by a particular customer but being the only price in inventory--constituted a direct labor costs function quite easy to calculate. The specific costs identified within the distributions department were those that were incurred in moving goods from the warehouse or racks to the custom priced room. Cost per custom priced case to the shipping department was 6 to 9 cents per case more than cases having normal processing. Productivity* loss was estimated to be between 6.2% and 7.5% of distribution department labor.

The problem of allocating the burden of the costs of custom pricing (that is, deciding who will pay the cost) is distinguishable from the problem of estimating costs. When a cost analyst says that a program will "cost" so much he is usually asserting only that it requires certain resources--resources that either are identical or can be

exchanged equally in the overall organizational processes. If the management decision-maker wants to incorporate into the concept the real burdens of any program, then (1) there will be no way of identifying the cost of a program short of estimating its impact on the total fiscal program of the organization, and (2) there will be no meaningful way of adding up the real burdens of the program into a single number.

A vivid example of the transfer pricing problem within a military logistics function can be seen in the maintenance of "mount-out" supplies. This contingency type of logistical planning centers around the idea of stand-by costs. These are costs incurred in order to be ready to carry out some possible future mission. It is difficult to separate stand-by costs from normal operating costs. Just as it is difficult in the custom pricing example to determine when and who should pay what portion of those costs incurred to provide better customer service, it is equally difficult to determine when and who will absorb the cost of contingency supplies maintenance. The physical separation of certain scarce supplies may be relatively easy when compared to separation of the necessary input maintenance costs incurred by an already taxed military unit. In the Marine Corps, for example, considerable time, money, and man hours are expended maintaining more than adequate "mount-out" stocks, while common everyday line items continually go NIS (Not-In-Stock).

b. The Input/Output Function

Thus far the discussion of financial aspects has centered upon the input half of the input/output function*. Output information is needed for two purposes: (1) to measure efficiency*, and (2) to measure effectiveness*. A measure of efficiency or effectiveness, couched in output terms, can be expressed in a variety of ways. Most output measures, however, center around the subjective judgment of some person or group of persons. In some cases, attempts are made to derive quantitative data to measure output from sources not dependent on human judgment. Of the several measures of output encountered throughout this research design, the one which seems most appropriate to this analogue is a productivity measure.

Defined as input divided by output, productivity standards encountered throughout this study varied greatly. A measurable output on an individual basis or group basis, productivity within a distribution department is also a measure of departmental performance since it is the end product for the department and the firm. Utilization of departmental productivity standards provided a trenchant measure of efficiency and effectiveness in all firms observed. Introduction of standards applicable to the department and especially to individuals as they relate to adverse reaction by the employees will be discussed in the section on the human resources aspects of this study. As relative to distribution of a standardized product, engineering studies

were utilized to produce productivity standards within one of the organizations studied.

2. Inflation--The Great Equalizer

It might have been argued that the two extremities of this analogue differ significantly in fiscal matters; research has led to the conclusion that inflation*, one of the dominant economic problems in the United States for the past decade, has greatly equalized management approaches to problem solutions within both realms. Only the rarest of all managers would discount the influence inflation has had on directing management concerns as it affects profit margins as well as costs constraints.

Predicting inflation to continue to increase at rates between 7 1/2% to 8 1/2% for the next four years, one industrial concern has gone as far as having each department systematically include this assumption in monthly budgetary plans. A prevasive force in the economic life of every concern, the intensity of inflation is measured through indices designed to reflect changes in the general level of prices. Management control as well as strategic control decision-makers must monitor movements of the major price indices* as a determinant of both government and business strategies [Wallace, p. 5].

A price index designed to measure price changes in an item over time is a ratio of one price to the price of the item in a different period of time. Avoiding several conceptual and statistical issues involved in developing the

more complex price indices, suffice it to say that they are designed to measure the movement of aggregate prices over time. The Consumer Price Index shows values for all items and for the major categories of consumer goods; all commodities such as durables and non-durables including food; separately food at home and away from home; and services. The Wholesale Price Index shows values for all commodities such as, industrial commodities, and farm products and processed foods and feeds. Although it may be easy to visualize the significance for management control decision-makers at all levels of industry to know and monitor these indices, the implications for military management decision-makers is all too often overlooked. Taking a lesson from civilian firms, military logistics planners at every level must be not only allowed, but made to cope with this ever more present problem of effective management control. Realistic assessments of inflation factors significant enough to be useful must be allowed at every level, and insisted upon from the national level.

3. Economic Order Quantity/Economic Lot Size

Before going on to the next section on the actual material movement aspects of this endeavor it is important to introduce two additional financial aspects which should be kept in mind throughout the development of this model. One problem common to both sides of the picture is deciding what quantity of an item to order for the replenishment of

inventory. If the demand for an item in a logistics organization is predictable and reasonably steady throughout a year, it is possible to calculate the optimum amount to order at one time, i.e., the economic order quantity. If the item is part of a manufacturing concern, the same technique can be used to determine the quantity that should be manufactured in one lot, i.e., the economic lot size. Without burdening the paper with the mechanics, suffice it to say that by the use of calculus, it can be demonstrated that the economic order quantity/economic lot size is the quantity at which the annual ordering costs equals the annual inventory carrying costs. This quantity can be found from the following equation [Anthony and Welsh pp. 275-277].

$$Q = \sqrt{\frac{2OR}{C}}$$

where:

Q = economic order quantity (number of units in one order)

O = ordering costs for one order

R = annual requirements in units

C = inventory carrying costs per unit, per year

For a discussion of the various mathematical solutions to this model see [Smith pp. 460-475].

4. Capital Investment Economics

The last concept considered important to the concept of financial aspects of this thesis has to do with the expenditure of funds for capital investment. The payback period* is the number of years it takes an organization to recover its original investments in any project from the projected net returns. Emphasis on the use of the payback method of funding analysis is only feasible when an organization is short of cash and, therefore, must achieve a quick return of its funds so that they may be put to use in meeting other needs (cash shortage implies a high opportunity cost or a high cost of capital). The two greatest deficiencies of the payback method are: (1) It ignores income beyond the payback period, and (2) it ignores the "time value" of money (a dollar today is worth more than a dollar tomorrow). These two deficiencies are overcome by the complementary use of Discounted Cash Flow Rate of Return Analysis. It discounts the negative and positive flows related to project through the life of the project. In other words, very heavy investment negative flows "frontload" followed by several years of very high returns. Prescribed by DoD Instructions, this method of realizing the actual costs of proposed projects is now accepted as the most realistic method by which alternative programs can honestly be evaluated.

B. MATERIAL MOVEMENT ASPECTS

The nucleus around which other parts of this thesis are centered lies in the detailed analysis and the construction

of an Inventory Management System and a Materials Management Department. It must be pointed out that the varied aspects of this section were derived from the analysis of the materials handling operations of three industrial manufacturing organizations. By way of background, each of these firms were in differing stages of perfection in terms of their approach to material handling. One firm had a sophisticated computer based management system, perfected through years of operation, which maintained a perpetual inventory accuracy beyond the 95 percent level. While another, responding to the harsh criticisms of its parent corporation, had barely completed the initial stages of implementation of material control functions designed to improve its sagging 60 percent inventory accuracy. Although no directly identifiable reference will be made to any one firm, the details and approaches to problem solutions contained herein, are real-world strategies and actual working models.

1. Inventory Classifications

As of any moment in time, the current assets of a manufacturing company include three types of inventories: raw materials, goods in process, and finished goods [Anthony & Welsh p. 151]. Raw materials inventory is made up of materials that will be used subsequently in the manufacturing process and will be classified as either direct material* or as indirect material*. Goods in process inventory, which includes direct material, direct labor* and manufacturing

overhead, is made up of those items on which production has been started but not yet completed. Finished goods inventory includes all products that have been manufactured but not yet sold. Finished goods inventory is comparable to the merchandise inventory in a military logistics operation. (A merchandising system of distribution will have no raw materials or goods in process inventory.)

In order to complete the mental contract proposed within this analogue, it will be necessary to further break down the identification of the various aspects of inventories. The most similar inventory classification found within a military logistics organization to that discovered during this study was in the area of what can be called resupply inventories. In many seasonal type manufacturing or production industries,. distribution systems must be designed not only to respond to demand for output, but also for critical sources of input items. This situation is not at all unlike the circumstances a military organization might find iteself in during the early stages of war or hostilities. Although management control systems may be carefully designed to handle all normal input/output functional contigencies during a time of peace, it is not difficult to imagine the implications for control problems when suddenly items previously unexpendable become rapidly depleted. Industrially developed inventory control systems designed to handle seasonal type production operations, shed significant light on the analogue model being created.

Another similarity that can not be avoided is in the area of reserves held whether they are needed or not--sometimes called by military units as deprivation levels. Inventory levels below which it is felt intolerable to operate regardless of the costs represent a major area of concern for materials managers and find vivid expression within both organizational types. These similarities are introduced here as a definitional medium through which the following detailed description of a working inventory management system can evolve. This management control system is a conglomerate of at least two functional systems and will act as the heart of this analogue model.

2. Inventory Management Systems (IMS)

a. Problem Statement

From personal experience, some military logistics units have no overall formal inventory control system as intricately established as those encountered in civilian industry. Rather, the task of inventory control is handled by segments of formal systems and numerous informal systems which have been patched together throughout the years of numerous tour rotations and new management techniques. This results in a management by crisis mode, with planning in each department restricted by a lack of appropriate, accurate, and timely information. This results in suboptimization of inventory levels, merchandizing costs and customer service. The inventory management system posited by this thesis is designed to address the following specific problem areas:

1. Inaccurate and untimely inventory records.

2. Insufficient ability to relate inventory quality with customer demand.

3. Inability to economically locate all product that is in fact on hand.

4. Inability to monitor adherence to plan and to provide performance measures on all inventory management activities.

5. Inability to routinely ship standard products to customer within a few days lead time.

6. Inability to effectively plan for expected customer demand.

7. Difficulty in reacting to changing customer demands.

8. Inability to always reserve inventory for customer shipment in inventory records.

9. Inability to provide consistent, accurate detailed management information reports on inventories.

10. Inability to maintain the status of active customer orders.

11. Inability to make timely purchasing decisions based on year-to-date distribution information.

12. Inability to accurately and timely place value upon the inventory.

13. Inability to determine packaging material requirements on a timely basis.

Admittedly all these problem areas do not exist in every distribution/logistics activity. Enough of them do, however, to warrant this analysis of some civilian approaches to solving these types of problems.

b. Objectives

The overall objective of Inventory Management Systems is to provide a computer-based, integrated, formal inventory control system that allows for the optimizing of inventory, maximizing of customer service, and the minimizing of merchandising costs. Specific objectives are:

1. To provide for accurate and timely updating of inventory records through the use of storekeepers, cycle counting*, exception reports and performance measures.

2. To provide for planning, replanning, scheduling and rescheduling of purchasing to meet customer demand.

3. To provide inventory information by quality characteristics through the classification of product to match customer specifications.

4. To provide effective storage and retrieval of merchandise.

5. To provide the basis for predicting future customer demand.

6. To provide reusage information and input to future cost accounting systems.

7. To provide the ability to monitor productivity versus plan and standard.

8. To provide the ability to allocate inventories to specific pack schedules or customer orders.

9. To provide timely management information.

10. To provide merchandise traceability from material receipt through processing to shipment to customer.

11. To provide the ability to accurately and timely value on-hand inventory.

c. Scope

The scope of the inventory management system includes the forecasting, planning, monitoring, classification, storage, retrieval, and customer order processing of all in-process and packaging materials. The system begins, with the receipt of raw materials in the case of manufacturing firms or merchandise in the case of merchandising and military logistics organizations, and includes physical inventory areas. The system is designed to be separated into two phases. The first phase, being the control phase, consist of material control, material location, reporting and monitoring of various processes, and data management. This phase creates the accurate records and provides the timely information to provide theenvironment where planning and controlling activities can take place. The second phase consisting of maser scheduling, material planning, forecasting and order processing, provides the tools to management to determine the proper level of inventory, efficient operations, and desired customer service levels.

d. Phase I--Control

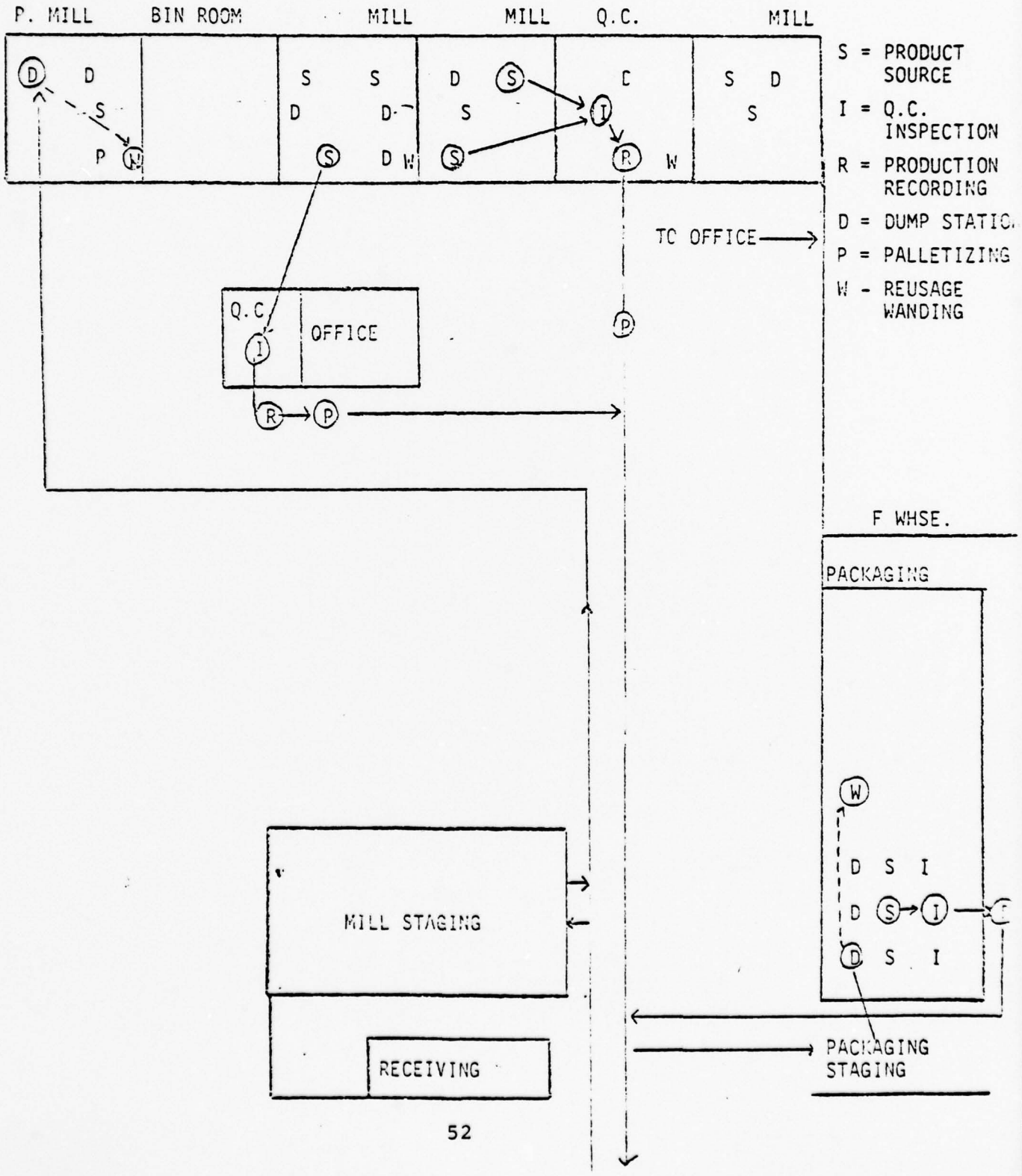
(1) System Flow

As merchandise is received, a unique source sequence number* is applied to it (see Figure 7--System Flow Diagram). This number refers to a specific source, and is related to a specific pack schedule or receiving report. The source sequence label is both man and machine (bar code)* readable. Merchandise requiring Quality Control (Q.C.)* passes through Inspection Q.C. where appropriate sampling and testing are conducted and the source sequence number is recorded. The product then moves to a recording station where the source sequence label is read through the use of a lightpen* (wand)*. A unit of measure is created within the computer versus the pack schedule in effect at that time.

After palletizing, the product is moved to the warehouse location where it is received by a storekeeper. The storekeeper wands the source sequence label. This relieves accountability for the product from the Production Department and places it under the Material Control Department. The product is then placed in a specific row in the hold area based on the time required to complete Q.C. tests. The purpose of the hold area is to allow the completion of all testing and classification of the product prior to its labeling and movement to final storage.

Quality Control, utilizing Inspection Services and Lab Services test results, classifies the merchandise

FIGURE 7
SYSTEM FLOW DIAGRAM



and determines its product code. Classification ranges are established to provide the necessary determination of quality level of merchandise for customer demand. The product code lot numbers are then established in the computer versus the specific source sequence numbers. After completion of the classification activity, the merchandise is moved from the hold area row to a conveyor leaving the hold area. At that time, a storekeeper again wands the source sequence number. The computer, knowing the classification of the product versus that source sequence number, generates a printed label which identifies the product as to product name and code, lot number, source sequence number and units of issue. The computer also identifies a location assignment for that pallet based on a daily warehouse plan created by the Material Control Department.

The product is moved to its final storage location and the lift truck driver marks the check digit* painted at the row location on the pallet ticket which he returns to the storeheeper. This check digit is compared by the storekeeper to the check digit assigned to that row to ensure storage was accomplished at the proper location.

Merchandise for shipment, repack, or rework, is initially reserved by the use of a shipping order or a pack schedule. At the appropriate time prior to utilization of this product as input or for shipment, a picking list is generated. This picking list will cover all the requirements

to be picked for the next work period. In order to provide efficiency, it is generated by product code and references the pack schedule or shipping order that specific merchandise is pulled against. The computer-generated picking list, with specific locations, is provided to the Material Control lift truck operators who pick the orders. The orders, as they are picked, have a destination sticker applied and are moved from the warehouse storeroom through storekeepers to the appropriate shipping or material staging areas. As the product passes the storekeepers it has the source sequence number read and recorded against a specific pack schedule or shipping order number. A check is made by the computer to see if it is the correct code and quantity per the order. The product is then processed for shipping and loaded on the truck or placed in the appropriate storage location. As the product is stored or loaded onto a truck, the source sequence labels are removed, read (wanded) and recorded against pack schedule and storage station of shipping order. This then provides the necessary traceability data and a comparison of input versus output for physical loading versus shipping order for shipments. For shipping orders, the Bill of Lading is automatically generated, matching that which was actually loaded on the truck.

(2) Major Features of the System

1. All inventory transactions previously described are on-line to a computer and immediately update

inventory records and indicate errors for immediate correction, if appropriate. Performance measures or exception reports are provided for all major activities to ensure that the system and its users are performing at the desired level.

2. Cycle counting* is utilized within the storekeeper area to ensure that the management specified inventory record accuracy is maintained by location. Products are cycle counted by product code using the source sequence number, or product code lot number, or total units in a row. The frequency of cycle counting for a specific product code is determined by the activity within that product code. It is likely that different inventory level goals will be established for different product codes depending on their impact on customer shipments and operations.

3. Pack schedules are run based on dispatch lists which prioritize pack schedules by system and their scheduled start time. These pack schedules are generated by the planning subsystems.

4. The system provides for immediate inventory information primarily through the use of computer attached Cathode Ray Tube* (CRT's) located at critical locations.

5. Processing control, through the use of CRT, can determine available inventory at the lot level to include specific characteristics of that merchandise in each lot.

6. Customer needs are categorized into distinct classifications which allow for shipment and packaging of virtually all input by the product code and not at the lot level.

7. Traceability from input to output is accomplished by manual as well as computerized activities.

8. Each location where merchandise is stored, received or relocated is identified by a unique three digit number.

9. The use of cycle counting should replace the need for semi-annual physical inventories when the accuracy level is considered satisfactory by the Controller and outside auditors*.

e. Phase II--Operations

(1) Forecasting

The Forecasting subsystem is accomplished on an annual basis. It consists of forecasting at the product code level (to include package), and customer level for the following year. On a monthly basis, corrections to the forecast are made. These will be the result of information from usage data and analysis of current material requirements. In addition to the yearly by product code forecast, a forecast by total logistical needs will be provided to correspond to a five year plan on an annual basis. For military logistics units the specific forecasting models that will be utilized to generate a mechanical forecast will be determined at the national level.

(2) Order Processing

The Order Processing Subsystem is designed to be an on-line order entry system which will enable rapid inquiry as to material availability for customer orders and reservation of the item when available. Planned delays in meeting the customer specified ship date will be identified quickly and resolved with the customer by communications channels. The system provides automatic customer confirmation, shipping order preparation, invoicing and Bills of Lading. Additions and corrections, as appropriate, can be made. Order status reports are provided to allow for detection of problem orders.

(3) Master Scheduling

The Master Schedule Subsystem is the center of the planning activity. It combines the demand from the forecasting system with the inventory levels, capacity constraints and management desires to provide the merchandising plan for the purchasing function. Master scheduling is done at the finished goods level in manufacturing organizations. In certain cases, quality groupings or specific product codes are used. These expected outputs will then be compared against forecast demands to determine if additional actions must be taken. Lead time for testing, and purchasing of appropriate items must be considered. Capacity constraints of storage facilities and Q.C. test facilities will also be considered. In the case of packaging operations, certain products will likely be maintained at a level requiring

final assembly to meet specific customer needs, to allow for rapid processing to final product code.

(4) Material Planning

The Material Planning activity for the packing operation will largely be a standard Material Requirements Planning (MRP)* application which employs the time phased order point technique. Packaging material requirements are not based on minimum/maximum basis but are calculated to meet master schedule requirements. The material planning activities will generate purchase orders for packaging material in quantity size determined by planning activities. From a list of desired inputs, the material planning scheduler, knowing the current inventory level and usage rate, will determine the purchasing quantity requirements. For most specific product codes a recommended sample Bill of Lading will be provided to aid the scheduler in this task.

3. The Materials Management Department

The Materials Management Department has overall responsibility for coordination and implementation of the entire inventory management control system. Some of the extremely unique features of the operations of this department require the talents of a skilled manager well-versed in managerial techniques that run the gamut across the entire spectrum of management expertise. In the first place, the very goals and objectives of the department within

any organization creates a need for a delicate balance between goals in natural conflict. The Materials Management Department Director must remain loyal to customer service, the maintenance of minimum inventory, and plant efficiency on a continuous basis. The potential for almost every manager to emphasize one of these goals over the others is enormous.

For instance, one industrial firm studies had established a customer service goal of 97% order fill from inventory with only one or two days delivery time. An expensive goal in itself, this objective placed the materials management department in a position of constantly having to violate their goal of economically minimal inventory levels. A nationwide organization, the real frustration of this particular aspect of operations was that this goal held two entirely different meanings for the east and west coast arms of the industry. Having originated as separate companies and then later incorporating into one national organization, the west coast unit found it harder to satisfy customers because of the history of customer service as created by the corporation. The west coast customer no longer demanded 97% satisfaction, but simply expected it, because things had always been done that way. Although the same goal was established for the entire organization, a 97% customer service target on the west coast was an entirely different 97% customer service target than that on the east coast.

In terms of minimal inventory and plant efficiency an entirely different balancing act must be performed by the astute materials manager. Having had no prototype industry to follow, one of the firms studied built a perpetual inventory* management system capable of an Mean Absolute Deviation (MAD)* from net inventory error of less than two percent on an annual basis. Without discussing the volume being handled, suffice it to say that by anyone's standards this accomplishment was quite impressive. However, the parent organization, unable to achieve the same success on the opposite coast--where the operation had grown out of entirely different roots--complained that such inventory management was too accurate. It was felt that such accuracy in inventory management meant the firm was spending too much time handling accuracy which was not necessary for good materials management. Intuitively, such accuracy was not cost effective.

Before concluding this section of the thesis, it is important to mention two organizations discovered during the course of the research that have contributed significantly to the development of the field of materials management. The American Production and Inventory Control Society offers course work through tenant educational institutions leading to certification as an inventory manager. One department head encountered had begun to require all department personnel to attend at least some of this course work and, as a result, anticipated significant improvement in capabilities. The

School of Industrial and System Engineering at the Georgia Institute of Technology has also explored the realm of materials management and conducts seminar-type studies for truely aggressive managers. Continual education seemed to be the keynote to successful accomplishment in areas of managerial advancement throughout all industrial firms studied.

C. HUMAN RESOURCES ASPECTS

> "I believe that the only game in town is the personnel game. If you have the right person in the right place, you don't have to do anything else. If you have the wrong person in the job, there's no management system known to man that can save you..."
>
> Walter Wriston, Chairman of the Board and Chief Executive Officer of Citicorp, the holding company for First National City Bank, the second largest bank in the world, in an interview reported in The Harbus News (April 4, 1974).

Human Resources Management (HRM), perhaps the most talked about and controversial management "innovation" of the past decade, has long been an area of underemphasized importance. Tracing the historical development and cultural causes of the incorporation of human resources management into almost every modern theory of effective managerial control, is not the intention of this report. Nor is it considered necessary to review the academic or professional achievements in this vital link between theory and practice. Rather (reviewing for a moment the comments contained in the introduction), it

is the intention of this section to cement the bond between other aspects of the analogue by way of a description of the management of human resources encountered during this research. Under the theoretical umbrella introduced earlier (i.e., the three theories of management: (1) traditional, (2) human relations, and (3) human resources), various real-world management techniques encountered will provide examples, both effective and ineffective, of how anyone, military or civilian, might approach this managerial area. It is intended that one might understand available and possibly alternative methods of reacting within this area of concern.

1. Theoretical Approaches

Understanding and effectively utilizing the human element by either side of this analogue presents some interesting applications of theory as it expresses itself into fact. For instance, one firm encountered, expressed their concern in this area through publication of an annual executive summary with explicit personnel directions. For this organization, it was felt that policies and procedures have had synonymous meaning for the entire function, whereby applicable policies have or are being incorporated into procedures. The organization further claimed to recognize and commit to the basic principles of Multiple Management*. Each department was directed to carry out its roles to ensure that people are motivated by challenging work, that

they are part of the decision-making process, and receive proper recognition for their accomplishments.

Running the gamut of management all the way from patriarchal despotism to multiple decision-making at the lowest level, the manner in which prescribed policies and procedures ultimately evolved created tremendous examples of personnel management useful for every civilian distributions manager or military logistician. Referring briefly to the organizational Figure 5, contained in the second section, one can see the importance placed on the need for management of human resources by top-management. A separate department, placed near the top of the formal structure and granted recognition as a viable function to proper operation, the Human Resources Management Department in every organization observed, played a continually increasing role in shaping the formal atmosphere of the function. Translation of the formally intended utilization of personnel by the vast interwoven networks of informal control structures, provided a necessary comparison which truly led to dissolution of the myth of management differences between the public and private sectors of this analogue.

Although not necessarily falling into neatly categorized theoretical patterns paralleling those mentioned earlier, expressions of all management efforts concerning personnel could be grouped into those three avenues. For instance, one department director, having grown into his position by way of a career which closely paralleled the

development of the company as a whole, approached all personnel matters in the traditionalist mode. Unable to shed the attitude that explicit rules and regulations defining the responsibility of each department member was all that was required to function effectively, this manager had essentially delegated the responsibility for management control to his two or three immediate subordinates. Relegating himself to a position which allowed his day to be filled with management meetings, material conferences, and other non-personnel matters, this manager saw little need to become involved in human resources planning beyond the quantitative arena.

Within this same distributions department another manager saw his role somewhat in a different light. Being a member of the management team who had "come up from the ranks," this line manager practiced a theory of management closely reflecting the elements of the human relations model. Astutely recognizing the need to deal with people and their needs to be recognized as individuals, this manager's technique placed him in a precarious position of having to balance the demands of top management with an effective working relationship throughout the department. Discipline and the need for counselling of subordinates, culling of weak links, and reorganization of human resources into more productive patterns, gave way to the more pressing concerns of day to day crisis management.

Before going into subordinant responses observed and the intended relationship of this descriptive narration to the analogue being developed, another interesting management response noticed within a separate but related department deserves comment. Drawing widely from the former military community, this industrial organization had placed into top management positions personnel who had, effectively, "retired on active duty." Although presented with attractive advancement potential, one particular manager complained of too much room at the top. Since he was certainly doing an adequate job at his present position and since he felt little desire for increased responsibility, this manager wanted no part of offers of steps up the traditional success ladder. Little or no obvious reflection of this attitude was observable from subordinates within this department. However, dealing with this personnel aspect from above presents some interesting mental cognitions for military and civilian managers alike.

2. Subordinate Responses

Subordinate responses within the organization containing many of the above type management techniques were surprisingly, almost universally homogeneous. Recognized as a major threat to operational success, this firm listed as a prominent concern the loss of more than one key person in a short time frame in the same department. Dependent upon the continued family image type support of its labor force, even the very top management positions recognized

their vulnerability to key personnel loss. On the individual picker level within the deistributions department, for instance, no worker encountered had been with the company less than a decade. Although many had evolved to the distributions department by way of other functions, every person expressed a feeling of belonging on the team and a member of the family. Obtainable only on a short time basis within most military organizations, this feeling of homogeneity is not at all a stranger.

Cautiously it must be added that not all avenues of product distribution and materials management were evenly tempered and constantly rosy for firms within the realm of personnel administration. Closely paralleling the development of trade unionism within the country as a whole, many industrial firms found themselves in an era of tense personnel negotiations with labor unions on virtually every issue involving employees. Facing most of the financial considerations discussed earlier, every organization found it necessary to cut costs, increase prices, and enact whatever techniques seemed to fit in order to counter the threat of labor and overhead costs increasing at a greater rate than unit growth. One of the most widely held objectives of increasing contribution margins within any given department is to increase productivity. Intimately interwoven with the input/output function, any attempt to enhace productivity ratios in view of relatively fixed and steady inputs, is to increase output per laborer.

3. Productivity Standards

Employing a traditionalist theory, it would appear only necessary to establish a system of standards designed to assure uniform productivity increases and require adherence to the standard throughout. Unionism, management commitment to human resources techniques, and development of a labor force not prepared to adhere to traditionalist techniques, seemed to make this approach untenable in all but a few situations involving materials management/logistics. Fear of approaching the subject of productivity standards with the union caused one organization to continue in an unenhanced productivity mode when it was actually unnecessary. Conferences with labor force members and union representatives led to conclusions that reluctance to discuss the necessity of better productivity ratios were being reserved unnecessarily by management. In fact, the recommendation felt by most management consultants to have the most credence in this area, was to have the union or other labor force organizations set the standards themselves and assist in the enforcement and regulation of the same.

Following closely the techniques of Management By Objectives (MBO)*, an attempt should be made to write objectives in quantitative terms, although some felt that objectives or targets could be stated in qualitative terms. Further, the broader implications of the MBO process includes a focus on overall organizational goals to which the objectives of the different units, managers, and employees

relate [French, p. 321]. In some organizations, the process focuses mainly on the managerial, supervisory, and professional levels: In some instances, the process is extended to all employees. In all cases, where substantial organizational success had been achieved by way of an application of MBO, it had been accomplished through a permeation of the process down to and including employees at virtually every level within the structure.

4. Employee Rebellion

Encountering personnel problems of quite a different nature, another industrial firm studied had come head on into an active employee rebellion. Perhaps, not as likely to occur within a military logistics organization, this situation affected greatly the scheduled implementation of systems designed to revolutionize the distribution function of this particular organization. Faced with staggering inefficiency which had led to a number of consecutive years of losses, this organization had implemented a 3.5 million dollar computer-based information management system similar to the one described in the preceding chapter. Top management was totally unprepared to cope with the negative reaction of various echelons of management throughout the organization.

On the middle management level, several of this firm's potential top managers elected to resign rather than face the prospect of centralized computer systems management.

Others who had decided not to resign found themselves with jobs twice the size in terms of hours to accomplish them and little recognition of efforts which would essentially be credited to computer efficieny. On the laborer level, many supervisory level personnel found long established informal control networks threatened and in many cases totally subverted. In this regard, physical efforts at sabotage, designed to make computer operations infeasible, were primitive and easily detected. As implementation phases continued, however, the power of automated efforts at sabotaging the system took on sophisticated patterns so complex that, in some cases, over a year passed before their discovery. The mistakes made in this case will be further discussed in the following section on how an automated data processing system can successfully be implemented.

5. Organizing for Change

Introduction of the above example is done in order to illustrate the existence of attempts throughout these organizations designed at every personnel level to advance personal goals over organizational ones. Few employees encountered during the course of this research study intentionally initiated actions designed to purposely subvert the organizations involved. However, the simple exclusions of key supervisory personnel or key employees at the lowest level in either the decision-making processes or at least in the forming of goals and objectives for new activities was

indeed costly. Successful implementation of new projects requires both the backing of top management and acceptance by those who must implement it.

In the role of an advocate of change the middle manager must create a climate conducive to carrying out innovation. Once the objective of any new project is clear, the implementation plan must be effectively communicated to those who must be convinced of its worth. Since there appears to be a natural resistance to change, the astute manager must utilize solid management skills in motivation and leadership, and it is in this aspect of the job that rapport developed with both top management and the other department heads is absolutely essential. Implementing change for change's sake should be avoided at all cost. Others recognize that for what it is, and there will develop resistance which will make implementation of future projects even more difficult. Any military unit which has survived through years of numerous tour rotations and countless new management techniques, can easily identify with the syndrome of change for change's sake.

6. Top Level Management Self-Image

The vital area of human resources management can not be concluded without at least a few words about the management of top level personnel. In terms of this analogue, the president of the industrial firm and the commanding officer of the organization containing the hypothetical military logistical unit being postulated, must be understood and

manipulated just as effectively as any other personnel within the organizations. The myriad of available literature on "how to handle the boss" clearly indicates the need to understand and include this avenue of human resources planning in every management effort. Experience during the conduct of this research design distinctly accentuated the problems that can be encountered when the management of top level personnel is mishandled.

One of the industrial firms studied had grown from a five million dollar a year entrepreneurial type organization to a thirty-five million dollar a year operation in the course of a very short period. Geared up for continued growth, the original businessmen from whose imaginations the company had flourished were totally unprepared for either the leveling off of the enterprise or the massive new management requirements of a business seven times its original size. Faced with the realization that increased sales could no longer be expected to absorb increase cost and unable to see the stignation of small-company-minded middle managers, radical changes had to be implanted into the thinking of top president and vice presidents. This of course had to be done delicately and through the thorough understanding that these necessary changes originated at the top. When last observed this particular company was still groping with the growing pains which accompany this aspect of the management control system.

Not at all unlike the situation in which a military logitical middle manager might find himself during the rapidly expanding horizons of a military conflict, the above example implies an extensive knowledge of human behavior and management skills. Just as this entire section has brought to mind many similarities between the private and public sectors, especially military components of the public sector, the handling of too management brings a resemblence of significant note to those frustrated middle manager's who have heard, "just carry out the order." Although it may not have provided absolute answers to human resources management problems, this section has at least expressed, though both effective and ineffective real-world examples, the vital need for incorporation of personnel planning, programming, and budgeting at every level of management control.

D. AUTOMATED DATA PROCESSING (ADP) ASPECTS

The implementation of the Inventory Management System (IMS) described in the materials movement section was designed to be separated into two phases, the control phase and the planning phase. The control phase included the subsystems of Data Management, Locator, Material Control and Production Reporting and Monitoring. The planning phase includes master scheduling, material planning, forecasting, and order processing. As mentioned earlier, development of the entire inventory management system was based upon three real-world

models, i.e., studies of three industrial distribution systems. The structure of this section centers around the superimposing of a Management Information System (MIS)* on top of the conceptual design based on the phased development and implementation of a typical plan of action. This section discusses the main stages of EDP* growth as encountered in constructing this analogue model.

1. Four Stages of Growth

The S-curve that typically describes the kinds of growth experienced by those firms researched, can be divded into four stages of EDP growth: initiation, expansion, formalization, and maturity [Gibson and Nolan pp. 76-88]. Drawn from academic endeavors and placed on top of the actual systems encountered, the following discussion is provided to briefly describe and introduce the permentation of automated data processing throughout efficiently managed operations. Hopefully, it will provide a framework for understanding the necessary management control mechanisms needed to insure completion of this management control analogue.

a. Initiation

Initiation of a computer-based system into an organization where manually based systems have been used for some time brings with it many problems which most military logistics units have already eliminated. Judging from the organizations studied, however, the present trend appears to be toward establishing a wholly independent department

for the data systems management personnel. Attractive to top management at first, this type of structure still must overcome resistance by the employees and the tendency by the ADP section to build up power and influence internally. Job-displacement anxieties, concern over doing old jobs in new ways, and fear of loss of personal identity with their work are just a few of the human responses, similar to those mentioned in the previous section, which appear during this stage. The key to successful initiation of the data system is communications throughout the organization, regardless of its size, of the management intentions for the computer. Successful transition through the succeeding stages should help overcome much of this anxiety.

b. Expansion

For the military logistician who walks into an organization ready to manage effectively stage 2 is probably where he will find the organization. Regardless of the length of time the organization might have had a computer capability, most organizations are still finding new and "innovative" techniques to enhance operation. The main difficulty to successful management in this stage is acquiring or developing middle managers for EDP who recognize the need for priorities and criteria in project selection. Balancing the need for dedicated specialist professionals within the EDP realm with an emphasis on organizational values, is the most serious aspect of this stage. Expansion must be well controlled, characterized by highly successful short-run

objectives which enhance the value of automation within the entire organization, and managed by personnel set upon long-ranged innovative techniques for future utilization.

c. Formalization

Careful and deliberate control mechanisms during stage 2 will help to insure that the formalization stage, in the development of a totally automated management system, will not be forced upon a reluctant top management unaware of the possibility of run-away expenses. Maintaining control by a well-informed top management of this resource without stifling innovative applications work must be done during formalization of ADP processes if it has not been anticipated previously. Minimizing the strains of the formalization stage can be accomplished if organizations, both military and civilian alike, employ certain techniques at the outset of stage 2. These techniques include centralizing certain components of the ADP resource, installing a steering committee or some equivalent, and spreading enough of the systems analysts through the company to ensure that user's needs are met adequately. One organization studied realized the need for a steering committee in early implementation phases of ADP development so that this important aspect of the process was functioning even before the hardware was obtained. As well as systems analysts, this committee must be composed of top management and department directors throughout the organization.

d. Maturity

The final stage of ADP maturity takes an organization into a complex situation involving the need to balance the organizatinal structure created and keeping that entity up to date in its technical environment. There are two keys to success in this stage of development. The first centers around keeping the top management at the very highest level in close touch with the uses and needs of this resource. Communications is the vital link which must be cultivated on a continuous basis. Communications downward as well as upward is also absolutely essential to insuring complete maturation of the ADP resource. Strengthening the avenues of communications between the users and computer personnel, is the second essential key to success in this stage. One of the firms providing data for this thesis, after a tremendously successful evolution through stages 1 through 3, lost their independent computer capability because of a failure to negotiate successfully into the maturity stage. Innovation had leveled, communications had stagnated, and centralization had left this firm with very limited local resources. Absorption of this organization by a larger functioning conglomerate and relegation to a role of tenant status seems only a matter of years away. The centralization of logistics organizations within the military to support each coast and related overseas bases, is not at all uncommon and should be anticipated during growth stages.

2. The User Element

Avoiding negative change and employee resistance to the implementation of automated data processing may be the easiest of all the problems of this aspect of civilian distributions/military logistics organizations. Although many of the staged developmental aspects of ADP may be out of the hands of department heads and unit OIC's, the importance of knowing where to turn and what questions to ask can never be over-emphasized. The astute manager who questions seemingly non-progressive programs and remains innovative in his approach to keeping distribution functions modern, will always be the essential link to firmly establishing this element of this analogue model within either realm of this analogue.

E. EVALUATION ASPECTS

Collection, evaluation, and analyses of data obtained from human subjects was perhaps the most often misapplied area encountered throughout the development of this thesis. Problem solving and extraction of meaningful results from actual human factors data was continually under-emphasized and ineffectively utilized. One distribution department encountered, maintained extensive quantitative data on virtually every facet of human behavior, with absolutely no idea as to either what the data was revealing or what decision-making inferences could be drawn. In any information gathering attempt the compiler is attempting to draw

certain inferences or make a decision about some hypothesis or "hunch" that he has concerning the situation being studied. The life of managers at every level consists of a series of decision-making situations. Statistics, a tool of evaluation, may be defined as a tool for decision-making in the light of uncertainty [Hicks, Ch 1]. The "buy or make" decision in a civilian production process and the "refurbish an old piece or buy a new piece of vital mechanical device" within a military unit are vivid examples of an appropriate situation where statistics can be a significant factor.

1. Experimental Design

If decision-making is based on the use of statistical tools is to be useful, the way in which the data are collected becomes extremely important. An experimenter, so anxious to collect data and stuff the results into a computer and make his decision, all too often neglects the important phase of the design of the experiment. Defined very simply as the order in which an experiment is run, experimental designs are used to help reduce the statistical error in the data collected. The experiment includes a statement of the problem to be solved, choice of response or dependent variable, selection of factors to be varied, choice of levels of these factors (quantitative or qualitative; fixed or random), and how factor levels are to be combined. The design phase of a project involves the number of observations to be taken, order of experimentation, method of

randomization to be used, and the appropriate mathematical model to describe the experiment. The final step, analysis, includes the procedure for data collection and processing, the computation of certain test statistics to be used in making decisions about various aspects of an experiment, and interpretation of results for the experimenter.

2. Non-Parametric Techniques

The nonparametric techniques of hypothesis testing are uniquely suited to the data of the behavioral sciences or human factors analysis. Non-parametric techniques are ideally suited for use with data that are not exact in any numerical sense. Middle managers, who need to spend more time and reflection in the careful formulation of their problems and in collecting precise and relevant data, will turn more attention to these pursuits if they are relieved of the necessity of computing statistics which are dependent upon the assumptions of normal distributions and independent samples. Useful with small, often skewed samples with or without interval scale measurement, the computational simplicity of nonparametric statistical tests provides this advantage. (See Siegel for the most useful accumulation of nonparametric tests available.)

3. Computational Procedures

Since most managers have neither the resources nor the inclination to spend the necessary time to concentrate on theoretical discussions and mathematical proofs of the various concepts involved in computational statistics, a

review of statistical concepts and tests as they are applied should be the aim of the progressive manager. The extensive use of examples and the step-by-step presentation of the computational procedures used to provide models to be followed in computing analyses, such as that provided by Bruning and Kintz, are of enormous help to a busy manager. Aimed at a user oriented solution to the basic formulas and assumptions of statistical inferences, Bruning and Kintz's handbook should assist in fulfilling this need within the management control analogue created herein.

IV. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

A recent newspaper article (Los Angeles Times Service article by Robert A. Rosenblatt, reprinted in The Monterey Peninsula Herald Sunday, December 24, 1978) expressed a widely held view that governmental services are full of "culturally deprived" people who only want to write rules and have forgotten what government is about. Claiming that managers in private industry can be induced to support each other because they may switch jobs, Rosenblatt quotes from manufacturing giants turned government manager, turned civilian again, that private industry is more understanding of other person's problems. If the accusation that all government managers want to do is write more rules can be countered, then bridging the gap between government and business, as expressed in this model, may be one approach.

Throughout development of this analogue model the discussion of common themes and problems of civilian distribution and military logistics organizations has been aimed at one goal: building a predictive model created from an observed similarity between civilian finished goods distribution and military logistics systems. The most vital resources, workable management control systems, can be seen as a continuing, functional element present in both civilian and military operations. The model, displaying how a

manager can go into an organization with an eye at how better to accomplish his managerial tasks, has been framed within boundaries practical for civilian and military units alike.

Recognizing that there are differences between the logistics requirements of military units and the industrial organizations studied as a part of this thesis effort, there are, nonetheless, enough similarities in logistical management principles applicable to each to make transferability between them a realistic possibility. It is possible that military logistics organizations might be well advised to study the innovative applications of automated data processing systems as they have been applied by civilian distribution functions toward an effective system flow from wall to wall*. Within the same area, civilian firms might profit immensely from avoidance of the problems surrounding the introduction and expansion of information processing that have already been encountered, and to a significant degree overcome, by many military units.

Though it can never be claimed that either has solved the inherent problems presented by current economic pressures, military units could operate more efficiently in the short-run by the application of many of the profit and loss mechanisms at work in civilian organizations. A closer attention by civilian units to the cost controlling aspects of day-to-day operations, as observed in military service organizations, could enhance operations for the civilian realm as well.

Inventory Management Systems may succumb to the mechanisms of change, but the ever increasing need to continually better handle inherent problems in moving material deserve continual study. Future research toward an even more ecnomical application of men, money, and material resources should be undertaken by any serious student of distribution/logistics. A better way to insure customer service whether the customer represents increased profit or a better supplied, more efficient military unit can be found if the proper techniques for study are applied.

Observation of the actual daily organizational arrangements--both formal and informal--at work in every operation of every size is the place to start. Looking at how the human resources of the organization are functioning can never be over-emphasized. Observation has substantiated that the human element is the key to organizational success, and neither the military, with its advance HRM programs, nor civilian industry with its need to cope with unionism, have done much more than simply scratched the surface in this regard.

Finding the time for healthy contemplation and exercise of some of the concepts of this descriptive thesis can assist significantly in riding the cultural deprivation of all too many military logisticians. As long as the operational effectiveness of military organizations remains a key element in the evaluative process, and the criteria by which success is to be measured, better, more efficiently managed supply

trails will continue to be a vital link on the road to success. Conflict after conflict has re-emphasized the need for well run economically managed logistics support as a necessary element of battlefield victory. Operational effectiveness may be more than merely "beans, bullets, and bandaids" but having the right item at the right place, at the right time, and in the right quantity shall always be a function of many of the principles presented in this model.

V. GLOSSARY

-A-

ABC CLASSIFICATION - Classification of the items in an inventory in decreasing order of annual dollar volume and/or turnover. This array is then split into three classes called A, B, and C. Class A contains the items with the highest annual dollar volume and receives the most attention. The medium Class B receives less attention, and Class C, which contains the low-dollar volume items, is controlled routinely. The ABC principle states that effort saved through relaxed controls on low-value items will be applied to reduce inventories of high-value items. Syn: distribution by value.

ACCESS TIME - The amount of time that the computer takes to locate and transfer data from a storage device into primary storage. See: micro-second, nano-second, pico-second.

ADDRESS - An identifying number given to a particular data record so that it can be found in a computer storage device.

ALPHAMERIC - Data that is made up of both numbers and letters. Syn: Alphanumeric.

ALLOCATION - (1) An allocated item is one for which a pack shcedule or shipping order has been opened but which has not yet left the warehouse; (2) An authorization by a designated official of a component of the DoD, which makes funds available within a prescribed amount to an operating agency.

AUDIT, FINANCIAL - A process for substantiating the accuracy of the financial records and reports of an enterprise.

AUXILIARY STORAGE - A supplementary data storage. Auxiliary computer storage can take the form of drum storage, disc storage, magnetic tape, etc.

-B-

BAR CODE - An array of rectangular marks and spaces arranged in a pattern which, when "read" by an appropriate scanning device, is translated into specific numbers and/or letters. These marks may be arranged either vertically ("ladder") or horizontally ("picket fence").

BILL OF MATERIALS - A listing of all materials that go into finished product showing the quantity of each required to make one unit. Materials can generally be categorized together as components. Bills of Material for items having common components can also be structured in where used form.

BIT - A binary digit. The basic unit of information with which the computer works. The bit can take the form of a magnetized spot, an electronic impulse, a positively charged magnetic core, etc. A number of bits together are used to represent a character in the computer. See: byte.

BLOCK DIAGRAM - A diagram in which a system or computer program is represented by annotated boxes and interconnecting lines. Syn: flow chart.

BUDGETING - A plan expressed in quantitative, usually monetary, terms that covers a specified period of time, usually one year; in military terms it expresses the programs in annual funding requirements.

BYTE - Consists of 8 bits used to store two numeric or one alpha character. See: bit.

-C-

CENTRAL PROCESSING UNIT - The main computer component that is made up of a control section and an arithmetic-logic section. The other basic units of computer system are input-output units and primary storage.

CHECK DIGIT - A digit added to each number in a system which allows for detection of errors in the recording of the numbers. Through the use of the check digit and a predetermined mathematical formula, recording errors can be noted.

CLASSIFICATION - The logical arrangement of objects and information in groupings according to recognized criteria. A taxonomy is an example of a classification.

CODE - A number, or number/letter combination, which represents predetermined data.

COMMITMENT - A firm administrative reservation of funds, based upon firm procurement directives, orders, requisitions, or requests which authorize the recipient to create obligations without further recourse to the official responsible for certifying the availability of funds.

COMPUTER - A device capable of solving problems by accepting data, performing prescribed operations on the data, and supplying the results of these operations.

CONTROLLABLE COSTS - An item of costs is controllable if the amount of cost incurred in (or assigned to) a responsibility center or cost center is significantly influenced by the actions of the center.

COST - A monetary measure of the amount of resources used for some purpose.

COST CENTER - The smallest segment of an organization for which costs are collected.

CRT (CATHODE RAY TUBE) - A device which looks like a television with a typewriter keyboard. Used to enter information into the computer and to display information previously entered.

CUSTOMER SERVICE RATIO - A measure of delivery performance usually in the form of a percentage. In a make-to-stock company this percentage usually represents the number of items or dollars shipped compared with the number of items or dollars on the customer's order. In a make-to-order company it is usually some comparison of the number of jobs shipped in a given time period compared with the number of jobs that were supposed to be shipped in that time period.

CYCLICAL INVENTORY COUNT - A physical inventory-taking technique where inventory is counted continuously rather than once a year. For example, a cycle inventory count may be taken when an item reaches its reorder point, when new stock is received, or on a regular basis usually more frequently for high-value fast-moving items and less frequently for low-value or slow-moving items. Syn: Cycle Counting.

-D-

DEFECT LEVELS - The various groupings into which specific ranges in quantity of an undesirable item are placed.

DEMAND - Demand is the desire to purchase a commodity, accompanied by means of payment. In inventory control, "demand" is different from "sales" because demand does not necessarily result in sales (i.e., if there is not stock, there will be no sale to satisfy demand).

DEPENDENT DEMAND - See: independent demand.

DIRECT INPUT - In-process material of one system which is conveyed directly into another system for further processing without being recorded as either finished or in-process production.

DIRECT LABOR - Labor which is specifically applied to the product being manufactured or labor utilized in the performance of a service.

DISCOUNTED CASH FLOW - See: present value.

DISPLAY - The representation of data in visible form, i.e., cathode ray tube, lights or indicators on the console of a computer, or a printed report.

DOWNTIME - Time when a machine is not producing because it is down for repairs or scheduled reasons.

DUMP - To transfer all of the information contained in a computer record into another storage medium. For example, a disc record could be dumped onto tape or paper.

-E-

EFFECTIVENESS - The relationship between a responsibility center's outputs and its objectives.

EFFICIENCY - The relationship between the planned labor requirements for a task(s) and the actual labor time charged to the task(s). The degree to which a machine or system produces to capacity. The ratio of outputs to inputs, or the amount of output per unit of input.

ELECTRONIC DATA PROCESSING (EDP) - A unified seres of self-controlled operations for collecting, sorting, analyzing and reporting data.

END ITEM - A product sold as a completed item. Any item subject to a customer order or sales forecast. Finished product.

EXPENDITURE - An actual cash disbursement which, when preceded by a previously recorded obligation, liquidates the amount obligated.

-F-

FEEDBACK - The flow of information back into the control system so that actual performance can be compared with planned performance.

FEED RATE - Rate at which material is introduced into a system.

FIFO - First in, first out method of inventory evaluation. The assumption is that oldest inventory (first in) is the first to be used (first out). See: LIFO.

FILE - In computer terminology, an organized collection of records of the storage device on which these records are kept.

FINISHED PRODUCT - Product produced with the intent that it will require no further processing.

FINISHED PRODUCTS INVENTORY - Are those on which all manufacturing operations, including final testing, have been completed. These may be finished products which have been authorized for transfer to the finished stock account. These products are now available for shipment to the customer as end items.

FIXED COSTS - An expenditure that does not vary with the production volume, for example, rent, property tax, salaries of certain personnel. The key here is that although these costs may be changed, they do not vary with volume. See: variable costs.

FLOW CHART - A systems analysis tool to graphically present a procedure in which symbols are used to represent operations, data, flow, and equipment. Syn: block diagram.

FORECAST - A forecast is the extrapolation of the past into the future. It is an objective computation which is an estimate and which is management's anticipation of changes and of new factors influencing demand. A forecast is a calculation of future conditions (such as sales) as a result of study and analysis of available data.

FORECAST ERROR - The difference between actual demand and forecast demand.

FUNCTION - All the positions within an organization encompassing one kind of work that are grouped together to form an organization component. In an organization function, all the positions specializing in one kind

of work are grouped under one functional head in a hierarchical pyramid. Thus, the marketing function may include not only sales but also advertising, market research, and sales promotion, all eventually reporting to the same marketing head.

-G-

GOAL AND OBJECTIVES - In this thesis, the word goals is used for the broad, overall aims of the organization and objectives for the more specific statements of planned accomplishments in a given time period. Some people use these two words interchangeably, and others reverse the meanings given above. The words target and aim are also used as synonyms for either word. Confusion can result if these differences in intended meaning are not understood.

-H-

HARDWARE - The actual computer system machine units. Physical hardware as opposed to a computer program.

HOLD AREA - A point at which stock is accumulated while awaiting assignment of final classifications. This hold time is usually the result of lab analysis tests requiring lengthy processing.

-I - J - K-

INDEPENDENT DEMAND - Demand that is directly related to customer demand and as such must be forecast. The demand on finished goods inventories is typically an independent demand while the demand for components or raw materials is dependent and may be calculated.

INDEX - A ratio of one quantity to another. It expresses a given quantity in terms of its value relative to a base quantity.

INDIRECT COSTS - Cost which is not directly incurred by a particular job or operation. Certain utility costs, such as plant heating, are often indirect. An indirect cost can be either a fixed cost or a variable cost.

INFLATION - A rise in prices that is both general and widely diffused.

INPUT - (1) Resources that are taken in and used in the process of creating output. (2) Insertion of data for processing into a computer.

INSPECTION SERVICES - That area in the Quality Control function designated to provide: (1) Adequate inspection of incoming raw material, merchandise, and packaging materials so as to assure that they conform to recognized quality specifications. (2) Process control information by auditing product produced to assure that Manufacturing is provided with adequate information to help it maintain all processes under adequate control to provide a finished (or in-process) product that meets desired specifications.

INSTRUCTION - A statement to the computer in a series of characters that tells the computer what operation to perform. An instruction is usually made up of an operation code and one or more operands, an operand being that which tells the computer where the data to be processed is stored.

INVENTORY - Stocked items which are held in a stock point and which serve to separate successive operations in the process of manufacturing a product and/or distributing it to the consumer. Inventories may consist of finished goods ready for sale, they may be intermediate (in-process) products, or they may be raw materials.

INVENTORY WRITE-OFF - A deduction of inventory dollars from the financial statement because the inventory is no longer saleable.

-L-

LAB SERVICES - Quality control area designated to provide physical, chemical, microbiological, and sensory testing capabilities and services.

LEAD TIME - The lead time starts as of the date an order is released by the customer and ends with the first receipts. In inventory control, there are often several different lead times to consider, such as the processing lead time (time for an order to be processed), delivery lead time (time for an order to be delivered), replenishment lead time, etc.

LIFO - Last in, first out.

LIGHTPEN - A hand held code reader or scanner which utilizes a light source to "read" a bar code by being passed over the code and in contact with it. See: wand.

LIMITING OPERATION - Where no alternative routing exists, the capacity of the total system can be no greater than the operation of machine with the least capacity.

LINE MANAGERS - A connotation of command, or unilateral formal authority exercised downward to the people represented by the lower boxes on the organization chart.

LOAD LEVELING - Spreading orders out in time so that the amount of work that falls in the time periods tends to be distributed evenly.

LOCATOR FILE - A file used in the stockroom or stores room where each item does not have a permanent specific location. The locator file records where the product has been stored.

LOT - The grouping of a quantity of like products. In general, products from the same source and pack schedule would comprise a lot. The lot number exists internally within the computer.

-M-

MANAGEMENT BY OBJECTIVES (MBO) - A formalized system of superior-subordinate goal setting; a system that features a periodic agreement between a superior and a subordinate's objectives for a particular period and a periodic review of how well the subordinate achieved those objectives.

MANAGEMENT CONTROL - The process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's goals.

MANAGEMENT INFORMATION SYSTEM (MIS) - An integrated man/machine system for providing information to support the operations, management and decision-making functions in an organization [Davis p. 5]. The system provides the required information to all levels of management to help them control resources and meet objectives. (IBM)

MANUFACTURING FORECAST - The sales forecast translated into meaningful terms for the manufacturing departments. A sales forecast might show total units, for example, while the manufacturing forecast might be broken down into total hours by significant work center.

MARGINAL COST - The additional out-of-pocket costs incurred when the level of output of some operation is increased by one unit.

MARGINAL REVENUE - The additional income received when the level of output of some operation is increased by one unit.

MASTER SCHEDULE - Where an inventory control system is used, the master schedule often specifies the end products and the time periods in which they are to be manufactured. It can best be described as a high level schedule from which detailed schedules are made.

MEAN - The average of a group of values. See: median, mode.

MEAN ABSOLUTE DEVIATION (MAD) - The arithmetic mean of the absolute values of the deviations from the mean of the distribution. For a normal distribution, the mean absolute deviation is equal to 0.8 of the standard deviation.

MEDIAN - The middle value in a set of measured values when the items are arranged in order of magnitude. If there is no middle value, the median is the average of the two middle values.

MEMORY - See: storage.

MICRO-SECOND - One millionth of a second.

MODE - The most common or frequent value in a group of values.

MODEL - Composed of a number of assumptions from which conclusions--or predictions--are deduced, the purpose of a model is to make predictions concerning phenomena in the real world.

MOVE ORDER - The authorization to move a particular item from one location to another.

MRP (MERCHANDISE REQUIREMENTS PLANNING) - A method of predicting shortages in merchandise by comparing by time period the expected on-hand inventories with the expected requirements for finished goods. Typical use includes generation of replenishment orders and rescheduling existing orders.

MULTIPLE MANAGEMENT - A system designed to develop executive talent through a "team" approach to conducting business. It has a two-fold purpose; (1) advancing the individual in knowledge and experience; (2) advancing the company to higher levels of success.

-N-

NANO-SECOND - One billonth of a second.

NET CHANGE - A materials planning system where the materials plan is not recalculated periodically, but instead is updated as each requirement change occurs.

NORMAL DISTRIBUTION - A particular statistical distribution. For a distribution to be classified as a "normal" distribution, it must be unimodal--that is, most of the observations must fall fairly close to one mean--and symmetrical; that is to say, a deviation from the mean is as likely to be plus as it is likely to be minus. When graphed, the normal distribution takes the form of a bell-shaped curve. Syn: Standard distribution.

-O-

OBLIGATION - An expense incurred when an order is placed, a contract is awarded, a service received, or similar transactions are entered into during a given period requiring future payment of money in an agreed amount. Normally an obligation liquidates a previously recorded commitment.

OFF-LINE OPERATIONS - Data processing operations that are handled outside of the regular computer program. For example, the computer might generate a magnetic tape which would then be used to generate a report off-line while the computer was doing another job.

ON-HAND - The balance shown in perpetual inventory records as being present at the stocking location. This balance is normally reconciled with a periodic physical count of the inventory.

ON-ORDER - The stock on-order is the quantity represented by the total of all outstanding replenishment orders. The on-order balance increases whenever a new order is released, and it decreases whenever material is received to fill an order, or whenever an order is cancelled. These receipts and cancellations may be for the full quantity ordered, or partial quantities. There may be receipts which do not affect the on-order balance: customer returns, adjustments after physical inventory counts, production surpluses, and so on.

OPERATIONAL CONTROL - The process of assuring that specific tasks are carried out effectively and efficiently.

OVERHEAD - Costs incurred in the operation of a business which cannot be directly related to the individual products or services produced. These costs, such as light, heat, supervision, maintenance, are grouped in several pools (department overhead, factory overhead, general overhead) and distributed to units of product, or service, by some standard method such as direct labor hours, direct labor dollars, direct materials dollars.

-P-

PACK SCHEDULE - Paperwork forms to coordinate the production on an item among all departments involved.

PALLET TICKET - A special multi-part form assigned to each pallet of finished or in-process product leaving a department. These tickets contain location information and are used by the Warehouse for finding specific product at a later date.

PALLETIZE - Placing of packaged goods on individual pallets for removal by lift trucks.

PARKINSON'S LAW - A tongue-in-cheek observation that "work expands so as to fill the time available for its completion." (Reference: Parkinson's Law, C. Northcote Parkinson, Houghton-Mifflin Company, Boston, 1962.)

PAYBACK PERIOD - This method is utilized when the significant factor in the decision-making process is the time required to recover the initial investment. The ratio (Initial Investment ÷ Annual Net Cash Flow = Payback Period) determines the number of years required to recoup the amount of money paid out to make the investment.

PERIODIC INVENTORY SYSTEM - An actual physical count of the goods remaining on hand at the end of each given period.

PERPETUAL INVENTORY SYSTEM - The maintenance of detailed inventory records on a continuous, transaction-by-transaction basis throughout a given period.

PICO-SECOND - One trillionth of a second.

PLANNING - In civilian organizations this term is used to develop the stages and control mechanisms to be utilized in exercising control. For the military it has come to mean assessing the global threat and defining a strategy to meet that threat.

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PPBS - A DoD acronym for the program which defines forces and programs required by the national strategy and once the need is quantified, development of the most cost effective means of acquiring the posture that could be funded. Evolved today into program strategies at all levels of military organizations.

PRESENT VALUE - The value today of future cash flows. For example, the promise of ten dollars a year from now is worth something less than ten dollars in hand today. Discounted cash flow.

PRIMARY STORAGE - The "memory" of a computer where instructions and data being worked upon are contained. Most primary storage today is made up of small iron rings or cores which can be electrically charged; therefore, primary storage is often called core storage. Syn: main storage.

PROCEDURES - Definitions of approved methods of performing various operations.

PRODUCTION CONTROL - The process of directing or regulating the orderly movement of goods through the entire manufacturing cycle from the requisitioning of raw materials to the delivery of the finished product to meet the objectives of customer service, minimum inventory and maximum manufacturing efficiency.

PRODUCTION PLANNING - The function of setting the limits or levels of manufacturing operations in the future, consideration being given to sales forecasts and the requirements and availability of men, machines, materials, and money.

PRODUCTIVITY - Refers to a relative measure of output per labor or machine hour.

PROFITABILITY INDEX - Accounting for the time value of money, this procedure provides a much better comparison of alternatives than the Payback Period method, and qualifies decisions made using straight present value analysis. The ratio (Present Value of Net Cash Flows ÷ Initial Investment) equals the Profitability Index. Syn: present value index or savings investment ratio.

PROGRAM - A set of instructions directing the computer to perform a series of actions in order to achieve a desired result.

PROGRAMMING - The process of deciding on the programs that a civilian company will undertake and the approximate amount of resources that are to be allocated to each

program. This phase for the military organization translates the strategic plans into alternative structure programs defined in terms of men, material, and financing.

PROGRAMMER - A person involved in designing, writing or testing computer programs.

PURCHASE ORDER - A document conveying authority to a vendor to ship specified materials in specified quantities within a specified time; a type of replenishment order. See: purchase requisition.

PURCHASE REQUISITION - A document conveying authority to the Purchasing Department to purchase specified materials in specified quantities within a specified time. See: Purchase order.

-Q-

QUALITY CONTROL (Q.C.) - Function assigned to assure the adherence to all sanitation and quality standards of all raw material, manufacturing processes, techniques, and products to meet customer specifications and requirements of regulatory agencies, and to perform services to support company and corporate Key Objectives.

QUALITY SERVICES - Quality Control area designated to develop, collect, organize, and present product quality communications.

-R-

RANDOM NUMBERS - A sequence of integers or group of numbers (often in the form of a table) which show absolutely no relationship to each other anywhere in the sequence. At any point, all integers have an equal chance of occurring, and they occur in an unpredictable fashion.

RANDOM SAMPLE - A limited selection of observations taken from all of the possible observations of a phenomena in such a way that each chosen observation has the same possibility of selection as every other observation of the phenomena.

RANGE - The statistical term referring to the spread of a aeries of observations. For example, the range of anticipated demand for a particular product might range from 10 to 500 per week. The range would, therefore by 490.

REAL TIME DATA PROCESSING - The processing of transactions as they occur rather than batching them.

REJECTS - A general term applied to "unwanted" material.

RESOURCES - Tangible, such as material and equipment, and also human resources.

RESPONSIBILITY CENTER - A group of people headed by a manager who is responsible for what it does. For this analogue, a cost center as sometimes used in military organizations has somewhat the same connotation, as each is responsible for the input/output function within its sphere.

REUSAGE - Product which is used in an operating system for input. "Finished" and/or in-process materials make up reusage.

RUNNING TIME - The time during which a machine is actually producing product. For example, the running time for a machine tool would include time cutting metal and the time moving into position to cut metal, but running time would not include set up, maintenance, waiting for the operator.

-S-

SAFETY STOCK - The average amount of stock on hand when a replenishment quantity is received. Its purpose is to protect against the uncertainty in demand and in the length of the replenishment lead time. The size of the safety stock is dependent upon the expected deviation of the actual lead time usage from the forecasted usage.

SAMPLE - A portion of a universe of data chosen to determine some characteristic(s) about a whole universe. The universe of data could consist of historical delivery cycles, unit costs, sizes of customer orders, number of units in inventory, etc.

SAMPLING - A statistical process whereby generalizations regarding an entire body of phenomena are drawn from a relatively small number of observations.

SEMIVARIABLE COSTS - Costs that vary in the same direction as, but less than proportionately to changes in volume. These may include some maintenance costs, clerical costs, or indirect labor.

SET-UP COSTS - The out-of-pocket costs associated with a machine set-up that would increase or decrease if the number of set-ups were increased or decreased.

SHORTAGE COSTS - The marginal profit that is lost on each item that a customer demanded but that was not immediately available in stock. Care must be taken to isolate all of the additional profit that would have occurred had the item been sold at the time it was demanded. Likewise, a customer whose demand is not satisfied may, in the future, reduce his potential demand at this particular establishment.

SIGMA - A common designation for the standard deviation which is a measure of the dispersion of data or the spread of the distribution. The standard deviation is calculated by finding the differences between the average and the actual observations, squaring each of them, adding them all up and finding the average and then taking the square root of this average.

SOFTWARE - The processor programs, routines, manuals, and other service programs supplied by a computer manufacturer to facilitate the use of a computer. In addition, it may refer to other programs especially developed to fit the users' needs.

SOURCE - That point at which a particular product (one of many possible finished or in-process products) originates as that product. Sources are normally assigned a number description.

SOURCE-SEQUENCE NUMBER - A code used to describe from where (which source) and when a particular item originated. The code is logical in that it is comprised of the actual source number and also given the particular sequence number for the item in question.

STAFF MANAGERS - The positions organized primarily to provide advice and services to others in the achievement of overall objectives. Auxiliary, service or supportive managers who are not directly involved with the end product of the organization; connotation of advice giving, or authority of a technically competent nature.

STAGED MATERIAL - Material collected ahead of the department in which it is to be utilized so that it is immediately available when called for.

STAGING - Pulling of the material requirements for an order from inventory before the material is actually required.

STANDARD DEVIATION - See: sigma.

STOCK - Stored products ready for sale as distinguished from stores, which are usually raw materials.

STOCKOUT - The lack of products which are normally expected to be on hand in stores or stock.

STOCK STATUS - A periodic report showing the inventory on hand and usually showing the inventory on order and some sales history for the products that are covered in the stock status report.

STORAGE - A computer oriented medium in which data is retained. Primary storage: internal storage area where the data and program instructions are retained for active use in the system, normally core storage. Auxiliary or external storage is for less active data. These may include magnetic tape, disk, or drum.

STRATEGIC PLANNING - The process of deciding on the goals of the organization, on changes in these goals, on the resources used to attain these goals, and on the policies that are to govern the acquisition, use, and disposition of these resources.

SUPERVISE - To direct personally. A supervisor exercises leadership by personally overseeing the activities of others. Supervision implies that the people supervised report directly to the person who is supervising.

SYSTEM - (1) An integrated whole made up of diverse but interdependent parts that work together in unison, often under the influence of an overall logic or plan. (2) An organized collection of people, equipment and/or hardware and/or software required to accomplish a set of specific functions.

-T-

TABLE LOOK-UP - A computer technique that stores a table of data in a computer so that the data can be used during the running of the program.

TERMINAL - A remote input or output unit which is directly connected to a computer, such as CRT, a printer, or a wand.

THEORY - An explanation of how and why someone or something behaves, occurs, or responds as he or it does under a given set of circumstances: the principles governing practice.

THROUGHPUT - Total production. The amount of material run through a system in a given amount of time.

TIME SHARING - The use of a single computer by more than one person where the computer handles each requirement so quickly that each person feels that he has the computer to himself.

TWO BIN SYSTEM (Of Inventory Control) - A type of fixed order system in which inventory is carried in two bins. A replenishment quantity is ordered when refilled and the excess is put into the working bin. This term is also used loosely to describe any fixed order system even when physical "bins" do not exist.

-U-

UNIVERSE - In statistics, the population, or large set of data, from which samples are drawn. Usually assumed to be infinitely large or at least very large relative to the sample. See: sampling.

-V-

VARIABLE COSTS - An operating cost that varies directly with production volume, for example; materials consumed, power, direct labor, sales commissions.

VARIANCE - The difference between the expected or planned and the actual.

-W - X - Y-

WALL TO WALL INVENTORY - Raw material, parts, and assemblies may enter the plant at one end and are processed through the plant to end product without ever having entered a formal stock area. When this technique is used the inventory is referred to as wall to wall inventory.

WAND - A hand held devide which looks like a pen and is used to "read" bar-coded labels and enter information into a computer. See: lightpen.

WEIGHTED AVERAGE - An averaging technique where the data to be averaged is multiplied by different factors. For example, a regular average is equivalent to a 50-50 weighted average. An average could be made up by

taking 90% of one figure and 10% of another figure. This would then be a weighted average. Note that the weights must always be equal to 1.00 or 100%.

WORK CENTER - An area of an organization where a particular type of work is performed.

WORK ORDER - The term work order is used to designate orders to the shop for maintenance.

WORK STATION - The assigned location where a worker performs his job; it could be a production system or a work bench.

-Z-

ZERO DEFECTS - A program designed to achieve error-free performance. The objectives of such a program include improved product quality, increased employee morale, and decreased costs.

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