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## THESIS

STUDY OF THE PRODUCTIVITY ENHANCEMENT  
INITIATIVE, ENGINEERING THE WORKPLACE

by

John Lawrence Higgins

and

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December 1985

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Engineering the Workplace

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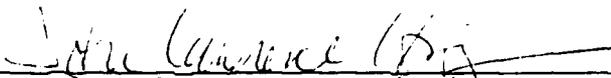
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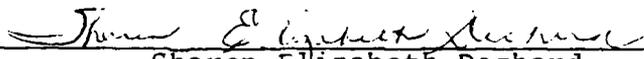
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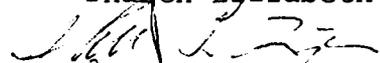
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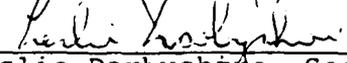
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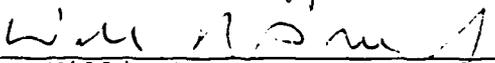
  
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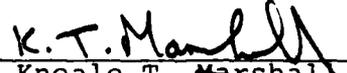
  
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## ABSTRACT

The Naval Supply Systems Command (NAVSUP) operates stock points all over the world. Resources expended for the physical distribution function at these stock points amount to millions of dollars per year. It is imperative that these stock points operate to provide higher productivity at lower costs. Engineering the Workplace (ETW) is the productivity enhancement program NAVSUP feels will accomplish this. Comparing ETW with past productivity improvement programs within the Navy as well as current industry proven productivity improvement programs is the method used to determine the requirements and feasibility of its implementation. ETW is built on sound, proven industrial engineering techniques. Commercial productivity improvement programs can be adapted for use at government physical distribution activities. With proper headquarters support and with properly trained, well informed and supportive employees, ETW should be a successful program.

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## I. INTRODUCTION

Productivity growth in the United States has become a national priority. Improvement in productivity in the Navy, as well as throughout the government, is part of a nationwide concern. Effective and proven strategies for accomplishing this improvement need to be developed and implemented.

### A. ISSUES

As early as the 1900's the Navy, as well as the other uniformed services, was interested in improving productivity by applying engineered standards to some of its industrial activities. Through the next several decades, a proliferation of productivity enhancement programs were developed. Although these programs were a step in the right direction towards improving productivity, none was considered a total success.

The Naval Supply Systems Command (NAVSUP), in its strategic plan published in 1984, addressed, as a specific goal, the improving of productivity through work simplification, standards, and efficient information systems [Ref. 1]. The eleven supply centers/depots (NSCs/NSDs) that the Navy operates expend thousands of manhours and millions of dollars each year on the physical distribution function. Considering the magnitude of this effort, it is imperative that these supply centers/depots operate on proven industrial techniques that optimize productivity. NAVSUP feels that the current management tools and

techniques in place at the supply centers are suboptimal in providing capability to improve productivity. In the process of developing a productivity enhancement program, NAVSUP wants to adopt proven management engineering techniques used in private industry. With the previously mentioned problems and concerns in mind, NAVSUP has developed the concept of "Engineering the Workplace" (ETW); a systems approach to improving control and productivity in the physical distribution function at NSCs/NSDs.

#### B. OBJECTIVES

The major objective of our research was to provide NAVSUP with an independent, conceptual analysis of ETW and its implementation plan. By comparing ETW to past productivity enhancement programs, we hope to provide some insight into the reasons behind the lack of success of these programs, and be able to make specific recommendations for the implementation of ETW. We will also investigate some successful productivity and control programs in the private sector to see if ETW compares favorably. We will investigate the possibility of establishing standards used in private industry to a government agency with a military support mission.

#### C. METHODOLOGY

We examined in detail the Defense Integrated Management Engineering System (DIMES). This productivity improvement program was the most recent forerunner of ETW and, like ETW,

dealt with work simplification, standards and reporting. By visiting the NSC, San Diego, California, Subsistence Division, we were able to see the actual application of a portion of ETW. For comparison, we visited the facilities of two grocery distributors in southern California who have achieved industry recognition for their productivity improvement and control programs.

Through various interviews with the program sponsors at NAVSUP, along with a literature review, we discuss ETW in detail.

Presentation of our research effort is organized in seven chapters. Chapter II defines productivity and provides an approach for categorizing the various types of productivity measures. It also explains how a productivity enhancement program will benefit the NSC's. Chapter III focuses on past productivity programs; specifically DIMES--how it started, how it was developed and implemented, and the causes for its lack of success in the Navy. By studying past productivity programs, we will be able to determine what portions of these past programs should not be repeated. Chapter IV examines ETW in detail. It addresses the program in total, identifying portions which are actually being applied today and those portions of the program that are still being developed. Chapter V is a close look at one of the portions (Statistical Process Control (SPC)) that is actually being applied at the NSC San Diego. Chapter VI looks into two very successful productivity

improvement and control programs in private industry. Finally Chapter VII is our summary of findings, conclusions and recommendations.

## II. CONCEPT OF PRODUCTIVITY IN BUSINESS APPLICATIONS

Without productivity objectives, a business does not have direction.

Without productivity measurement, it does not have control.  
(Peter Drucker)

With these ominous words, we will begin our discussion of productivity. What is productivity? How is it measured? What potentialities exist for productivity enhancement? Before honing in on the actual productivity measures used in the NSCs and in the private firms we are using for comparison, we will provide an overview of productivity and why the particular measurement unit developed by the NAVSUP as the basis for their engineered standards is central to the outcome of the productivity enhancement program.

### A. DEFINING PRODUCTIVITY

Conceptually, productivity is a simple ratio: output/input. The productivity measure attempts to capture the relationship between the output produced by a manufacturing/service organization to the inputs consumed during the process. Although the concept is straightforward, the actual implementation of the productivity definition in real organizations can be illusive. It is unlikely that any organization produces a single output using a single input. Thus, the concept requires a mechanism whereby disaggregate entities are weighted, and then aggregated together into a systems-level index. It is also important to

recognize the multi-dimensionality of the productivity concept. Although we have habitually viewed productivity on a labor basis, many systems exhibit a larger portion of input from other categories. These include materials, energy, capital, management, and support personnel. To develop a true system-wide perspective of productivity, the various outputs which a system produces must be clearly defined; the same must be done with the inputs consumed through the conversion process. Appropriate weighting mechanisms must be applied to tie the various entities together.

A productivity measurement must be responsive to the following set of objectives.

1. It must assist management in diagnosing the location and severity of various problems that exist within the entity. Ranking these problems in order that management can attend to their solutions in a prioritized fashion is also helpful.
2. In an ongoing way, a viable measurement system should help management in assessing the impact of specific actions taken within the organization to enhance the level of productivity.
3. The productivity measurement system should motivate the employees at all levels to seek out improvement opportunities.

When designing a productivity measurement system, it is important to understand and analyze the actual process that is taking place. A measure is made of some characteristics that can be quantified and are believed to reflect the level of that characteristic during some time period. Measures typically take on a comparison mechanism. The actual level

of an indicator is monitored and compared to some other recorded levels such as a standard or previous period.

In using a productivity measurement system, the optimality concept is unlikely to be useful. Most real systems are too complex to warrant a comparison with a known optimum. With all the uncertainties and interdependencies in a complex system, it is not likely that an optimal level could even be established. Thus the use of engineered standards gives management a perspective of progress.

Most modern productivity measurement systems consist of a number of indicators that monitor various aspects of total system performance. In assessing the usability of a particular measure, the following characteristics are important to consider:

1. Controllable: Measures should be controllable; the person or group being measured should have control over all aspects of productivity that make up the measure.
2. Congruence: The productivity measure should relate to the overall goals of the organization.
3. Unequivocal: The outcome or value of the measure should be impossible to misinterpret.
4. Reproducible: The outcome of the measure should occur again if the performance is the same.
5. Accurate: An accurate measure is not subject to random biases.
6. Objective: The productivity measurement is not based on human judgment.
7. Understandable: The measure should be understandable to the person or group being measured.

8. Choosable: The person or group being monitored needs to have some direct influence over the productivity measure that will be used. Employees should be involved in the process of selecting the appropriate productivity measures. [Ref. 3]

## B. MEASURING PRODUCTIVITY

The way productivity is measured determines the meaning it carries. Many different methods of productivity measurement exist. A brief introduction to some of these approaches will provide some insight in understanding the choices of productivity measurement made by NAVSUP as well as the private firms we observed.

### 1. Efficiency Measurement

#### a. Output/Input Measures

The first category of measures defines productivity efficiency as a ratio of outputs to inputs. Both outputs and inputs can be expressed in terms of physical units (e.g., pounds, hours, miles, gallons, number of units, etc.) or in terms of cost or value expressed in dollars. Using these dimensions, the four resulting types of Output/Input ratios are:

1. 
$$\frac{\text{Output in Physical Quantity}}{\text{Input in Physical Quantity}}$$
2. 
$$\frac{\text{Output in Price Form}}{\text{Input in Physical Quantity}}$$
3. 
$$\frac{\text{Output in Physical Quantity}}{\text{Input in Price Form}}$$
4. 
$$\frac{\text{Output in Price Form}}{\text{Input in Price Form}}$$

Measurement type refers to whether or not the denominator of the ratio includes a single input (partial) or multiple inputs

(total factor). In general, total factor measures are preferable to partial measures because they provide a more accurate accounting of an organization's true efficiency. A rule of thumb for determining the inputs for efficiency ratios is that the efficiency measure for a unit should include in the denominator only those inputs over which the organization has some control.

Ratio 1--Physical Quantity Input and Output--

Physical quantity measures offer many advantages for efficiency measurement. Since they are not affected by inflation, they can be compared directly with data from previous periods. Other advantages include the relative ease of computation, ease of understanding, and generally high acceptability. Disadvantages of the measure are that the index may fluctuate as a result of factors that are not controllable by the organization. For example, a labor partial ratio used in a government supply center could be misleading since managers usually have little control over the number of personnel assigned. In addition, aggregating outputs can be misleading if large differences exist in the time to process them. Using weighted or standardized outputs would give this measure more relevance in this case.

Ratio 2--Price Outputs and Physical Quantity

Inputs--This measure presents outputs in terms of dollar values. Such measures are widely used in the private sector where sales in dollars are a frequently used output. Government organizations

have difficulty establishing dollar values for their outputs. As a result it is not a widely used measure for the military establishment.

This measurement form is easily understandable and acceptable to managers. It is also easy to compute since most organizations maintain the necessary data. In their raw form, these indices can be misleading. In general, physical measures of output are preferable to output stated in dollars because dollar measures are affected by inflation. Selling prices are affected by wholesale prices, selling expenses, markups, etc. Dollar values, even when adjusted for inflation, do not provide an accurate way to aggregate different types of outputs.

In a manufacturing context, the confounding effects of other costs are often removed by subtracting the cost of materials from the value of the outputs. This adjustment produces an output value called 'value added by manufacturing.' The most accurate approach to adjustment is the double inflation approach in which the deflated cost of materials is subtracted from deflated value of output. [Ref. 4:p. 27] This produces an index:

$$\text{Value added per manufacturing hour} = \frac{\text{Value added}}{\text{Labor Hours}}$$

In the military environment, except for industrially funded activities, few situations exist in which sales or value added are appropriate output measures. Furthermore, when aggregated

output measures are used, they are relatively insensitive to changes in organizational efficiency which may be less than the fluctuations in the dollar values because of factors unrelated to organizational efficiency. Because of the need to correct for inflation and other cost factors, this measurement form requires considerable computation. This difficulty, coupled with its low validity, reduces its acceptability to managers. As a result, it is of little use in guiding managerial decisions.

Ratio 3--Physical Quantity Outputs and Price Inputs--This form measures reported outputs in physical forms and inputs in price or value terms usually expressed in dollars. Particularly for the military, where outputs can be more easily expressed in physical quantity terms than in price terms, this form can be very useful. Since outputs are expressed in physical terms, this measure is easy to interpret and meaningful to managers. Its inverse can be interpreted as the cost per unit of output. With the denominator (inputs) expressed in terms of deflated costs, it is usually possible to obtain the necessary input data directly from existing cost accounting systems. Ratio 3 measures are amenable to total factor productivity measurement. Disadvantages of this form are few, except for organizations having a large number of outputs. Combining all outputs into a single index may be difficult from the standpoint of developing an acceptable weighting scheme. It may also be undesirable because, as the complexity increases, its

acceptance and utility to managers decrease. In such an organization, multiple indices covering the significant outputs and their associated costs are recommended.

Ratio 4--Outputs and Inputs in Price Terms--Ratios of this type are essentially financial ratios. These ratios represent the most common ratios used by managers so their acceptability is very high. However, these ratios are seriously flawed from the standpoint of providing useful information to managers about the true efficiency of the organization. Price forms are less useful than physical quantity formulations. This is very true in the military context. Even when corrected for the effects of inflation and expressed in index terms, price or economic value is not a good basis for aggregating outputs in forming efficiency ratios unless prices are proportional to units of work (labor, energy, etc.) used to produce them. The rationale for this adjustment is based on Bureau of Labor Statistics (BLS) practice. When forced to use unit price weights instead of unit labor weights in aggregating output, the BLS makes the assumption that unit value weights are proportional to number of unit employee hours required to produce the outputs. [Ref. 4:pp. 21-30]

In addition to the various ways of computing productivity ratios, categories for measuring different types of productivity also exist. Efficiency, effectiveness and utility are all related to productivity and how it is measured.

## 2. Performance Efficiency Measures

Performance efficiency measures are measures that deal with the relationship between an actual or obtained level of performance and a standard or expected level of performance. Again, we have several measures.

### a. Performance Efficiency Based on Engineered Standards

Two types of engineered standards are in use. One is the end-item standard that provides precise estimates of 'should take' times for an average qualified worker to perform a task. A second type of standard is the manpower standard used for determining staffing lines and provides a basis for computing the number of personnel required to handle a given volume of work. We will focus on the end-item standard only.

The military establishment has made the most use of end-item standards for work in the maintenance area. Standards have been developed for most maintenance actions. For a specified repair, inspection, or other maintenance action, an average time exists that is required for the average qualified technician to make a given repair. If the actual time for the repair is compared with the standard, this leads to a measure of performance efficiency. The general form of a performance efficiency index is:

$$\text{Performance efficiency} = \frac{\text{Standard Time}}{\text{Actual Time}}$$

The above index can be used for assessing the efficiency of an individual on one task or it can be averaged to assess the efficiency of an organization.

The advantages of performance efficiency measures include quantifiability, understandability, and utility to managers as a guide to management practice. Assuming that the standard is accurate, the process is objective and requires relatively simple bookkeeping and computational procedures. As an evaluation tool, the efficiency index provides an acceptable criterion assuming both the input (labor hours) and the workload are under the control of the organization. For example, if an organization has a fluctuating workload generated by an outside organization and it cannot adjust input accordingly, its rate of efficiency will not be a useful gauge of the organization's actual efficiency.

A disadvantage of the approach is that the development of engineered standards is expensive. Standards that are not updated as work and work processes change lose their validity over time. There is usually some resistance by workers to this procedure unless they are consulted and have an input into the standards development process. This and other efficiency-based approaches can be criticized if they make no provision for changes in quality of the output. The approach assumes that quality is constant for the units of work counted. In high volume operations where work is quite standardized and other quality monitoring procedures are in

effect, this assumption may be reasonable. However, in less routine work centers, where there are some decisions to be made by workers and some discretion in processing is required, this approach is expensive to apply and maintain and probably not cost-effective. Performance efficiency indices using engineered standards are useful in situations that fit the constraints underlying the method. Most of the problems with the method result from poor implementation and failure to keep standards current, rather than from flaws in the methodology itself.

b. Performance Efficiency Based on Statistical Standards

In the development and application of manpower standards across work centers or across time periods for a given work center, multiple workload factors are typically utilized. This enables the procedure to comprehensively cover the organization's workload. For example, the work for an office of administrative services within a federal agency is measured on four outputs: number of pieces of correspondence routed, number of pieces of cash mail handled, number of transactions in an internal fund, and number of travel inquiries answered. Inputs are the number of hours worked. Using historical data from a period of 52 weeks, a multiple regression analysis is conducted relating outputs to input. This process produces an equation that can be used to predict hours worked on the basis of variations in the level of output.

This procedure offers a useful way to track an organization's labor efficiency over time. It requires some statistical knowledge to understand and apply the process. The output measure is relatively straightforward, and the procedure is attractive because it provides a mechanism for aggregating different outputs at the work center level.

A disadvantage of the approach is that it is useful only for assessing labor productivity. However, the approach can be used to generate standard labor costs for outputs that might be combined with other input cost data in developing total factor measures for different output classes. Acceptance of the approach by managers may be complicated by its statistical foundation. Finally, the process loses its effectiveness quickly if the work performed by the organization changes in significant ways. It appears to be best suited to bureaucratic organizations where there is high task specialization and where work roles and the actual work performed are relatively consistent over time.

As an evaluation tool, this methodology offers a very effective and objective way to evaluate the impact of organizational change programs. If an organizational change program leads to improved efficiency, this will be reflected in an increase in the number of earned hours, assuming that the volume of work is elastic and can expand with the increase in organizational capacity. In addition, improved efficiency will be reflected in changes in the regression weights when

the equation is reapplied. This could produce a statistical test for assessing the impact of organizational change.

c. Performance Efficiency Based on Historical or Technical Audit Standards

Situations in which the work load is relatively low volume, non-standard in nature, and requires considerable judgment to process do not lend themselves to either engineered or statistical standards of the type previously covered. The approach required to establish standards in such work centers may make use of either historical standards or what is known as technical estimation. To illustrate the methodology, an example will be used from a procurement organization.

Procurement personnel perform a number of different types of procurement actions. Each of these actions varies in terms of the length of time for processing and each is subject to various complexity factors which may or may not occur but which have time demands. For each type of procurement item, standard times for processing can be determined simply by adding the time for all the complexity elements that apply. The time estimates are based on a combination of operational audits, historical records and technical judgment. Self-reporting by the procurement officer provides the input for hours worked as well as a categorization of the type of procurement action and its complexity factors. The procurement file represents a clear audit trail and can be reviewed as a quality check to determine if individuals accurately report time to complete procurement actions and work performed.

On a monthly basis, efficiency measures are computed by establishing a ratio of the standard time (earned hours) and actual hours.

The primary advantage of this approach is that it can be applied to work situations not suited for use of statistical or engineered standards. The logic of the approach is clear and straightforward, thereby increasing its acceptance to management. A by-product of the approach is that it provides careful analysis of the type of work performed in the work center. The approach can be easily modified by adding or deleting complexity elements or by revising the time estimates as requirements change. The approach produces indices that are directly compatible with the mission of the organization and its outputs can be defined in such a way that the total mission of the unit can be captured. In its implementation it is almost inevitable that individuals in the organization become involved in development of the procedure. A final advantage of the procedure is that there should be high agreement among observers as to whether a particular complexity element is performed which would lead to high reliability.

Use of historical or technical audit standards has some disadvantages. First, it requires a considerable investment of time to develop the complexity and time estimates. Second, in operation, the procedure relies on self-reports of incumbents. Individuals must be willing to take the time to accurately report time spent and work performed. To achieve

valid reporting, employees must be made to feel that it is in their best interests to do so. If employees feel that their efforts to participate in a measurement system will be rewarded by getting additional staff or in other ways, the quality of the data is likely to improve. The quality of the output data can be assessed through periodic quality control checks since a clear audit trail exists.

### 3. Utilization Measures

In its simplest form, a measure of utilization is the ratio of actual utilization to the potential utilization of labor, space, equipment, or other aspect of organizational capacity. Some utilization ratios drawn from physical distribution/logistics include:

$$\text{Equipment Utilization} = \frac{\text{Equipment hours used in put-away}}{\text{Total equipment hours available}}$$

$$\text{Facility Utilization} = \frac{\text{Sq. feet of storage used}}{\text{Sq. feet of storage available}}$$

$$\text{Labor Utilization} = \frac{\text{Labor hours spent in replenishing stock}}{\text{Labor hours worked by replenishment workers}}$$

In general, the more of an organization's capacity being used the better. Certainly this is true for civilian organizations. However, for military organizations, particularly those having wartime missions, utilization ratios during peacetime may not be meaningful. Units which are authorized equipment for wartime use would probably not find high rates of utilization

during peacetime. Low utilization would not mean that the units were inefficient, but rather that the mission workload which called for the utilization of the equipment was not present. However, utilization rates for personnel and equipment required for peacetime missions can and should be tracked.

Utilization rates are meaningful indices for managers to the extent to which valuable assets are being used. However, it is important that consistent definitions be developed in order to have accurate recording of capacity. For example, in determining equipment availability, is the time spent conducting preventive maintenance on a piece of equipment counted as time when the equipment is used, is it counted as time to be subtracted from total time available, or is it actually counted as utilization time? Clear and unambiguous recording procedures must be established in order to have meaningful utilization measures. Such measures are useful in assessing the effects of organization change programs.

#### 4. Effectiveness Measurement

Effectiveness is defined as the extent to which an organization achieves its goals. The definition can be broadened to include not only the dimension of goal achievement, but also other dimensions such as quality of the output, impact on the external environment, and impact on the organization itself. Effectiveness dimensions relevant to the services of government are: responsiveness, timeliness, accessibility, availability, participation, safety, reliability and citizen satisfaction.

Goal or mission oriented criteria are the most frequently mentioned measures of effectiveness by managers. Others considered important by military managers are training, operational readiness, having sufficient resources, safety, communications, adequate maintenance and quality of equipment. A virtually unlimited number of effectiveness criteria exists. The most widely used category of effective measurement is that of goal achievement.

The goal achievement approach assumes that quantifiable goals have been established and performance is assessed relative to those goals and standards. In addition to ratios, goal achievement may also be measured in terms of adherence to schedules, planned achievements versus actual achievements, etc.

Measuring the effectiveness in terms of performance against goals or standards is an understandable approach as long as an organization has established measurable goals and objectives that are consistent with the mission of the unit. In establishing effectiveness measurement procedures, it is important that the measurement operations be explicitly defined. This is necessary to prevent bias in the measurement as workers look for ways to present themselves in the most favorable light--this is usually accomplished by bypassing the standard or interpreting it in the way that provides the best measure.

Generally, measures of effectiveness that refer to the achievement of goals are measures that are useful to managers

and are understandable. If managers participate in establishing goals, and if they are considered fair and attainable by actions under the control of the organization, then these goal oriented measures are more likely to be acceptable to them. The cost effectiveness of goal attainment measures is high if organizations have delineated and prioritized goals and are measuring those things which are really important. Frequently, it is better to measure well a few objectives that are critical to an organization's mission, rather than try to measure everything the organization does, but measure it poorly.

All of the above efficiency and effectiveness measurements are examples of methods used to measure productivity. These measures are not all inclusive nor do they include all categories of productivity measurement. Many firms use measures centered around quality of product; some even use measures of quality of work life. Defining productivity and its measurement is not a black and white business. This summary of the measures provides some insight into the research required and the choices that must be made before a productivity enhancement program can be realistically developed.

#### C. WHY NSC'S NEED A PRODUCTIVITY ENHANCEMENT PROGRAM?

NAVSUP determines and provides supply management policies and methods to the eleven NSCs/NSDs under its cognizance. It is responsible for resource utilization and the operating efficiency of these activities. The principal mission of these

supply centers is to receive, store and issue material to Navy activities. Civilian labor costs at the centers have increased more than 70% since 1980. [Ref. 5:p. 5] Increasing productivity through the more efficient utilization of labor forces could result in significant cost savings. Since the early 1970's, the Navy supply centers have been without an overall plan to develop and implement a work measurement system for productivity improvement.

By 1974, the Navy had begun decreasing its emphasis on work measurement. NAVSUP officials justified the elimination of work measurement support staffs with austere funding and other priorities.

NAVSUP, as well as DOD, instructions provide for the use of work measurement and management information systems to properly manage labor resources, control costs, and measure the operating efficiency of the supply centers. Work measurement consists of identifying the most efficient way to accomplish a specific task and then determining how much time should be allowed to do it.

An effective work measurement system and management information system are needed by the supply centers to monitor activities and identify opportunities to increase efficiency and decrease costs. NAVSUP management is currently relying on a more general management system that is not providing the necessary information. Managers, therefore, do not have an adequate basis for evaluating activity budgets, establishing

productivity goals, or identifying areas of inefficient labor use.

Two major weaknesses exist in the management information system that seriously inhibit effective determination of labor force efficiency and requirements. First, the information system is not based on methods analysis or labor standards and uses productivity indicators that are too broad. Second, the production and labor data that are reported often are not sufficient to allow meaningful comparisons between the amount of work produced and the amount of labor used.

1. Productivity Indicators

Supply centers use historical trends for broad categories of work to judge operational efficiency. However, these categories often include such a diverse mixture of work that historical productivity rates have little meaning in identifying labor force efficiency.

An example taken from the supply center at Norfolk will illustrate the problem of using a performance indicator that includes diverse mixes of easy and difficult work. The packing division's productivity rate in September 1984 was 16.1 cubic feet per person per hour. Production rates for the division's operating units were not visible. However, a GAO study developed rates for five of the operating units and discovered a range of rates from 6.3 to 35.0 cubic feet of material packed per person per hour. [Ref. 6:pp. 9-10]

The productivity range between operating units came from the different types of work performed. For example, the

flat and round metal unit constructs wooden crates to pack large metal sheets or long metal rods whereas the ocean freight unit places a sheet of plastic over material already packed in cardboard boxes and sends it through a machine which shrinks the plastic around the box. In the flat and round metal unit, five people take one hour to pack 31.5 cubic feet of material. In the ocean freight unit, one person packs 35 cubic feet of material in one hour.

The packing division rate of 16.1 cubic feet per person per hour is not, therefore, a good reflection of the efficiency of the operating units. Nevertheless, the supply centers use these summary indicators to identify productivity trends. These trends could be the result of changes in the mix rather than changes in worker efficiency. Even if a change in the productivity index was due to a change in labor efficiency, the supply center could not tell the operating unit responsible for the change. Thus managers are not in a position to identify inefficient operations or nonproductive workers.

## 2. Operating Unit Performance Criteria

Without a formal work measurement system, the operating units use various subjective criteria for measuring the performance of workers. At the NSC Oakland CA., one supervisor did the packing himself, divided the number of packs completed in half, and used the result as the criteria. Another used 80 percent of the prior year's production rate in bin operations to measure performance. Some NSCs used historical data and

personal experience to set the data, one even used engineered labor standards as the criteria for measuring performance. However, many of the standards used were outdated because the staff responsible for maintaining the standards had been reduced and those who remained were assigned other higher priority tasks. [Ref. 6:p. 11]

### 3. Production and Labor Data

Another complication arising from the existing management information system is that it does not contain sufficient production and labor data to allow meaningful comparisons and trend analysis.

The GAO used regression analysis to analyze the relationships between the number of work units produced and the number of labor hours required to produce those work units. They analyzed 24 major physical distribution cost accounts in 6 of the 7 supply centers in the management information system for fiscal years 1980 to 1983. They found no statistical relationship between the number of work units produced and the number of labor hours used for 64 percent of the cost accounts. This lack of a relationship ranged from a high of 77 percent to a low of 40 percent. [Ref. 6:p. 12]

An example from the shipping department at Oakland will illustrate the lack of relationship between the number of work units produced and the number of labor hours used. In December 1982, Oakland used 4312 labor hours to ship 12,361 tons of material. The following month the labor hours

increased to 4859 but the tons shipped decreased to 9390. In February 1983, the opposite situation occurred--the labor hours decreased to 3215 but the tons shipped increased to 9761. [Ref. 6:p. 12] The lack of a relationship was also evident from other functions.

Such wide and apparently inconsistent fluctuations cannot be explained using existing data in the management information system. More detail is needed before meaningful comparisons can be made. Since the current system does not provide the needed information, it is not an effective management tool for evaluating labor force efficiency. NAVSUP's latest productivity enhancement program is designed to correct these deficiencies.

### III. PAST PRODUCTIVITY PROGRAM

#### A. INTRODUCTION

Recognition of the need for using management engineering in the military services is not new. As early as the 1900's the military establishment applied engineered standards to some of its industrial activities. Because of restrictions in the appropriations acts, the use of time study was prohibited until 1949. When these restrictions were lifted, most of the attention around engineered standards was focused on work measurement. [Ref. 7] In 1952 NAVSUP (then known as BUSANDA, Bureau of Supplies and Accounts) initiated programs aimed at the development of engineered work standards including the areas of physical distribution and material handling. These programs, known as M.I.P. (Management Improvement Program), E.T.S. (Engineered Time Standards), E.P.S. (Engineered Performance Standards), and M.E.P. (Methods Engineering Programs), were the forerunners of the Defense Integrated Management Engineering System (DIMES).

#### B. BACKGROUND OF DIMES

The need for adequate manpower control systems was emphasized by President Johnson in 1962 when the Office of Management and Budget (OMB), then known as the Bureau of the Budget, issued Circular No. A-44 stating:

The President has stressed that responsibility for manpower control and utilization rests with the head of each

agency. Each department and agency will be expected to undertake vigorous and continued efforts to eliminate non-essential activities and positions, and to increase productivity by improved manpower control and utilization and strengthened supervision. [Ref. 8]

In response to Circular A-44, the Secretary of the Navy issued SECNAVINST 5310.8a as guidance to the Navy in January 1963.

This Instruction assigned responsibilities to the Chief of Naval Operations and the Bureau Chiefs to carry out the provisions of Circular A-44 that pertained to their speciality or command function. Specifically, the Navy Material Command (NAVMAT) was tasked to:

Coordinate--in producing that portion of the schedule having to do with work measurement, work standards, productivity analysis, organization and management studies, work methods, simpler systems and mechanization, management staff, contractor-in-house consideration, etc. [Ref. 9]

In April 1963, the Secretary of Defense, in DOD Directive 5010.5, established project DIMES as the principal work measurement system to be used in the Department of Defense. The aim of DIMES was to ensure that the managers of military industrial type activities had available to them the same proven, generally accepted industrial management techniques found in their best managed civilian industrial counterparts. [Ref. 8:p. 3] Because of NAVSUP's experience in the past with the previously mentioned industrial engineering programs, NAVMAT requested that they monitor the installation of DIMES (for supply operations) in Naval Air Stations (NAS), Naval Supply Centers (NSC), Naval Shipyards (NSY), Construction Battalion Centers (CBC), and Inventory Control Points (ICP).

NAVSUP's concept of DIMES and its application to supply functions was very similar to the ongoing program M.E.P. To avoid confusion and to facilitate the installation of DIMES, NAVSUP dropped M.E.P. and adopted DIMES. In other words, the program known as M.E.P. was kept intact but the name was changed to DIMES.

#### C. PURPOSE AND OBJECTIVES OF DIMES

DIMES was developed to:

improve labor productivity through the application of management engineering principles and techniques, and provide a common data base of work measurement and productivity data which can be used in developing budget estimates and manpower requirements, in planning and control, and in developing productivity performance indices relating to outputs. [Ref. 11]

The overall general objectives of the DIMES program can be summarized as follows:

- (1) To adopt the basic principles of industrial engineering to determine if methods improvements can be made;
- (2) To adapt these principles to individual station needs by using work measurement techniques to develop time and performance standards for each job. From these standards, workloads and manpower requirements can be projected;
- (3) To assure that a reliable management information system (MIS) is incorporated in the program to enable managers to make decisions based on accurate, timely and useful information.

#### D. THE IMPLEMENTATION OF DIMES

##### 1. Training

Before a program with the magnitude of DIMES could be implemented, a group of highly skilled and trained experts had

to be organized at the headquarters level. This group, originally called the Office of Management Engineering (OME), was responsible for implementation and monitoring of the DIMES program at NAVSUP activities. This office was the point of contact with commands entering the DIMES program. OME was responsible for establishing local Methods and Standards Divisions and conducting all training and orientation courses.

NAVSUP tailored the training for management because the program had different impacts at each level. The three levels for training purposes were top management (Navy officers and top ranking civilians), first line supervisors and productive employees.

In its presentation to top level management, NAVSUP stressed the overall importance of the program. In particular, the necessity for dedicated management support through all phases of implementation. Without management support, NAVSUP felt the program would have little possibility for success.

First line supervisors received virtually the same training but in greater detail. They were shown what information the program used and produced, as well as what application the information had for better management control of manpower and fiscal resources. Because the time to conduct a methods improvement study could take months, even for experts, knowledge of the system by first line supervisors was essential to enhance cooperation and smooth implementation.

Training the productive workers was not done by NAVSUP, but was left to the already trained first line supervisors,

through the use of activity newspapers and other written publications. Less formal, more basic concept explanations were used to make the program more easily understood by each employee.

Of utmost importance was the training of the methods and standards staff itself. Each member was required to attend an eight-week in-depth classroom training program where they were taught all known techniques of methods analysis in process charts, flow charts, frequency distribution charts, time study, random work sampling, Methods-Time Management (MTM), standard data and more. They were taught the steps necessary to accumulate these data into a valid set of standards of performance and finally to calculate the optimum staffing level. NAVSUP retained a representative at each activity for five to nine months to help guide the newly trained analyst through the first study. [Ref. 12:p. 22]. The size of the staff depended on the activity size and its mission. Regardless of the size, a basic goal for the staff was to produce more benefit from the work than its cost to maintain the staff.

Like the main objectives of DIMS, the implementation can be broken down into three stages: (1) pilot implementation study, (2) work measurement and standards establishment, and (3) installation of a reporting system. Figure 1 shows the flow of events during implementation.

A methods improvement study is a formal approach to improving work, tasks or methods. There are, in most industrial

# DIMES

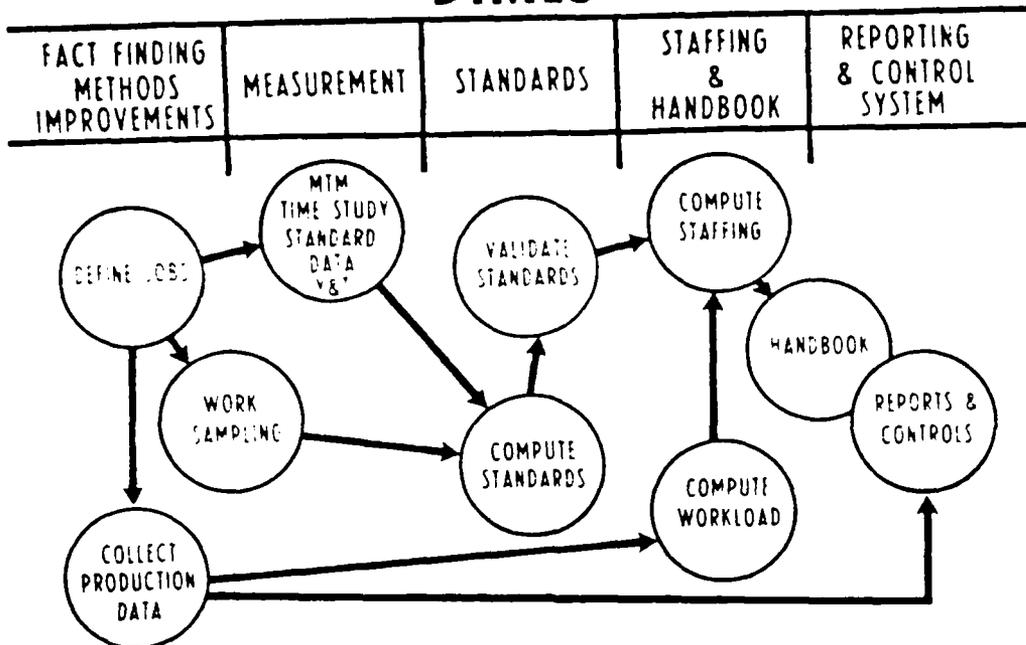


Figure 1. DIMES Implementation Stages

activities, many places where improvements can be made. The areas that should be studied first are areas that are high in volume, labor and machinery intensive and have a history of backlogs and bottlenecks.

## 2. Methods Improvement

The first step in a methods improvement study is a critical examination and documentation of the existing methods of doing the work. During this step the analyst obtains information on the mission of the activity, current personnel

organization and current work measurement units. They will review all documentation on current operating procedures, set-up work flow charts, develop process charts, look at previous surveys and set up personnel control charts. In preparing flow, process and frequency charts, every task is scrutinized, using the steps in Appendix A, for rules of motion economy and work place layout. Other industrial engineering techniques are applied in order to produce a more productive process [Ref. 12:p. 2]. Figure 2 is an example of a process chart used by an issue control branch of an NSC for material initial screening of requirements. Once the study is completed, the analysts review their findings with management and decisions are made on their approval and implementation.

After everyone has agreed upon the new methods to be implemented, a system for recording the output count (productive data) must be established for each task. Records of data must be kept during the entire implementation of the program. These data will be used later in the work measurement phase of the program.

### 3. Work Measurement and Standard Setting

The second stage of the program is measurement and establishment of time standards for each task. Measuring work is done by using several management engineering techniques. The techniques used in the implementation of DIMES were time study, work sampling, standard data and MTM.

Time study is the basic stop watch method. Each task is broken down into small elements. The time it takes to

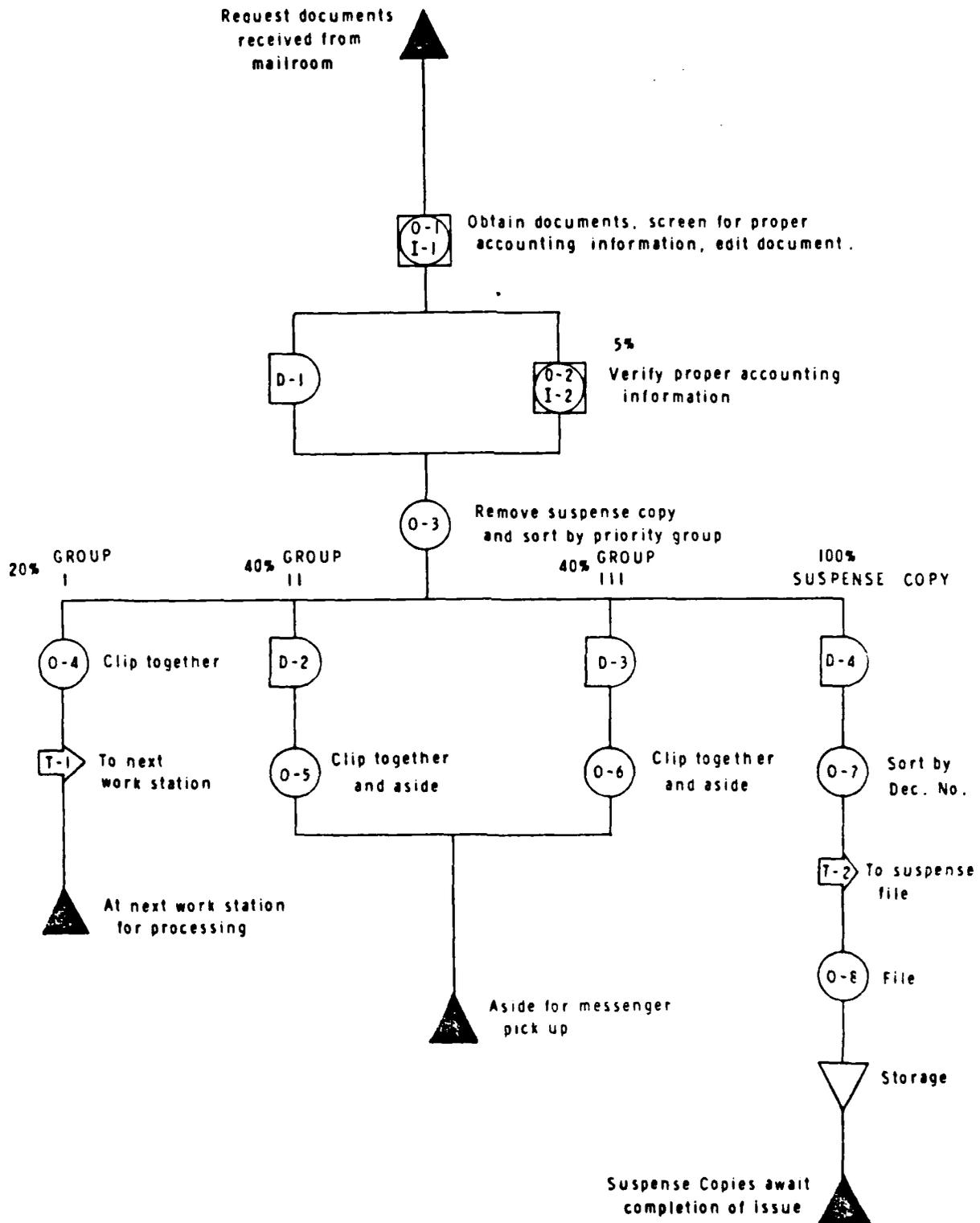


Figure 2. Flow Process Chart

perform each task is monitored by the analyst through several repetitive cycles to give him a statistically valid average time for performing the task. In other words, the results of the time study should show the average time it takes an operator with average skill working with average effort under normal conditions to complete the task.

The use of time study requires the analyst to make judgment calls about the skill level of workers. What he considers a highly skilled worker should perform at about 125-130 percent of the standard and a less motivated, less skilled worker would probably perform at 70-80 percent level of the standard. This average time standard is called a levelled time.

Before a standard can be set there is still more time to be added. Additional time added includes time for personal allowances, fatigue, breaks, lunch, unavoidable delays and other administrative duties that take employees away from the direct performance of their assigned tasks.

In MTM the tasks mentioned above are broken down into even smaller segments. These segments are analyzed through a coded system which describes the basic hand motions such as reach, move, apply pressure and grasp. The time it takes to perform these coded motions can be read from a standard table and summed to give the time allowed to perform a task. Because the times allotted to perform these tasks are taken from pre-approved tables of standards, the analyst is not required to use personal judgment as to skill and effort. [Ref. 12:p. 3]

The third technique, work sampling, is a fact-finding, technique based on the laws of probability. Through sample observations made at random, facts about the whole operation can be derived. Work sampling can provide basic data for determining allowances for break time, personal time, delays, etc. A standard can be set up using these data. Also, if the analyst applies the standard set by MTM and at the same time rates operator skill and effort, a levelled work sampling standard can be developed. [Ref. 14:pp. 13-14]

The fourth technique is standard data which simply adds the individual motion times determined through MTM together to form motion patterns for frequently observed activities. An example [Ref. 12:p. 4] is the basic "Get and Put Away" pattern found with almost any paperwork operation at a desk. The operator gets a pile of paper, performs the task with them and then returns them to the proper pile. The analyst recognizes this pattern so he can go directly to the prepared tables for the standard time without having to break down the entire motion pattern. The advantage here is in time saved during the study.

Depending on what type of activity is being measured, a work measurement technique is chosen and a standard is established. Most work could be covered by a logical mix of standards where both engineered and non-engineered (statistical) standards could be combined for a total measurement concept that best suits the operator and management.

Normally labor standards used in management engineering can be broken down into four distinct levels as shown by Figure 3 [Ref. 13:p. 33]. Detailed standards are the lowest level of measurable activity from which all other standards are derived. Intermediate level standards are a combination of detailed

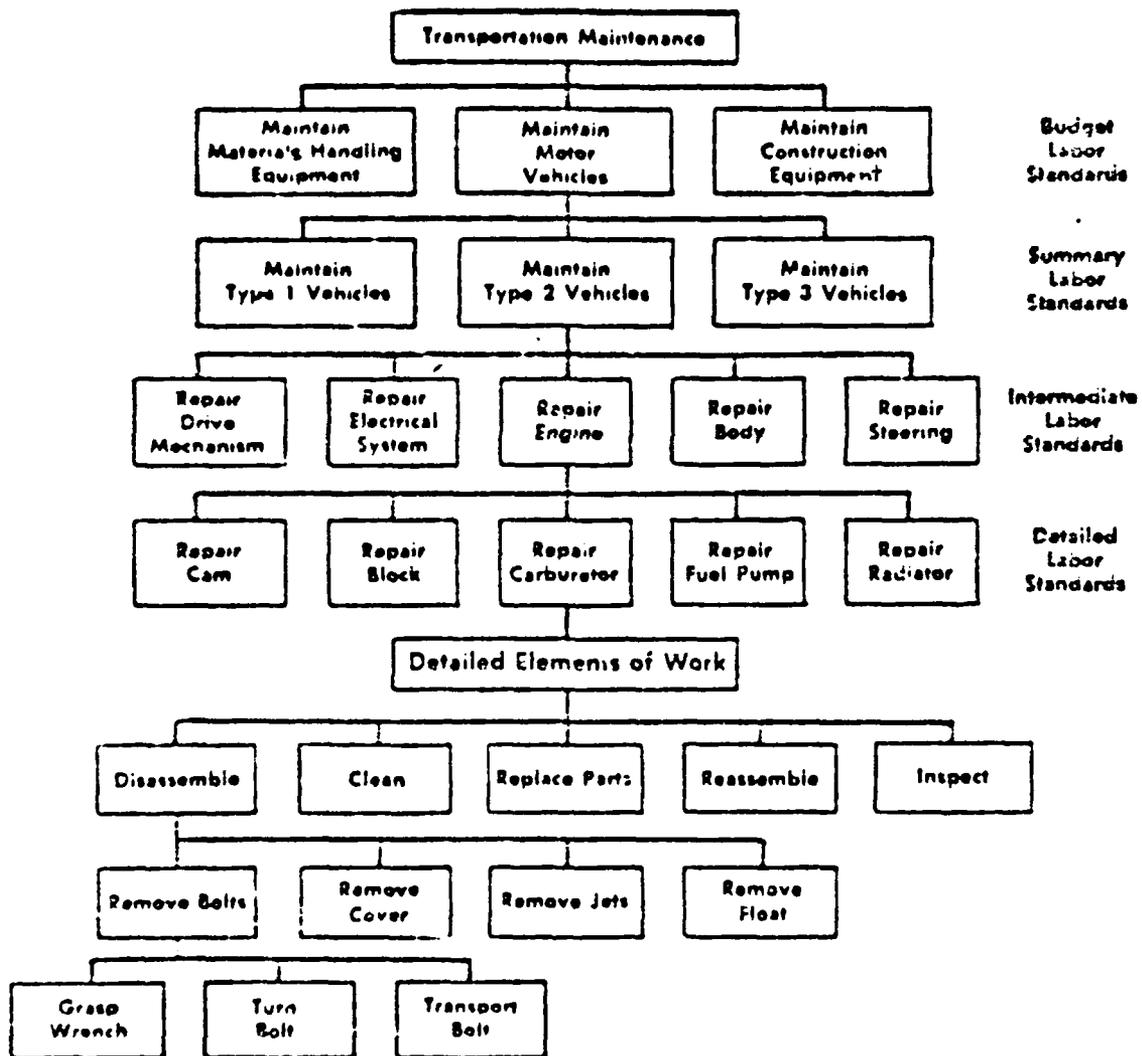


Figure 3. Level of Standards

standards for the next higher level of operation. Summary standards are the combination of all intermediate standards. They can be used to relate workload to mission, and to budget standards. These summary standards can be applied to workload projection by function, project or product to develop a budget estimate. [Ref. 13:pp. 35-37]

To determine the total manhours required to accomplish a task for a given day, the standard is applied to the average or forecasted workload. To that, allowances for supervision and other administrative requirements are added. Figure 4 gives an example of a typical staffing determination for a work center.

	<u>MANHOURS</u>
1. STANDARD MAN HOURS REQUIRED	
A. STANDARD HOURS X AVERAGE DAILY WORKLOAD	
B. .0091 X 2250 •	20.48
2. FIXED ALLOWANCES	
A. SUPERVISION •	6.02
B. SPECIAL REPORT •	10.00
3. LEAVE AND TRAINING FACTOR	
A. MAN HOURS REQUIRED X FACTOR	
B. 36.50 X 16% •	5.84
4. TOTAL MAN HOURS REQUIRED PER DAY •	<u>42.34</u>

Figure 4. DIMES Manhours Calculation

#### 4. The Reporting System

Once standards have been established, managers require timely and accurate information for the standards to be effective as a management tool. DIMES uses the 'earned hour concept' [Ref. 15:p. 2] which provides a quantitative representation of output to input. Forms are prepared for supervisors' use in collecting daily work count and actual hours applied against each standard. This comparative relationship between actual and earned hours provides the manager a measure of efficiency and identifies the mismatch of manpower to anticipated workload. Each installation may have its own reporting system tailored to its individual needs. The standard reporting document was the Methods Engineering Production Report NAVSANDA Form 1230. A copy of this form, along with a guide for its completion, is in Appendix B.

The Methods Engineering/DIMES Production Report was designed to provide production data in the form of man-hour distribution, work counts and performance measured by standards. Through this report an objective measure of group or individual performance was obtained.

Other uses for managers of the information generated by these reports were: [Ref. 13:p. 35]

- (1) forecasting workload,
- (2) determining manpower requirements,
- (3) determining standard costs of budget justification,
- (4) workload scheduling,

- (5) evaluating effectiveness of operations,
- (6) improving efficiency of operations by eliminating and highlighting excessive idle and delay time,
- (7) recognizing areas that need management attention,
- (8) providing a basis for incentive awards,
- (9) planning and controlling production,
- (10) justifying requests for additional manpower and equipment.

Another useful result of the DIMES study was the generation of a handbook. This handbook contains details of what jobs were modified, what jobs were performed, how the jobs were performed, the time to perform each job and the reporting system. It also contains flowcharts of the new processes developed, work sampling summaries and results of each measurement survey. These handbooks are useful to managers as training devices; to the DIMES staff as tools for follow-up action and review; and to personnel as complete job descriptions.

#### E. PROGRESS OF DIMES

When DIMES was first introduced, NAVSUP envisioned that approximately 80 percent of the personnel in supply functions at field activities would be covered by management engineering techniques [Ref. 16:p. 9]. As the program grew, techniques in work methods measurement and standards were refined, so soon the goal of 80 percent coverage was raised to 100 percent. NAVSUP felt that such a comprehensive coverage was necessary for standards to be fully integrated into the budget process. This 100 percent coverage did not mean every worker would be

monitored by engineered standards, but rather all operations would be examined for measurement within the limitations of available techniques.

1. Problems, Alternatives and Recommendations

DIMES coverage did not reach the NAVSUP goal for a variety of reasons. The two most significant were that (1) its application within NAVMAT was pretty much limited to industrial type activities such as shipyards, public works departments, production and supply departments (those with over 100 personnel assigned) and (2) the major portion of its implementation was left to the local commands with not much assistance from the claimants and SYSCOMS.

Additional problems with the implementation of DIMES were revealed by NAVSUP in 1966 [Ref. 15:pp. 1-4]. Progress in establishing additional coverage with engineered standards was not satisfactory. There was a steadily decreasing trend in planned initial coverage and at the same time decreasing performance in accomplishing the planned coverage.

The following list was determined by NAVSUP to be the major causes of these decreasing trends:

- (1) Uniform Automated Data Processing System (UADPS) in ICP. There was insufficient trained manpower to implement both UADPS and DIMES.
- (2) Competition for trained resources. Other areas and programs competed for these trained resources. Also, attrition had its effect.
- (3) NAVSUP's emphasis on NAS's and NSY's. Headquarters staff spent a major portion of their time in these two areas.

- (4) Reduced communication with NAVSUP field activities.
- (5) The glamour wore off. NAVSUP had been installing several different management programs in the previous years. Each of these programs competed for management's attention. Problems arose in determining program priorities.

After identifying these problems, NAVSUP proposed four alternate courses of action for the program:

- (1) retain status quo,
- (2) decentralize DIMES responsibility,
- (3) establish a stronger centralized NAVSUP control, or
- (4) reemphasize DIMES to management and define its objectives in more detail.

NAVSUP chose alternative four as their course of action. Their approach to this solution was multi-faceted. They published goals and reiterated NAVSUP policy towards DIMES. They conducted field visits for greater exchange of information and scheduled regular and special training for analysts. A final plan was developed which spelled out the goals and included a time table for their completion.

## 2. DOD Work Measurement Survey

Carpenter [Ref. 7:pp. 98-105] reported the results of a DOD Work Measurement survey taken in 1973. Responses to this survey were received from all uniformed services in the DOD. For this study, only the results applicable to the Navy (10 installations were surveyed) are discussed.

### a. General Findings

The general findings of the survey showed that approval of work measurement was not high among respondents

both as a group and within individual categories (supervisors, middle management, top management). The results showed that the higher the management level the more favorable the response. Personnel who indicated that they had training and were familiar with work measurement and the DIMES program responded more favorably than personnel who had no such training.

b. Cost Effectiveness

Forty-one percent of those who responded agreed that work measurement was cost effective; fifty-four percent thought otherwise. There was a large split between supervisors and top management on this issue with a greater percentage of supervisors disagreeing. According to the DOD study, this can be attributed to the fact that supervisors work closer to the work process and don't have the commitment to make work measurement succeed. [Ref. 7:p. 103]

The results of the survey also revealed that the majority of workers felt that methods improvement was more important than work measurement and not enough attention was given to this area. A great majority also felt that work measurement involved too much paper work.

To summarize, Carpenter [Ref. 7:p. 100] states "The case for the cost effectiveness of work measurement, as now practiced within DOD appears to be weak."

c. Control of Manpower and Workload

The survey results had strong support for work measurement being useful in the areas of financial planning,

manpower requirements determination, scheduling workload, work planning and control and financial management. But, the survey also showed that there was a general feeling that supervisors did not actually use these measurements.

Results showed that work measurement was effective for use in determining manpower requirements but not effective at justifying them, as over fifty percent of the respondents said they felt they were understaffed.

d. Employee Relations

How does work measurement affect employee morale? Approximately forty-five percent felt that it had an adverse affect; fifty percent felt it didn't. The most common complaints by respondents who wrote in were that work measurement was being used in areas it didn't belong, supervisors weren't using the data, people weren't properly trained to use the data or conduct the surveys and that the system was too difficult to maintain.

e. Survey Conclusions

Carpenter drew two conclusions from this survey [Ref. 7:p. 101]. The first is that the implementation of DIMES was constrained by a lack of clear definition of the program at all levels, by the lack of coordination between DIMES and manpower planning and by the inadequate measurement of DIMES' impact on the effectiveness and efficiency of the organization. Secondly, he felt that the existing DIMES work measurement system lacked coverage and credibility to be

useful as a management tool, lacked adequate support of management, didn't increase productivity and was resisted by employees.

### 3. Conclusions

The authors found no data to dispute Carpenter's conclusions concerning DIMES in the DOD study. These deficiencies, along with the funding cuts in the early 1970's, which severely cut the work measurement staffs, were the basis for the unsuccessful implementation of the DIMES program in the Navy.

#### IV. ENGINEERING THE WORKPLACE (ETW)

##### A. INTRODUCTION

As discussed in Chapter III, the use of management engineering approaches by NAVSUP to solve productivity problems in supply operations has been around for years. As management engineering techniques developed and were refined, NAVSUP incorporated many of them into practice at their field activities. In August 1984, NAVSUP (Code 06) issued the concept paper for the Program Objective Memorandum (POM) 87 titled "Naval Supply Center of the Future or Engineering the Workplace Naval Supply Center" [Ref. 2:p. 1]. The basic motivating force behind this concept was the feeling that NSCs did not have the proper management tools and techniques to provide an opportunity to improve productivity. This concept of ETW was to use a process approach in developing a productivity strategy evolving from the use of management engineering techniques for labor standards and scheduling. The strategy will be based on both the physical side (methods, equipment and space) and the managerial side (procedures, control and organization and information handling) of operations at field activities. This chapter discusses the major elements of ETW. Further analysis of the program will be provided in Chapter VII.

## B. BACKGROUND

NSCs are unique in the physical distribution functional area compared to private industry. While the actual functions may be similar, the methods to conduct them are usually quite different. Many national chain stores such as Sears, which have distribution warehouses throughout the country, operate each one using the same corporate plan for methods, procedures, reporting, etc. [Ref. 18:pp. 1-6] NSCs can differ from one another in a variety of ways. Each activity can have a different organizational structure which relates to their separate mission or function. The size of each in both physical space and volume of business varies considerably. The types of equipment used, the layout of buildings over the naval base, the types of buildings, all differ from one NSC to another. Because of these factors, NAVSUP wants to apply proven management engineering techniques used in private industry to the physical distribution function of NSCs in order to increase productivity and reduce costs [Ref. 19:p. 2].

## C. OBJECTIVES

The objective of ETW is "to improve effectiveness and efficiency of the physical distribution system" of the Naval supply system [Ref. 19:p. 21]. To achieve this objective, several smaller sub-objectives must also be reached. First is to determine what problems exist in the physical distribution system and then correct them. Another is to increase productivity by way of three separate measures: (1) quality of both

work being performed and management information; (2) quantity of work being performed and (3) timeliness of work and information. NAVSUP wants to improve the utilization of available resources, improve performance of the operating system, decrease the cost to operate the system and finally to provide a program which will continuously monitor for ways to improve methods and operations.

#### D. GENERAL DESCRIPTION OF ETW

At present ETW exists as a whole only in the Request for Proposal (RFP) stage. There are several prototype operations at different NSCs which are being used to test elements of ETW in actual practice. Chapter V will look at one of these elements taking place at NSC San Diego.

The elements of ETW have been broken down into four main tasks. Task A is a Materials Flow Study, Task B is the implementation of Statistical Process Control (SPC), Task C is a Work Scheduling and Control System (WSCS) and Task D is the installation of a Productivity and Performance Decision Support System (PDDSS). The contractor who will be awarded the contract to complete this project must be able to meet all requirements of each task.

##### 1. Task A--Materials Flow Study

In the materials flow study, the first step for the contractor is to conduct a baseline study of current material and paperwork flow. Because warehouse locations were based

on the current needs of the naval base at the time the requirements were identified, most NSCs have storage facilities dispersed throughout the naval base. Most of the buildings are old and were not originally designed for warehousing. Since warehouse locations can be so widely spread out, it is sometimes necessary to move large volumes of material long distances. Because of the layout of some of these warehouses equipment utilization may not be optimal. Also, when operating under these conditions, idle labor may exist in some buildings.

The contractor shall conduct an engineering work flow study of Base Material Flow with the objective to "improve productivity by minimizing movement of material on the Naval base" [Ref. 19:p. 6]. In conducting this study the contractor must be aware of current building and material storage constraints. In other words, he can't require that new warehouses be built or existing ones renovated. All recommendations must be based on proven systems in analogous commercial activities.

Other considerations the contractor must be aware of during the Materials Flow study are: [Ref. 19:p. 5]

- 1) The proposed system for improving material flow should be high quality and free from defects which might affect customer service. The system should be able to operate under the environmental conditions that are normal at the sites specified for study.
- 2) System should be safe, effective and efficient to avoid jammings and overflows at any point.
- 3) System should represent the state-of-the-art equipment.
- 4) System should be designed for simplicity and economy of all maintenance functions.

Once the system has been identified and approved, the contractor shall develop a plan to implement the system (to include costs, productivity improvements and recommended contractor assistance during implementation). The contractor shall also provide training and training material to the government in order to facilitate [Ref. 19:p. 7]:

- (1) Techniques for developing and implementing physical distribution operations improvement and labor cost reduction projects; and
- (2) Implementation of contractor physical distribution improvement recommendations.

The NSC shall be responsible for implementing the recommended improvements. The contractor can recommend and quote the cost of assistance in areas they feel require it.

## 2. Task B--Statistical Process Control (SPC)

The intent of SPC is to provide the NSC management with "a statistical process for the qualitative monitoring of the physical distribution process" [Ref. 19:p. 7]. The SPC system the contractor proposes must be one that has proven performance either in the government or private industry. The SPC system should enhance the physical distribution system proposed by Task A. Installation and implementation can be done in five stages: (1) conduct a preliminary survey; (2) conduct a detailed survey; (3) implement the SPC; (4) install the SPC; and (5) training the management and workers.

The preliminary survey is a survey of the existing physical distribution system at the activity. The contractor must provide a report of this survey to include:

- (1) a preliminary schedule of implementation and installation,
- (2) an analysis of the physical distribution system in each area showing strengths and weaknesses,
- (3) areas that have an acceptable work measurement unit and an approach to develop one for areas that don't.

During the detailed survey, the contractor shall establish "specific objectives and goals and a timetable delineating targets and dates for achieving goals" [Ref. 19: p. 8]. He shall also develop accurate work measurement units taking into account "quality, quantity, timeliness, output, and variables that are representative of the work functions being performed" [Ref. 19:p. 8]. Along with these work units the contractor must develop systems that use these units to measure productivity and utilization. The contractor shall seek assistance from NSC personnel while defining and developing these systems. The final responsibility of the contractor during the detailed survey is the development of an implementation plan for the SPC system.

Implementation of the SPC system requires the contractor to develop a SPC Automated Data Processing (ADP) software system that can be used with the work units and performance and utilization measures established in the detailed survey. It must be able to generate reports for all levels of management on a daily, weekly and monthly basis.

According to the RFP, the SPC system shall include:

A procedure for tracking, monitoring, and evaluating charts and related work study data developed in the preliminary survey or detailed survey and for taking corrective

action on an ongoing basis. The SPC system must be capable of programmatically monitoring standards, objectives and goals as they relate to the work units being recorded in the system. The SPC system shall be capable of statistically charting the quality control and inventory accuracy within the physical distribution system where the SPC system is applied. The implemented SPC system shall have the capability of generating control charts that represent the average sample data (X-charts) and the range variance (R charts) for the sampled data at any given interval of time (i.e., weekly, monthly, etc.). This shall include trend analysis of the charted data and the data shall be graphically presented by histograms and/or normal distribution curves for the X and R charts. [Ref. 19:p. 9]

The system must also be capable of being implemented at any NSC with little or no modification.

Once complete, the contractor shall be required to install and demonstrate the performance of the SPC system. Installation has the following requirements: [Ref. 19:p. 10]

- (1) System must have SPC management information software programs for on-line process control as well as detailed chart interpretation analysis.
- (2) ADP software must be user friendly with menu driven programs.
- (3) System shall demonstrate the SPC methods and procedures for measuring quality, productivity, timeliness. Tracking and monitoring against standards for specific objectives and goals and monitoring standards for quality, quantity and timeliness.
- (4) The contractor shall also be required to provide ADP documentation in accordance with Navy standards. [Ref. 20]

Finally the contractor shall be required to provide training and training material as outlined in Appendix C for the proper use and implementation of the SPC system.

3. Task C--Workload Scheduling and Control System

The RFP requires that the contractor:

design, develop, implement, and install a management system which shall include as a minimum, workload/manpower scheduling, productivity monitoring and reporting and utilization. [Ref. 19:p. 13].

The system shall have to be able to use ADP software to generate productivity reports to all levels. The system shall have to be able to relate work unit standards, utilization factors and objectives and goals established for SPC. It shall also have to be able to use data files that were developed for SPC and/or any other Navy approved data files.

Before implementing the system, the contractor shall be required to submit a Concept Paper that describes the proposed system design approach.

Once approved the contractor shall install the system to run on government furnished equipment. The contractor shall also provide training to management and user levels. [Ref. 19:pp. 13-14]

4. Task D--Productivity and Performance Decision Support System (PPDSS)

Once tasks A, B and C are complete, a system to integrate the information must be developed. In relation to this, the RFP states:

Now that we have a smooth flow of material through the Material Flows Program; and have increased the quality, quantity and timeliness or control of this smooth flow through Statistical Process Control; and defined what measurements we should use for productivity and utilization of resources through Workload Scheduling and Control Systems, we must complete this whole effort by deciding how

to determine the amount of labor required to get the job done. This system will provide a tool for the command at the department levels to better manage resources and workload at NSCs to achieve the objectives stated.

[Ref. 19:pp. 14-15]

The objectives referred to in this quote from the RFP are the same as those presented in Section C of this chapter.

Before the development of the PPDSS the contractor reviews the current system used for determining, acquiring, allocating and scheduling resources. Into the design he must incorporate the SPC system and the WSC system to include work units, standards, utilization factors, goals and objectives.

The PPDSS shall have the following requirements

[Ref. 19:pp. 15-16]:

- (1) Maintain data/information on work units for quality, quantity, and timeliness to include measures, standards, objectives, goals, performance criteria, utilization factors and cost.
- (2) Be able to roll up productivity and performance data for work units to higher echelons across the NSC.
- (3) Be able to roll up productivity and performance data at the NSC level to have one aggregate measure for Headquarters to monitor performance and compare one NSC with another. If one single unit can't be attained, use the minimum required.
- (4) Measure and project workload for work units and rollup of work units.
- (5) Measure and project work accomplishment by unit and rollup of units.
- (6) Determine effectiveness/efficiency and utilization by unit and rollup of units.
- (7) Compare performance and productivity and cost of work units and rollups.
- (8) Determine and project resource requirements.

- (9) Cost and project cost of past and projected workloads.
- (10) Compile periodic (month/quarter/annual) management reports as follows for work units and management rollups (Branch, Division, Department and Activity): productivity (quality, quantity, timeliness), performance, utilization, cost and resource requirements.

Like the ADP software systems discussed earlier in the chapter, the PPDSS shall be capable of running on government furnished equipment. Documentation will be as required by Reference 19. The contractor will provide training on system use and implementation to all management and user levels.

#### E. HEADQUARTERS SUPPORT

Once ETW is up and running in the NSCs, NAVSUP intends to remain very active in monitoring the program. A headquarters staff comprised of industrial engineers, supply system specialists, quality control specialists, budget analysts and distributors, facility specialists and procurement specialists will be organized to coordinate productivity projects and manage contractor efforts required in developing engineered work standards throughout all functional areas. The staff will also monitor the systems already in place as well as continually search the private sector for more ways to enhance productivity. NAVSUP believes that applying engineered standards to the workplaces will result in a systematic reduction of end strength across all functions involved in this program. [Ref. 2: p. 3]

## V. STATISTICAL PROCESS CONTROL (SPC)

### A. INTRODUCTION

Before the full application of ETW, NAVSUP initiated prototype projects at several NSC's. The purpose of these projects is to "test the techniques and to prove out their application in our arena" (physical distribution function) [Ref. 2:p. 1]. NSC San Diego is currently the test site for application of SPC. Specifically, we will look at SPC's application to the subsistence function. To begin, we will give a short explanation of SPC and its use as a management tool.

### B. SPC THEORY

Perfection, in any operation, whether it be a production process, an accounting function, or physical distribution, is virtually impossible to achieve. Because of this, managers must be satisfied with imperfect operations (as long as they fall within an acceptable range). Managers can use SPC to determine if the process being studied is operating within acceptable limitations (in control) or not within acceptable limits (out of control). Originally, SPC was a tool for quality control in production processes. Now though, SPC has many other applications. In this chapter, we will discuss SPC's use in measuring productivity.

Control charts are the fundamental management tool of SPC. They are used in the daily control of the process in question.

Charts are constructed using sample values drawn from the population which the manager is trying to control. Plotted against time, these values can give the manager a measure of the degree of variability in the observations, which in turn give him an idea of what variance is probably random and what variance needs close management attention.

The two types of control charts we will discuss are the  $\bar{X}$  (average mean) chart and the R (range) chart. The  $\bar{X}$  chart is used to indicate changes in the average of the samples taken while the R chart is used to indicate changes in the spread of the highest and lowest values in that same sample.

The construction of  $\bar{X}$  and R charts are quite similar. The first step in the construction of the charts is to take samples. After the data are collected, the average and range of each sample observation are calculated. After this, control limits must be set. The size of the control limits depends on how tight a standard management requires for the particular population being observed. In theory, with control limits of plus or minus one standard deviation from the mean (assumes a normal distribution), approximately sixty-eight percent of the observations should be within the limits. With plus or minus two standard deviations as the control limits, approximately ninety-five percent of the observations should be within the limits; with plus or minus three standard deviations, approximately ninety-nine percent. By visually analyzing the data on the charts, management can determine when corrective action is necessary in the process.

Two types of variation affect the observation. They are random variation and assignable variation. Random variation is expected in most processes and occurs without any pattern. Assignable variation is systematic and requires management attention. Figure 5 is an example of assignable variation in an  $\bar{X}$  chart.

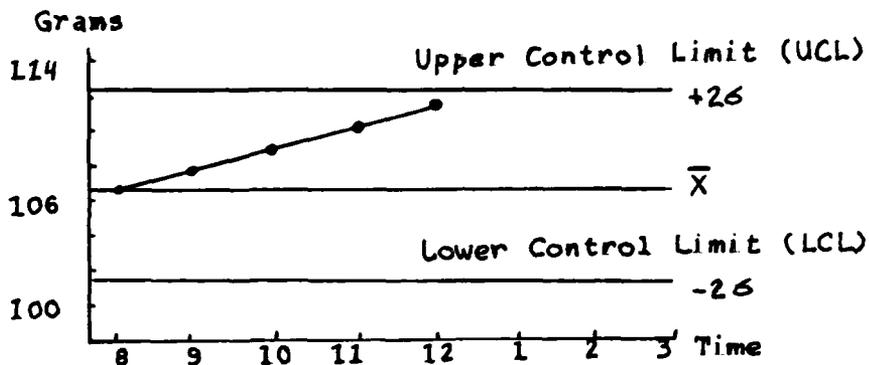


Figure 5. Assignable Variation (A)

In this example, there is a trend developing in the data which indicates the mean is actually moving upward and will soon be out of control. Management should not wait for more observations in this case, action is required now to determine the cause of the trend. Figure 6 is another example of assignable variation. Although the observations are within acceptable limits, the mean has obviously shifted upward and the cause must be investigated.

Some advantages of using mean charts are that they do not require skilled personnel to maintain them once they are set up.

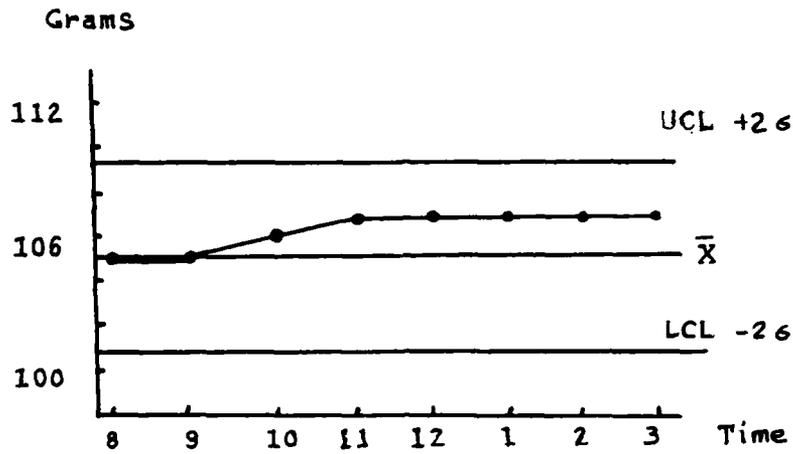


Figure 6. Assignable Variation (B)

They require very little management time. They allow managers to use management by exception. Mean charts are excellent for detecting problems before they get out of control and for recognizing what type of problems are causing the variation.

Although effective when used separately, it is essential for management to use  $\bar{X}$  and R charts together. This is because in some situations the use of just one chart may not accurately portray the correct situation.

For example, Figure 7 shows a situation where the mean ( $\bar{X}$ ) is changing, but the range is the same. If the manager had looked only at the R chart, Figure 8, he would have assumed all was well and would have done nothing to correct the process. But, had he also looked at the  $\bar{X}$  chart, Figure 9, he would have recognized a trend going out of control.

The same is true for the reverse. Figure 10 shows that the mean is staying the same but the range is increasing.

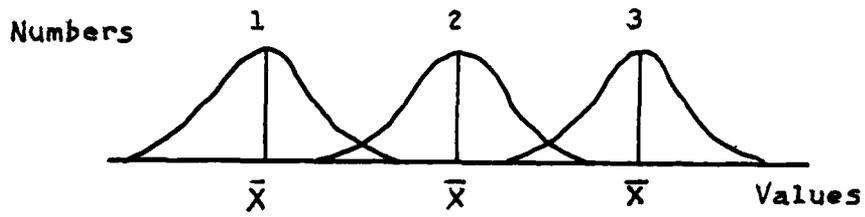


Figure 7. Mean Shift

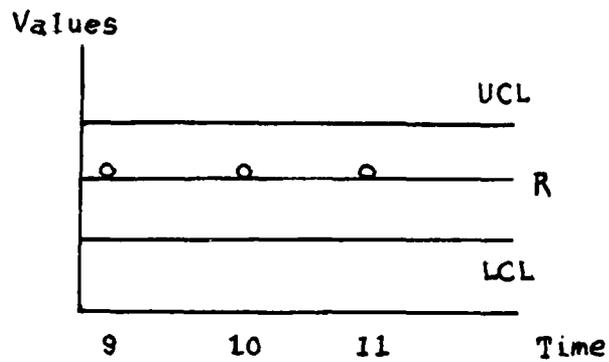


Figure 8. Mean Shift R Chart

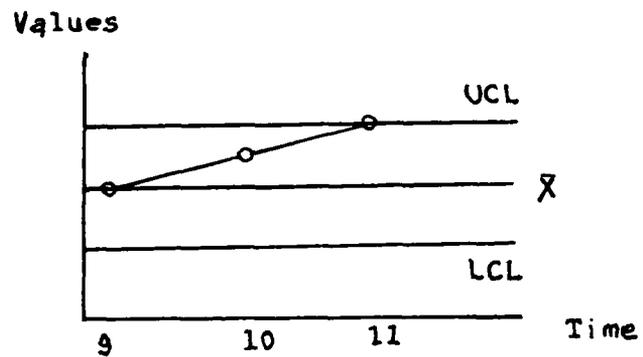


Figure 9. Mean Shift  $\bar{x}$  Chart

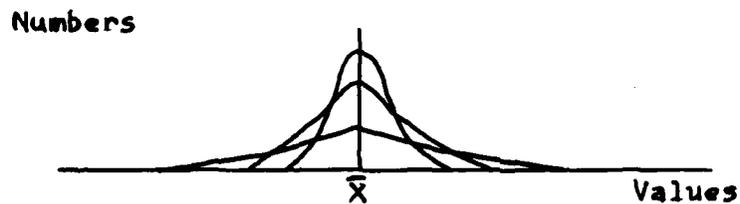


Figure 10. Range Shift

If the manager had seen only the X chart, Figure 11, he would have assumed all was well in the process.

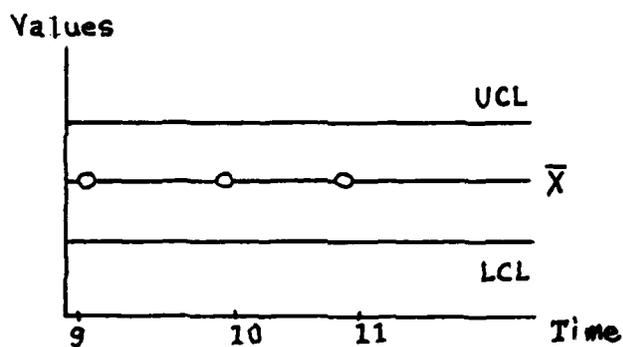


Figure 11. Range Shift  $\bar{X}$  Chart

But if he had also seen the R chart, Figure 12, he would have seen the trend starting to go out of control [Ref. 23:pp. 440-458]. For effective management control, it is essential that both X and R charts be used together.

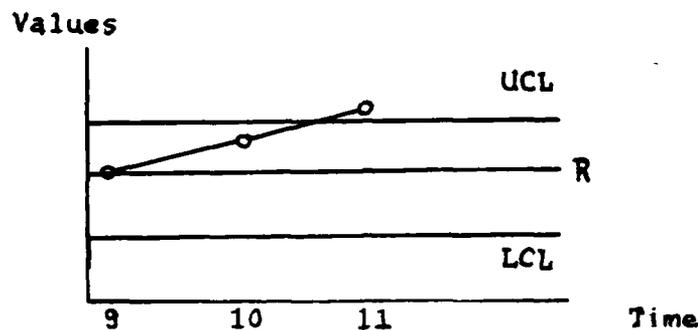


Figure 12. Range Shift R Chart

### C. SPC APPLICATION AT NSC SAN DIEGO

#### 1. Purpose and Objectives

The contract for the pilot project to implement SPC at NSC San Diego was awarded to Perry Johnson Seminars, Inc. (PJS), of Southfield, Michigan. In its detailed survey of the SPC project, PJS [Ref. 23:p. 2] explained that the purpose of the detailed survey and analysis was to:

more specifically define the targeted improvements, weigh the possibility of effecting these improvements and implement--where possible--techniques which would immediately enhance quality and/or productivity.

Any changes to the physical distribution system offered by PJS shall include consideration of:

- 1) Quality--as measured by the number of errors that are made in the issuing and receiving functions;
- 2) Quantity--total output (per group or person);
- 3) Timeliness--response time to accomplish a task; and,
- 4) Utilization--ratio of capacity used to capacity available.

## 2. Method

In order for SPC to be useful there has to exist a technique to measure output. This measurement must be valid (a true representative of actual output) and reliable (will always generate the same results under the same conditions).

PJS's research into past techniques used for measuring output in physical distribution was unable to yield much useful information. Consequently, PJS developed its own measurement approach.

In selecting its measurement method, PJS compiled a list of indicators it felt were important in evaluating performance. They were: [Ref. 23:p. 4]

- (1) Percentage of time spent in constructive tasks versus percentage of time spent in non-constructive tasks.
- (2) The industry of a given worker performing a given task.
- (3) The industry of a given department during a given time period.
- (4) The effect of a given individual on the productivity of a given department.
- (5) The performance of one individual relative to another.
- (6) The effect of a given individual on the quality of a given department.
- (7) The performance of a department relative to a given warehouse layout.
- (8) The performance of individuals relative to a given warehouse procedure or method.
- (9) The performance of an entire department relative to a given warehouse procedure or method.
- (10) The performance of a given segment within a given department relative to a given procedure or method.

To collect this information, PJS chose the Work Study method. The Work Study was used to obtain information about the process--specifically the time to complete each task. Along with the subjective evaluation of a worker's performance by the supervisors, Work Study was used to evaluate problem areas. PJS is developing a software program to monitor the subjectivity of information. This way invalid and unreliable information could be excluded. PJS conducted interviews with foremen to get their opinions of the current strengths and weaknesses of the physical distribution system. To help develop a better measure of quantity, time studies were conducted.

### 3. Application to Subsistence Function

PJS, based on its Work Study, found that the current method of measuring productivity in the subsistence function was very inadequate [Ref. 23:p. 32]. The current method measured quantity of work by the number of line items processed. No distinction was made between one line item that had one piece to process and another line item that had 1000 pieces to process. Because workers and foremen recognized this disparity, they seldom paid attention to reduced or varied daily production reports. Other problems related to use of this measurement technique as identified by PJS [Ref. 23:p. 32] were the inability of the foremen to measure individual productivity and the inability to compare one worker to another.

Using the information obtained in the time study, PJS [Ref. 23:p. 41] suggested that the subsistence issue operation be divided into three groups of work: (1) processing a



For control chart purposes, units per manhour are charted in the subsistence function. Appendix D gives an example of the control chart used at NSC San Diego and the data used to construct it, along with possible explanation for trends. The average is a moving average based on actual performance. Charted values are the cumulative output for the day being observed.

PJS has proposed new measurement units for SPC charting in several other physical distribution functions. As of this writing, they have not been approved for use in the prototype project. Other areas addressed in the detailed survey stage but not approved for use include a new quality control sampling procedure and a pay incentive plan for workers. Initiation of these programs are due to start with the follow-on contract for SPC to be awarded in the fall of 1985.

## VI. MATERIAL HANDLING IN PRIVATE INDUSTRY

Everyone involved with material handling wants to increase productivity in warehouses. Increased productivity means lower operating costs and increased profits, thus positioning a company in a solid competitive stance for future activity. Other than price increases, improved productivity is the only means by which a company can offset the effects of inflation. The opportunity for improving productivity in physical distribution is a continuing one with advancements being made in computer software, automated equipment, and robotics utilization. The problem consists of making the right choices to enhance the productivity of a particular firm given its unique characteristics.

Grocery distributors routinely handle large quantities of goods usually by very labor-intensive methods. The grocery material handling industry is analogous to the subsistence handling warehouse function at the NSC's. Numerous productivity programs are in use in private industry. Size, volume, throughput requirements and automation all have an impact on the design of these programs and the type of program chosen. In this chapter, two such programs are analyzed.

### A. RALPH'S GROCERS

Ralph's Grocers operates a conventional warehouse in southern California to supply its 200 stores. Ralph's uses

two computer programs--On-Line Warehouse Management System and On-Line Labor Management System--and a labor incentive program for its order pickers and forklift operators to enhance their productivity. They have been marvellously successful and provided an example for grocery distributors that has been widely emulated.

Sometimes a store will run out of a product for reasons over which they have no control--demand for the product may be so great they have difficulty keeping it in stock; or the product itself may be in short supply. Sometimes it's not the product but the warehouse system itself that has caused the shortage. Here's an example. All of Ralph's stores place weekly orders. An average of ten cases per week have been shorted or not shipped due to a weakness in the warehouse system. Some of the reasons for these shortages were that the product was shown in their inventory records but they couldn't locate it in the warehouse; the product wasn't reordered on time because they didn't have up to the minute inventory count; the product was delivered to them by the vendor too late to be entered in their inventory file that day; and merchandise wasn't transferred from reserve stock to the warehouse in time to be selected and shipped to the store. These problems have resulted in lost sales, but Ralph's now has a system to solve these problems.

Prior to this system's implementation, Ralph's top management had known for some time that they needed a more modern,

efficient, and effective warehouse system. The reason was obvious. They were doing a tremendous volume of business and the old system was not designed to handle it. In analyzing their future warehouse needs, they established four major objectives: (1) better product control from the time the merchandise entered the warehouse until the time it was shipped out; (2) quicker, more accurate methods of physical inventory; (3) more efficient receiving and replenishment procedures, and (4) improved utilization of existing warehouse square footage. An examination of Ralph's old system and their new system will readily reveal whether or not these objectives were attained.

But first some statistics will present a more graphic picture of the challenges faced by Ralph's in fulfilling their material handling requirements. They operate two grocery warehouses--each receiving up to 400,000 cases each week. That's close to half a million units that have to be received, processed, handled and stored every seven days. They select and ship more than 200 store orders each week. Their stores all have different delivery requirements and receiving schedules. Their shipments of store orders have to match these individual requirements. During seasonal item peaks and promotional phases, their facilities are filled to overflowing with no usable storage space. It's amazing that their old system functioned as well as it did. With the introduction of the On-Line systems, problems of this nature became problems of the past.

## 1. On-Line Warehouse Management System

To better understand this system, think of it as a simulation model of the warehouse that runs like the warehouse itself--a computer model warehouse. The system model contains all the locations and dimensions of every selection slot and storage area in the warehouse and the current item and case quantity of every item in every slot. The computer knows where everything is, where it can be moved and how it should be moved for efficient storage, selection and rotation of product. The computer model also contains information on where specific products are to be stored for selection and for reserve storage purposes. The computer contains all the necessary information for the movement of merchandise in and out of the warehouse. Warehouse Allocation Control Tables are used to program the computer model. These Tables set all the parameters for the storage of products. The program allows all the dimensions regarding the placement of products in the warehouse to be made, ensuring maximum utilization of existing space.

To illustrate the advantages of this system, we'll process the receipt of a product by the warehouse under the old system and explain the differences. Under the old system, as a product was delivered to the warehouse, a computer printed worksheet had to be checked to verify the receiving according to the purchase order. Then each item had to be manually checked to ensure that it matched the item ordered. Under the new system, computer terminals have been located in various

locations throughout the warehouse. As a product comes in, the original purchase order is called up on the screen. The information on the screen is matched with the information for the merchandise being delivered. If everything matches, an entry is made to signify the transaction is complete and correct. Under the old system, after the product was checked in, pallet labels had to be prepared. They were filled in with the date the merchandise was received, the stock code number and the selection slot. After these labels were placed on the pallets, a forklift operator would take them to the assigned selection slot or find an available place for storage. Watch what happens with the new system. Once the receiving is verified on the terminal, the computer printer will automatically print a label for each pallet of merchandise received. Based on warehouse allocation control tables, the computer will decide in which slot the pallet should be placed. The pallet label contains vendor name and number, a description of the product, pallet tie and high, the size of the pallet, and where the pallet is to be placed in the warehouse. The forklift operator will not have to search for an available slot. The computer knows which slots are full and which are empty. This is based on the simulated model of the warehouse in the memory bank of the computer. After individual pallet labels are printed, a summary label is printed--it summarizes all the information for that single receiving. It shows where every pallet will be placed in the warehouse. It

provides a convenient way to track down and confirm discrepancies or errors in vendors' deliveries. So the advantages of the new system are that the pallet receiving labels do not have to be made by hand, the forklift operator doesn't have to search for an open slot, and the summary label provides all the information needed about the products received, including where they will be stored.

One of the most important features of the new system is inventory control. As merchandise is received and verified on the terminal, inventory is immediately adjusted to reflect the change. Under the old system, inventory update would not have been made until the next day. This on-line system provides immediate notice of what's in the warehouse and where it is in the warehouse.

The order selector is the next person who is influenced by the warehouse system once the product has been received, verified, labeled and put away. The order selector receives computer-generated selection labels. Using these as his guide, he selects the store orders, moving from one selection slot to the next. Under the old system, when an order selector came to an empty slot, he would have to alert a forklift operator who would then have to locate the merchandise and bring it to the selection slot. Since there was no way to identify a storage area, the forklift operator would have to start searching for the merchandise. This procedure is improved by the new system. At the time store billing is done, a new report

called a letdown schedule is prepared. It's a separate set of labels. It establishes the time a particular pallet should be moved to the selection slot based on the store delivery schedule. This letdown schedule enables forklift operators to replenish slots before they are depleted. With this on-line system, Ralph's knows exactly what's in their inventory at any given point in time. As store orders are filled, the inventory is continually updated on-line. Computer-generated letdown schedules ensure that a product will be available for selection at the time it is needed. Thus the order selector and the forklift operator can work more efficiently at their jobs. The handling of merchandise will be expedited and store orders will be processed and shipped, with a minimum of delay, on schedule. In addition to finding the proper space to store incoming products in the warehouse, the computer also provides for the proper rotation of products. It always finds the oldest product first and selects it for shipment to the stores. So the first product in will be the first product out.

This On-Line Warehouse Management System gives Ralph's greater product control, provides them with better replenishment and receiving capabilities and allows them to better utilize every square foot of warehouse space. Another feature of the system is its ability to facilitate quick, accurate, physical inventory. Computer-generated inventory sheets called count books make it easier for them to count the

warehouse merchandise and compare it with the inventory in the on-line system file. Adjustments are made immediately--on-line. Each individual slot is updated to reflect the actual inventory count. Store returns, damaged merchandise and special orders are processed immediately to allow them to reflect an accurate inventory count. The primary objective of this new system is to control the daily movement of merchandise through the warehouse, but it actually allows them to do much more. It helps the warehouse staff do a more efficient job by providing them with a better way to do it and improve service to all of Ralph's stores.

## 2. On-Line Management System

In conjunction with the warehouse management system, Ralph's also uses the On-Line Labor Management System. Work to be done in the warehouse is packaged into standardized assignments. The system uses a foundation of time and motion standards defined by industrial engineers. These standards define the one best way to accomplish a task and determine a standard time allowed to perform it. Once these standards have been identified, data tables are generated. These are used in the calculation of standard times for each assignment. These standards are summations of the various small tasks that comprise a work assignment and are specific to type of work, type of equipment, cube, weight, personal and fatigue allowances and distance and location within the warehouse. The system for Ralph's employees is described below.

a. Order Pickers

Upon receipt of his specific work assignment, the employee keys in his unique employee code and assignment onto the warehouse screen. The start time is automatically recorded. This screen provides the employee with a performance recap of his previous assignments and verifies his current assignment. Based on data tables which describe the warehouse, the distance and travel time to the first slot from which the merchandise will be picked is calculated. Standard time at each pick slot is based on slot height, case pick, cube and number of units. The system continues to add standard time until an assignment break time is reached by either cube or weight. At the assignment breakpoint, credit is given for such activities as travelling to the loading dock, stretch wrapping pallets and loading the truck. Upon completion of the assignment, the worker returns to the screen area for another order.

b. Forklift Operators

To guide the forklift operators in replenishing the pick slots, letdown labels are generated once for each store billing. The labels are printed by warehouse section, in wave, and slot sequence. A wave is the means the system uses to synchronize letdown and picking activities and is directly related to the number of stores whose orders will be selected at approximately the same time. As with the order selector, the forklift operator keys his own assignment onto

the warehouse screen. The system follows the path the forklift operator will take and credits him with such things as travel time, slot level, lift time, personal and fatigue allowances and any other table defined activities. Unlike order selectors, forklift operators may move in any direction in the aisles. The system calculates and assigns the fastest route between two letdowns.

c. Screens

The menu screen is an index to the various labor management functions. Each function has its own screen. The screen to start or finish a standard work assignment is used by the employee or management to start or stop a standard work assignment. The screen to start or finish miscellaneous assignments is used by management to assign nonstandard functions such as loading, warehouse maintenance, etc. The screen to adjust assignment details, post delays is a multi-function screen used for posting individual delays, including equipment delays, battery changes or making corrections on assignment details. The screen to add, change or delete employee information is used to maintain current employee status such as full time, part time, probation, shift and days off. The screen to input each day's hours and employee work is used by management at the end of a shift to verify the amount of time worked according to the individual employee's time card punches. There are two inquiry screens. The first contains current employee information and is a summary of past and current

individual employee information. The second inquiry screen provides answers to individual assignment queries on standard work assignments. The screen to change past time is used to update previous weeks' history such as standard time, time on standard and incentive information. The screen to assign delay is used for posting group delays such as breaks, lunches, meetings, etc. A final screen is used as an audit inquiry for capturing incomplete employees' hours worked at the completion of a shift.

d. Reports

A broad variety of reports is produced by this system. Some of these include a daily recap, daily audit trail, shift performances, labor history and delay reports by code. These reports are used by management to evaluate the performance of individuals. Employee reports are posted on inhouse bulletin boards so individuals can see how they rank with their peers and various information concerning incentive statistics. In summary, Ralph's On-Line Labor Management System enables management to exercise its best judgment and expertise in assigning the available labor to the shift's work in the most efficient manner before the shift begins.

Appendix E contains a complete description of the labor standards used by Ralph's, including the computation of incentive pay.

In managing a conventional warehouse, Ralph's has identified the most efficient use of warehouse space, and

through engineered work standards has identified the one best way to accomplish each work assignment in the most efficient time. To motivate its employees to complement this effort, Ralph's instituted its labor incentive program. By providing employees with a choice of either more money or time off for exceeding the standard output, Ralph's has more than recovered its costs in instituting this program and its productivity is still improving.

#### B. ASSOCIATED GROCERS OF COLORADO

In contrast to Ralph's, we will now look at a company that has a heavier reliance on automated equipment to make it less labor intensive. Associated Grocers of Colorado recently installed three separate computer control systems, along with a variety of racking, conveyor systems and automatic identification equipment in their distribution center in Aurora, Colorado. Since this facility began operating, the automated systems have combined to increase the throughput of the warehouse from 130 to 350 cases per hour; increased the throughput of nonconveyable groceries from 130 to 190 cases per hour; increased picking accuracy; and cut the number of required fork trucks in half.

In the distribution center, workers pick cases of grocery items from three walk/pick modules. For slower moving items, other workers ride on pick cars and select items from storage racks. Bar code labels are applied to the top of each case as it is picked.

After being merged and sorted into orders to be delivered to retail supermarkets, grocery items are conveyed to the dock, loaded into trucks and delivered.

Computers are at the heart of the Aurora operation. Three separate control systems oversee the flow of goods through the facility and help ensure that retail supermarkets receive the grocery items they should.

The computer breaks orders up so that the work load is balanced at all palletizing stations and at the shipping dock. They have such a variation in size of orders that it is critical that the work load be balanced if productivity is to remain high. These control systems also ensure that the proper cases are shipped to the proper store. They help minimize human error and increase efficiency.

The mechanized portion of the distribution center consists of order selection modules where items are stored in pallet racks, a mezzanine where the merge and sorting systems are located and the shipping dock. This portion of the warehouse handles 80 percent of the company's grocery cases and 92 percent of the grocery items. The balance of the stock is non-conveyable and is handled one order at a time with conventional equipment such as pallet jacks. However, even this section of the warehouse is under computer control.

The main control system is linked directly to the company's host computer. After receiving a list of the day's orders from the host, the control system prints a report showing the weight,

volume and cases grouped by selection department for each retail store in that batch as well as for the total batch.

The system simultaneously prints a historical average for each store to which the order can be compared. A manual operator checks that day's orders to ensure that none is too large or too small. Once this is completed, the control system groups orders into picking waves that consist of up to 22 orders or stores per wave.

The forming of waves by the control system is aimed at achieving optimum use of the equipment on the shipping dock. If the operator doesn't like the waves the computer creates, he can use the keyboard terminal to change any of them.

Once the picking waves are set, the control system generates the printing of bar code labels. While labels are being printed, the computer breaks orders into selection assignments and standard work times. The standard times take into account the weight and volume of cases to be picked and the distance between items to be picked.

After all items are picked, sorted and loaded at the dock, this same control system produces a printed receipt for each store, taking into account any items that were ordered but not shipped from Aurora. Previously, Associated Grocers checked shipping accuracy using handwritten documentation created before the truck was loaded, not after.

A second computer control system identifies each case by store and product, using information taken from the bar code

label on each case as it's scanned. The bar code indicates the product contained in the case and the store that ordered the case as well as the proper shipping lane.

At the end of each wave of picks, the computer produces a report that lists items that should have been scanned but were not. The shift supervisor then uses the report to take corrective action and ensure that each order is filled as accurately as possible before shipment.

The third computer control system tracks the quantity of cases that exit each pick level of each pick module. Optical scanners are used to count each case as it moves past a certain point on a conveyor. The control system updates the display screen in the control room every ten seconds with the quantity of picked cases coming out of each level.

During picking, this same control system estimates the time required to complete each wave of picks. A supervisor in the control room uses information display on the screen to make certain that all picking ends at about the same time.

Once orders are received in Aurora and all bar codes are printed, workers pick fast-moving items from the three walk/pick modules, as well as slow-moving items from two pick car modules. All modules contain pallet loads of goods stored in gravity flow racks.

Each walk/pick module is 500 feet long. All modules but one contain pallets three deep in racks on each side of the aisle. The floor level of one module is set up differently.

Here, pallet loads are five deep on one side, and one deep on the other. Fast-moving items are stored on the five-deep side, and returned goods are stored on the other.

The pick car modules contain pallet loads six high and two deep on both sides of each aisle. The picker rides on the car and raises or lowers himself using an automatic lift. The car straddles a conveyor used to move picked cases away from the car.

After cases are picked and the bar code labels applied, the cases move along the overhead conveyors prior to the merge point on the mezzanine. At the merge point, an operator sits at a control console which is linked to the computer system. He uses pushbuttons on the console to control the flow coming into the merge point from 13 conveyor lines. A terminal screen guides the operator, who ensures that none of the lines becomes completely full of picked cases.

If a conveyor line becomes full, the control system automatically shuts down the pick line that feeds that conveyor. Because this decreases productivity, the merge operator tries to make certain that no line becomes full by balancing the release of cases from all the accumulation lines in the system.

After picked cases are merged, they move under one of two bar code laser scanners. Each sorter can sort up to 75 cases per minute. After scanning, cases are diverted onto one of fourteen shipping lines by pop-up wheel diverters. If necessary, an operator uses a hand-held scanner to read case labels. As

a last resort, the operator can manually encode the desired shipping line into the microcomputer using the keyboard. For small orders and special orders, Associated Grocers has installed a mini-sorter that allows these orders to be handled with the same efficiency as larger ones. Any case that contains a bar code label that cannot be read moves to a recirculation line that feeds back into the sort conveyor for rescanning. If the scanner cannot read the label again, the case moves to a dump line where it's handled manually.

After being sorted, the cases move down an inclined conveyor to the shipping docks. There, the cases are either loaded directly into trucks or palletized at palletizing stations before being loaded into the trucks for delivery to the customers.

This explains how the conventional warehouse and the more mechanized warehouse operate in the grocery industry. Associated has an incentive program for its employees similar to that used by Ralph's. The consensus of grocery distributors is that an incentive system is necessary to support the engineered work standards. One without the other has not proven successful in generating significant productivity increases.

## VII. SUMMARY AND CONCLUSIONS

### A. ENDMETHOD

NSCs perform a variety of physical distribution functions related to material management and movement, including receipt, storage and issue of material. These centers have a variety of configurations of land, buildings, space layouts and automation. The volume of workload, including items carried, and receipts and issues, varies considerably by activity. The mission, organization and functions may also vary as described in their respective organization manuals. It is desirable to apply state-of-the art, industry-proven management techniques to improve the effectiveness and efficiency of supply center physical distribution operations while reducing the cost.

Encompassing all of the above factors into our analysis of ETW is far beyond the scope of our research. The land, buildings and space layouts of the NSCs are fixed. To recommend that all existing warehouses be razed and completely automated warehouses be constructed in their places is ludicrous. Automated warehouses may be state-of-the-art, but the type of capital investment required is simply out of the question for the Navy. How receptive would our legislators be to the elimination of a sizable number of jobs in particular districts due to automation and the use of robotics? For our purposes, the labor force at NSCs had to be considered fixed. We were unable to incorporate the nuances of politics and the impact on our

budgeting system of any recommended changes. Our investigation was limited to the subsistence area and the NSC's role in supplying these items to Navy ships and shore commands. We saw this facet of an NSC's operations as analogous to the operation of a grocery warehouse in its function of filling store orders. So within its current operating situation, we examined what NAVSUP is trying to accomplish in the subsistence physical distribution arena at NSC San Diego and contrasted that with what some of the leading grocery warehouses are doing with similar operating situations. In observing both private industry and government warehouses--their facilities, functions and the actual work being performed--we discovered no basis for reinforcing the myth that private industry productivity measures cannot be adapted for use in the military environment because of their national defense mission. We could find nothing to substantiate this often heard argument, and, indeed, found the operations in the subsistence physical distribution arenas of the two sectors to be quite similar.

NAVSUP's productivity strategy is centered around a process control for labor standards, labor scheduling and the capability for continued improvements to productivity. They want to establish a command strategy based on the physical side (methods, equipment and space) and the managerial aspects (procedures, information handling, control and organization) of operations. This multi-faceted plan consists of the following major elements:

- (1) Standardize procedures to the greatest extent possible. Make it easy to make an issue or a material stow and make it simple to process the paperwork and perform quality control checks.
- (2) Develop engineered standards.
- (3) Project the workload in the physical distribution functional area and staff to these projections. Provide incentives to commands to staff at low levels when activity is low and to bring on part time workers for workload surges.
- (4) Measure performance of workers at the individual level, both in productivity and quality. Provide incentives to increase productivity. Establish firm disciplinary measures for poor performers. This is part of the engineered standards development process.
- (5) Institute SPC in the physical distribution environment and in clerical functions. Measure quality, quantity and utilization. Analyze results and make needed changes to work hours, work habits, plant layout, storage aids and material handling equipment to increase productivity.
- (6) Develop a decision support system to aid managers by continuously monitoring and reporting on the process.

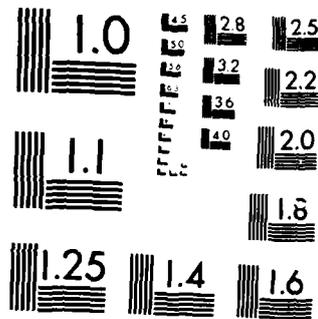
All of these elements have been or are nearing implementation at NSC San Diego except for portions of Number (4). The use of an incentive pay program or an incentive time off with pay program is not feasible under existing federal regulations. However, the use of incentive programs has been vital to the success of the productivity programs in private industry. Authorization to institute a program of this type would have to be specifically requested as an exception and eventually would require changes to the United States Code. When NAVSUP is ready to implement an incentive program, its plan is for one very similar to that used successfully by Ralph's. They envision developing an on-line individual productivity measuring

system. This system would provide an instantaneous productivity rating expressed as a percent of the norm. The norm would be based on engineered work standards and measured units processed. Individual productivity measurement can only occur after the workplace is engineered; however, it will provide a basis for employee evaluation and can assist in identifying individuals requiring additional training. It can provide a more competitive work force that will seek to perform at a more productive pace.

In comparing NAVSUP's program with that used by a successful private conventional grocery warehouse, we find no reason to predict failure for the productivity enhancement program based on any major flaws. Ralph's Grocers is the private concern that operates a highly successful conventional warehouse with the same type of equipment now being used at NSC San Diego. Our analysis is centered around what Ralph's did right and what the NSC is similarly doing to evaluate the enhancement program.

Ralph's objectives, in modernizing the warehouse, were to have: (1) better product control from the time merchandise entered the warehouse until the time it was shipped out; (2) quicker, more accurate methods of physical inventory; (3) more efficient receiving and replenishment procedures; and (4) improved utilization of existing warehouse square footage. All these improvements at Ralph's were made possible from the basic time and motion studies developed by industrial engineers and the studies made to compile their Warehouse Allocation Control





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

Tables for use in their On-Line Warehouse Management System. Referring back to the major elements of NAVSUP's plan, Numbers 1, 2 and 5 are basically the same. By standardizing procedures and engineering the workplace, NAVSUP is accomplishing the same objectives as Ralph's program accomplished for them. The Navy's use of SPC is an extra check for monitoring its warehouses' and workers' functions. It is not what the Navy is trying to do that will spell success or failure for its productivity enhancement program. The methods it has selected have been around too long to be disputed, and the success of private firms using these techniques is attested throughout the literature. It is not what what they are doing but how they go about doing it that can determine the success or failure of their program.

What can be learned from past productivity enhancement experiences? As early as 1952, NAVSUP had initiated programs to develop engineered work standards in the area of physical distribution and material handling. What happened to MIP, ETS, EPS, MEP and in particular DIMES? What lessons can be learned to enable this latest program to flourish and actually provide some benefits? The aim of DIMES was to ensure that the managers of military industrial type activities had available to them the same proven, generally accepted industrial management techniques found in their best managed civilian industrial counterparts [Ref. 8:p. 3]. This aim is exactly that of the current program--to increase productivity by emulating the

successful techniques of analogous private firms. To reiterate what was discussed in Chapter III, DIMES was developed to improve labor productivity through the application of management engineering principles and techniques, and provide a common data base of work measurement and productivity data which can be used in developing budget estimates and manpower requirements, in planning and control and in developing productivity performance indices relating to outputs. Again, the same statement could be used in discussing the current program.

The whole implementation process for DIMES, if updated with current buzz words and the use of computers, could be applied to ETW. The emphasis on training, the work measurement methods used, setting of engineered standards and the installation of a reporting system--all of these are incorporated in the new plan now being implemented. Both programs used the most sound engineering and management practices known. ETW goes further than DIMES by emphasizing a systems approach to productivity enhancement. What can guarantee the success of this "new" program? The problems which seemed to contribute the most to the demise of DIMES were management commitment, training and communication, funding and the proliferation of other similar programs. We will discuss each of these and how NAVSUP is attempting to close these loopholes.

#### B. GUIDELINES FOR IMPLEMENTING A PRODUCTIVITY ENHANCEMENT PROGRAM

As discussed earlier in the chapter, productivity and productivity improvement programs have been around the Navy for a

long time. Although past productivity enhancement programs did a good job of attacking the issue of improved productivity, they lacked an effective overall plan to implement and maintain the program. Jamali has developed guidelines in his model for successfully implementing a productivity enhancement program [Ref. 24]. He points out that in order for a productivity improvement program to be successful it must include productivity measurement, evaluation, planning and improvement. His guidelines for implementation of a productivity improvement program include six steps:

1. Creating awareness
2. Productivity measurement
3. Productivity evaluation
4. Productivity planning
5. Productivity improvement
6. Control reporting

By incorporating these guidelines into their program, NAVSUP will eliminate most of the loopholes that could jeopardize their success.

1. Creating Awareness

Creating awareness is accomplished first by defining, to the employees and management, what productivity is and emphasizing its role in job performance. Creating this awareness in employees will help them in understanding and accepting productivity programs. Jamali states that it is vital to define not only what productivity is but also what it is not.

Employees must understand that productivity is more than a yardstick to measure production quantity. Increasing output may or may not result in improving the productivity. Both benefits to the employee and to the organization from productivity improvements must be addressed.

ETW addresses the issue of creating awareness very well. In developing the initial training programs, the Contractor shall develop and implement supervisory training programs that address supervisor and employee roles, motivation, performance evaluation, planning and communication techniques for operational improvement, and cost reduction. The training program will consist of training manuals and training aids. This plan is fine as far as it goes. But it doesn't go far enough. A training program must be developed to meet the employees needs--to educate them on what the program is, what are and how it will accomplish its objectives, why the program is needed and the program's impact on these workers--how it will affect them and what they must do to help the Navy and ultimately to help themselves. If no effort is made to involve these employees in the implementation of this program, and to instill in them some enthusiasm for committing themselves to this productivity program, all of these great plans may have been for naught. It is the workers themselves who will ultimately provide the productivity improvement. They must become a part of the plan.

## 2. Productivity Measurement

Productivity measurement is deciding what factors (input, output) will be used in measuring productivity. Chapter II points out that numerous methods to measure productivity exist. Selecting the proper measurement is a difficult task. Many factors must be considered. These include the nature of both inputs and outputs, the complexity of the operation and the level on which the productivity is being measured (individual, branch, department, activity). The measure selected must be a valid representation of the process being measured. Also, historically, it has been proven that when employees assist in the selection of appropriate productivity measures, the chance of the measures being successfully implemented is increased. Here, then, is another step that NAVSUP can use to involve its activity employees in ETW. Development of this type of communication relay between management and the workers might develop worker enthusiasm for the program and help increase their awareness of what the program is attempting to achieve and how they can contribute to it; and at the same time benefit themselves through the incentive program.

ETW recognizes the inadequacy of the productivity measurement units in use at NSCs today. For example, when polled by PJS, employees and supervisors at NSC San Diego came up with several different definitions of a measurement ton. ETW requires that the contractor consider quality, quantity and timeliness when developing measures. The measures currently

in use in the subsistence function at NSC San Diego are temporary. When developing measurements for ETW, the contractor must consult the employees for their input before developing an appropriate measure--again increasing employee involvement and commitment to ETW.

### 3. Productivity Evaluation

Productivity evaluation identifies problems and opportunities for improvement in the process being evaluated. It is done by comparing the productivity in the current period with that in the base period. By examining these ratios of productivity, management should be able to determine the cause of problems and identify the opportunities for improvement. Included in this evaluation is an analysis of the reporting systems to determine whether they provide the information management needs for decision-making and for maintaining control over the manufacturing or service function.

ETW addresses productivity evaluation through SPC. Through the use of control charts, managers can identify both problem areas and opportunities for improvements as shown in Chapter V. SPC also provides a reporting system to monitor the process. The investigation by PJS into current productivity measures revealed that NSC workers disregarded production reports. A variety of reasons exists for this disregard. The most significant ones were a general feeling that the measures used were inadequate, and the reports were too cumbersome. The problem with line items was used as an example in Chapter V.

With the new measurements being developed, those control charts provided through SPC can also have meaning for production workers if they are trained to understand and use the information provided.

#### 4. Productivity Planning

Productivity planning involves the use of information in the evaluation stage to plan for the future and to follow-up on previous decisions. This area is addressed in ETW through the WSCS. The WSCS will be designed to be used for workload/manpower scheduling, productivity monitoring, reporting and utilization. This system will provide daily productivity measurements for each warehouseman. This will enable supervisors to compare workers, check for inadequate performance and make incentive pay determinations.

#### 5. Productivity Improvement

Improving effectiveness, efficiency and quality lead to productivity improvement. This includes methods for work simplification and development of standards. ETW incorporates these areas in Task A--Material Flows Study--which attacks work simplification and Task D--PPDSS--which develops standards that include measures for quality, effectiveness and efficiency.

#### 6. Control Reporting

Jamali's final step in developing a viable productivity enhancement program is control reporting. Control Reporting deals with reporting on the implementation of the productivity program and then providing information on the program's progress

once it is operational. It will provide reports to all management levels on all aspects of the process. Jamali believes that with proper measurements and effective use of reports, management should be able to optimize the utilization of resources.

The tool for better management of resources provided by ETW is the PPDSS which shall be designed to provide the manager with the information he needs to evaluate a given situation and make an intelligent decision based on the information. Each component of ETW will merge in the PPDSS. This system will be the tool that will verify whether ETW's objectives have been achieved. This performance reporting will include such items as achievement of the desired performance criteria by the department/employees, how employees are spending their time, how much work is being done, amount of resources used in performing the work and productivity performance trends. With such a comprehensive program, can problems still develop? Problems can and will develop--it is impossible to eliminate all of them. However, through careful, comprehensive planning, problems can be minimized.

#### C. CONCLUSIONS

Once again we will reiterate the importance of management commitment, training and communication. A strong commitment to this program by the headquarters element will be necessary to ensure that the funding is provided and preclude the interference which could come from the introduction of premature follow-on

programs. With the current emphasis throughout the government on proper resource utilization and the accounting for these same resources, NAVSUP will have to protect its program and give it a chance for full implementation; rather than rolling over for the next flurry of productivity programs with the 'new' buzz words and spectacular results they will all promise. This commitment at the highest levels might diffuse itself throughout the entire NAVSUP structure, infusing the lower levels with enthusiasm for this program. The importance of a program with such high level support will become known at the lowest levels. The constant traveling of the NAVSUP staff to supply centers and their supportive attitude as the centers enter various implementation stages will help transfer some of this NAVSUP enthusiasm to the local commands.

Training and continued communication (both up and down) will reinforce this initial awareness of what the program is about and what it is meant to accomplish. Continued input from the lowest employee levels will increase the probability of this program's success. Numerous examples can be found which substantiate the success of productivity improvement programs that, very early on, established the employee as an important element in the program--a resource that could offer valuable inputs [Ref. 25].

The Institute of Industrial Engineers conducted a survey of its members to gather their opinions on the best strategies for initiating productivity improvement programs [Ref. 25].

The most significant factor they identified for the success of productivity programs was worker attitudes. Good employee attitude was reflected by low absenteeism and tardiness, employees taking action to solve problems--acting responsibly, and employees making suggestions and exhibiting trust in each other and in their supervisors.

Other important factors were employee motivation and incentives. How do you motivate employees to perform better, produce more and offer good ideas to improve productivity? Industrial engineers felt that personal recognition offers the best encouragement for employees to achieve those goals. Ranking second was monetary reward (incentives), followed by promotions.

When asked what they felt were the biggest obstacles to productivity improvement, the five most common responses were:

1. Management failing to understand how productivity can be improved.
2. Management failing to authorize sufficient manpower to direct productivity improvement.
3. Insufficient training programs.
4. Management failing to apply proper measurement programs in order to evaluate productivity improvement.
5. Inability of labor and management to work toward common productivity goals.

This synopsis of the IE survey is used to further substantiate the points we are making. NAVSUP has indeed developed a productivity program based on a solid foundation of universally accepted engineering and management techniques. If a threat exists to the success of the program, it is not the

lack of management commitment, but the failure to communicate this commitment to the worker. With this commitment being impressed upon the worker, the training and communication channels needed should evolve and the success of ETW will become a reality.

APPENDIX A

PRINCIPLES OF MOTION ECONOMY

1. Both hands should begin as well as complete their motions at the same time.
2. The two hands should not be idle at the same time except during rest periods.
3. Motions of the arms should be made in opposite and symmetrical directions and should be made simultaneously.
4. Materials and tools should be located to permit the best sequence of motions.
5. Hand and lower arm movements are preferred to upper arm and shoulder movements for light work.
6. Rhythm is essential to smooth, automatic performance.
7. Tools, materials and controls should be located close in and directly in front of the operator.
8. Gravity feed bins and containers should be used to deliver material close to the point of use.
9. Drop deliveries should be used wherever possible.
10. The hands should be relieved of all work that can be done more advantageously by a jig, fixture or a foot operated device.
11. Smooth, continuous motions of the hands are preferable to straight lines or zig-zag motions involving sudden or sharp changes in direction.

LAWS OF MOTION ECONOMY AND THEIR COROLLARIES

Law No. 1

When both hands begin and complete their motions simulatenously and are not idle except during the rest periods, maximum performance is approached.

Law No. 2

When motions of the arms are made simultaneously in opposite directions over symmetrical paths rhythm and automaticity develop most naturally.

Law No. 3

The motion sequence which employs the fewest basic elements is the best for performing a given task.

Law No. 4

When motions are confined to the lowest practical classifications maximum performance and minimum fatigue are approached.

Law No. 5

When conditions are the same, the time required to perform all basic elements is constant for any given degree of skill and effort.

When motions are confined to the lowest practical classifications, maximum performance and minimum fatigue are approached.

Corollary No. 1

Hesitation, or the temporary and often minute cessation from work, should be analyzed and studied and its cause accounted for and, if possible, eliminated.

Corollary No. 2

The shortest time taken for each motion during the course of the study made should be considered the desired goal, and all variations of time from this goal should be analyzed for each motion and the causes determined.

Corollary No. 3

The best sequence of motions for any one class of work is useful for suggesting the best sequence for other kinds of work.

Corollary No. 4

Where delay occurs, consideration should be given to the advisability of providing additional work which will permit utilizing the time of delay, if study indicates that the delay is unnecessary for overcoming fatigue.

Corollary No. 5

All materials and tools should be located within or as near as possible to the normal grasp area.

Corollary No. 6

Tools and materials should be located so as to permit the following of the proper sequence of motions. The part required at the beginning of the cycle should be next to the point of release of the finished piece.

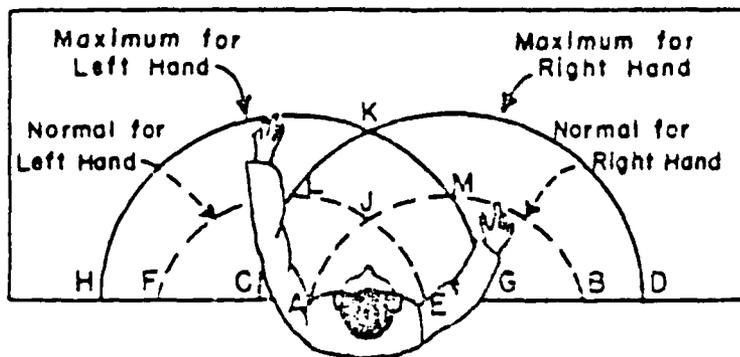
Corollary No. 7

Tools and materials should be pre-positioned in order to eliminate the search and select basic operations.

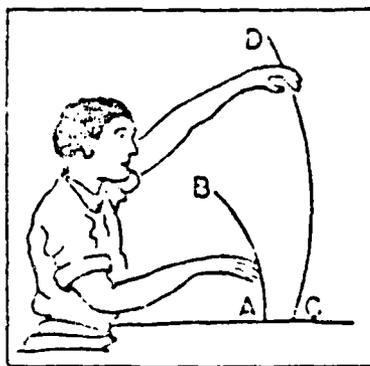
Corollary No. 8

Hands should be relieved of all work that can be done with the feet or other parts of the body, provided there is other work which the hands can do at the same time.

WORKING AREAS



Normal and Maximum Working Areas for the Hands  
in the Horizontal Plane



Normal and Maximum Working Areas for the Hands  
in the Vertical Plane





PRODUCTION REPORT NAVSANDA FORM 1230

1. Instructions for the Preparation of the Methods Engineering Production Report NAVSANDA Form 1230 (Rev. 6-65) (Final Reporting System)

a. Instructions for Individual Employees or Control Desk Clerks

(1) Heading Information (entered each reporting period)

Block (a), COMPONENT: Department or division to which assigned (usually preprinted).

Block (b), NAME: Name of individual performing reported work.

TITLE: Job title such as clerk-typist.

Block (c), INCLUSIVE DATES: The beginning and ending dates of reporting period (usually Sunday through Saturday, but also required for partial reporting weeks at end-of-month).

(2) Standard Production Information (entered daily) (Lines 1-18)

Column (d), BUDGET/STANDARD NO.: The Budget Number and Standard Number for which work was performed (usually preprinted) (may be Job Order Number).

Column (e), DESCRIPTION: The name of the standard worked on (usually preprinted).

Column (f), WORK UNIT: The work unit counted for a standard (usually preprinted).

Column (g), WORK UNITS COMPLETED: The number of work units for each standard actually completed during each day of the reporting period.

(3) Standard Production Information Summary  
(entered at end of each reporting period)

Column (h), TOTAL W/U's: The total of all work units for each standard entered in daily columns (g).

Column (j), BACKLOG W/U's: Number of work units remaining to be done for each standard at end of reporting period.

(4) Man-Hour Distribution Information: (entered daily)  
(Lines 20-30) (back of form)

Block (k), BUDGET NO.: The Budget Number to which man-hours were charged (usually preprinted) (may be Job Order Numbers).

DESCRIPTION: The name of the category to which man-hours were charged (usually preprinted).

SUN-SAT: Man-hours expended by category for each day of the reporting period.

Block (l), NON-STANDARD REPORTING: Itemization of Non-Standard man-hour charges entered on line 37.

BUDGET NO.: Applicable Budget Number (may be Job Order No.).

W/U: Work Unit representative of work performed.

NO. W/U's: Number of work units completed.

M/H: Number of man-hours expended on the work.

Line 20, COMPLEMENT: The eight hours a day each individual is regularly assigned to a component (may be less if regular assignment is only part-time).

Line 21, BORROWED: The number of man-hours an individual is borrowed into a component each day other than the one normally assigned to (enter component borrowed from in description block).

Line 22, OVERTIME: The number of man-hours assigned each day in addition to the regular eight-hour work day.

- Line 23, GROSS HOURS AVAILABLE: The total of lines 20 through 22 for each day.
- Lines 24-31, FIXED ALLOWANCES: The number of man-hours actually expended daily on each fixed allowance.
- Line 32, SUPERVISION: The number of man-hours actually expended on supervision each day.
- Line 33, TOTAL FIXED ALLOWANCES: The total hours expended each day on fixed allowances, lines 24 through 32.
- Line 34, LEAVE: The number of man-hours actually expended on annual, sick, holiday, and terminal leave each day.
- Line 35, TRAINING (FORMAL): The number of man-hours actually expended on authorized formal training each day.
- Line 36, LOANED: The number of man-hours an individual is loaned out of a component each day other than the one normally assigned to (enter component loaned to in description block).
- Line 37, TOTAL NON-STANDARD HOURS: The number of man-hours actually expended on work not covered by standards or fixed allowances each day as itemized in block (1).
- Line 38, TOTAL: The total man-hours each day for lines 33 through 37.
- Line 39, NET HOURS AVAILABLE: The man-hours difference between line 23 and line 38 each day.

(5) Man-Hour Distribution Information Summary (entered at the end of each reporting period).

Block (k), TOTAL: The total man-hours expended for each category (the vertical total for this column should balance with horizontal total for line 39).

Block (l), TOTAL NON-STANDARD MAN-HOURS: The total man-hours expended for work not covered by standards or fixed allowances (the total for block (l) should balance with the total for line 37).

b. Instructions for Component Summary Report Preparation

(1) Component Heading Information (entered each reporting period).

Block (a), COMPONENT: Department or division summarized (usually over-printed).

Block (b), NAME: The word "SUMMARY" (usually overprinted) and the initials of the component supervisor.

Block (c), INCLUSIVE DATES: The beginning and ending dates of reporting period (usually Sunday through Saturday, but also required for partial reporting weeks at end-of-month).

(2) Component Standard Production Information Summary  
(entered at the end of each reporting period)  
(lines 1-18)

Column (h), TOTAL W/U's: Total number of work units completed for each standard by the component.

Column (i), STD. HOURS: The standard man-hours allowed to produce or process one work unit (usually preprinted).

HOURS EARNED: The product of the total work units completed by a component for each standard, column (h), multiplied by the standard hours for each standard, column (i). (Hours Earned total is entered on line 19.) (Budget Number totals are entered at appropriate points in Hours Earned column.)

ACTUAL HOURS: Actual hours expended by Budget Number on standard work are obtained by the following proration:

<u>Total Hours Earned on a Given Budget Number</u>	x
Total Hours Earned on all Standards (line 19)	
Total Net Hours Available (block k, line 39)	=

Total Actual Hours for a Given Budget Number

Column (j), BACKLOG M/H: Backlog man-hours are obtained by multiplying column (j), Backlog W/U's, by column (i), Standard Hours, for each standard. (Column (j), Backlog M/H, total is entered on line 19.)

- (3) Component Man-Hour Distribution Summary (entered at the end of each reporting period) (Lines 20-39)

Block (k), TOTAL: Total man-hours expended for each category by the component.

Block (l), NON-STANDARD REPORTING: Itemization of component non-standard work and component total of non-standard hours expended (should balance with line 37, block (k)).

- (4) Component Supply Management and ME Analysis Information Summary (entered at the end of each reporting period).

Block (m), SUPPLY MANAGEMENT DATA FOR S&A 1143.

BUDGET NO.: Applicable Budget Numbers charged by the component.

EARNED HOURS (L. 48): Enter total hours earned by each Budget Number for the component from Budget Number sub-totals in column (i).

AVAIL. HRS. (L. 49): Enter total hours actual by each Budget Number for the component from Budget Number proration totals in column (i).

AUTH'D (L. 50): Enter total authorized fixed allowance hours by each Budget Number for the component from ME Study Handbook. (Authorized fixed allowance hours per week may be preprinted in Block 9k) for each allowance.)

ACTUAL (L. 51): Enter total actual fixed allowance hours by each Budget Number for the component from Block (k), lines 24-32.

NON-STD. (L. 52): Enter total actual non-standard hours by each Budget Number for the component from Block (l).

Block (n), PRODUCTIVE EFFECTIVENESS: 
$$\frac{\text{Total Hours Earned (line 19)}}{\text{Net Hours Available (line 39)}} \times$$

100 = P. E.

Block (o), FIXED ALLOWANCE VARIATION: Obtain difference between fixed hours authorized for component from ME Survey Handbook and fixed hours actual from block k, line 33. (Fixed hours authorized per week may be preprinted in block (k).)

Block (p), NON-STANDARD PERCENTAGE:

$$\frac{\text{Non-standard Hours (line 37)}}{\text{Gross Available Hours (line 23)}}$$

$$\times 100 = \text{Percent Non-Standard}$$

c. Additional Instructions for Preparation of the Methods Engineering Production Report (Final Reporting System for Areas not Covered by Engineered Standards)

- (1) Report will be prepared in the manner indicated for the Preliminary Reporting System. In addition, the form will be prepared in the manner indicated for the Final Reporting System for those portions of the form not covered by the Preliminary Reporting System Instruction.
- (2) One variation in the preparation will be the figures entered in column (i), Std. Hours. This will be the result of dividing the Work Units in column (h) by the actual man-hours in column (i) for each job. This results in a statistical production rate.

APPENDIX C

SPC TRAINING PROGRAM

A. Government Furnished Training for Management Staff

This basic training program will consist of a two-day workshop entitled "Introduction to Statistical Process Control." This training program will include the seminar, training manuals and a question-and-answer period as outlined below:

- (1) The Basics
  - (a) What is SPC?
  - (b) Purpose of SPC
  - (c) Graphing
    1. Histograms
    2. Normal Distribution
  - (d) Variability
    1. Local Causes
    2. System Causes
  - (e) Sampling Techniques
    1. Advantages
    2. Disadvantages
- (2) Constructing Simple Control Charts
  - (a)  $\bar{X}$  and R Charts
  - (b)  $\bar{P}$  Charts
  - (c)  $\bar{X}$  and s Charts
  - (d) c Charts
- (3) Evaluating Simple Control Charts
  - (a)  $\bar{X}$  and R Charts
  - (b)  $\bar{P}$  Charts
  - (c)  $\bar{X}$  and s Charts
  - (d) c Charts
- (4) Process Capability Evaluation
  - (a) Plotting on Probability Paper
  - (b) Evaluation of Process Capability

- (5) Constructing Charts for Short Runs
  - (a) Constant Runs
  - (b) Variable Runs
- (6) Relating SPC to Physical Distribution Systems
- (7) Using Attribute Data Effectively
  - (a) Constructing Charts with Independent Variables
  - (b) Constructing Charts with Dependent Variables
  - (c) Evaluating Charts
- (8) Use of charts to control physical distribution processes
- (9) Charting work studies
  - (a) Applicability
  - (b) Use
  - (c) Evaluation

B. Government Furnished Training for Line Operators

Training will consist of a one-day workshop entitled, "Basic Principles of Statistical Process Control," as outlined below. Included with this training program will be a training manual for each person and sample control charts.

- (1) The Basics
  - (a) What is SPC?
  - (b) Purpose of SPC
  - (c) Graphing
    - 1. Histograms
    - 2. Normal Distribution
  - (d) Variability
    - 1. Local Causes
    - 2. System Causes
  - (e) Sampling Techniques
    - 1. Advantages
    - 2. Disadvantages
- (2) Constructing Simple Control Charts
  - (a)  $\bar{X}$  and R Charts
  - (b) P Charts

- (c)  $\bar{X}$  and s Charts
  - (d) c Charts
- (3) Evaluating Simple Control Charts
- (a)  $\bar{X}$  and R Charts
  - (b)  $\bar{P}$  Charts
  - (c)  $\bar{X}$  and s Charts
- (4) Using Attribute Data Effectively
- (a) Constructing Charts with Independent Variables
  - (b) Constructing Charts with Dependent Variables
  - (c) Evaluating Charts
- (5) Use of Charts to control physical distribution processes
- (6) Charting work studies
- (a) Applicability
  - (b) Use
  - (c) Evaluation

C. Government furnished classroom training for management personnel on SPC implementation in accordance with the following outline.

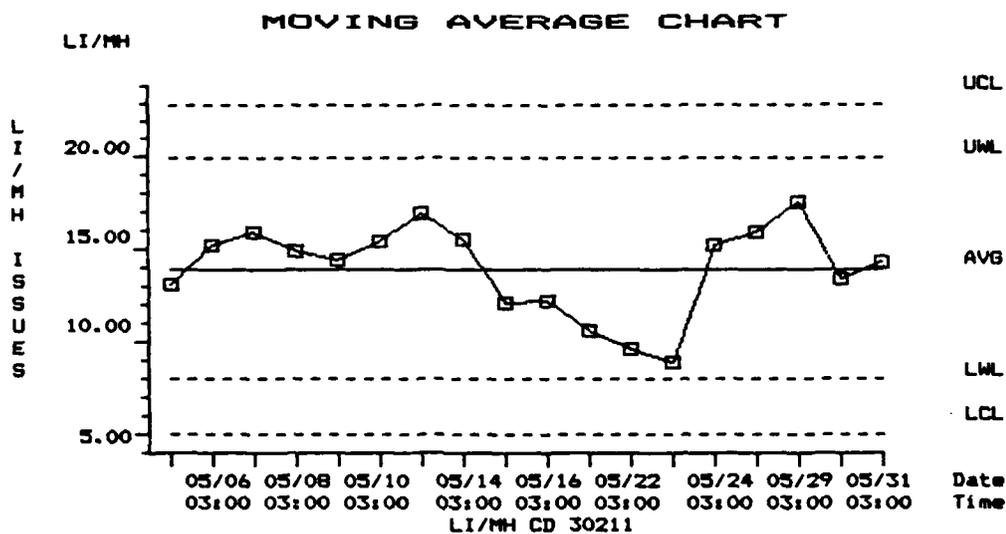
- (1) Chart Interpretation, Part 1--Analysis of  $\bar{X}$  Charts. Each chart tells a story about the process. In this section the instructor will discuss how the charts can be used to determine sources of problems. This is the first of a series of discussions that go beyond the elementary concept of out-of-control to correlate to specific chart patterns to specific problems.
- (2) Chart Interpretation, Part 2--Analysis of  $\bar{X}$  Charts. This is a continuation of the concepts discussed in the first section. Here, jumps in process, cycles, clusters, erratic patterns, concentrations and eccentricities are analyzed in detail. In this section we begin to see how every control chart tells a story about the process and how each pattern helps outline the strengths and weaknesses of the system.
- (3) Chart Interpretation, Part 3--Analysis of Range Charts. In this section the instructor will demonstrate how range charts can be analyzed to determine the causes of going out-of-control. Patterns in the range charts will follow a different set of rules in

interpretation than did those same patterns in the average charts. Here, the most common range patterns are analyzed to facilitate a faster trouble-shooting effort.

- (4) Chart Interpretation, Part 4--Correlation of  $\bar{X}$  and R Charts. Positive and negative correlations between  $\bar{X}$  and R charts provide additional information about the system. Using the two charts collectively gives the trouble-shooter a much clearer picture of the problems in the process. In this segment we see how to effectively use the relationships between the  $\bar{X}$  and R charts to determine the cause of going out-of-control.
- (5) Chart Interpretation, Part 5--A Case Study. Here, we analyze a real-life example of how a control chart was used to improve the process. There will be an actual example of a case in which the instructor collaborated with employees to use SPC to improve the process. In this segment the instructor will provide a simple and amazingly effective trouble-shooting formula which will show how the control chart becomes an effective tool for continually improving the process.
- (6) How to Coordinate an Effective, Viable and Sustaining SPC Program. This section will outline a program for coordinating all involved employees into a cost-effective, manageable SPC effort. Here, everything from initial training through trouble-shooting to follow-up is discussed. The instructor will explain how to bring all factions together, but more importantly, how to keep the program of SPC dynamic and effective.

APPENDIX D

SAMPLE SPC CHART



X-Double-Bar: 13.93 LI/MH

Limits - UCL: 22.89 UWL: 19.90  
LCL: 4.97 LWL: 7.96

**SIGMA DISTRIBUTION**

Sigma Units	Above the Mean		Below the Mean		Rel. to the Mean	
	Samples	Pct	Samples	Pct	Samples	Pct
0 - 1	10	55.5 %	4	22.2 %	14	77.7 %
1 - 2	1	5.5 %	3	16.6 %	4	22.2 %
2 - 3	0	0.0 %	0	0.0 %	0	0.0 %
3 +	0	0.0 %	0	0.0 %	0	0.0 %
<b>Total</b>	<b>11</b>	<b>61.1 %</b>	<b>7</b>	<b>38.8 %</b>	<b>18</b>	<b>100.0 %</b>

CHART ANALYSIS

#	Date	Time	Ref Oper Insp	Sample	M-Avg.	M-Range
1	05/01/85	03:00		12.60		
	Sample:	12.60				
2	05/02/85	03:00		15.40		
	Sample:	15.40				
3	05/03/85	03:00		11.20	13.06	4.20
	Sample:	11.20				
4	05/06/85	03:00		19.10	15.23	7.90
	Sample:	19.10				
5	05/07/85	03:00		17.50	15.93	7.90
	Sample:	17.50				
6	05/08/85	03:00		8.20	14.93	10.90
	Sample:	8.20				
7	05/09/85	03:00		17.50	14.40	9.30
	Sample:	17.50				
8	05/10/85	03:00		20.40	15.36	12.20
	Sample:	20.40				
9	05/13/85	03:00		12.70	16.86	7.70
	Sample:	12.70				
10	05/14/85	03:00		13.40	15.50	7.70
	Sample:	13.40				
11	05/15/85	03:00		10.10	12.06	3.30
	Sample:	10.10				
12	05/16/85	03:00		13.00	12.16	3.30
	Sample:	13.00				
13	05/17/85	03:00		8.80	10.63	4.20
	Sample:	8.80				
14	05/22/85	03:00		6.90	9.56	6.10
	Sample:	6.90				
15	05/23/85	03:00		10.90	8.86	4.00
	Sample:	10.90				
16	05/24/85	03:00		27.70	15.16	20.80
	Sample:	27.70				
17	05/28/85	03:00		9.00	15.86	18.70
	Sample:	9.00				
	** Moving Range Chart - Out of Control Process Detected					
18	05/29/85	03:00		15.70	17.46	18.70
	Sample:	15.70				
	** Moving Range Chart - Out of Control Process Detected					
19	05/30/85	03:00		15.50	13.40	6.70
	Sample:	15.50				
20	05/31/85	03:00		11.70	14.30	4.00
	Sample:	11.70				
	** Moving Range Chart - Out of Control Process Detected					

APPENDIX E

RALPH'S INCENTIVE PLAN AND LABOR STANDARDS

RALPH'S - INTER-COMPANY COMMUNICATION - GET IT RIGHT...IN WRITING

DATE: January 20, 1982

To: Grocery Warehouse Personnel/Local 595

From: Larry Cooper

Subj: Incentive Program Administrative Guidelines

Since the inception of work standards and incentives, the results have been gratifying to both management and employees. We have continually been streamlining our Incentive Guidelines, and Jon Killion has done an excellent job in administrating the program.

The following Guidelines, with some minor changes, will take effect on February 2, 1982. Currently, meetings with order selection crews are taking place to explain and discuss our incentive program. Below is a complete outline of our Incentive Guidelines:

1. Incentive hours that are earned by each employee on a weekly basis will be accumulated in an incentive account.
2. There are two ways that incentive hours may be taken or withdrawn from each employee's incentive account.
  - a. First, employees may take time off from regularly scheduled work and be paid at their base pay rate.
  - b. Second, in addition to pay for worked hours, employees may receive bonus pay for earned incentive hours which is paid at each employee's base pay rate.
3. During the first week of each fiscal accounting period, according to Ralphs' fiscal calendar, incentive request forms for the following four weeks are distributed to each eligible employee.
  - a. These forms show an "Available Balance" of incentive hours that each employee has remaining to use in his account.

- b. The form also provides space for the employee to indicate both the time off with pay and/or the amount of bonus pay desired for the following four weeks.
4. As many requests for time off on each day as practically possible are approved. The actual number allowed off for each day is determined by work schedule limitations, such as the expected daily workload, the number of employees scheduled for that day, and the number of available replacements.
5. When there are more requests for time off than can be reasonably accommodated, the determination of the requests is based on two factors:
  - a. Employees requesting the greatest number of hours off together are given preference.
  - b. Employees with the greatest number of hours in the "Available Balance" on hand are given secondary preference.
6. All employees may take all of the total number of incentive hours earned in the form of paid time off from work. However, at least 25 percent of the total hours that a full-time employee has earned must be taken in the form of time off.
  - a. Employees are allowed to take time off from work in increments of full hours for any regularly scheduled day during the month. No part of an hour may be taken off. For example, employees cannot take 3.5 hours off, but could take either 3.0 or 4.0 incentive hours off.
  - b. Time off with pay is considered hours worked for the purpose of computing weekly overtime. However, time off on Sunday will not include the Sunday premium pay.
7. Employees may receive up to 75 percent of the total incentive hours earned in bonus pay. However, bonus pay is not included in the hours worked for the computing of weekly overtime.
8. When an employee changes to a permanent work assignment that is non-standard, for example, a Receiving Clerk, he may be paid up to 5.0 earned incentive hours of bonus pay, without taking 25 percent in time off.
9. All employees will be permitted to maintain an "Available Balance" shown at the beginning of each period that is 80.0 incentive hours or less. This means that, when the

status of an employee's account is determined under 3-a above, no more than 80.0 hours shall be carried forward to the next period. (However, the "Available Balance" may exceed 80.0 hours during a period because of subsequent earning of incentive hours during that period.) All employees with an "Available Balance" over 80.0 incentive hours at the beginning of each period will automatically be paid in cash ("bonus") down to that 80.0 hours maximum level.

10. Every reasonable effort will be made to honor all incentive requests for time off, subject to the bona fide needs of the operation.

We have been very pleased with the results of our incentive program to date and would like to continue to share the benefits with all employees. We look forward to the continued success of this program.

JB:kg

## OUTLINE

### LABOR STANDARDS SINCE 1980

The following outline describes the events that take place concerning order selection, letdown forklift activities and receiving putaway labor standards.

#### I. ORDER SELECTION LABOR STANDARDS

- A. The Labor Standards Program begins with the processing of a store billing. The computer interfaces the store billing information with data files of the Chain Store On-Line Inventory System.
  - 1. ITEM FILE - This file contains information concerning master case cube, weight and pack of every item in the warehouse.
  - 2. SLOT FILE - Each item is tied to a unique slot in this file and the actual level (distance from the floor) is identified.
  - 3. Once a billing takes place, the computer utilizes these two data files to assimilate the necessary information to develop building blocks for standards computations.
- B. Various Labor Standard Tables are referenced once the store billing information updates the On-Line data files.
  - 1. STORE TABLE (ST) - Identifies unique requirements of individual stores.
  - 2. PICK TABLE (PT) - Time values per shipping unit based on weight, cube and level.
  - 3. TIME TABLE (TT) - Order selection task values.
  - 4. DISTANCE TABLE (DT) - Time value from an exit point to an entry point.
  - 5. BAY TRAVEL (BT) - Constant time per bay movement.
  - 6. ENTRANCE TABLES (ET) - Beginning/ending point of aisles.

- C. Once all of the store billing information is digested by the Labor Standard Tables, individual work assignments are generated according to store shipping sequence.
1. The duration of an order assignment is determined by two factors:
    - a. Cube break is set at 134 cubic feet.
    - b. Weight break is 4100 pounds for two pallets.
  2. The following data elements are included in the computerized standard:
    - a. Administrative time
    - b. Fatigue time
    - c. Personal allowances
    - d. Unavoidable delays
    - e. Level of slot
    - f. Distance traveled
  3. All time increments were determined through numerous stop watch audits performed by Industrial Engineers while observing the Order Selector's environment.
- D. Upon request, a Labor Standards Audit Report can be printed to review time allotted for every activity that took place while creating an individual order selection assignment. This audit report breaks down an assignment into the following elements:
1. Obtain pick labels
  2. Obtain jack and pallets
  3. Aisle move
  4. Bay move
  5. Shipping unit(s) selection
  6. Review order cycle and adjust load
  7. Stretch wrap pallets
  8. Enter trailer and drop load
  9. Sign off load sheet
  10. Travel to order desk
  11. Walk to order desk and close order
- E. Order selection documents are printed which provide the Order Selector with the following information:
1. Store number
  2. Door numbers where product will be unloaded.

3. Individual case labels with corresponding selection slot numbers.
  4. Two labels to be placed on loading door worksheet indicating where pallets were positioned in trailer.
  5. One label that documents standard time allowed for assignment, which the Order Selector keeps for his personal record.
- F. Each Order Selector is assigned a Labor Control Card which tracks their performance level on a daily basis to include:
1. Clock-in time
  2. Clock-out time
  3. Individual Standard Time labels
  4. Equipment number
  5. Non-standard activity codes
  6. Shift performance level
  7. Cumulative Standard Time
  8. Time on Standard
  9. Total time
  10. Total Non-standard time
- G. Once an Order Selector completes his assignment, they are required to load the pallets into specified trailer(s). At this point, they are instructed to post two labels indicating the position of the pallets inside the trailer.
- H. Each day all Labor Standard averages are posted for review.
- I. Every week an Employee Incentive Report is compiled that indicates all pertinent statistics concerning Labor Standards Incentives.
- J. Incentive time earned is computed using the following guidelines:
1. Averages ranging from 101-114 are factored by .45 minutes per hour.
  2. Averages above 115 are factored by .60 minutes per hour.

For example: (60 minutes per hour rate)

An Order Selector completed 772 minutes worth of Standard Time in 632 actual minutes.

- a.  $772 \div 632 = 122$  percent effective
- b. Divide 772 minutes by 60 to convert to hours = 12.86
- c. Order Selector performed at 21 points higher than was required by Standard. Multiply  $12.86 \times .21 = 2.7$  hours of incentive earned.
- d. If the Order Selector performed at a 110% level (.45 minutes per hour rate), the incentive time earned would be multiplied by .75. Multiply  $2.7 \times .75 = 2.0$  incentive earned.

## II. LETDOWN FORKLIFT LABOR STANDARDS

- A. The Chain Store On-Line Receiving System provides slot control for all reserve pallets in the warehouse. This computer system identifies inventory increments on a pallet-by-pallet basis, and is essential in a labor standards environment for forklift drivers.
- B. Once a store billing takes place, a program called letdown is activated. This program is responsible for replenishing the selection slot on a timely basis. During the billing process, the letdown program monitors the slot file, which lists each item's reserve location(s).
  1. On the item file, every stock code that is assigned a selection slot has a specified replenishment number called a letdown point.
  2. This letdown point is referenced as product is being depleted from the selection slot during the store billing cycle. A letdown is generated once this point is reached.
- C. The letdown program provides the necessary building blocks in the development of Forklift Labor Standards.
- D. While the store billing and letdown programs are processed, the computer references the following Labor Standard Tables:
  1. AISLE RANGE TABLE (AR) - Defines the ending and beginning slot numbers of aisles for use in calculation of travel distances.
  2. CONSTANT TIMES BY LEVEL (CL) - Shows times to perform certain tasks which vary depending on the level of the pick slot.

3. CONSTANT STANDARD TIMES TABLE (CS) - Shows constant standard and time factors for all Constant Time Tasks.
  4. LETDOWN CODES AND VALUES TABLE (LC) - Used to maintain parameters and codes required for calculation of Letdown Standards.
  5. POINT-TO-POINT DISTANCE TABLE (PP) - Contains an entry for each valid travel route.
  6. PHYSICAL SECTION TABLE (PS) - Used to maintain parameters and codes required for calculation of Letdown Standards.
- E. During the letdown process, the Labor Standards program categorizes the letdown assignments into waves.
1. Waves can be defined as a given number of stores letdowns that are sorted in TO slot selection sequence.
  2. The number of stores in a given wave can be changed On-Line by day.
- F. After all of the letdown data is consumed by the Labor Standard Tables, individual work assignments are produced according to order selection sequence.
1. The length of a given assignment can be changed On-Line by day.
  2. The duration of an assignment will vary the number of individual fork drivers required by wave.
- G. Letdown labels are produced that indicate the FROM slot, TO slot and the store number that activated the letdown.
1. Directional information is highlighted on each letdown label which indicates the shortest distance to the next slot.
  2. Two summary labels are printed denoting Standard Time allowed for completion of assignment at a 100% rate.
  3. Additional descriptive information is printed on each pallet label to insure proper identification of product.

- H. An audit report can be produced to verify data time elements of each letdown task. Included in the audit report are the following elements of the Forklift Drivers job:
  - 1. Start letdown assignment
  - 2. Get forklift
  - 3. Travel to reserve slot
  - 4. Get pallet from reserve
  - 5. Travel to pick slot
  - 6. Put pallet into pick slot
  - 7. Travel to desk
  - 8. Work assignment terminated
- I. Every Forklift Driver is assigned a labor control card which monitors their performance level on a daily basis. This Labor Standard card is very similar to the Order Selector's card.
- J. All posted lists indicating Forklift Drivers percent effective, incentive hours earned, etc., are the same as the Order Selectors.

### III. RECEIVING PUTAWAY LABOR STANDARDS

- A. The Receiving Putaway Labor Standards Logic is basically an extension of the Letdown Labor Standards Program. The major difference is that Receiving Putaway Standards are initiated by the processing of a Purchase Order, while letdowns are driven by the processing of store billings.
- B. The Receiving Putaway Labor Standards Program interfaces with the On-Line Receiving while utilizing the same Labor Standard Tables as the letdown program.
- C. Once a Purchase Order Receiving is processed through the On-Line Receiving System, the actual door number where the product will be unloaded at must be entered into the On-Line Receiving System.
  - 1. This door number enables the computer to calculate the distance from that point to any slot in the warehouse.
  - 2. The logic in the computer references various Labor Standard Tables and assigns a time value based on these events.
    - a. Travel from Assignment Desk to the Receiving Door.

- b. Travel distance from the Receiving Door to the first reserve slot.
  - c. Raise the mast of the forklift to a certain slot level.
  - d. Deposit the pallet in the specified slot.
  - e. Lower the mast.
  - f. Return to the assigned Receiving Door.
- D. After a Purchase Order is entered into the On-Line Receiving System, individual pallet labels are printed.
1. Each pallet label specifies the actual slot the receiving pallet will be placed into.
  2. The door number where the product will be unloaded at is also indicated on the receiving label.
  3. Two summary labels are printed that specify the individual pallet standard time allotted and a total standard time for the entire Purchase Order.
- E. A warehouse Putaway Audit Report indicates the following elements of a Receiving Putaway Forklift Driver's job:
1. Start putaway assignment
  2. Get forklift
  3. Pick up and maneuver at door
  4. Travel to reserve slot
  5. Put pallet into putaway slot
  6. Travel to desk after last assignment
  7. Putaway assignment terminated
- F. The same labor control card and reporting system for averages and incentive as the letdown program are used by the receiving putaway program.

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