

AD-A242 968



NAVAL POSTGRADUATE SCHOOL Monterey, California



0110
S
C

THESIS

HOW IMPLEMENTATION OF TQM AND THE
DEVELOPMENT OF A PROCESS IMPROVEMENT MODEL,
WITHIN A FORWARD SUPPORT BATTALION, CAN
IMPROVE PREPARATION OF THE MATERIAL
CONDITION STATUS REPORT (DA FORM 2406)

by

John B. Simpson

December 1990

Thesis Advisor:

Sterling Sessions

Approved for public release; distribution is unlimited

01 12 011

91-17023



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2a SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b. OFFICE SYMBOL (If applicable) Code 37	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School			
6c. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000		7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000			
8a. NAME OF FUNDING / SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER			
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS			
		PROGRAM ELEMENT NO	PROJECT NO	TASK NO	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) HOW IMPLEMENTATION OF TQM AND THE DEVELOPMENT OF A PROCESS IMPROVEMENT MODEL, WITHIN A FORWARD SUPPORT BATTALION, CAN IMPROVE PREPARATION OF THE MATERIAL CONDITION STATUS					
12. PERSONAL AUTHOR(S) Simpson, John B.					
13a. TYPE OF REPORT Master's Thesis	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) 1990, December		15. PAGE COUNT 82	
16. SUPPLEMENTARY NOTATION The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Process Improvement Model; Implementation of TQM		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) The purpose of this thesis is to examine how implementation of Total Quality Management (TQM) and the development of a process improvement model, within a Forward Support Battalion (FSB), can improve preparation of the Material Condition Status Report (DA Form 2406). It attempts to establish the framework Forward Support Battalions can implement in order to develop a process improvement model and identifies some ways to monitor the progress the improvement model is making with the preparation of the DA Form 2406. The findings suggest that when TQM is implemented within the FSB, and if the "Plan-Do-Check-Act" process improvement model is also implemented, the preparation of the DA Form 2406 process can be improved.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Prof. Sterling Sessions			22b. TELEPHONE (Include Area Code) (408) 646-2479	22c. OFFICE SYMBOL Code AS/Sq	

DD Form 1473, JUN 86

Previous editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

S/N 0102-LF-014-6603

UNCLASSIFIED

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

#11 - TITLE - (CONTINUED)

Report (DA Form 2406)

Approved for public release; distribution is unlimited

How Implementation of TQM and the Development of a Process Improvement Model, Within a Forward Support Battalion, Can Improve Preparation of the Material Condition Status Report (DA Form 2406)

by

John B. Simpson
Captain, United States Army
B.S., Mount St. Mary's College 1981

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1990

1. Section For _____
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____
 7. _____
 8. _____
 9. _____
 10. _____
 11. _____
 12. _____
 13. _____
 14. _____
 15. _____
 16. _____
 17. _____
 18. _____
 19. _____
 20. _____
 21. _____
 22. _____
 23. _____
 24. _____
 25. _____
 26. _____
 27. _____
 28. _____
 29. _____
 30. _____
 31. _____
 32. _____
 33. _____
 34. _____
 35. _____
 36. _____
 37. _____
 38. _____
 39. _____
 40. _____
 41. _____
 42. _____
 43. _____
 44. _____
 45. _____
 46. _____
 47. _____
 48. _____
 49. _____
 50. _____
 51. _____
 52. _____
 53. _____
 54. _____
 55. _____
 56. _____
 57. _____
 58. _____
 59. _____
 60. _____
 61. _____
 62. _____
 63. _____
 64. _____
 65. _____
 66. _____
 67. _____
 68. _____
 69. _____
 70. _____
 71. _____
 72. _____
 73. _____
 74. _____
 75. _____
 76. _____
 77. _____
 78. _____
 79. _____
 80. _____
 81. _____
 82. _____
 83. _____
 84. _____
 85. _____
 86. _____
 87. _____
 88. _____
 89. _____
 90. _____
 91. _____
 92. _____
 93. _____
 94. _____
 95. _____
 96. _____
 97. _____
 98. _____
 99. _____
 100. _____

Author:

John B. Simpson
John

John B. Simpson

Approved by:

Sterling Session
Sterling Sessions Th

Sterling Sessions, Thesis Advisor


Keebom Kang, Second

Keebom Kang, Second Reader

David R. Whipple, Chairman,
Department of Administrative Sciences

ABSTRACT

The purpose of this thesis is to examine how implementation of Total Quality Management (TQM) and the development of a process improvement model, within a Forward Support Battalion (FSB), can improve preparation of the Material Condition Status Report (DA Form 2406). It attempts to establish the framework Forward Support Battalions can implement in order to develop a process improvement model and identifies some ways to monitor the progress the improvement model is making with the preparation of the DA Form 2406. The findings suggest that when TQM is implemented within the FSB, and if the "Plan-Do-Check-Act" process improvement model is also implemented, the preparation of the DA Form 2406 process can be improved.

TABLE OF CONTENTS

I.	INTRODUCTION -----	1
	A. THESIS SCOPE -----	2
	B. THESIS ORGANIZATION -----	2
	C. METHODOLOGY -----	3
	D. LIMITATIONS AND ASSUMPTIONS -----	3
	E. DEFINITIONS AND ABBREVIATIONS -----	5
II.	THE "PLAN-DO-CHECK-ACT" CYCLE -----	6
	A. ORGANIZATIONAL STRUCTURE -----	6
	B. PLAN PHASE -----	13
	C. DO PHASE -----	19
	D. CHECK PHASE -----	27
	E. ACT PHASE -----	31
	F. SUMMARY -----	36
III.	MATERIAL CONDITION STATUS REPORT -----	37
	A. U.S. ARMY MAINTENANCE -----	38
	B. PMCS -----	38
	C. PURPOSE OF THE DA FORM 2406 -----	40
	D. UNIT EQUIPMENT READINESS GOALS -----	40
	E. DA FORM 2406 PREPARATION PROCESS -----	41
	F. READINESS REPORT FLOW -----	43
	G. SUMMARY -----	44

IV.	THE DA FORM 2406 AND "PLAN-DO-CHECK-ACT" CYCLE -----	45
	A. BACKGROUND -----	45
	B. CURRENT PERFORMANCE -----	46
	C. IMPROVEMENT GOALS -----	46
	D. GENERAL PROCESS STEPS -----	46
	E. ANALYSIS OF THE PREPARATION PROCESS -----	47
	F. CAUSE-AND-EFFECT ANALYSIS -----	50
	G. QUALITY CHARACTERISTICS -----	50
	H. PROCESS IMPROVEMENT ACTIONS -----	54
	I. EVALUATION OF PROCESS IMPROVEMENT ACTIONS --	56
	J. REQUIREMENTS FOR THE LONG-TERM -----	56
	K. FUTURE IMPROVEMENT OPPORTUNITIES -----	57
	L. SUMMARY -----	57
V.	SUMMARY AND CONCLUSIONS -----	58
	A. SUMMARY -----	58
	B. CONCLUSIONS -----	59
	APPENDIX A: DEMING'S MANAGEMENT PRINCIPLES -----	62
	APPENDIX B: ABBREVIATIONS AND DEFINITIONS -----	64
	APPENDIX C: MTOE -----	69
	LIST OF REFERENCES -----	70
	BIBLIOGRAPHY -----	71
	INITIAL DISTRIBUTION LIST -----	73

LIST OF FIGURES

1.	The "Plan-Do-Check-Act" Cycle for Continuous Improvement -----	7
2.	The "Plan-Do-Check-Act" Cycle During Process Improvement -----	8
3.	Process Improvement Model for Total Quality Management -----	10
4.	The "Plan" Phase of the Process Improvement Model -----	13
5.	Process Flowchart -----	17
6.	The "Do" Phase of the Process Improvement Model -----	20
7.	Cause-and-Effect Analysis Chart -----	23
8.	The "Check" Phase of the Process Improvement Model -----	28
9.	The "Act" Phase of the Process Improvement Model -----	32
10.	DA Form 2406 Process Flow -----	48
11.	Cause and Effect Diagram -----	51
12.	Frontside DA Form 2406 -----	52
13.	Backside DA Form 2406 -----	53

I. INTRODUCTION

The Department of Defense (DoD) is adopting a management approach known as Total Quality Management (TQM) in an effort to improve quality and productivity. This approach is based on a set of management practices and statistical measures and processes that, when combined, can identify the causes of poor product quality and excessive cost.

The management practices and analytic methods adopted by DoD and currently being implemented within the Army are based primarily on the TQM concepts of W.E. Deming. Some of the critical concepts are:

- Quality is defined by customers' requirements.
- Top management has direct responsibility for quality improvement.
- Increased quality comes from systematic analysis and improvement of work processes.
- Quality improvement is a continuous effort and conducted throughout the organization.

Appendix A provides a complete listing of Deming's management principles.

A TQM approach emphasizes the major role that managers have in achieving quality and productivity improvement for an organization. The focus of this study is implementation of TQM within a Forward Support Battalion to improve the preparation process of the DA Form 2406.

A. THESIS SCOPE

The objective of this thesis is to serve as a link between TQM theory and DA Form 2406 preparation process improvement. Specifically this thesis has three objectives:

- To define the steps of the process improvement model I selected, by describing specific activities associated with each step and describe how this model can improve preparation of the Material Condition Status Report (DA Form 2406).
- To describe roles and responsibilities of managers and others in relation to this model.
- To describe ways to monitor the progress a Forward Support Battalion (FSB) is making with the preparation of the DA Form 2406.

This thesis is not a "how to" manual for improving product quality, but rather documentation of one approach to process improvement that might have general applications.

This thesis is patterned after A Total Quality Management Process Improvement Model, published by the Navy Personnel Research and Development Center [Ref. 1].

B. THESIS ORGANIZATION

The thesis is organized into five chapters.

Chapter I is a brief introduction to the thesis topic. It discusses: (A) the thesis organization, (B) the scope of the thesis, (C) the methodology used in its preparation, (D) the limitations and assumptions of the thesis, and (E) a list of definitions and abbreviations.

Chapter II outlines the "Plan-Do-Check-Act" cycle and presents related requirements. Chapter III presents

background information on the Material Status Condition Report (DA Form 2406). Chapter IV examines the effects the "Plan-Do-Check-Act" cycle could have on the DA Form 2406. Chapter V is a summary of issues with formulated results.

C. METHODOLOGY

Data collection methods used to address the objectives were personal/telephone interviews, and a review and study of pertinent literature and publications. Data on the DA Form 2406 and maintenance procedures were provided by the Division Support Command (DISCOM), 1st Infantry (Mechanized) Division, Ft. Riley, Kansas. Information concerning TQM and the "Plan-Do-Check-Act" cycle was provided by the Army Management Engineering College, the Defense Systems Management College, the Navy Personnel Research and Development Center, the Sacramento Army Depot, and a Hewlett Packard representative manufacturing division.

D. LIMITATIONS AND ASSUMPTIONS

The significant limitation of this thesis is that it assumes that TQM will continue to be a management philosophy accepted by the U.S. Army. As of the date of this thesis, TQM has not been implemented within an Army FSB. Reasons for this lack of implementation include budget limitations that limit training money available and lack of top management training. TQM must be adopted by top management within an organization in order to be successful and as of this date this requirement

has not been met. This thesis is written with the assumption that TQM will be implemented and the "Plan-Do-Check-Act" cycle will be chosen as the process improvement model used by the FSB (Details on the "Plan-Do-Check-Act" cycle will be addressed in Chapter II).

It is assumed the FSB has accomplished the following:

- Identification of the FSB customer's needs and wants.
- The organizational system for the "Plan-Do-Check-Act" cycle has been established within the FSB. The Battalion (Bn) ESC has developed the TQM strategic plan, identified the DA Form 2406 process as a significant process and chartered the QMB to improve this process.
- An organizational assessment of the FSB has been completed. This assisted the FSB in assessing the Battalions' readiness for change. It also assisted the FSB in measuring the effectiveness of all subsequent change efforts.
- All required initial training and education within the FSB has been completed. An on-going TQM training program has been established.
- Management will tolerate no errors on the front or backside of the DA Form 2406. Every error identified will require immediate correction and preparation process delay. At what point in the DA Form 2406 preparation process an error is detected will ultimately determine the amount of manhours required to rectify the discrepancy. On the average it takes over 25 manhours for each correction.

As previously stated, although the TQM strategy has not been implemented within an FSB, we believe it will be implemented. TQM will significantly change management philosophy within the U.S. Army. These assumptions are the crux of this thesis.

E. ABBREVIATIONS AND DEFINITIONS

Abbreviations and definitions are included in Appendix B.

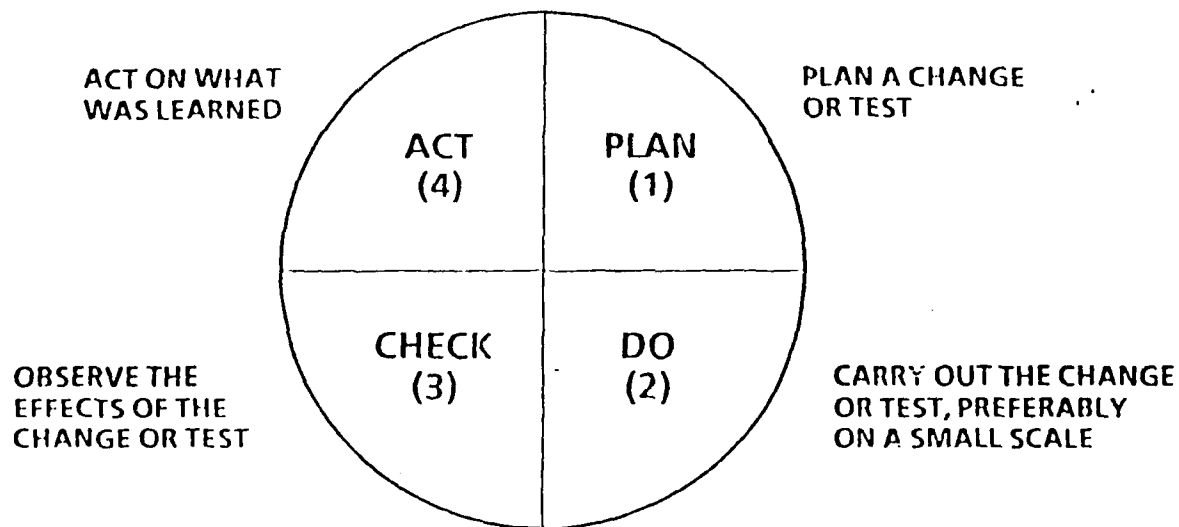
II. THE "PLAN-DO-CHECK-ACT" CYCLE

For this research, we expect to achieve quality improvements through the use of a process improvement approach known as a "Plan-Do-Check-Act" cycle (see Figure 1). This approach was originally associated with the analytic work of Shewhart. [Ref. 2] The representative Hewlett Packard firm we visited believes in this process improvement approach and implemented it in 1981. Our visit provided information on the process.

A. ORGANIZATIONAL STRUCTURE

This cycle is now closely associated with Deming's philosophy on quality improvement. The cycle, as illustrated in Figure 1, describes a method which is best suited to "off-line" quality control where experiments are conducted. In this thesis, an adaptation of the cycle for "on-line" quality control is presented (Figure 2). In this version of the cycle, the FSB chain of command identifies important organizational goals during the "Plan" phase. Activities in the "Do" and "Check" phases involve the identification and analysis of process variables that affect achievement of the goals. During the "Act" phase of the cycle, process corrections and improvements are made and evaluated. Effective changes are formally installed and the process is

THE SHEWHART CYCLE (Deming, 1986)



5. REPEAT STEP 1, WITH NEW KNOWLEDGE.

6. REPEAT STEP 2, AND ONWARD.

Figure 1. The "Plan-Do-Check-Act" Cycle for Continuous Improvement

USE OF "PLAN-DO-CHECK-ACT" CYCLE

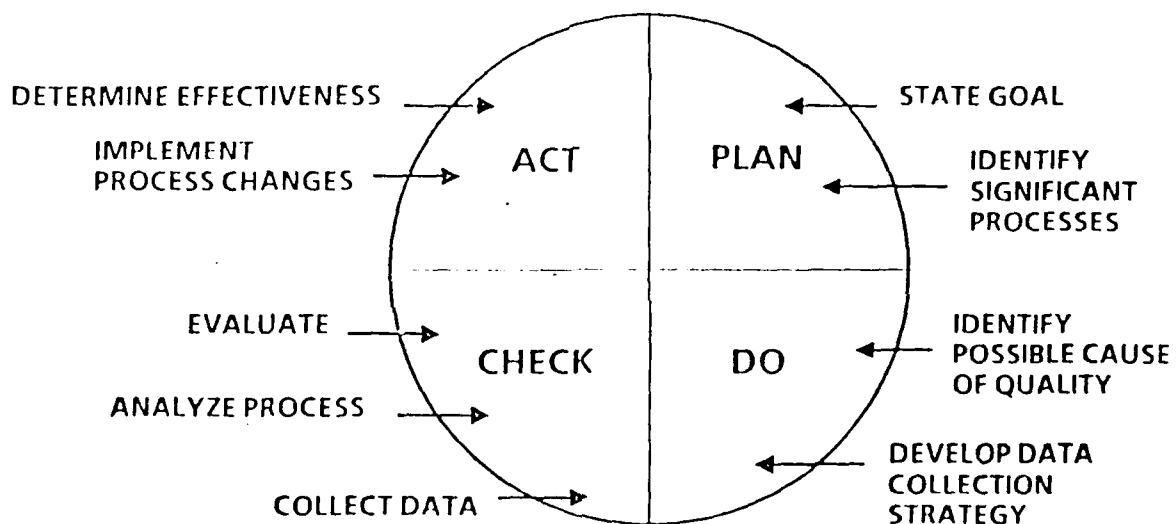


Figure 2. The "Plan-Do-Check-Act" Cycle During Process Improvement

monitored to maintain the improved performance. The cycle is then repeated to pursue continuous improvement.

The specific activities in the "Plan-Do-Check-Act" cycle are presented in the form of a flow chart and displayed in Figure 3.

The use of the "Plan-Do-Act-Check" model within the FSB requires coordination of all organizational levels. The following organizational structure is presented as a way to manage people involved in process improvement efforts. The structure consists of three levels: Executive Steering Committee, Quality Management Boards, and Process Action Teams.

1. Executive Steering Committee

The Executive Steering Committee (ESC) represents the highest level of management and as such is made up of a number of top managers in the organization. For the FSB, an ESC would probably include the Battalion Commander and each of the Company Commanders.

The ESC identifies strategic goals for organizational quality improvements efforts. It obtains information from customers to identify major product and service requirements. It is through the identification of these major requirements that quality goals for the organization are defined. After the ESC has identified customer requirements, it prioritizes and lists the organizational goals for quality improvement. During the course of quality improvement efforts there will be

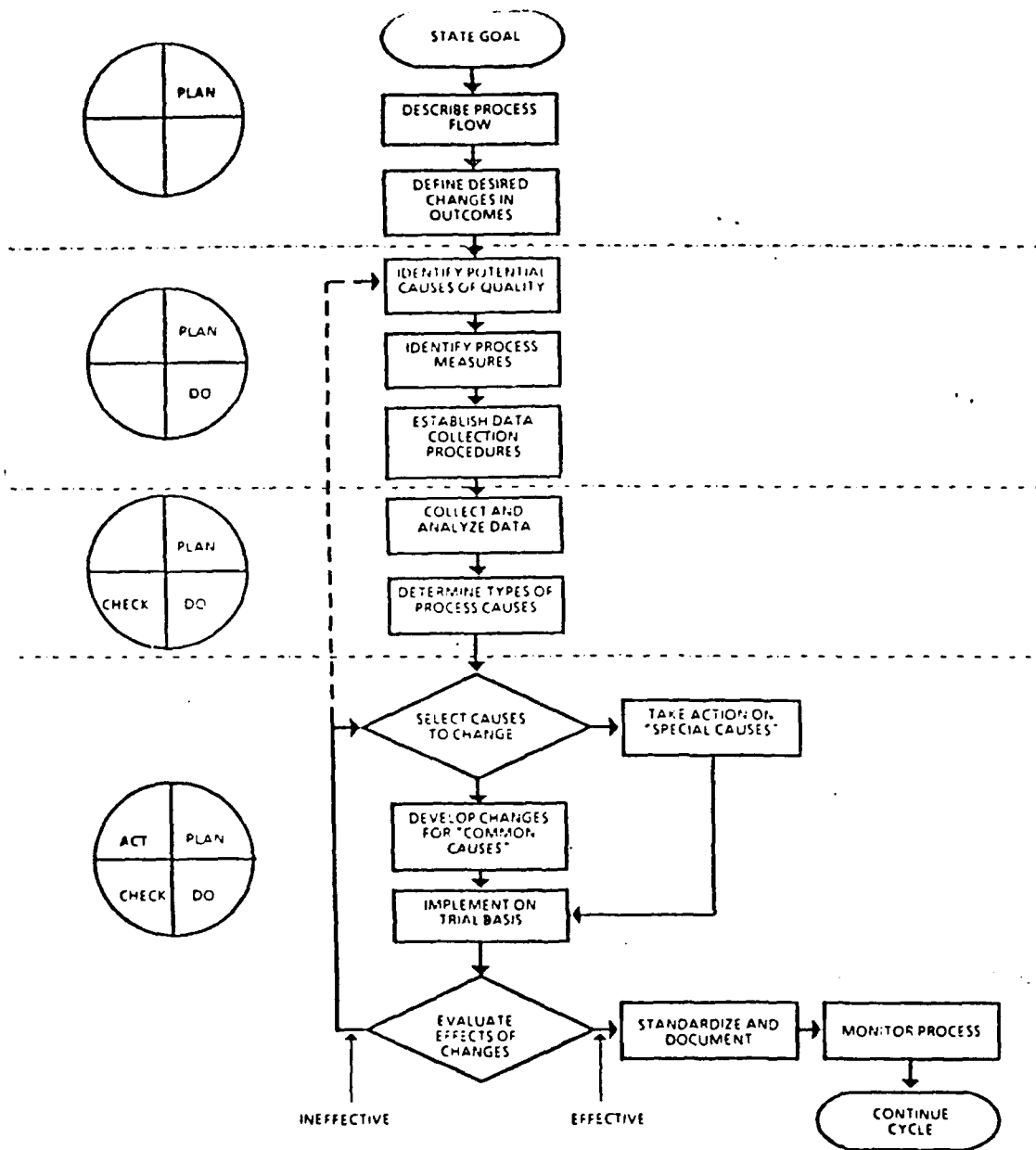


Figure 3. Process Improvement Model for TQM

changes that require support and resources that only can be provided by top management. The ESC is expected to ensure that these requirements are met.

After process changes are made, the ESC is involved in determining the effectiveness of the changes in meeting the quality needs of the customers. As effective process changes are made, the ESC provides the resources to standardize and document these changes.

2. Quality Management Boards

Quality Management Boards are permanent cross-functional teams made up of top- and mid-level managers who are jointly responsible for a specific product or service (see principle #9 of "Deming's 14 Management Principles," in Appendix A). The structure of the boards is intended to improve communications and cooperation by providing vertical and horizontal communication throughout the organization.

Although the members of the QMBs are expected to be permanent, the chair and the focus of a specific QMB can shift, depending on the current product or service goal. During the formation of QMBs, it is crucial that the members selected have the knowledge and ability to relate the ESC's quality improvement goals to specific outputs and processes.

The QMB carries out the majority of the process improvement model activities. The QMB uses its combined knowledge to select the organizational areas that might have the most significant impact on the goals. The QMB works with

the ESC to define indicators of quality improvement and cost reduction.

The QMB organizes ad hoc Process Action Teams (PATs) that collect and analyze information about work processes. As the teams perform their work, the QMB conducts experiments to identify what common causes of variation appear to be most critical to process performance. Based on these causes, the QMB makes changes designed to improve process performance. The QMB tracks the performance of the process to determine the impact of the changes on the selected goals.

3. Process Action Teams

The Process Action Teams or PATs are comprised of staff and/or hourly workers involved in the processes being investigated by the QMBs. The members of a PAT are chosen by their respective managers on the QMBs. The primary consideration for PAT membership is that the individuals selected be highly knowledgeable about the operations in their shop or unit.

The main function of PATs is to collect and summarize process data for QMBs. A major task of a PAT is to collect baseline information on process performance. PATs use basic statistical process control (SPC) methods to analyze a process and identify potential areas for improvement. It is important to note that PATs and, by extension, the entire Process Improvement Model (PIM), are only of use when dealing with quality goals that can be achieved by using objective data.

B. PLAN PHASE

The Plan phase involves identifying the critical product and service requirements of major customers (see Figure 4). Process improvement efforts are based on these critical customer requirements. The ESC and QMBs work together in translating customers' requirements into appropriate goals.

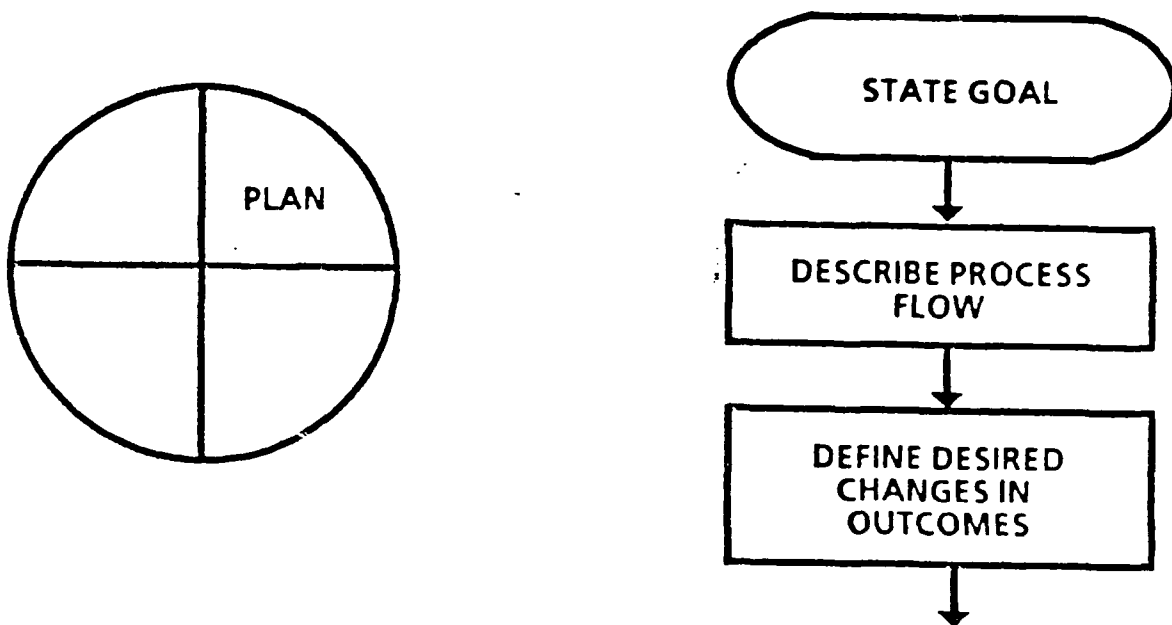


Figure 4. The "Plan" Phase of the Process Improvement Model

A fundamental assumption of the TQM approach is that "quality" is defined by the customer. Therefore, the selection of major quality goals must be based on the

information received from customers. During the planning phase there are certain questions that should be answered:

- "Who are our major customers?"
- "Which products or services are most important to them?"
- "What characteristics of these products or services could be improved?"
- "What operations in the process have the greatest effect on the products or services?"
- "How does the performance of these operations need to change?"

Addressing these questions aids in the development of a quality improvement plan. A well-developed plan enables an organization to concentrate its resources on achieving maximum quality improvements. Failure to develop a well-defined plan with specific, measurable goals can result in wasted time, misused resources, and needless frustration.

The first objective of the ESC is to state the goal of the organization. A goal within this context refers to some desired change in products or service. Examples of goals could be: (1) reducing processing time for customer orders, (2) increasing the service life of a product, (3) shortening the delivery time to customers, or (4) reducing the cost charged to the customer.

While TQM is a very effective way of obtaining quality improvements, certain conditions must be met before using the TQM methods and structure to address a goal. For instance,

goals addressed by TQM should be relevant to the mission of the organization and measurable.

Selected goals should reflect the potential for significant improvements in the product or service. Avoid "so what?" goals that have little, if any, impact on the central mission of the organization. For example, if the central mission of an organization is to repair Army aircraft, then it is unlikely that a major quality concern would be processing travel orders for personnel. Whenever possible, it is best to establish goals that will provide a direct benefit to the final customer.

TQM is often concerned with economically related goals and relies on SPC methods to achieve these goals. Use of these methods requires that goals be defined so that their achievement can be verified by data, not subjective opinion. A goal that can not be measured in some fashion is not appropriate for the process improvement model.

1. Process Flow

In many traditional organizations, managers and employees are encouraged to specialize in those activities and operations they perform. This emphasis has advantages, such as the development of operational expertise, clear job responsibilities, and well-defined management boundaries. There are potentially serious disadvantages associated with this "departmentalizing" of a work process, however. Some of the disadvantages include: conflict between interrelated

operations in separate departments, restriction of needed information, duplicated efforts, and sub-optimization. Sub-optimization occurs when actions are taken to improve the performance of an isolated operation to the detriment of related or subsequent operations.

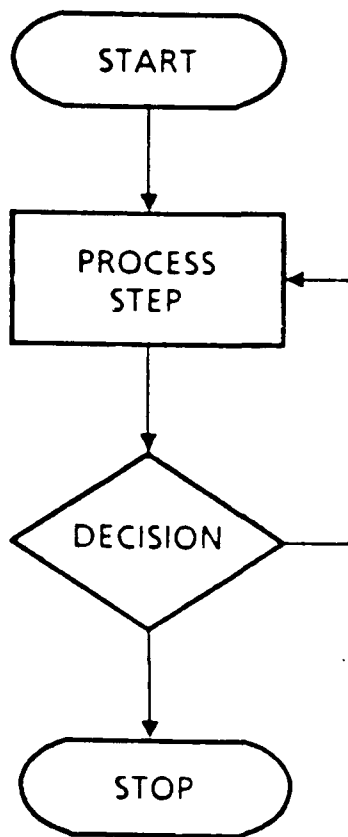
One way to avoid the disadvantages of a narrow process focus in a QMB is for the group to identify major interrelated process operations and departmental responsibilities. One way of accomplishing this is by using the flowchart method. The flowchart is a graphic method of describing the interrelation of operations and decisions required to transform resources into outputs (see Figure 5).

After the QMB has constructed a process flowchart, it should analyze the chart to identify such things as duplicated efforts between operations, "gaps" in accountability, overuse of inspection, and ways to streamline the process. During streamlining the QMB constructs a flowchart of the ideal process, that is, a depiction of a process that creates perfect products in the most efficient manner. The comparison of the actual operations with the streamlined process can then be used to guide improvement activities.

2. Define Desired Changes in Outcome

a. Outcomes

The achievement of quality goals will require specific changes in process performance. A critical task of the ESC and QMBs is to identify and define these needed



- LINES AND SYMBOLS CHART
- REPRESENTS MAJOR STEPS OF A PROCESS
- FORMS BASIS FOR IDENTIFYING EXCESSIVE COMPLEXITY AND WASTE

Figure 5. Process Flowchart

changes. During the planning and other phases of PIM, there are three types of information that will be needed to achieve and maintain quality improvements. These types of information are: outcome, output, and process.

b. Outcome

This information represents the customers' evaluation of the product or service. This information can include timeliness, price, or "fitness for use." These measures are provided by customers external to the

organization. It is information from such customers that is the basis for defining product or service quality. If the organization's current customer information system is considered inadequate, then different methods of obtaining information must be developed. Failure to obtain adequate definitions of customers' requirements seriously weakens the entire foundation of the TQM approach.

c. Output

Output information describes objective features of a product or service. This information typically represents a comparison of critical characteristics of the final product or service with customer-defined requirements. These requirements could address physical specifications, degree of accuracy, or time standards. This type of information can usually be obtained through the review of inspection or audit records.

d. Process

Process information describes the resources and operations required to develop a product or service. This information can address equipment performance, condition of incoming material, variations in work methods or work characteristics. In the TQM approach, this information is gathered by individuals who work directly with the process. Process information is collected to identify variables that have the greatest effect on the product or service.

Measures of outcome, output, and processes are used throughout the process improvement cycle. The ESC obtains outcome information to identify major organizational goals. The ESC and QMBs work together to relate the outcome relationships to specific process outputs. The QMBs and PATs work together to identify the process variables that have the greatest effect on output quality. As these variables are changed, output and outcome information is collected.

C. DO PHASE

After the quality goals have been identified, the process variables related to improved quality need to be identified. The identification of these variables is the task of PATs. The PATs consist of individuals working on the process selected for improvement. In the "Do" phase of PIM, these teams have three major responsibilities (see Figure 6). First, PATs study the current process and its outputs to identify variables related to quality. Second, the teams develop measures of those variables. Third, the teams collect or design a format to collect data.

PATs are expected to use their experience and knowledge to identify variables that affect output quality. Statistical methods are used by PATs to study process performance. First, information on past performance of outputs characteristics is gathered. This is known as baseline information. Second, a description of the process as it currently exists is

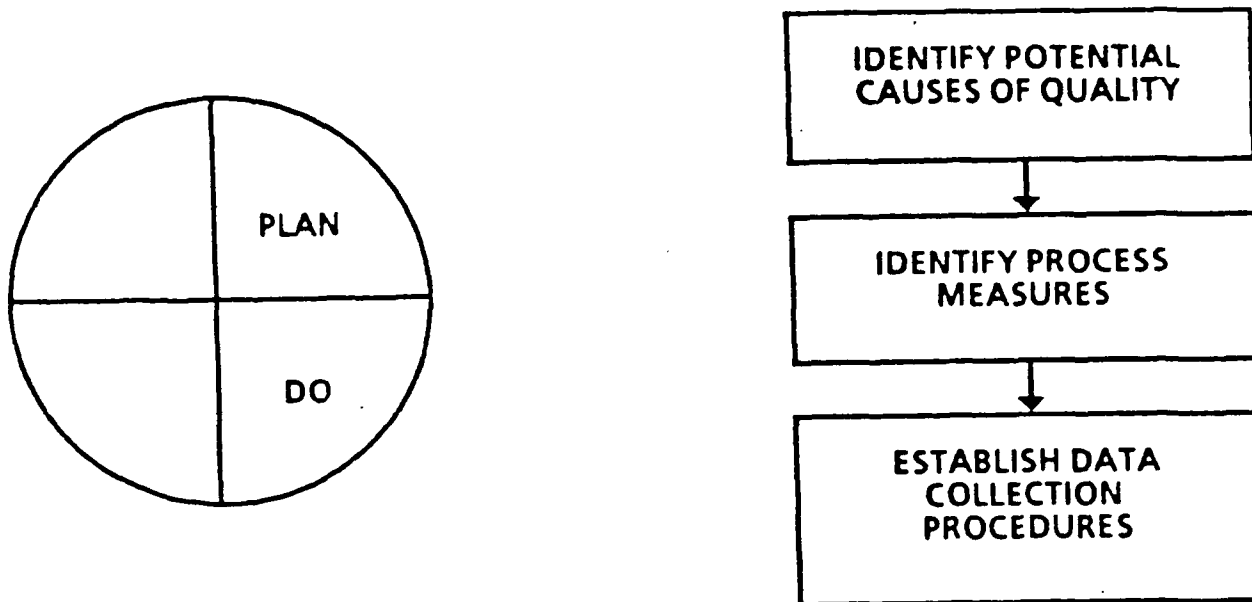


Figure 6. The "Do" Phase of the Process Improvement Model

developed. It takes the form of an "as is" flowchart. Third, the identification of specific process variables is accomplished through a cause-and-effect analysis. The following sections provide further discussion of these steps.

1. Develop Baseline for Process Outputs

The first step in baseline development is to clearly define what quality characteristics of the process output will be studied. This definition is critical to subsequent process analysis and improvement efforts. Development of a baseline for a process output involves evaluation of the output over a period of time. The purpose is to determine how the process performs prior to and following any improvement efforts.

The output studied by a PAT depends on the type of process. The output of a production process is usually a physical product, for example, automobiles, cameras, or clothing. Such outputs have physical dimensions that can often be quantified and objectively evaluated. The outputs of service processes can vary greatly from customer to customer and are often evaluated on the basis of subjective criteria. Thus, collecting baseline information on service outputs can require much more continuous and direct communication with customers than is required when the output is a product.

There is no easy answer for determining what output characteristics should be measured to create a baseline. The characteristics should have logical relationship to the goals defined by the ESC and QMB.

2. "As Is" Flowchart

Each PAT should develop a flowchart that depicts its section of the process as it actually functions. Such flowcharts should be used to identify formal descriptions of operations. It could be discovered that the "as is" description includes redundant steps or that the informal process omits critical activities. It is also important to determine how the operations within a process interact. Process improvements must relate to the process as it functions. The "as is" flowchart can also serve to provide QMB members with more detailed knowledge of critical processes.

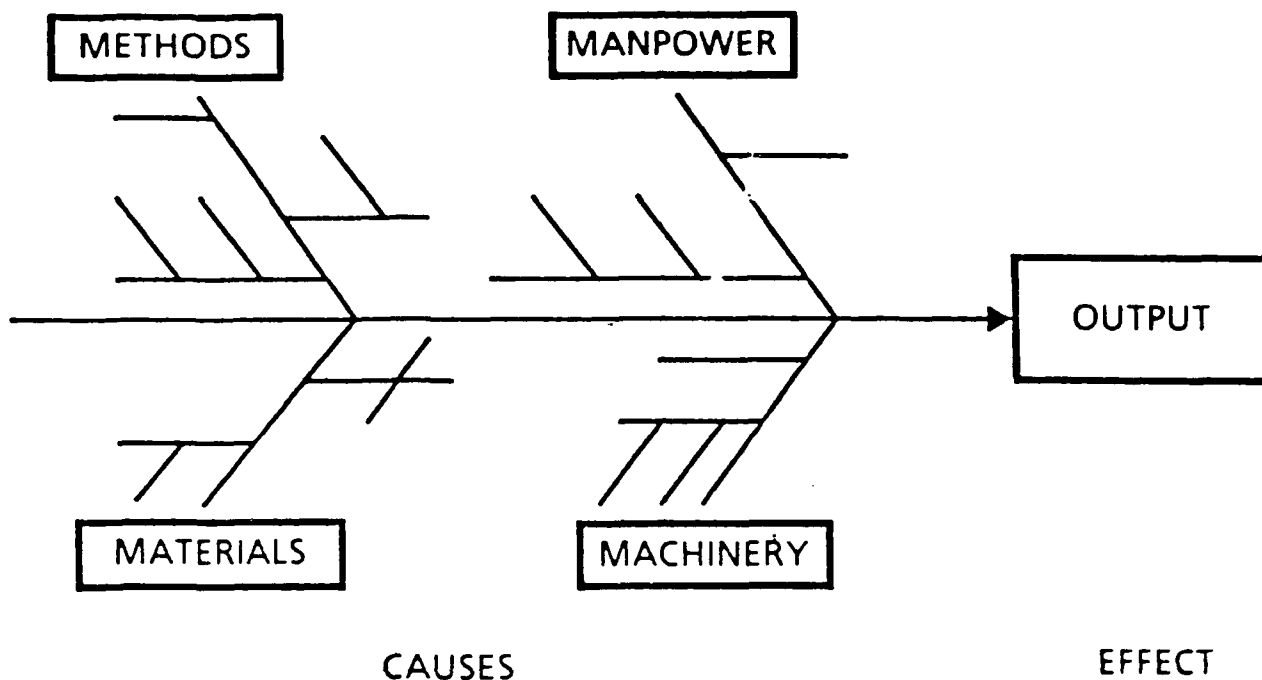
3. Cause-and-Effect Analysis

Cause-and-effect analysis is a brainstorming method used by a team to create a branching diagram. It shows the relationship between a set of possible process variables and a specific process result. [Ref. 3] The results often focused on during cause-and-effect analysis concern quality, costs, or schedule (see Figure 7). Most cause-and-effect analysis concentrates on four categories of process variables. These categories are:

- MANPOWER--the attributes of the people involved in the process such as their experience, training, strength, or even reading ability.
- MATERIALS--the physical resources or raw materials used in the process; within the setting of Army maintenance organizations, these resources can include material such as transmissions, final drives, or engines.
- METHODS--the combination of information and procedures used to create process output. Information sources may be standardized, for example, technical manuals or forms. Methods can include informal work experiences such as "short cut" workers learn from others.
- MACHINES--the equipment and tools used in the process. For an FSB, this could include computer terminals, typewriters, or tow trucks.

While these four categories are commonly used in the identification of important "causes" of process performance, other categories can be added to or substituted for them.

The purpose of conducting the cause-and-effect analysis is to identify the variables that appear to have a major influence on process results. Once these potential "causes" have been identified, they can be analyzed using an



- BRAINSTORMING COMBINED WITH BRANCHING DIAGRAM
- LISTS POSSIBLE CAUSES FOR GOOD OR BAD QUALITY
- SHOWS RELATIONSHIP BETWEEN "EFFECT" AND ITS "CAUSES"
- AIDS IN ANALYZING COMPLEX INTERACTIONS

Figure 7. Cause-and-Effect Analysis Chart

SPC graph such as a scatter diagram. Such analysis is conducted to verify that the "causes" significantly affect process performance. The variables identified during the cause-and-effect analysis are also studied to determine the type of influence these variables have on process results.

4. Identify Process Measures

As important as it is to have valid data on outputs and outcomes, it is vital to obtain process measures as well. Unfortunately, Forward Support Battalions rarely have systems established to collect data on process characteristics. When such data are not available, it becomes necessary to develop the process measures.

Unfortunately, there is no single method of developing measures for process variables. This is a problem that each team will have to work through by using its best judgment. However, once process measures have been identified and developed, it is possible to statistically determine the validity and reliability of these measures. As more knowledge is acquired on processes, the easier it will become to determine what variables should be measured and how they should be defined.

5. Establish Data Collection Procedures

After the PAT has developed measures, it must decide how to collect the data. Data must be collected in a systematic fashion to ensure accuracy of analysis and interpretation. After they have been collected they are

analyzed to identify those variables that are the most critical to quality.

The first part of the data collection strategy requires that the team collect information on the "causes" of variation identified through cause-and-effect analysis. This information is collected to determine how the various "causes" influence the output or effect.

Five questions need to be addressed prior to collecting baseline data on "causes."

a. What Process Information Will Be Collected?

This question concerns the type of information collected on each "cause." In some cases a measure is a simple tally, for example, counting defects in a product, counting forklift trucks available at a receiving dock, or counting errors in a document. Some variables require detailed measurement, for example, size of packages received from vendors, or minutes required to assemble and deliver an vehicle transmission kit.

b. How Will the Data Be Collected?

There are a number of issues that need to be addressed here. First, the PAT must develop a standard data collection format. In some cases this might require the team to construct check sheets or other recording forms. The individuals who use the forms must use them in a consistent fashion. The second issue is that of sampling. Sampling involves collecting data in such a way that it represents the

effect of process variables accurately. A professional statistician is often required to ensure proper sampling.

c. Who Will Collect the Information?

An obvious, but sometimes overlooked, item is deciding individual responsibility for data collection. If individuals are not given specific data collection tasks, there is considerable danger of inaccuracy, that is, data collection failing to be carried out because no one was responsible for it. The individuals selected to conduct data collection should be able to do so as a routine part of their duties. This is likely to occur when the data collector works in the part of the process where the variable is found.

d. Where Will the Data Be Collected?

The PAT must decide at what points in a process data should be collected. The "as is" flowchart developed by the PAT could be used to identify appropriate process data collection points. Data should be collected on "cause" at the points where they occur, rather than waiting to infer the existence of the "cause" through a change in the effect.

e. When Will the Data Be Collected?

This question refers to identifying deadlines for data collection activities. Data collection deadlines are used to obtain process data in a timely manner. The time span should be long enough to provide a representative sample of measures. Expert assistance from statisticians or operations

analysts could be used to help the team determine an adequate time frame.

6. Perform PARETO Analysis

After baseline measures of the process "causes" have been gathered, the relative importance of the causes must be determined. Rather than expand the organization's resources to correct a host of causes all at one time, it would be more effective to address those causes that have the greatest impact on the effect first. A method commonly used to identify the most important causes is the Pareto analysis. This analytical technique involves the use of a vertical bar graph of discrete data that depicts causes sorted in descending order according to their impact on the selected effect. Pareto analysis aids in selecting improvement areas.

From a review of a Pareto chart, a PAT could identify those variables that have the greatest effect on an output characteristic. Those variables could then be analyzed to determine their precise influence within the process. The following section describes the methods frequently used to study process variables.

D. CHECK PHASE

1. Collect and Analyze Data

In the "Check" phase (Figure 8), the PATs collect process and output data. During the data collection period, they summarized the data using graphic methods. Once the data

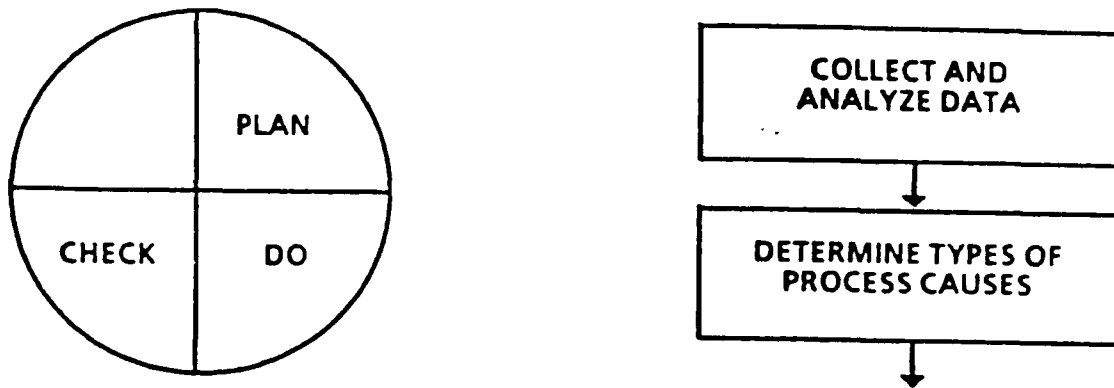


Figure 8. The "Check" Phase of the Process Improvement Model

have been summarized, the PATs and QMBs interpreted the findings to confirm which process variables have a significant effect on outputs and, subsequently, outcomes.

In addition to flow charts, cause-and-effect diagrams, and Pareto charts, there are four other methods commonly associated with process analysis.

a. Histograms

Histograms are bar graphs of continuous data that display the amount and type of variation in process outputs. They can be used to show how the majority of process outputs compare with a goal value as well as with its specification limits.

b. Scatter Diagrams

Scatter Diagrams are a scatter plot of paired measurements used to test the relationship between a suspected

"cause" and the output effect. These diagrams can be used to show if changes in a process variable result in changes in the output.

c. Run Charts

Run Charts are a simple display of process performance over time displayed on a line graph. They can be used to test "before" and "after" effects of process changes.

d. Control Charts

Control Charts, which are line graphs with estimated performance parameters that evaluates the stability of a process, diagnose problems (Problem analysis), and assesses effects of improvement actions (Process control). These charts can be used to distinguish among variables that consistently affect all of a process' outputs (common causes) and those that have an unpredictable effect on outputs (special causes). [Ref. 4]

These methods are used, when appropriate, by QMBs and PATs to uncover causes of unwanted variation in process performance. Once the data have been graphed, both the PATs and the QMBs interpret the findings. Based on the results of their interpretation, process improvement changes are made and evaluated in the "Act" phase.

2. Determine Types of Process Causes

Before taking actions to improve quality, QMBs and PATs should determine what types of causes or variables are within the process. Causes have either a "common" or

"special" influence on a process. Common causes are those that arise from the system itself and influence overall performance in a statistically predictable fashion. Examples of common causes could include the accuracy of standards supplied to a work area, the training given to workers, or the consistency of materials used in the process.

Special causes refer to variables that are not regarded as part of the system and have isolated and statistically unpredictable influence on outputs. Special causes are often "local" to a specific operation, machine, or lot of material. Examples of special causes include a bad lot of material, a single malfunctioning machine, or a new worker using inappropriate procedures. Sometimes the source of a special cause can not be determined or could reflect an unusual statistical event.

Failing to identify the exact nature of a problem could result in short-term "solutions" being used on long-term problems. This is usually the result of incorrectly assuming that a common cause is a special cause. It is also possible to err by implementing broad-scope, long-term changes on what could have been a short-term aberration. Common and special causes can often be identified through the use of control charts. [Ref. 5]

E. ACT PHASE

1. Select Causes to Change

At the conclusion of the "Check" phase, the PATs select process variables believed to be major contributors to process quality. These variables are used during the "Act" phase in efforts to improve process quality (see Figure 9). At this point in the model, a critical task of the QMBs is to identify those variables that can be handled at the lower organizational levels and those that require the efforts of upper management. Typically, actions on special causes, those isolated and unpredictable process influences, can be dealt with at the worker level. Changing common causes, those variables that affect total process performance, usually involve major changes that require the attention of higher management.

2. Take Action on Special Causes

In some cases it is necessary to take corrective action(s) as soon as a "special cause" is identified. If unsafe working conditions are discovered, it is not necessary to wait until all of analytic efforts have been carried out to improve the working conditions. Early in an organization's TQM effort many causes identified could require immediate action. It should be remembered that the main purpose of correcting special causes is to stabilize a process. After a process is stabilized it is possible to address common causes and improve overall performance.

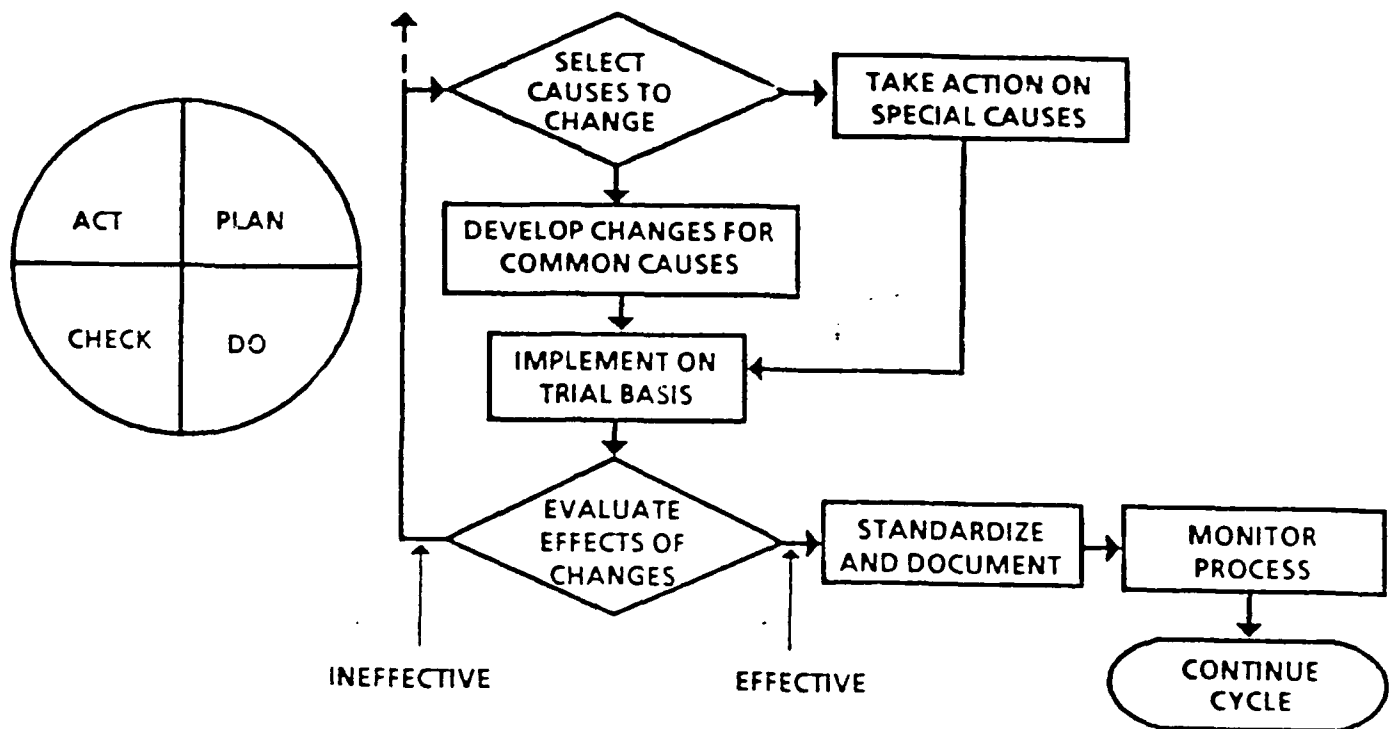


Figure 9. The "Act" Phase of the Process Improvement Model

3. Develop Changes for Common Causes

As a process is stabilized and common causes are identified, the QMBs and ESC work to improve process-wide influence on quality. The QMBs and ESC identify the resources and authority levels required to make the changes. As part of the change design, the QMBs and ESC will have to decide how long a trial period should be. Two factors that should be taken into consideration are the nature of the change and production time. Some changes might take a relatively short time to put in place and be expected to show immediate

results. Other changes could require a longer period of time to install.

The determination of trial periods should be decided using statistical criteria before the change is implemented to avoid incorrectly evaluating the effectiveness of a change. For example, a change might be considered to be effective before it is actually tried, and once it has been put in place, any positive results could be interpreted as sufficient evidence that it was working. The trial would then be stopped and a potentially ineffective change installed as part of the process. By collecting data for an established time period, changes that only have a temporary effect can be ruled out.

After changes have been designed by the QMBs and the ESC, the changes are put into effect for a trial period. The QMBs continue to work with the PATs and others involved in the changes to ensure that the design plan is properly executed. Failure to follow the change plan could lead to poor results and the discontinuance of an effective process change.

After the process change, the QMBs and ESC need to evaluate the effect of the change relative to the original goals identified during the "Plan" phase. Evaluation should be conducted at the process level, the output level, and the outcome level. These levels of evaluation are used to determine if the process change should be stabilized or if further investigation is required. The following sections describe evaluation activities.

4. Collect and Analyze Output Data

Once changes have been installed, the process is allowed to operate for the pre-selected trial period. Data are collected by PATs to assess the effects of the change, for example, use of a run or control chart to determine if the change has a significant influence on the output characteristic. The findings of the PATs are summarized and submitted along with graphs to be reviewed by the ESC and QMBs. QMBs integrate the data obtained from PATs to form a complete description of the effects that changes have had on outputs.

After the PATs have completed their collection of evaluative output data, the QMBs and the ESC compare those data with outcome information. The purpose of this comparison is to determine what effect the changes have made on the meeting of customer requirements. It is possible that a change could have a positive effect on performance at an internal level without those benefits being transferred to the user of the product or service. That is why it is very important for the QMBs to identify all of the major process operations during the "Plan" phase. If a critical operation is ignored within a process, its poor performance could neutralize other gains.

After reviewing evaluation data, the QMBs and ESC must determine if the process improvement goals have been achieved. If the changes lead to desired improvements, then the QMBs and ESC take the steps needed to make the changes permanent parts

of the process. If there has been no significant change in outcomes selected during the "Plan" phase, then other possible causes of performance must be investigated. This could require returning to the lists created during the "Plan" and "Do" phases and selecting different variables to work on. In an extreme case, a new set of causes might have to be identified for the process.

5. Standardize Process Improvements

If the results show a significant increase in process quality, then the QMBs and ESC take actions to make the changes permanent. Such actions include changing specifications, work methods, vendors, or new training to workers.

An important step in maintaining process improvements is documentation of improvement action and results. By recording such efforts it is possible to develop case studies for the continuing education of managers new to the TQM approach, for informing vendors of their responsibilities under a changed process, and for briefing customers on the organization's efforts to meet their requirements.

The final step of this model is the establishment of monitoring procedures. Once a process has been improved so that it meets the requirements of customers, then the process changes that led to the improvements must be maintained. Maintenance of a process at a higher level of quality requires the ongoing measurement of critical process variables. The

purpose of such measurement or monitoring is to ensure that process performance does not deteriorate.

At the conclusion of a successful improvement effort, the participating groups should develop the procedures and forms necessary to monitor the process. Unlike the previous process analysis efforts, data collection for monitoring is expected to be a regular task of the people involved in the process. Simplicity in data collection and analysis should be a major consideration in the development of a monitoring system.

Although this model focuses on the individual process improvement effort, it should be remembered that under TQM process improvement efforts are a continuous activity. The ESC should always search for new areas for improvement. At the organizational level, the ESC works to address new customer concerns and requirements as the previous goals are met. This could require increasingly detailed customer information systems. At the QMB and PAT levels, continuing efforts to reduce process variation and refinement of process improvements provide additional quality gains.

F. SUMMARY

In this chapter, we examined the components of the "Plan-Do-Act-Check" process improvement cycle. In Chapter III, the preparation process of the DA Form 2406 will be explored.

III. MATERIAL CONDITION STATUS REPORT

In accordance with forward support CSS concepts, the Forward Support Battalion (FSB) insures that its supported brigade units have sufficient food, repair parts, ammunition, and fuel (Appendix B). It also assists in providing other supplies and medical treatment and in insuring that repairs or replacements of critical weapon systems are made quickly.

Whether the FSB can provide sufficient support to its assigned brigade is largely dependent on the amount of serviceable equipment it has available to complete the mission. The document that informs the FSB commander on the status of the equipment he/she is responsible for, is the Material Condition Status Report (DA FORM 2406). The S-4 is the primary staff officer with responsibility for the preparation of the DA Form 2406 (Appendix B).

The combat readiness of the FSB is dependent upon the quality and the timeliness of maintenance operations performed on Army material. Each commander is responsible for the maintenance of material issued to or under the control of his unit, organization, installation or command, to include the efficiency of programs established for this purpose. The expense and loss of equipment availability resulting from a need for corrective maintenance is of primary concern to the FSB chain of command. To this end, particular attention must

be given to preventive maintenance services. The DA Form 2406 provides information to commanders at all levels on the success of such attention.

A. U.S. ARMY MAINTENANCE

The Army maintenance system consists of four levels: Unit (Organizational), direct support (DS), general support (GS), and depot levels. Organizational maintenance is the first level of the Army maintenance system and is the level that this thesis is oriented around. According to AR 750-1, the organizational level maintenance is the foundation of the Army's maintenance system. [Ref. 6] The function of organizational maintenance is to sustain material readiness. Each FSB has the capacity for the organizational maintenance of its equipment. Organizational maintenance is performed by the crew/operators of the equipment and organizational maintenance personnel.

B. PMCS

Preventive Maintenance Checks and Services (PMCS) are the foundation of unit level maintenance. The procedures and the category of maintenance to perform PMCS are found in the 10 and 20 Equipment Technical Manuals and Lubrication Orders. The before, during, and after-PMCS checks concentrate on ensuring equipment is fully mission capable (FMC). Faults not affecting FMC are corrected or reported before or during the mission. Army regulation states that commanders are required

to maintain equipment at TM-10/20 PMCS standards according to the appropriate technical manual. [Ref. 6] Unit mechanics use the TM-10 and TM-20 series to identify and correct faults. The TM-20 series PMCS tables are used to perform scheduled PMCS services which sustain and extend the combat capable time of the equipment. Performance of unit level maintenance will be documented using the forms and records as described in DA Pam 738-750, DA Pam 750-35 and AR 750-1.

Every Divisional FSB will receive backup maintenance support from their assigned direct support (DS) maintenance unit. While performing PMCS a fault or problem may be identified that causes equipment to malfunction. Faults that make the equipment not mission capable (NMC) are deficiencies and are recorded on the DA Form 2404. [Ref. 7]

A NMC indicates that equipment cannot perform any one or more of its combat missions. The DA Form 2406 will indicate to the FSB commander the total number of workdays the battalion's equipment was NMC for the reporting period.

Each company within the FSB has a company maintenance section under the supervision of the motor sergeant. The company motor sergeant supervises and assists the company's organizational maintenance personnel and equipment operators in the proper performance of organizational maintenance on organic equipment. They also cumulate the required information for the DA Form 2406.

It often possible that to repair the noted deficiency may require maintenance at a level above organizational (direct, general, or depot). When this is required a DA Form 2407 (Appendix D) is completed to request support maintenance and the equipment is reported on the DA Form 2406 as Not Mission Capable Maintenance (NMCM).

It also may be possible that a repair part, not available within the company, must be ordered to fix the equipment. When this is required the part is ordered through the unit maintenance computer and the equipment is reported on the DA Form 2406 as Not Mission Capable Supply (NMCS).

C. PURPOSE OF THE DA FORM 2406

This report provides;

- The Department of the Army (DA) staff and equipment managers with readiness information on reportable items of equipment, systems/subsystems.
- Commanders with information to analyze and predict equipment readiness and availability and the equipment status of their supported equipment.
- Unit commanders with a worksheet for computing EMC in accordance with AR 220-1.

D. UNIT EQUIPMENT READINESS GOALS

The equipment readiness goal for Equipment Mission Capable (EMC) is to reach and maintain a fully mission capable (FMC) of 90 percent for all equipment.

E. DA FORM 2406 PREPARATION PROCESS

All equipment LINS listed in AR 700-138 [Ref. 8] that are authorized on the Tables of Organization and Equipment (TOE)/ Modified Tables of Organizational Equipment (MTOE) or on-hand and on the unit property book will be reported on the DA Form 2406. A TOE prescribes the normal mission, organizational structure, and personnel and equipment requirements for a military unit. An MTOE (Appendix C) is an authorization document which prescribes the modification to a basic TOE necessary to adapt its mission, capabilities, organization, personnel and equipment to meet the needs of a specific unit or group of units. Equipment that is to be reported as a system is also listed in AR 700-138. When equipment is reported as part of a system (e.g., trucks and generators) reduce the number authorized and on-hand by one for each reportable item used with a system.

The DA Form 2406 preparation procedures within the FSB begin with the company TAMMS (The Army Material Maintenance System) clerk. On the 10th of each month, the unit Motor Sergeant prepares the DA Form 2406 with information supplied to him from the TAMMS clerk. The TAMMS clerk reviews the DD Form 314s [Ref. 7] he/she maintains for all the equipment end items in the company. By reading the DD Form 314, the TAMMS clerk knows when each piece of reportable equipment is operational or NMC. If the equipment is NMC, the DD Form 314

will tell the TAMMS clerk whether the equipment is NMC for repair parts (NMCS) or direct support maintenance (NMCM).

The TAMMS clerk inputs the following information on the front side of the DA Form 2406 [Ref. 8]:

- The number of pieces of equipment authorized on the TOE/MTOE.
- The number of equipment that is authorized and is currently actually on-hand within the unit.
- The number of total days the reportable equipment was on-hand (possible days) during the month.
- The number of days the reportable equipment was operational (available days) during the month.
- The number of days the reportable equipment was NMC (nonavailable days) during the month.

The TAMMS clerk lists the reportable equipment currently NMC on the back side of the DA Form 2406 (Appendix G). He also lists the reason the equipment is NMC (repair parts or direct support maintenance) and the total number of days that reportable equipment has been NMC.

The Motor Sergeant then performs calculations to determine unit readiness. The total number of available days is divided by the total number of possible days and the resulting answer is the units monthly readiness status. A discrepancy on this report can cause the unit to fall below Army equipment readiness goals. Unit commanders do not tolerate mistakes on this report.

This appears to be a very simple process but the number of errors on the DA Form 2406 report each month is often

unexplainable. Discrepancies can arise from many areas. The number of pieces of reportable equipment on-hand within an FSB can change on a daily basis. When a piece of reportable equipment becomes NMC and requires evacuation, the dates must be verified with the direct support maintenance unit that received the equipment. The DSU is required to submit a report on when NMC equipment arrives and when they fix it. This report is the DSU report card. When the FSB orders a repair part from the DSU and when the DSU reports it the repair part was ordered are often different days.

The readiness of an FSB is contingent on the accuracy of the DA Form 2406 and as previously stated, an error of a single day could ensure the FSB does not meet U.S. Army equipment readiness goals.

F. READINESS REPORT FLOW

All companies within the Forward Support Battalion are required to fill out the DA Form 2406. Reporting units complete the DA Form 2406 at the parent unit level (no higher than battalion). For FSBs, the battalion is the parent unit.

Each Company Motor Sergeant submits the DA Form 2406 to his/her responsible Company Commander for approval. Each FSB Company Commander then submits the report to the Battalion Commander for approval. The Battalion S-4 consolidates the reports and in turn, the Battalion Commander submits it to the Brigade Commander for approval. And then the report is

further consolidated by the Brigade S-4. The Brigade Commander submits it to the Division Commander for approval. This report flow continues until it reaches the Secretary of the Army Office. At each turn-in point there is a meeting of Commanders to discuss the readiness posture of respective units.

G. SUMMARY

In this chapter we discussed the DA Form 2406 preparation process. In the next chapter, we will combine the "Plan-Do-Check-Act" cycle discussed in Chapter I with the DA Form 2406 preparation process and focus on the possible process improvements.

IV. THE DA FORM 2406 AND "PLAN-DO-CHECK-ACT" CYCLE

As previously stated, the Plan-Do-Check-Act cycle exercised, as a TQM process improvement model, has not been implemented within an FSB. The following data are provided to the reader as the best estimation of what would and could occur if the Plan-Do-Check-Act cycle (identified in Chapter I) were employed. The data are provided by many sources including the Army War College, the DISCOM of the First Infantry Division located at Ft. Riley, Kansas and the author's personnel awareness. It should be noted, TQM implementation will differ from organization to organization and therefore this study should be used as a guide only.

A. BACKGROUND

It is assumed that as a part of an FSB's total quality management efforts, organizational goals were determined through customer information. Members of the TQM Executive Steering Committee are responsible for obtaining customer information. During the gathering of such information, discussions with the supported Brigade Commander and the DISCOM Commander confirmed that the quality of the DA Form 2406 is a major factor in maintaining combat readiness of the FSB and ultimately the supported Brigade.

B. CURRENT PERFORMANCE

The FSB Executive Steering Committee conducted a review of archival information to determine current levels of accuracy associated with the DA Form 2406 preparation process. Processing data for 1989 from three FSBs were retrieved and analyzed. The following information about the accuracy of the front and back side were found.

Although unit commanders do not tolerate errors on this report, an average of five errors occurred on the front side of the DA Form 2406 per month per FSB. An average of ten errors occurred on the back side of the DA Form 2406 per month per FSB.

C. IMPROVEMENT GOALS

Identification and removal of unwanted variation in the DA Form 2406 preparation process is the major improvement goal. This will lead to fewer errors per FSB thus improving overall combat readiness. The results of process improvement actions will be compared with the baseline data. By reducing the errors in the DA Form 2406 preparation process numerous manhours will be saved, there is a potential yearly manhour savings of 4500 hours (15 errors per month x 25 manhours x 12 months).

D. GENERAL PROCESS STEPS

The Executive Steering Committee developed a general process flowchart to aid in identifying critical management

areas of responsibility in the DA Form 2406 preparation process. The following chart presents the major operations required (Figure 10).

Based on a review of the process flowchart and its cumulative knowledge, the FSB Executive Steering Committee chartered a Quality Management Board (QMB). The QMB was made up of the Battalion S-4, the Battalion Motor Officer, each Company Motor Sergeant, the three Company Commanders and the Battalion Executive Officer. It was given the responsibility of analyzing the output of the DA Form 2406 preparation process to determine process areas for detailed investigation.

The QMB chartered a Process Action Team to identify specific process variables that affected quality. This team was comprised of the Company Motor Sergeants and select individuals from each of the Companies.

E. ANALYSIS OF THE PREPARATION PROCESS

The QMB reviewed past DA Form 2406s to identify errors that had a major influence on the accuracy of the report. Four types of processing errors were analyzed through the use of Pareto analysis:

- Unit equipment actually on-hand does not match unit equipment listed on the DA Form 2406. It was discovered no coordination with the company supply personnel was the primary reason for discrepancy.
- The dates utilized on the DA Form 2406 by several companies, for equipment turned into the DSU for repair does not match the date the DSU is reporting the equipment was received by them. It was discovered no coordination with the DSU was the primary reason for

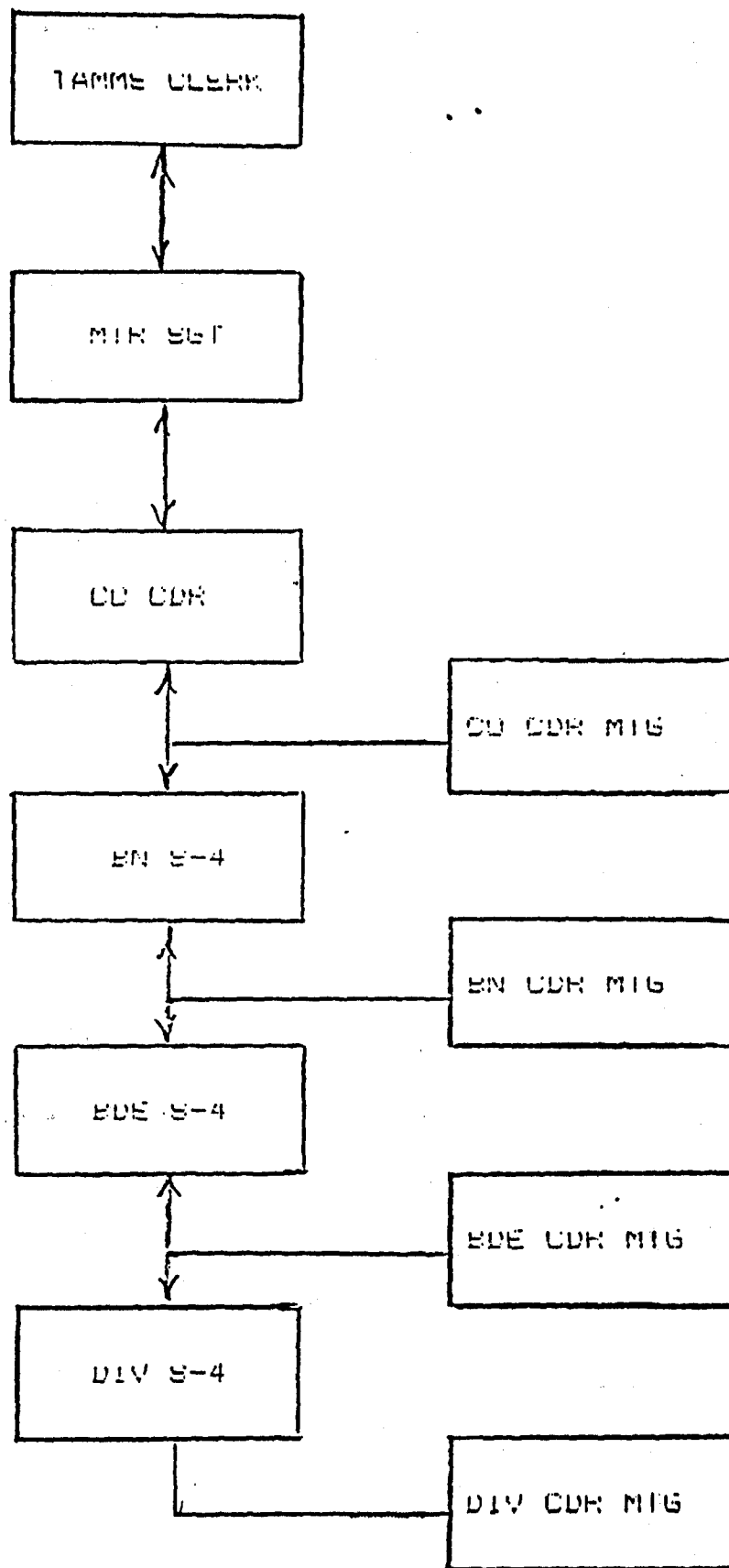


Figure 10. DA Form 2406 Process Flow

these discrepancies. This causes a miscalculation of readiness status by distorting the NMCM days.

- The dates utilized on the DA Form 2406 by several companies, for parts ordered from the DSU does not match the date the DSU is reporting the part was actually ordered. Again it was discovered that no coordination with the DSU was the primary reason for errors. This also will cause a miscalculation of unit readiness status by distorting the NMCS days.
- Math errors in calculating individual company readiness status, the number of days available does not match the combined totals of operational days and nonavailable days accounted for at least one error in each company. This was caused by a lack of knowledge by the preparer or lack of supervision.

As unit readiness was a critical customer concern each of these defects was targeted for improvement efforts.

The PAT developed a flowchart describing the DA Form 2406 preparation process. This chart describes the process as it actually operated and was compared with existing instructions and operations documents. It became apparent the DA Form 2406 preparation procedures varied from unit to unit depending on command emphasis. Errors in the DA Form 2406 report were always discovered and corrected each month. No one within the FSB had done an analysis of the preparation process. Therefore no one realized how many manhours could be saved. If you have to work 20 hours a day to do the job correctly--you worked the hours. Manhours are often overlooked. Army regulations tell you what is required on the report but interpretation of requirements varied significantly.

F. CAUSE-AND-EFFECT ANALYSIS

The PAT developed a cause-and-effect diagram to identify process variables that could affect the quality of the DA Form 2406 (Figure 11). The information shared during the construction of the diagram was valuable in directing the PAT's efforts to begin preliminary data collection. The next section presents the quality characteristics and process variables that were found to be critical in the process.

G. QUALITY CHARACTERISTICS

The PAT used scatter diagrams to identify the process variables that had the greatest impact on the quality problems associated with the DA Form 2406 preparation process. The findings are as follows:

- Quality Characteristic: Error on the frontside DA Form 2406 concerning amount of equipment on hand.
- Related Process Variable: The Company Supply Sergeant review of the frontside (Figure 12).
- Quality Characteristic: Error on the backside DA Form 2406 concerning NMCS days.
- Related Process Variable: DSU verification (Figure 13).
- Quality Characteristic: Error on the backside DA Form 2406 concerning NMCM days.
- Related Process Variable: DSU verification (Figure 13).
- Quality Characteristic: Error in readiness status due to company miscalculations.
- Related Process Variable: Preparers math aptitude.

Interpretation of the scatter diagrams supported the belief that cause-and-effect relationships existed among the

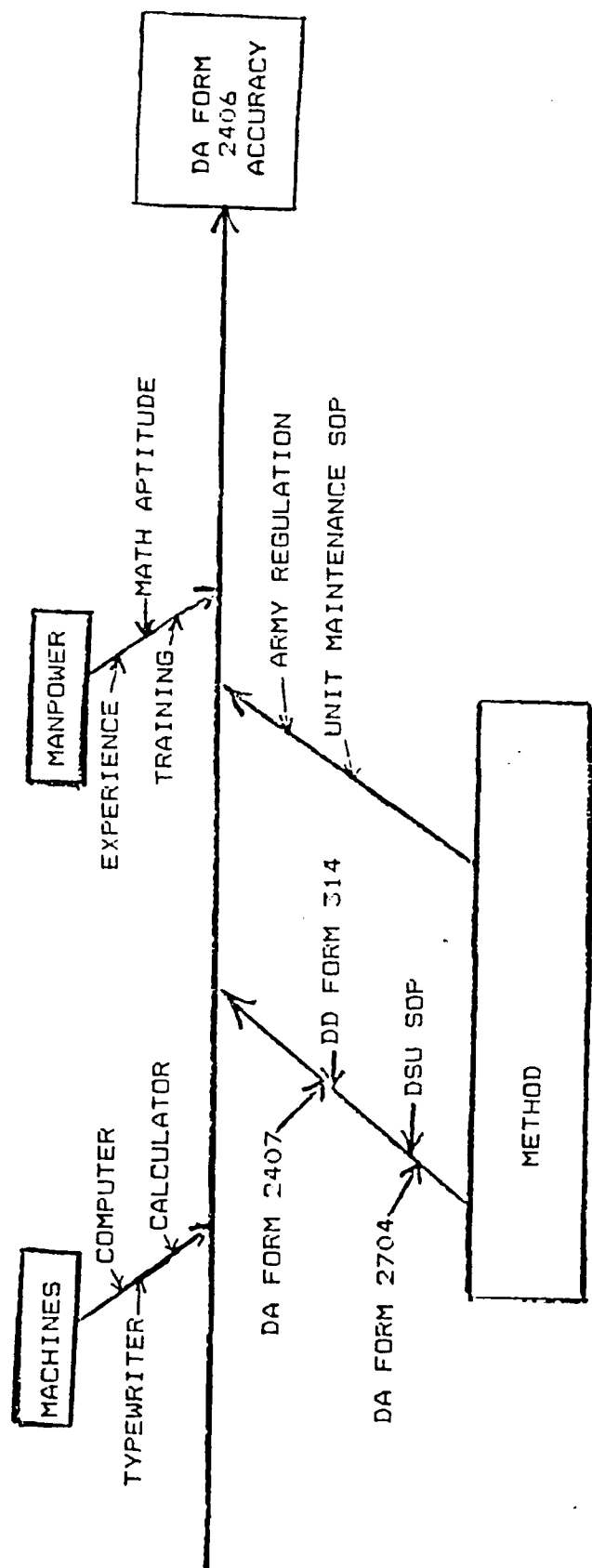


Figure 11. Cause and Effect Diagram

FRONTSIDE DA FORM 2406

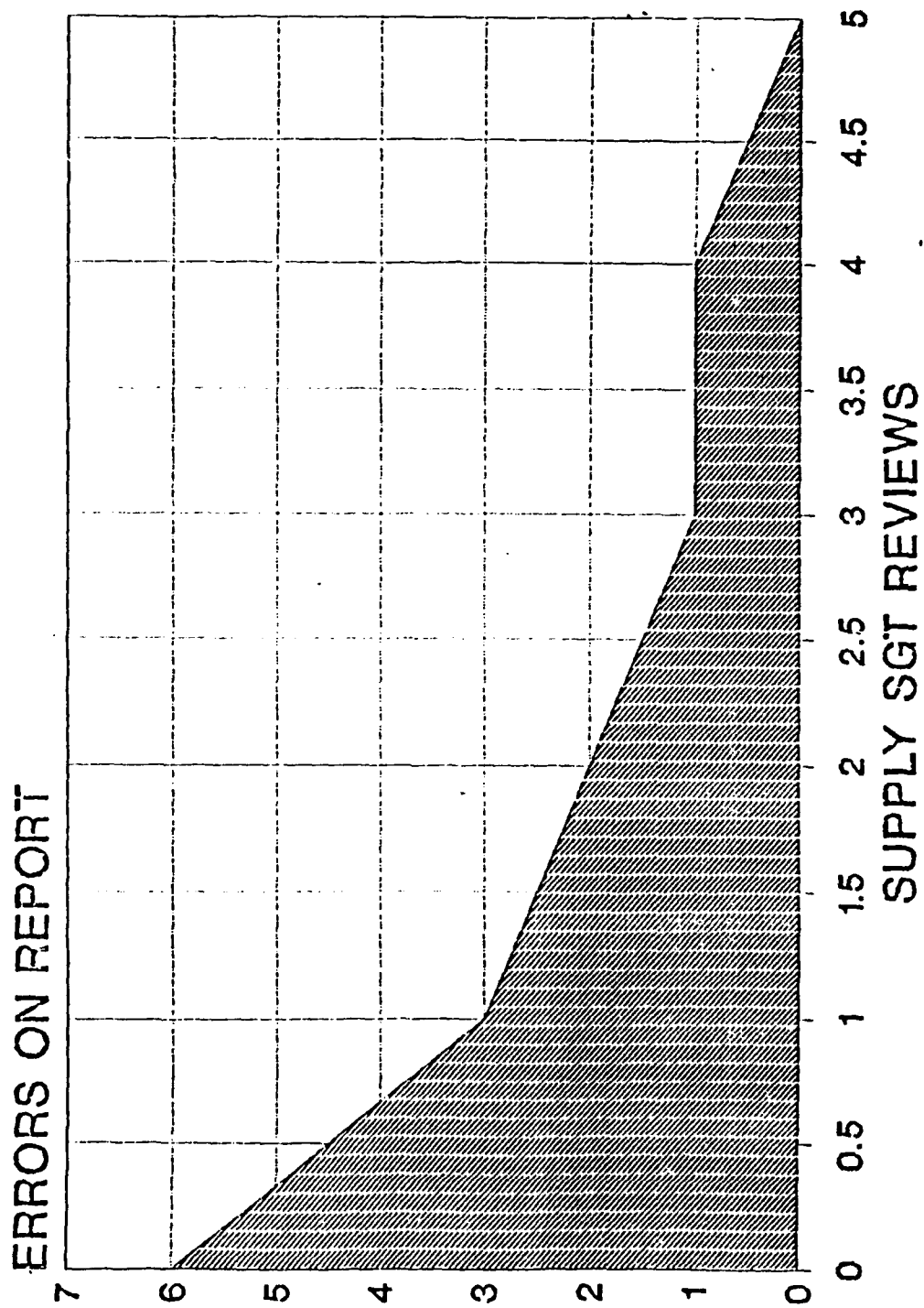


Figure 12. Frontside DA Form 2406

BACKSIDE DA FORM 2406

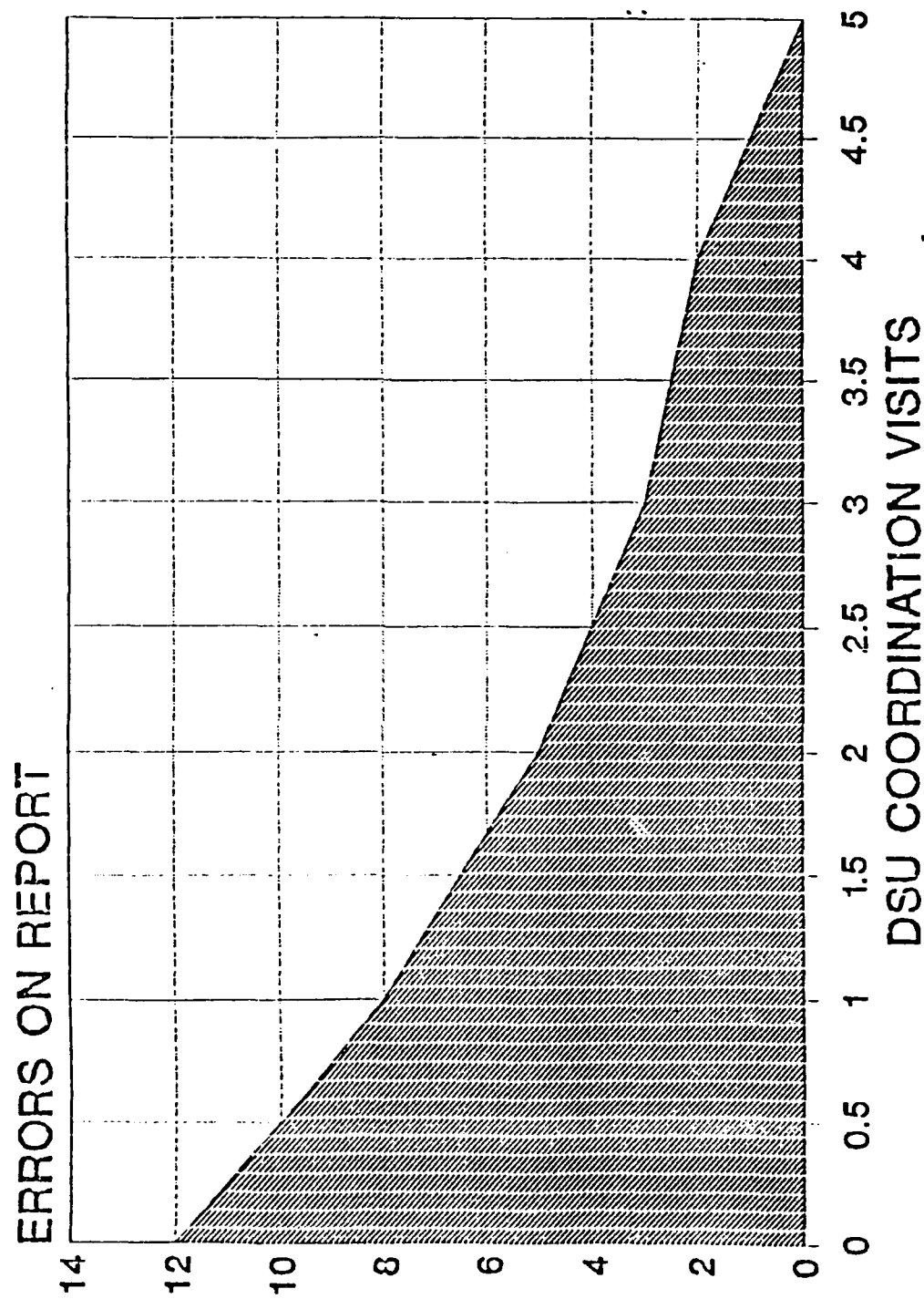


Figure 13. Backside DA Form 2406

variables and the quality characteristics. The next section presents the general actions taken to improve and control process performance.

H. PROCESS IMPROVEMENT ACTIONS

Based on information provided by the PAT, the QMB and the ESC took corrective actions. These actions have been organized according to their related quality characteristics and critical variables.

Quality Characteristic: Error on the frontside DA Form 2406 concerning amount of equipment on hand.

Critical variable: Review by the Co Supply Sgt

Action: The frontside DA Form 2406 will be reviewed by the Company Supply Sergeant at least 25 manhours worth (one error = 25 manhours) prior to actual report due date. The Company Supply Sergeant maintains the property books for the company and therefore can accurately verify the data on the DD Form 314s. If the DD Form 314s accurately reflect the equipment on hand the DA Form 2406 will also be correct. If the error is caught by the company supply sergeant, at the unit level, then numerous manhours will be saved. If the error is realized up the process chain then it must go through the entire process again. Frontside error data will be collected by each Company Commander.

Quality Characteristic: Error on the backside DA Form 2406 concerning NMCS days.

Critical Variable: DSU verification.

Action: The Co Motor Sgt will coordinate with the supported DSU at least three times a week. When a repair part is ordered from the DSU, the Motor Sgt will verify the date the part was ordered or the date the part was received. The Motor Sgt will then ensure the data is correctly transferred to the DD Form 314s. If the information on the DD Form 314s is the same as the DSU is reporting the DA Form 2406 will be accurate.

Quality Characteristic: Error on the backside DA Form 2406 concerning NMCM days.

Critical Variable: DSU verification.

Action: The Company Motor Sergeant will coordinate with the supported DSU at least three times a week. When a deadlined vehicle is sent to the DSU, the Motor Sgt will verify the date the vehicle entered the DSU or the date the vehicle was fixed and available for pick-up. The Motor Sgt will then ensure the data are correctly transferred to the DD Form 314s. If the information on the DD Form 314s is the same as the information the DSU is reporting the DA Form 2406 will be accurate. The backside error data (NMCS and NMCM days) will be collected by each Company Commander and consolidated by the Battalion S-4.

Quality Characteristic: Error in readiness status due to company miscalculations.

Critical Variable: Preparer's math aptitude.

Action: The calculations will be verified at each level within the process. The report preparer will receive additional training to ensure accuracy. Again, the calculation errors will be collected by each Company Commander and consolidated by the Battalion S-4.

I. EVALUATION OF PROCESS IMPROVEMENT ACTIONS

Evaluation data were collected on the preparation process. The effects of the process improvement actions on the accuracy of the DA Form 2406 are presented below.

Changes in error rate: The average number of errors on the frontside DA Form 2406 per month dropped from five to one and the average number of errors on the backside DA Form 2406 per month dropped from 11 to four.

J. REQUIREMENTS FOR THE LONG-TERM

1. Personnel

Training of all key DA Form 2406 preparation personnel will start immediately.

2. Methods

An SOP will be established by the Battalion S-4 shop on proper DA Form 2406 preparation procedures. All required forms and necessary actions will be included.

3. Machines

Training on each of the required machines (computers and calculators) will be mandatory for all report preparers.

4. Monitoring

Scatter diagrams have been established to monitor the progress of the following critical process variables within the DA Form 2406 preparation process:

- Frontside Errors.
- Backside Errors (NMCS).
- Backside Errors (NMCM).
- Miscalculations.

These scatter diagrams will be maintained by each Company Commander who will provide the data to the QMB. The QMB will then make recommendations to the ESC.

K. FUTURE IMPROVEMENT OPPORTUNITIES

Process monitoring and improvement efforts will be continued on the four quality characteristics identified by this analysis. The QMB is investigating the problems with DSU coordination.

L. SUMMARY

Although TQM has not been implemented within the FSB and the data presented in this study are an estimate of knowledgeable individuals, the "Plan-Do-Check-Act" cycle can provide significant improvements to the DA Form 2406 preparation procedures. In this section, I have identified some of the critical variables associated with the DA Form 2406 preparation and what improvements could be realized if this process were used.

V. SUMMARY AND CONCLUSIONS

A. SUMMARY

The successful continuous quality improvement operation is characterized by an organization of quality trained, motivated employees working in an atmosphere established by management and encourages initiative and trust, and where each individual's contributions are sought to upgrade quality. [Ref. 9]

This thesis addressed this initiative (TQM) within DoD by examining the effects of the development of a process improvement model on the preparation of the Material Condition Status Report (DA Form 2406) within a FSB.

Implementation of the "Plan-Do-Check-Act" cycle mandates many changes, and as noted in Chapter III, the most fundamental features are [Ref. 1]:

- Organizational Structure Change. The use of the "Plan-Do-Act-Check" model within the FSB requires coordination of all organizational levels. The structure consists of three levels: Executive Steering Committee (ESC), Quality Management Boards (QMBs), and Process Action Teams (PATs). The ESC identifies strategic goals for organizational quality improvement efforts. The QMBs carry out the majority of the process improvement model activities and uses its combined knowledge to select the organizational areas that might have the most significant impact on the goals. And PATs are to collect and summarize process data for QMBs.
- Implementing the Plan-Do-Check-Act cycle. During the "Plan" phase, the FSB chain of command identifies important organizational goals. Activities in the "Do" and "Check" phases involve the identification and analysis of process variables that affect achievement of goals. During the "Act" phase, process corrections and improvements are made and evaluated.

Although all of DoD is subject to the implementation of TQM, it will take many years before the entire U.S. Army has changed its management philosophy. This thesis was based on a premise that eventually TQM and a process improvement model such as the "Plan-Do-Act-Check" cycle will gain acceptance.

This study examined what conceivably could happen if TQM was implemented within an FSB and the "Plan-Do-Act-Check" cycle was developed to improve the preparation of the Material Condition Status Report (DA Form 2406).

B. CONCLUSIONS

The findings of this research are based on personnel interviews, telephone conversations and other source data which was gathered from the Naval Personnel and Research Development Center, the Army War College, Hewlett Packard, Sacramento Army Depot, and DISCOM, First Infantry Division, Ft. Riley, Kansas. This research attempted to answer three questions.

1. When Total Quality Management(TQM) Has Been Implemented in the Forward Support Battalior (FSB), What Process Improvement Model Can Be Developed to Improve the Material Condition Status Report (DA Form 2406)?

Interviews and available data suggest that the process improvement model, the "Plan-Do-Act-Check" cycle can be developed. This cycle is currently being taught and the Command and General Staff College and appears to have been

successfully implemented at the Sacramento Army Depot and Hewlett Packard.

2. What Are the Activities Involved with Implementing the Process Improvement Model That We Selected?

Employing the "Plan-Do-Act-Check" cycle, facilitated the use of a process flow diagram (Figure 5) which distinguishes each activity involved in the DA Form 2406 preparation. Once the process flow diagram has been completed, the cause-and-effect diagram (Figure 7) will list the possible causes for good or bad quality. It also shows the relationship between "effect" and its "causes."

3. What Are Some of the Ways to Monitor the Progress the Battalion Is Making with the Preparation of the DA Form 2406, After the Model Has Been Implemented?

During the "Check" phase, the PATs collect process and output data. During the data collection period, they summarize the data using graphic methods. This study distinguished numerous ways to monitor process analysis: flow charts, cause-and-effect diagrams, Pareto charts, histograms, run charts, and control charts. Also scatter diagrams were addressed and if the FSB Company Commanders would use them, they would provide an alternative method of monitoring progress.

At the time of this research, TQM has only slightly begun to impact the Army management. The findings of this thesis suggest that the preparation of the DA Form 2406 within

the FSB could improve dramatically once implementation is complete.

APPENDIX A

DEMING'S MANAGEMENT PRINCIPLES

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.
2. Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership (see point 12). The aim of leadership should be to help people and machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.
10. Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.

11. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
- 11a. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.
- 12a. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.
- 12b. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, inter alia, abolishment of the annual or merit rating and management by objective.
13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

APPENDIX B

ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS

Bn	Battalion
Bde	Brigade
DS	Direct Support
DISCOM	Division Support Command
CDR	Commander
CO	Company
CSS	Combat Service Support
DSU	Direct Support Unit
ESC	Executive Steering Committee
FMC	Fully Mission Capable
FSB	Forward Support Battalion
GS	General Support
HQDA	Headquarters Department of the Army
HQ AMC	Headquarters Army Material Command
MTOE	Modified Table of Organizational and Equipment
NMCM	Not Mission Capable Maintenance
NMCS	Not Mission Capable Supply
NMC	Not Mission Capable
PAT	Process Action Team
PIM	Process Improvement Model
PMCS	Preventive Maintenance Checks and Services

QMB	Quality Management Board
SPC	Statistical Process Control
TAMMS	The Army Maintenance Management System
TM	Technical Manual
TOE	Table(s) of Organization and Equipment
TQM	Total Quality Management

DEFINITIONS

1. After Operations Checks--Checks and services performed per the TM-10 series PMCS tables at the conclusion of the mission to identify and correct faults which preclude the next mission and to maintain the equipment to TM-10 series PMCS maintenance standard. Faults which render the equipment NMC must be corrected prior to the start of the next mission. Unit maintenance performs required services per TM-20 series to maintain the equipment to the TM-10 series and TM-20 series PMCS maintenance standard.
2. Available Days--The days equipment is on-hand in an organization and fully able to do its mission, the time equipment is FMC.
3. Before Operations Checks--Operator instructions included in TM-10 series PMCS tables. They are performed prior to equipment leaving its containment area or performing its mission.
4. Division Support Command (DISCOM)--Provides division-level logistics and medical support to all organic and attached elements of the division.
5. Deficiency--A fault or problem that causes equipment to malfunction. Faults that make the equipment NMC are deficiencies. A defect is a deficiency when it: (a) makes an item, subsystem, or system inoperable, (b) is listed in the "equipment is not ready/available if" column of the operator's PMCS list, (c) makes the equipment unsafe or endangers crew, (d) will seriously damage the equipment, and (e) makes the equipment so inaccurate it cannot do its mission as needed.
6. TM-10/20 Maintenance Standard--The condition of equipment when: (a) the equipment is FMC, (b) all faults are

identified using "items to be checked" column of the applicable TM-10 series and TM-20 series PMCS tables and (1) corrective action which are authorized to be accomplished at Unit level, and for which required parts are available, are completed, (2) required parts are requisitioned for faults which required them to complete the corrective actions, (3) corrective actions which are authorized to be accomplished at a maintenance level above the unit are on a valid direct support maintenance request, and (c) equipment services are performed within the scheduled service interval.

7. During Operations Checks--Checks performed by the operator/crew per the TM-10 PMCS tables which monitor and identify faults in equipment performance during the mission. Faults which render the equipment NMC require immediate correction. All other faults are corrected or reported.
8. Equipment End Item--A final combination of assemblies, components, modules, and parts which is designed to perform an operational function and is ready for intended use.
9. Fault--A term used to indicate that a piece of equipment has a deficiency or shortcoming.
10. Forward Support Battalion (FSB)--the division support command (DISCOM) combat service support (CSS) operator in the brigade area. Each FSB provides dedicated division-level logistical support for a specific brigade and to the units that directly support that brigade.
11. Full Mission Capable (FMC)--Systems and equipment that are safe and have all mission-essential subsystems installed and operating as designated by applicable Army regulation. The terms ready/available and full mission capable refer to the same status: equipment is on hand and able to perform its combat missions.
12. Modified Table of Organization and Equipment (MTOE)--A planning document which provides the personnel and equipment a unit is required to have to perform its assigned mission (Appendix B).
13. Nonavailable Days--The days the equipment was not able to do its mission, the time the equipment is not mission capable. This term is used on the DA Form 2406 to rate equipments' ability to do its combat or combat support job.

14. Not Mission Capable (NMC)--A material condition indicating that equipment cannot perform any one of its combat missions. NMC is divided into the following categories: not mission capable, maintenance or not mission capable supply. Equipment is NMC when the equipment has a fault that appears in the "not ready" column of the operator's PMCS.
15. Not Mission Capable Maintenance (NMCM)--Equipment that cannot perform its combat mission because of maintenance work underway or needed. NMCM time starts when the equipment has an NMC fault and is under the control of an organizational or an other maintenance activity. Equipment is normally FMC on the day it is inspected and signed out on the DA Form 2407. Unit NMCM covers all time used at the unit level for NMC maintenance. Unit NMCM includes time needed to deliver equipment and wait for acceptance of equipment sent to support maintenance. Unit NMCM ends upon completion of the support acceptance inspection.
16. Not Mission Capable Supply (NMCS)--Equipment that cannot perform its combat mission because of a supply shortage. NMCS time starts when no more maintenance work can be done on a NMC fault because a needed part is not on hand. NMCS cover time spent waiting for repair parts, chassis, assemblies, and subassemblies, and components. Both NMCS and NMCM time can occur on an item or system on the same day. Count the entire day for the one with most hours that day.
17. Preventive Maintenance Checks and Services (PMCS)--The care, servicing, inspection, detection, and correction of minor faults before these faults cause serious damage, failure, or injury. The procedures and the category of maintenance to perform PMCS are found in the -10 and -20 Equipment Technical Manuals. Procedures have been established for before, during and after operation checks.
18. Readiness--The capability of a unit/formation, weapon system, or equipment to perform the missions or functions for which it is organized or designed.
19. Substitute Item--An item authorized issue instead of, or in place of, an authorized standard item of like nature and quality. DA Pam 700-25 identifies items and procedures for making substitutions.
20. System--A combination of equipment end items, assemblies, components, modules and/or parts assembled as a single functional unit to perform a task or mission. For DA Form

2406, a system is a group of items, separately authorized on your MTOE that forms a single operational unit. Even though the items are listed separately, they work together to perform a particular mission or task.

21. S-4 /Logistics Officer--Each FSB is authorized a coordinating staff group which acts as principal staff assistants to the commander. Each is concerned with one (or a combination) of the broad fields of interest. They assist the commander by coordinating the plans, activities, and operations of the command. The coordinating staff officer for the commander in matters about supply, maintenance, transportation, and services is the S-4.
22. Technical Manuals (TM)--Technical manuals provide the detailed operation and maintenance information applicable to the piece of equipment for which they are published. The manuals come in sets or series, each of which covers a different category of maintenance.
23. Total Quality Management (TQM)--the application of quantitative methods and people to assess and improve: A) materials and services supplied to the organization, B) all significant processes within the organization, and C) meeting the needs of the customer, now and in the future.
24. Workday--Normal duty shift as defined by the local commander. A normal duty shift will not exceed a 12 hour period.

APPENDIX C

NTOE

PREPARED BY: 280503-1151-445
 PGM: 441-622
 PAGE: 15
 INPUT-AVAILABILITY-REPORT-NTOE-TYPE-2
 PART 1 INPUT TRANSACTION AND ERROR LISTING
 NTOE-44-810406
 PROPOSED-APPROVED
 MIDE 192624401
 CCHUM-441039

SECTION 111 EQUIPMENT ALLOWANCE

DATA	LINE	DESCRIPTION	QUANTITY	UNIT	PARENT UNIT	LINE TOTAL	NET CHANGE	AC
			REQ	REF	REQ	REF		
102	450243	ANALYZER SET ENGINE: PORTABLE SOLID STATE (STE/ICSP)	1	1	1	1	1	A
102	840272	BATCHER-CLIFF: W/SCANNARD FOR MICAL: RIFLE	102	95	102	95		A
102	867750	MINICULAR: MODULAR CONSTRUCTION W/ SCALE RETICLE T100W W/E	2	2	2	2	2	A
102	885721	CHEMICAL AGENT METER: (C4M)	2	2	2	2	2	A
102	832827	CLEANER STEAM HIGH PRESSURE HOT WATER JET: WHEEL MOUNTED	1	1	1	1	1	A
102	852375	BATTERY CASE: 2-41J-21	2	2	2	2	2	A
102	867719	CABLE TELEPHONE: WD-1/TT DR-B 172 M	1	1	1	1	1	A
102	880145	CAMOUFLAGE SCREEN SYSTEM: MONOLAND LT HT RADAR COAT W/O SPT S	11	11	11	11	11	A
102	849213	CAMOUFLAGE SCREEN SUPPORT SYSTEM: MONOLAND/RECENT PLASTIC POL	11	11	11	11	11	A
102	099573	CHARGER BATTERY: PP-24/M5M	1	1	1	1	1	A
102	800533	CHARGER: 2012C DETECTOR PP-1575/20	2	2	2	2	2	A
102	870294	COMP UNIT: MCP: 174 2 MIL PHU TIAEC GAS URVN 5 CFM 175 PSI	1	1	1	1	1	A
102	854041	GEN ST DSL ENG: SKID MTD 3KW 60 HZ AC 120/200V HEP-2143	1	1	1	1	1	A
102	846112	GEN ST GAS ENG: 3KW DC 20V SKD-SIN: TLR FRAME W/O TAC UTILITY	1	1	1	1	1	A
102	847617	GEN ST GAS ENG: 174 60HZ 2FL MTD 6V 1116 PU-520	1	1	1	1	1	A
102	824462	HEATER UNIT TYPE ATUL: GAS 250000 250 MIL W/	1	1	1	1	1	A

Best Available Copy

LIST OF REFERENCES

1. Navy Personnel Research and Development Center, A Total Quality Management Process Improvement Model, Organizational Systems Department, San Diego, CA, December 1988.
2. Shewhart, W.A., Economic Control of a Manufactured Product, Princeton, NJ: Van Nostrand Reinhold, 1931.
3. Ishikawa, K., & Lu, D.J., What is Total Quality Control? The Japanese Way, Englewood Cliffs, N.J.: Prentice-Hall. ISBN 0-13-952433-9, 1985.
4. Houston, A., Hulton, V., Landau, S.B., Monda, M., & Shettel-Neuber, J., Measurement of Work Processes Using Statistical Process Control: A Literature and Field Survey, NPRDC Tech. Rep. 86-21, San Diego, CA: Navy Personnel Research and Development Center, March 1987.
5. Wheeler, D.J., & Chambers, D.S., Understanding Statistical Process Control, Knoxville, TN: Statistical Process Controls, Inc., 1986.
6. Headquarters Department of the Army, The Army Material Maintenance Policies, Army Regulation 750-1, 30 October 1989.
7. Headquarters Department of the Army, The Army Maintenance Management System (TAMMS) Department of the Army Pamphlet 738-750, 31 October 1989.
8. Headquarters Department of the Army, Army Logistics Readiness and Sustainability, Army Regulation 700-138, 16 June 1990.
9. Strickland, J., Total Quality Management: A Guide for Implementation, LD NUMBER 076646A, January 1989.

BIBLIOGRAPHY

- Alexander, Roger S. Col., Overview to the Application of the Total Quality Management, LD NUMBER 077388A, April 1989.
- Ackoff, R.L., Creating the Corporate Future: Plan or Planned For, New York: John Wiley, April 1981.
- Albrecht, K., & Zemke, R., Service America! Doing Business in the New Economy, Homewood, IL: Dow-Jones-Irwin, 1985.
- AT&T, Statistical Quality Control Handbook, Charlotte, NC: Delmar Printing Company, May 1956.
- Deming, W.E., Out of the Crisis, Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study, December 1985.
- Dockstader, S.L., "What to Do When There Are More Than Five Deadly Diseases," Paper presented at Massachusetts Institute of Technology Conference on Quality and Productivity, San Diego, CA, June 1984.
- G.O.A.L. (Growth Opportunity Alliance of Greater Lawrence), The Memory Jogger. A Pocket Guide of Tools for Continuous Improvement, 1985, Lawrence, MA, 1985.
- Grant, E.L., & Leavenworth, R.S. Statistical Quality Control (5th ed.), New York: McGraw-Hill, 1983.
- Greebler, C.S., An Education and Training Strategy for Total Quality Management in the DoD, NPRDC-TN-89-28, July 1989.
- Headquarters Department of the Army, Unit Status Reporting, Army Regulation 220-1, 16 December 1986.
- Hollingsworth, James, Strategy for Educating the Department of Defense Acquisition Work Force on TOM, NPRDC-TN-89-19, February 1989.
- Juran, J.M. (Ed.). Quality Control Handbook, (3rd ed.), New York: McGraw-Hill, June 1985.
- Looper, L.T., Methodology for Generating Efficiency and Effectiveness Measures (MGEEM), AFHRL-TP-89-7, May 1989.

Mann, N.R., The Keys to Excellence: The Story of the Deming Philosophy, Los Angeles, CA: Prestwick Books. ISBN 0-9614986-0-9, May 1986.

McDaniel, Delora, Total Quality Management Case Study in a Navy Headquarters Organization, LD NUMBER 081000A, February 1990.

Scherkenbach, W.W., The Deming Route to Quality and Productivity: Roadmaps and Roadblocks, Washington, D.C.:CEEPRESS, ISBN 0-941893-00-6.

Telephone Conversations between Colonel Richard Frank (TQM representative--Defense Systems Management College), Mr. Jerry Burns (TQM Point of Contact--The Army Management Engineering College), and the author, 2 November 1990.

Walton, M., The Deming Management Method, New York, NY: Dodd, Mead, ISBN 0-396-08895-3, 1983.

INITIAL DISTRIBUTION LIST

	No. Copies
1. Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2. Library, Code 52 Naval Postgraduate School Monterey, California 93943-5002	2
3. Defense Logistics Studies Information Exchange United States Army Logistics Management Center Ft. Lee, Virginia 23801	2
4. Prof. Sterling Sessions, Code AS/Sg Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5000	1
5. Prof. Keebom Kang, Code AS/Ka Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5000	1
6. John B. Simpson III c/o Lawrence R. Pryor 221 Yorktown Drive Ft. Lee, Virginia 23801	3