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**IMPROVING OPERATIONAL READINESS
THROUGH
TOTAL QUALITY MANAGEMENT**

by

Herb Westphal

Defense Mapping Agency

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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Abstract of

**IMPROVING OPERATIONAL READINESS THROUGH
TOTAL QUALITY MANAGEMENT (TQM)**

A Case Study: The Defense Mapping Agency Combat Support Center (DMACSC) initiated a comprehensive study following the high level guidance provided by the DoD TQM Master Plan. This study encompassed CSC's Philadelphia Depot's requisition issuing branch. The goal was to improve CSC's and DOP's overall effectiveness and to improve customer satisfaction through the identification and eradication of recurring errors. Continuous process improvement methodology and employee involvement activities were employed to exploit and rectify recurring errors. These efforts furthered our mission readiness and ensured our world-wide commitments to the Armed Forces by "getting the right product, in the right quantity, to the right place -- at the right time." This report is intended to provide a synopsis of the methodology used in CSC's TQM improvement efforts and to promulgate this methodology through other DoD products and service environments; thereby, improving their operational readiness.



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CHAPTER I

INTRODUCTION

This report is intended to provide to the reader a synopsis of the Defense Mapping Agency Combat Support Center's (DMACSC) Total Quality Management (TQM) improvement methodology. This allows the reader to review the application of TQM methods in a "real world" environment. Further, it is hoped that this report will allow the reader to extract those elements of the Combat Support Center's (CSC) TQM methodology that he or she finds useful and incorporate those elements within their DoD product and service environment; thereby, allowing them to improve their operational readiness.

This report is intended for the manager/officer who has had moderate exposure to quality improvement endeavors and wishes to expand his base of knowledge to include TQM. It is necessary to first define TQM.

What is TQM/It's Origins?

TQM is the DoD strategy that focuses attention on "continuous process improvement"¹ through greater management awareness and employee involvement. The goal is to improve DoD's overall effectiveness and to improve customer satisfaction by identifying and eliminating recurring errors and rework. The elimination of recurring errors and rework will increase overall productivity by shortening time required to produce a product or service.

The origins of TQM can be traced back to WW II. The multitude of war materials produced for this effort and the desire to ensure these products fitness for use on the battlefield, led the War Department to request the American Standards Association (ASA) to create statistical based standards to provide quality control mechanisms. ASA's efforts resulted in the establishment of three standards that institutionalized the use of the "control chart"² to monitor process variation. Additionally, "acceptance sampling plans"³

¹Department of Defense, Total Quality Management Master Plan (Washington: Department of Defense), p.1.

²John P. McGovern, "The Evolution of Total Quality Management," Program Management, September-October 1990, p.16.

were developed and allowed large lots of materials to be accepted by only inspecting a small percentage of the lot.

Efforts to revitalize Japan's post war manufacturing capability incorporated these standards and integrated these efforts with a focus on management's role in quality control activities. Pioneering Japan's revitalization efforts in applying these principals were Dr. Edward Deming, Dr. J. M. Juran and Dr A. V. Feigenbaum. DoD's TQM effort builds on their pioneering work.

TQM is not new! "TQM is an amalgam of a number of different management theories that re-emphasize the need to prevent errors during the production process, rather than inspecting for quality only at the end."⁴ Additionally, TQM is dependant on participative management techniques and customer focus activities that feed data back into the process so "continuous process improvement" can occur.

Why is it Important?

TQM methodology and tools allow you to continually analyze and improve work processes by providing objective/measurable indicators that determine if a product or service is "Fit For Use."⁵ Additionally, enlistment of support of personnel, in a participative management approach, to obtain the objective/measurable indicators enhance employee as well as customer satisfaction (i.e. maximizing employee output by eliminating waste, thereby improving the quality of a product or service). TQM takes on even more significance now that the defense budget continues to decline. TQM allows you to do more with less available resources.

Where can TQM be used and who is it intended for?

DoD's TQM Master Plan states:

"DoD's TQM implementation strategy aims at achieving one broad, unending objective: Continuous improvement of products and services. This

³Ibid., p.17.

⁴Tom Shoop, "Can Quality Be Total?," Government Executive, March 1990, p. 20.

⁵J.M. Juran, Quality Control Handbook(New York: McGraw Hill, 1951),pp. 2-2, 2-3.

objective spans the breadth of DoD activities. "Product" means not only the weapons and systems fielded by military personnel but the result of all acquisitions and logistics functions, including design, procurement, maintenance, supply, and support activities. Everything that DoD does, every action that is taken, every system that exists, involves processes and products that can be improved or services that may be performed more efficiently. This concept applies to all products and services, including those ultimately employed on the battlefield. TQM affects everything DoD does, produces, or procures. It demands commitment and professional discipline. It relies on people and involves everyone."⁶

How do you implement TQM?

You start with senior management. A key element of TQM is "Top Down Commitment."⁷ No one will argue that any program or philosophy will not succeed without senior management support, the question is how to get it? How as a mid level manager, tasked with the job of improving quality, or unilaterally trying to improve a work process you are directly responsible for, can you win management support? It is not as simple as drawing up an organizational structure, issuing a quality position statement, requesting additional training dollars (hard to come by), etc., etc.. In fact, this in my opinion, is the wrong way.

The best way to gain management support is by showing how, with employee involvement a particular work process was improved, productivity was enhanced, costs were cut, and employee morale and pride of workmanship fostered a "continuous process improvement" environment.

The only way to do this is by "hands on", out in the work area commitment. Actually working a process improvement effort from beginning to end. The key to this effort is to be proactive: Physically working with the people involved in, as well as performing, the work function reviewed. Initially make the process review restrictive to a certain group. This tends to arouse the interest of others. Once a success has been achieved you won't have to sell the

⁶Department of Defense, Total Quality Management Master Plan (Washington: Department of Defense), p.1

⁷Ibid., p.3.

philosophy, everyone will want to pursue this TQM environment. After these criteria are met, pursue to develop a "continuous process improvement" environment that is tailored to your organization utilizing the guidelines laid out in the DoD TQM Master plan.

The case study that follows provides the vehicle to show how DMAASC achieved it's "success story" by applying TQM methodology. A savings of 1.75 workyears of reduced inspection time as well as a reduction of .5 workyear of rework time has resulted. This study is at the "operational level" wherein a work process is portrayed in a "before and after" fashion. Documentation of this effort provides the medium to enhance the reader's understanding of TQM concepts and provides an opportunity to incorporate these concepts into their DoD activity and infrastructure. **Therefore, it is important for the reader to keep their activity in mind when reading this case study.** The reader should substitute the elements of his or her activity into the examples provided to maximize the effect of this illustration. Critical elements of TQM strategy are **highlighted**. Definition boxes are provided for terminology and specific tools.

CHAPTER II

A Case Study

DMA Mission Overview

The Defense Mapping Agency (DMA) is a major combat support element of the Department of Defense. DMA's Mission is "to enhance national security and support our strategy of deterrence by producing and distributing to the Joint Chiefs of Staff, Unified and Specified Commands, Military Departments, and other Department of Defense users, timely and uniquely tailored mapping, charting, and geodetic products, services and training. To ensure our war-fighting forces have available to them effective mapping, charting, and geodetic support should our strategy of deterrence fail."⁸

The Combat Support Center (CSC) is the distribution arm of DMA. CSC's mission is "to provide responsive, and effective MC&G product distribution support to our military customers to enhance national security and support the strategy of deterrence."⁹ Responsive and effective means "getting the right product, in the right quantity, to the right place -- at the right time."¹⁰

CSC's Quality Improvement Effort

CSC's TQM efforts to date have focused on efforts to make employees/managers more knowledgeable of quality goals relevant to their assigned functions. **Quality goals must receive the same level of management attention applied to other performance goals.**

CSC is utilizing its **existing management structure for quality improvement** to ensure that managing quality is as second nature as is any other responsibility of that manager or supervisor. **This requires specific quality goals to be established for specific work functions. Critical to this effort is the proper documentation of flow charts and**

⁸Defense Mapping Agency, Annual Report(Washington, Defense Mapping Agency), p.1.

⁹Defense Mapping Agency Combat Support Center, Fact Sheet (Washington, Defense Mapping Agency), p.1.

¹⁰*Ibid.*,p.2.

standard operating procedures (SOP) depicting function statements. Flow charts and SOPs provide the mechanisms for reporting of resource expenditures, identifying duplication of efforts, traceability between related work functions, and identifying quality control and quality assurance steps. Reported hours against a processes task and the establishment of quality goals will allow the identification of "special and common causes"¹¹ which can be targeted for corrective action.

"Special and Common causes - are terms used to describe process variations that are discernable on control charts. Special Causes are those variations that fall outside derived control limits and actions taken to eliminate these causes is usually economically justified. Common Causes are those variations that fall inside derived control limits and are due solely to chance. These causes cannot economically be eliminated from a process. Ideally, only common causes should be present in a process, because this represents the minium possible amount of variation."

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Where to start - You can't solve all the problems at once!

This is the critical decision that will be the watershed between doing "business as usual" and the pursuit of TQM initiatives. Therefore, start in an area where you can win the support of the people involved and an area whose work process is reflective of other on-going work process. For CSC, this area was our Philadelphia Depot (DOP).

While pursuing this effort DOP's MC&G "issuing process" presented an opportunity wherein a work process could be used as an example to restructure current SOP and flow chart formats, which were deficient and uncoordinated. A "hands-on" realistic improvement opportunity ensued that could be documented to show how TQM philosophy can improve productivity, reduce costs, eliminate rework, improve morale, and enhance our mission effectiveness by improving customer satisfaction.

¹¹ W. Edwards Deming, Quality, Productivity, and Competitive Position (Massachusetts, Massachusetts Institute of Technology), pp. 7,8.

¹² J.M. Juran, Quality Control Handbook (New York: McGraw Hill, 1951), pp. 23-2, 23-3.

TQM Methodology/Tools used:

Statement of the problem

An initial quality survey of the work process indicated that a large rework rate was identified by quality assurance inspectors at the checking station for the issuing process. This checking station is located just prior to our packaging and shipping branch (the next step in this process). Issue Discrepancy Reports (IDR'S) documented the type of rework required to ensure requisitions were filled correctly. Unfortunately, a strictly enforced policy for use of the IDR's was not in effect. Sometime errors would be documented and other times they would be corrected but not documented. The non-documentation of errors was a result of using errors found against an employee during their annual performance rating. The system was broken! IDR's should have been used by management as a process indicator to eliminate recurring errors and to fix the process when it went out of control. If the IDR's after analysis found that it was an "operator controllable error"¹³ and not a "process (management) controllable error"¹⁴, then this data should have been used as a tool to help that person perform better and never be used (as a surprise) to rate a person's annual performance.

Operator controllable errors - are those errors which occur when the operator is in a state of self control and his or her performance does not conform to what he or she is supposed to be doing."

Process controllable errors - are those errors that are inherent in a work process and only a change in the work process will eliminate these errors or errors which can not be attributed to operators.

Our initial starting point was to gather as many as these IDR's that were on file to see if any patterns could be derived. Figure 1 was developed for this purpose and is commonly referred to as a "Pareto Chart."¹⁵

¹³Ibid., p 18-2.

¹⁴Ibid., p 18-2.

¹⁵Ibid., pp. 2-16, 2-17.

The Pareto chart - allows a comparison/prioritization of identified problems and where an initial starting point for process improvement can be chosen. This type of chart is also known as a 20/80 chart; Where 80% of problems found can generally be attributed to 20% of the identified error categories.

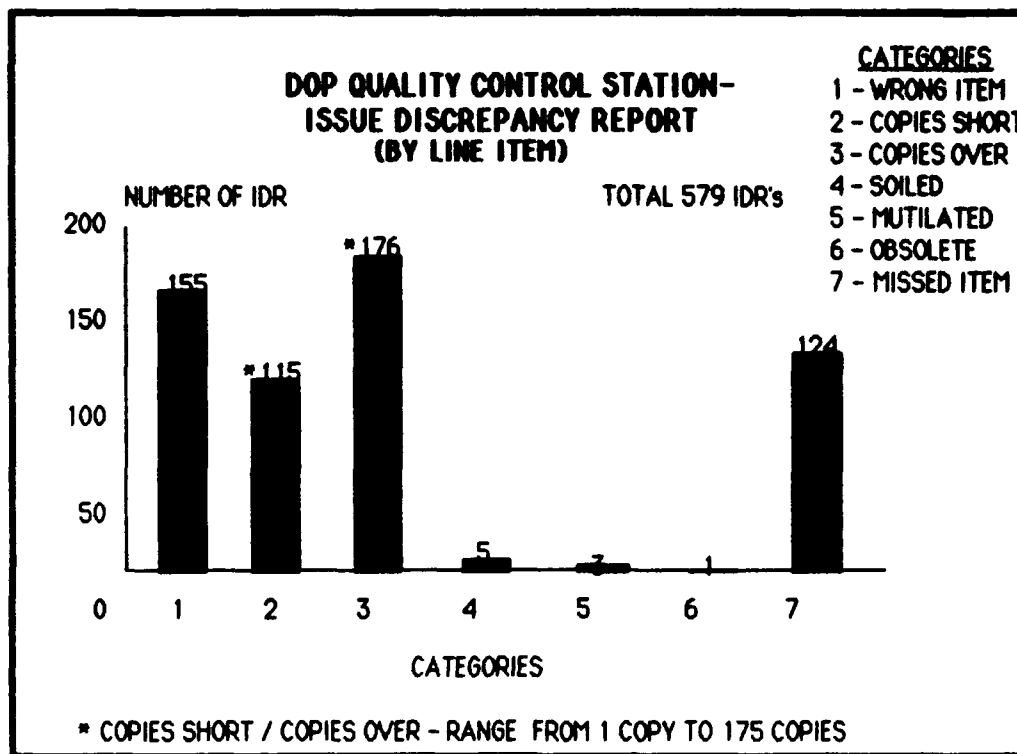


Figure 1

In figure 1, categories 2 and 3 were grouped together under "quantity errors" and represent 50% of all errors found. Categories 1 and 7 can be indicative of either bin or operator error. In short, the issuing process was not producing accurate units of work and Acceptable Quality Levels had not been established. 100% inspection efforts ensured that orders were shipped correctly.

Again, this data is not reflective of any specific time period as the use of IDR slips varied and an enforced procedure was not in place.

Data Gathering/Analysis

To substantiate the error rate, a three day observation period ensued where all IDR's were documented. 389 requisitions were checked with 63

errors found. An overall "nonconformance rate"¹⁶ ranged between 14 and 16 percent. Data was compiled which captured the number of errors on requisitions by product type (fig. 2).

Nonconformance - describes a unit of work that does not meet specifications. This unit must then be judge to determine it's fitness for use.

Nonconformance Rate - is the number of rejected units divided by the number of total units inspected

REQUISITIONS CHECKED / ERRORS FOUND BY PRODUCT TYPE			
	AERO	TOPO	HYDRO
REQ. CHECKED	168	88	141
ERRORS FOUND	22	28	15
MAXIMUM NONCONFORMANCE RATE	13%	32%	11%
*MINIMUM NONCONFORMANCE RATE	11%	19%	9%
* REFLECTS THE TOTAL PERCENT OF REQUISITIONS THAT CONTAINED AN ERROR WHICH INCLUDES THOSE REQUISITIONS THAT CONTAINED MULTIPLE ERRORS.			

Figure 2

By reviewing figure 2 it showed that while all product types had apparently high nonconformance rates, the topographic map issue area had a considerably higher nonconformance rate. Based on interviews with the quality checkers and employees, this was reflective of the overall processes performance and had been repeated for a lengthy period of time. Immediate action was required.

¹⁶Ibid., p. 23-6.

These errors were categorized (as in figure 1) for further analysis and are shown in figure 3 below.

ERRORS FOUND BY PRODUCT TYPE:				
	AERO	TOPO	HYDRO	TOTAL
ERRORS	22	28	15	63
ERROR TYPE:	↓	↓	↓	↓
WRONG ITEM	3 (14%)	9 (35%)	4 (27%)	16 (25%)
MISSED ITEM	2 (9%)	4 (15%)	6 (40%)	12 (19%)
QUANTITY	14 (64%)	11 (42%)	4 (27%)	29 (46%)
MUTILATED	3 (13%)	2 (8%)	0	5 (8%)
OTHER	0	0	1 (6%)	1 (2%)

Figure 3

Quantity errors continued to range from 1 to 175 copies. Wrong and missed item can be added and represent the second largest grouping of errors. As noted, these errors were caught prior to shipment to our customers. But with this high of a nonconformance rate, a percentage of these errors probably got passed the inspectors and made their way to the customer. No quality survey of the inspectors was obtained to determine the percent of nonconformances that they missed. The immediate problem was that overall productivity was being decreased due to the large amount of "rework"¹⁷ required for nonconforming orders.

Rework - describes the time required to correct nonconforming units. To make these units of work fit for use

¹⁷W. Edwards Deming, Quality, Productivity, and Competitive Position (Massachusetts, Massachusetts Institute of Technology), p. 1.

Cause and Effect Analysis

The next step was to determine why these errors were occurring. We looked at both process controllable errors and operator controllable errors. Process controllable errors will be addressed first. Management/Employee involvement was critical at this point with particular significance on contributions made by employees performing the issuing process. They were the grass roots of the improvement effort and could readily identify and were the key to the eradication of the recurring errors shown above. A "cause and effect diagram"¹⁸ was the tool used to document employee input and is shown in figure 4. When gathering the data for this diagram no comment was omitted. The cause and effect diagram provides an array of problems, whether perceived or actual, that will demand attention.

Cause and Effect diagram - helps to clarify the problem, identify and categorize possible causes, and select the most likely cause

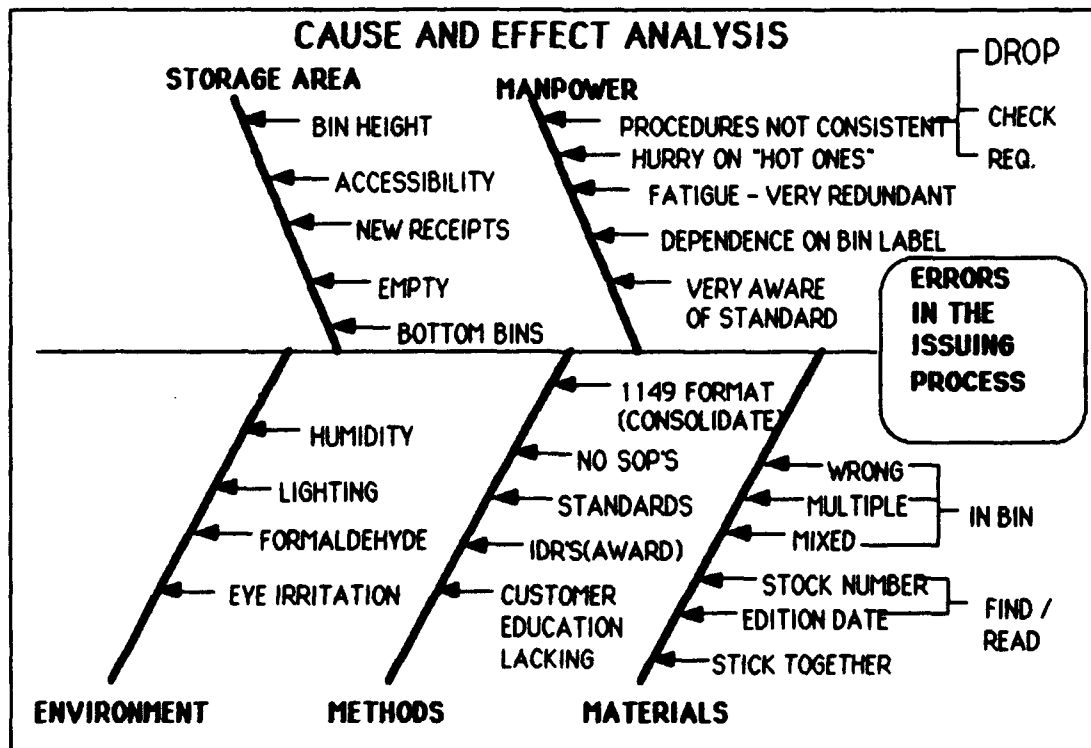


Figure 4

¹⁸Productivity Development Systems, Inc., Roadmap To Problem Solving(Florida, PDS, Inc.), pp. 2, 3.

Attacking Identified Causes

The next question was how we should attack the causes, "you can't solve all the problems at once." In order to continue to focus on causes in need of immediate attention a data matrix was developed, figure 5, to pinpoint employee/management perceptions. As through out this effort a participative management approach was used to develop this matrix. A listing of all causes (from Fig.4) was made and employees were asked *individually* to pick the three most recurring causes (no priority order) in need of immediate attention. Only those causes that were picked by an employee under this vote system appear on the matrix. Employee input was broken down along product lines as each of these products are stored in different areas in the warehouse and each have unique characteristics that affect the issuing process. The number of employees in each area is shown in parentheses next to the product type and each of their votes is numbered one, two, and three.

DMACSC DOP QUALITY SURVEY DATA LOG- THREE MOST RECURRING CAUSES (54 RESPONSES)					
CAUSES	AERO(4)	TOPO (8)	HYDRO(3)	CHECKERS(2)	TOTAL
BIN HEIGHT		3,1,2		3	4
HURRIED		3	2,3		3
FATIGUE				1	1
BIN LABEL		3,3			2
HUMIDITY			2,3		2
LIGHTING		1,1,2,3,2	1,1		5 (9%)
FORMALDEHYDE			1		1
SOP'S		3			1
1149'S		2		2	2
STANDARD		1,1,1	2,2	1	5 (9%)
WRONG MAT.	1,2,3,3	1,3			6
MULTIPLE MA	3,2,1,3				4
MIXED MAT.	2,1,1,3	1,1,1,2,3,3		2,3	14 (26%)

Figure 5

In reviewing figure 5 we began to see particular problems that could be targeted for improvement. In the aeronautical product branch, all employees identified wrong, multiple, and mixed material in the bins that caused the bulk of their errors. In the topographic product branch, lighting, wrong and mixed material in the bins, and the standard causes were identified as target areas. In the hydrographic branch, lighting, hurried and the standard causes were targeted for improvement. Of the possible 25 causes listed in figure 4, only 5 causes were targeted for immediate action by the employees, providing an example of the 20/80 rule.

Operator Error

Equally important is the operator controllable errors which are portrayed in figures 6,7, and 8 by product type. A productivity factor was added in order to weigh the errors charged to an employee, i.e. an employee working above or below the standard (productivity factor) may be expected to have different error rates. Process controllable errors can also be identified on these graphs, i.e. when all operators are making approximately the same number of errors of an individual "error type" (The only way to improve these types of errors is through a process enhancement). **The purpose for identifying process controllable and operator controllable errors is to provide Feedback to both management and employee so continuous process improvement can occur.**

Evaluating operator performance should not be used as a witch hunt. An employee who is not performing equal to his peers may not be because of inadequate training, SOP's, feedback, etc. etc..

In the Hydro area (Fig. 6) operator A (in this initial survey) was responsible for 8 of the 14 errors that occurred while performing just 1% over the work standard. Operator C performed at a rate 12% over the standard and only had two errors. The question was to find out why. What is operator C doing different that could possibly help Operator A? This matrix also seemed to validate the "recurring error matrix" for the Hydro area where these employees indicated that the "work standard" and "hurried" were the main causes contributing to errors in the issuing process.

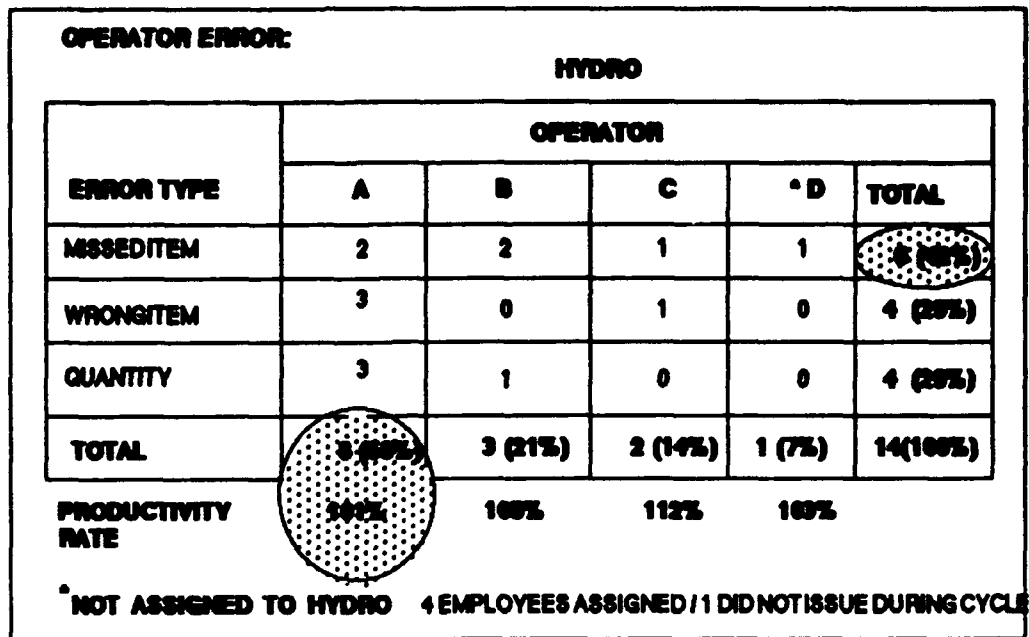


Figure 6

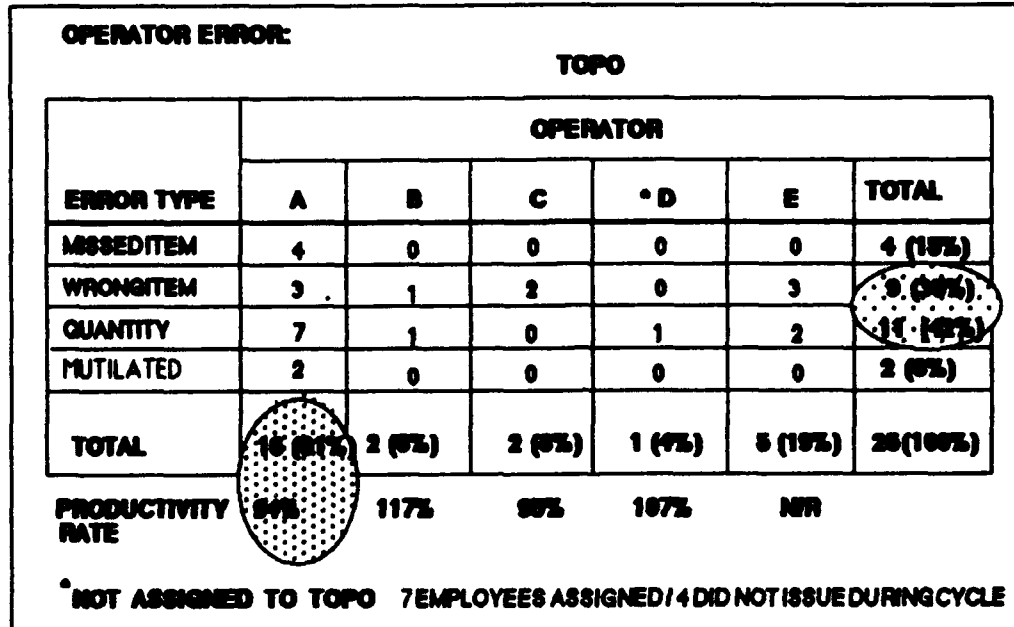


Figure 7

In the Topo area (Fig. 7) operator A appeared to be out of control in relation to the other operators and was performing below the work standard. The number of errors under "wrong item" appeared to validate the "recurring error matrix" for the Topo area. These employees indicated that the "Lighting" and "Mixed material in the bin" were the main causes contributing to errors in the issuing process. Quantity errors cannot be related to the "recurring error matrix" as operator A was responsible for 7 of the 11 errors made. Operator B was 17% over the work standard with only two errors. As in the Hydro area, we needed to exploit these operator's expertise so as to promulgate this expertise to the rest of the work force.

OPERATOR ERROR:						
AERO						
ERROR TYPE	OPERATOR					TOTAL
	A	B	C	D	E	
MISSSEDITEM	0	2	0	0	0	2 (9%)
WRONGITEM	1	1	0	0	1	3 (14%)
QUANTITY	4	1	3	3	3	14 (63%)
MUTILATED	2	0	0	1	0	3 (14%)
TOTAL	7 (32%)	4 (18%)	3 (14%)	4 (18%)	4 (18%)	22 (100%)
PRODUCTIVITY RATE	73%	100%	100%	100%	100%	

* NOT ASSIGNED TO TOPO 5 EMPLOYEES ASSIGNED/1 DID NOT ISSUE DURING CYCLE

Figure 8

In the Aero area, (Fig. 8) Operator A was a new employee and was not trained properly. All other operators assigned to this area were fairly consistent while two employees that were assisting performed slightly better. Only 23% of the errors (missed and wrong) appeared to validate the "recurring error matrix" for the Aero area where these employees indicated that the "Wrong, Multiple and Mixed material in the bins" were the main causes contributing to these errors. Quantity problems accounted for 14 of the 22 errors and could not be related to the recurring error matrix based on these

employees input. Later we were to find out that varying quantities of machine package 25 and 50 bundles contributed to this error rate. Additionally, quantity errors were made when operators inadvertently thought they were pulling bundles of 25 when they were actually 50 and vice a versa.

Identifying Costs

Critical to our improvement effort was to show the costs of operating a system with this high of a nonconformance rate. A before and after comparison of process cost is where, right or wrong, senior management support will ultimately be won. The issuing process at our Philadelphia Depot with a 16% nonconformance rate was costing:

- 100% inspection of requisitions required:
 - * 2 workyears of effort per FY or
 - * roughly 40 thousand dollars per year.

- 16% nonconformance rate meant that 32 orders a day required rework before shipment. Each reworked order needed an average of 10 minutes to correct errors or --- 320 minutes a day which equates to:
 - * 5.3 hours less productive time per day or
 - * .57 WY's less productive time per year or
 - * 12 Thousand dollars worth of non-productivity per year.

Corrective Action

The initial data collected (IDR's), the 3 day quality survey, and comments from the quality inspectors and employees that this data was reflective of the "issuing process" current and past performance over a lengthy period of time demanded immediate action. First and foremost was to ensure that the Philadelphia Depot fulfill CSC's mission statement of providing customers *requested products on time and in the right quantity.*

The following Corrective Actions were presented to bring this process back in control:

- Continue 100% inspection of requisitions so special and common causes can be eliminated.
- Implement the use of "Operator error control charts" (Fig. 9) at the checking table vice IDR's.
- Tally daily control charts weekly, evaluate collected data, and take corrective actions when trends indicate systemic or operator recurring errors (e.g. change in procedures, training, etc. etc.. Do not over-react to "special causes").
- Determine what the "Acceptable Quality Level (AQL)"¹⁹ should be.

"Acceptable Quality Level - The AQL is the maximum percent defective that, for the purpose of sampling inspection, can be considered satisfactory as a process average."

- Correct Identified "Causes":
 - * Lighting in the Topo and Hydro areas.
 - * Wrong, Multiple and Mixed Bins in the Aero and Topo areas.
 - * Validate/change the Work Standard for all areas.
- Report monthly to the Center Quality Manager on the issue error rate (number of requisitions inspected, the number of requisitions in error, the number of errors found, and any corrective action taken).
- Develop and implement the use of SOP's, flowcharts and training procedures for the issuing process. Especially for bin replenishment in the Aero and Topo area.
- When Operator and systemic errors have been reduced and the nonconformance rates are equal or less than the TBD AQL institute a

¹⁹J.M. Juran, Quality Control Handbook(New York: McGraw Hill, 1951),p. 24-8.

statistically valid and measurable sampling method vice 100% inspection.

Control Charts / Feedback

DMACSC(DOP) SOP

CONTROL CHART				DIVISION/BRANCH		DATE	
SOP		JMP ORGANIZATION 10D21.01		PROGRAM OF FUNCTION REQUISITION PROCESSING - ISSUING			
INSPECTION DATE		INSPECTED BY		APPROVED BY			
ERROR TYPE	PRODUCT - AERO - TOPO - HYDRO						
	OPERATOR (INITIALS)						
							TOTAL
MISSED ITEM							
WRONG ITEM							
QUANTITY:							
OVER							
SHORT							
DIRTY/ TORN							
OTHER							
TOTAL							
PRIORITY/GPP							
1							
2							
3							
CONTROL / DATA (END OF DAY)	PRODUCT - AERO - TOPO - HYDRO						
TOTAL LINES CHECKED							
TOTAL REQ. CHECKED							
TOTAL COPIES CHECKED							
REMARKS							
SIGNATURE OF SUPERVISOR						DATE	

Figure 9

The control chart in figure 9 was developed to replace IDR slips and to capture operator and systemic error data as described previously. The quality inspectors continued 100% inspection of all outgoing requisitions and documented nonconformances by product type. **Operators were required at the end of each work day to initial off on documented errors which provided them immediate feedback.** Prior to this chart an employee never knew when or how many errors that he or she had made. **Additionally, all errors were now corrected by the operator whose requisition was in error, this allowed the source of the error to be investigated and corrected.**

Management also received feedback by tallying control charts weekly/monthly to correct systemic problems and to help an employee where it was clearly an operator problem.

Providing meaningful feedback was the key for "continuous process improvement" as this allowed process variation to be reduced so a true process capability picture could be shown. **The feedback mechanism allows all who are involved in a process to communicate and to feel in control/ownership of the process.** The feeling of control and ownership will only exist if actions are taken by management and employees to correct identified process deficiency in a participative management approach .

CSC's "process improvement doloop"²⁰for the issuing process is shown in figure 10. **The supplier in this case was our requisition processing branch. A quality survey of this area was performed during the time frame of depot review.** The same TQM methodology presented herein was applied and found that greater than 20% of all orders processed contained data entry errors. Corrective measures were taken and process control mechanisms were put in place. **CSC's customer focus also was reviewed.** Quality feedback card sampling procedures were changed and comments returned are entered into a data base. **These comments now serve as meaningful performance indicators.** A customer assistance phone log was also

²⁰Productivity Development Systems, Inc., Roadmap To Problem Solving(Florida, PDS, Inc.), p. 3.

developed to capture customer comments and is also used as performance indicator.

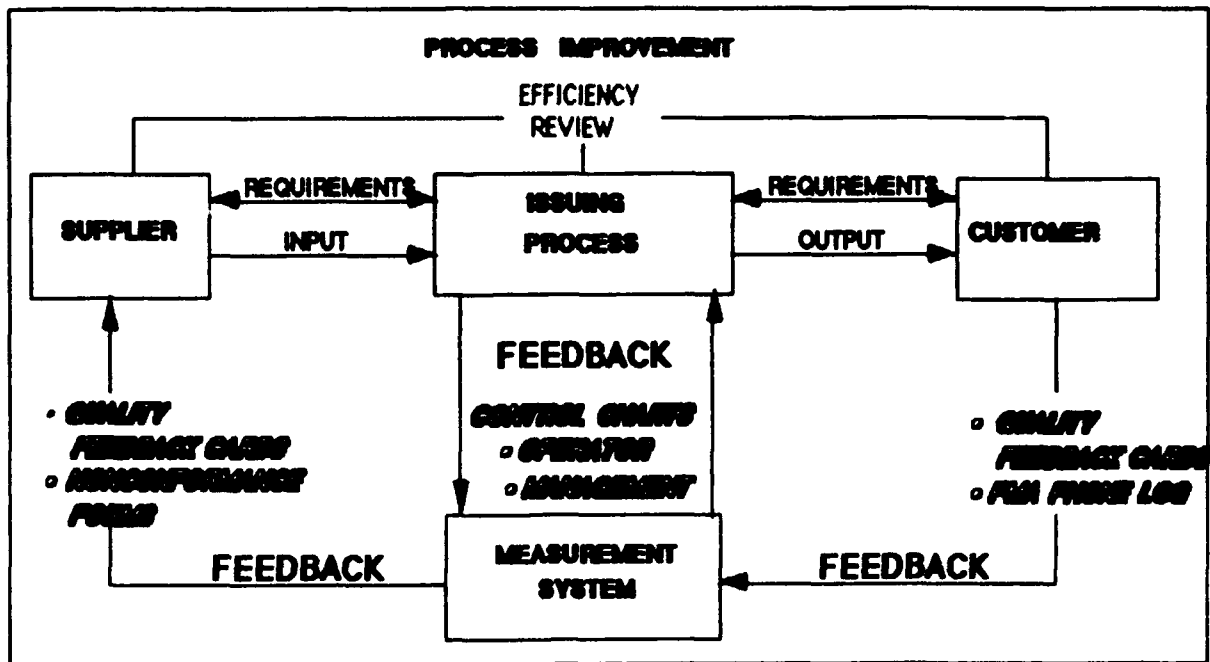


Figure 10

Once this was complete Acceptable Quality Levels, process control limits, and sampling procedures could be developed and allow a significant reduction in DOP's inspection and rework rates.

Follow Up

Data was gathered again (as described in the initial survey) to determine if DOP's (Philadelphia Depot) corrective actions were effective. Over a four week period 2949 requisitions were inspected with 124 errors being found for an overall nonconformance rate ranging between 3 and 4 percent. This showed that indeed the problem solving techniques employed were effective. However, caution was advised as Hawthorne experiments show that any process tends to improve temporarily in response to stimuli which appeals to its internal needs and drives. Our efforts now needed to focus on holding the ground we gained while continuing to improve our

overall accuracy rates. A comparison between our initial and follow up survey is shown in figure 11.

SUMMARY - AERO / TOPO / HYDRO					
		REQ.	ERRORS	MINMAX	LINES COPIES
INITIAL SURVEY		389	63	14 - 16 %	3890 58958
WEEK	1	461	47	9 - 10 %	5296 58239
WEEK	2	695	48	7 - 8 %	10192 127744
WEEK	3	983	29	2 - 3 %	8458 110545
WEEK	4	810	0	—	8224 91877
TOTALS - 4 WEEKS		2949	124	3 - 4 %	32168 388485
DEPOT ISSUING PROCESS ACCURACY RATES				ORDERS 96 %	LINES 99.6 %
AVG. REQ. 10 LINES / 131 COPIES					

Figure 11

Acceptable Quality Levels

From the data shown in figure 11 initial accuracy rates for process performance were established for line items and requisitions (by dividing the number of errors found by the number of lines [lines are individual products] and requisitions issued). The same method was employed to develop individual operator accuracy rates, figure 12. Data continued to be gathered over a nine month period to validate these rates, to complete quality enhancements in our requisition processing branch and to revamp our customer focus. **Together these measurements were used to determine depot process and operator Acceptable Quality Levels and to ensure that process improvement efforts were effective.**

The percent of errors to requisitions issued is used as a customer satisfaction rate indicator as well.

OPERATOR ACCURACY RATES

OPERATOR	REQ. PULLED	LINES PULLED	* OF ERRORS	ACCURACY RATES ORDERS PULLED	ACCURACY RATES LINE ITEMS PULLED
A	335	3348	28	92 (%)	99.2 (%)
B	316	3021	24	92.5	99.2
C	113	1385	8	93	99.5
D	222	2629	15	93.3	99.4
E	112	974	5	95.6	99.5
F	314	1890	13	96	99.3
G	353	2654	9	97.5	99.7
H	353	4793	7	98.1	99.8
I	535	5968	9	98.4	99.8
J	573	7122	4	99.4	99.9
K	196	6041	1	99.5	99.9
L	255	1829	0	100	100
M	160	1950	0	100	100
OPERATOR ACCURACY RATE				96.8	99.7

Figure 12

To broaden our approach in achieving a TQM environment of continuous improvement, the Black and Decker East Coast Distribution Center, Hampstead, Maryland was visited. This allowed us to review private industry's distribution operations specifically in the issuing process. **This was to be used as a benchmark in establishing accuracy rates.**

Figure 13 shows "Then" and "Now" accuracy rates for the issuing process with Black and Decker used as a benchmark.

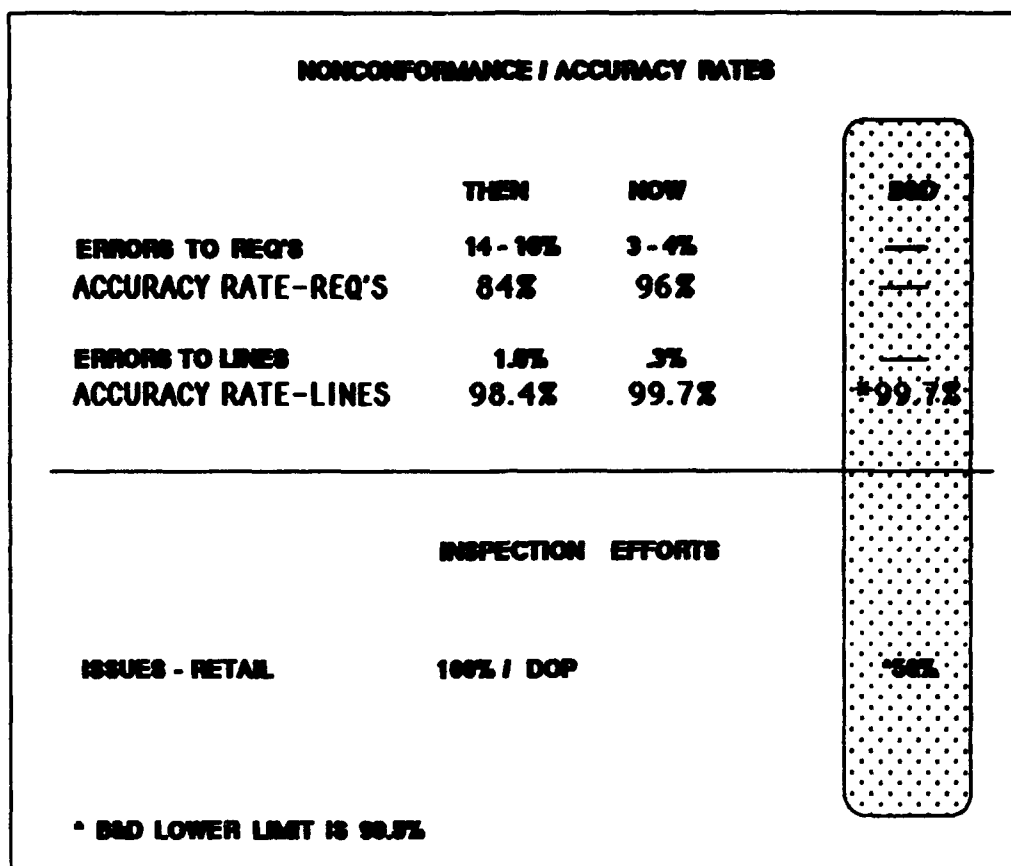


Figure 13

Process Control Mechanism

A correlation graph was used to portray data collected from control charts. Control limits were then calculated so "special and common causes" could be identified. Actions were taken to eliminate special causes. A positive correlation between Line Item Accuracy Rate and Requisition Filled Accuracy Rate became apparent. Both process and operator performance data indicated that at 99.5% Line Item Accuracy Rate a 95% Requisition Filled Accuracy Rate was to be expected. Additional data was gathered and charted to show this correlation and from which Acceptable Quality Levels were determined. Figure 14 shows this correlation as well as a process that is in control. Only normal process variation is present as all data fell within calculated control limits (The lower control limit was 99.4).

"Special and Common causes - are terms used to describe process variations that are discernable on control charts. Special Causes are those variations that fall outside derived control limits and actions taken to eliminate these causes is usually economically justified. Common Causes are those variations that fall inside derived control limits and are due solely to chance. These causes cannot economically be eliminated from a process. Ideally, only common causes should be present in a process, because this represents the minium possible amount of variation."

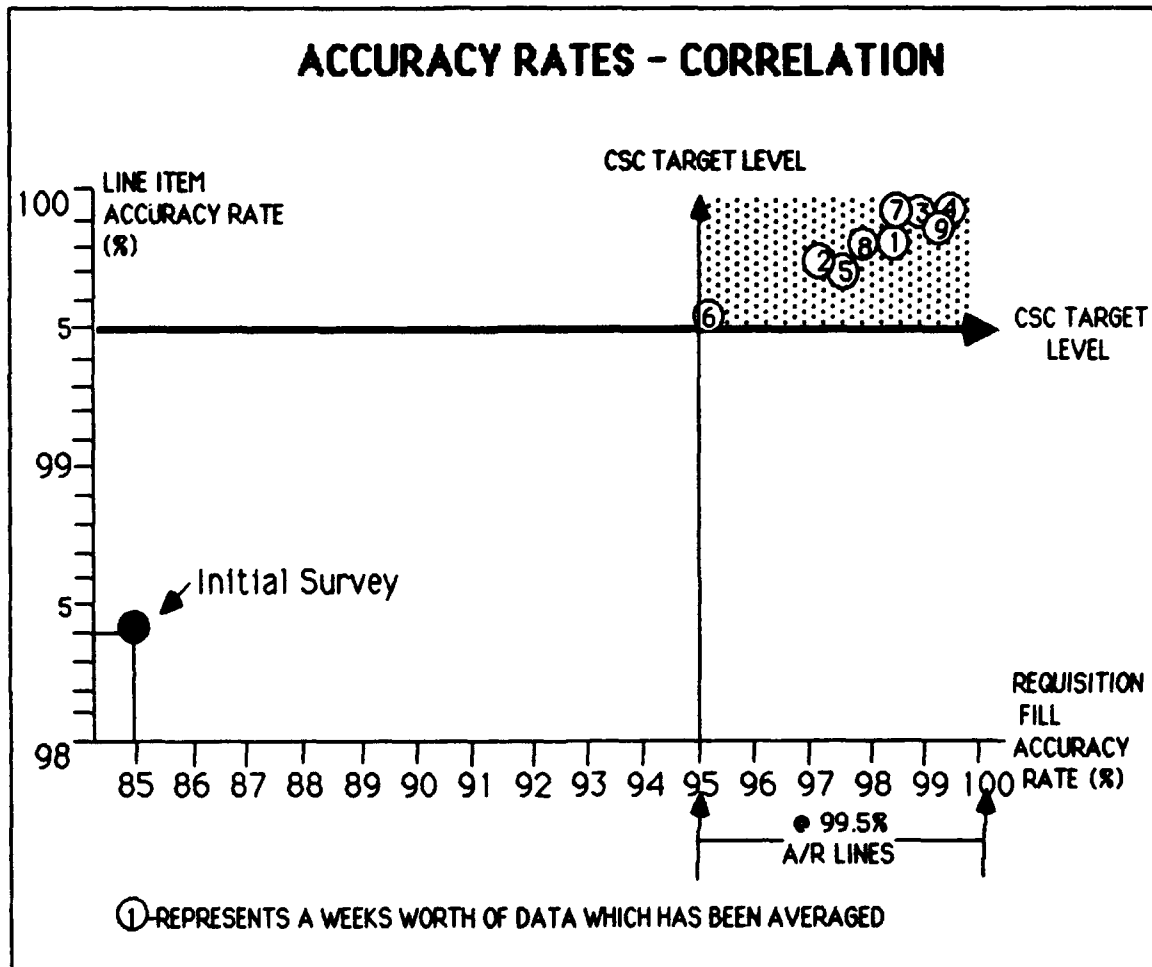


Figure 14

Reporting

In order to gain management support it is critical to get their attention by presenting, in a single vu-graph, a synopsis of "continuous process improvement" efforts to date and the amount of productivity enhancement that

has resulted from this participative management approach. Figure 15 shows how CSC reduced its nonconformance rate and associated rework time. Rework time being reduced from 5.3 hours per day to 1 hour per day; This means that 4.3 more hours a day are spent issuing orders. Over a year this reduction equates to approximately .5 WY's.

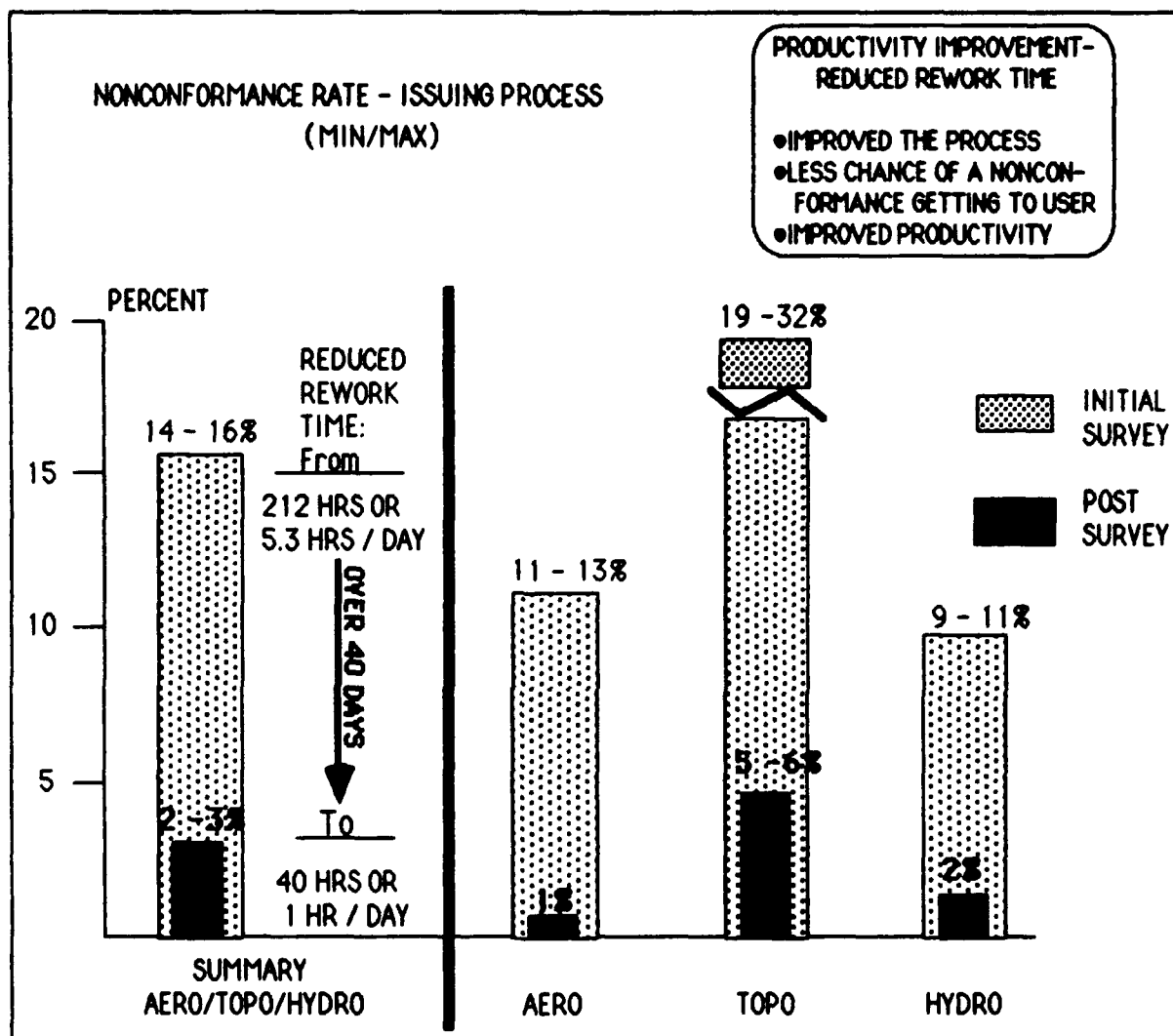


Figure 15

The next step was to develop a Quarterly Management Report that would be reflective of the data captured on the control charts and plotted on the correlation graphs(which are used to ensure the process is in control). Additionally, this report will ensure that Senior management attention remained focused on "continuous process improvement." Bar graphs were developed, Figure 16, to provide the mechanism to monitor process

variation so improvement gains are maintained. The 3rd quarter bar for "Requisitions Filled" indicates that 97.2% of all orders were filled correctly the first time. Additionally, "Requisitions Filled" for the 3rd quarter indicated that at least 97.2% of all customers were satisfied with the contents of their order. The 3rd quarter bar for "Line Items Processed" indicates that 99.8% of all products were pulled correctly the first time.

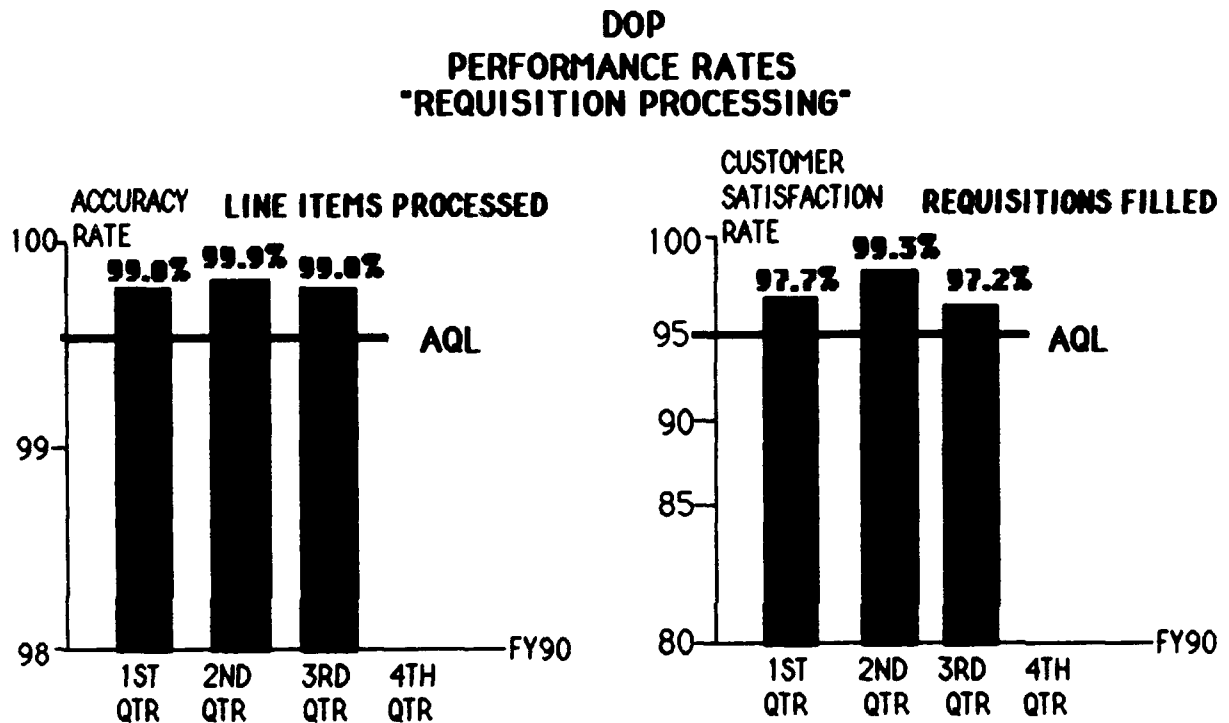


Figure 16

The AQL for "Requisitions Filled" is shown at 95% and for "line Items Processed" is shown at 99.5%. These graphs indicate that DOP had sustained it's improvement efforts for three consecutive quarters and had successfully:

- eliminated many of the "causes" for recurring errors.
- reduced rework time significantly.
- improved productivity (by reducing rework).
- incorporated participative management techniques.
- improved morale.
- enhanced customer satisfaction.

Now that the issuing process was able to produce repeatable results within established AQL's DOP was able to institute a sampling procedure in lieu of the 100% inspection efforts.

Sampling

A coordinated sampling plan was developed and allowed DOP to realign 1.75 wy of effort within depot operations. The checking station for the sampling methods remained prior to the packing line and requires .25 wy of effort to accomplish. The sample is controlled by the AQL's for line items and requisitions. This allowed a small percentage of requisitions to be sampled that are representative of the entire population. However, if the process begins to produce units outside derived control limits, which can not be attributed to "special causes", 100% inspection efforts are available until the process is fixed. This 100% effort, when required, will impact normal production.

MIL-STD-105D was referred to to determine the sample size. This effort indicated 7% or 14 requisitions per day should be sampled to be representative of DOP normal daily workload of 200 requisitions.

The sample included all requisitions without regard to issue priority group or product type. A computer program was used to randomly generate daily requisition numbers to be sampled. All nonconformances found during the sampling procedure were documented on established control charts. Data obtained from the control charts were summarized weekly and monthly for higher level review and consequent corrective action. Only critical nonconformances (e.g. wrong item, missed item, copies short) were counted as a nonconformance found when analyzing data to determine accuracy rates. Non-critical nonconformances (e.g. copies over, dirty/torn, other) were documented and used as process indicators. All nonconformances found on sampled requisitions were corrected before shipment was made.

All requisitions related to crisis management actions are 100% inspected.

TQM Efforts Still Required

If DOP and CSC are to fully benefit from DoD's TQM strategy for "continuously improving performance at every level, and in all areas of responsibility"²¹ the following efforts are still required:

- Ensure a "Top Down" commitment is communicated.
- Provide supervisory/employee training in statistical process control, problem solving techniques and team concept approaches.
- Develop Quality Improvement Teams / Process Action Teams.
- Develop Gain Sharing programs
- Continue to provide internal and external (customer) feedback loops back into the process.
- Continue to monitor and establish measurement points for work processes and performance.
- Take corrective action as a result of measurements/feedback.
- Identify resources required for training, TQM initiatives (Infrastructure development).
- Document process improvements(flow charts), as well as TQM measurement points and checklists when appropriate.
- Incorporate sampling procedures for controlled processes.
- Report performance rates, nonconformance rates, and savings as a result of "continuous process improvement" to senior management as well as employees.

²¹Department of Defense, Total Quality Management Master Plan (Washington: Department of Defense),p.1

CHAPTER III

Conclusion

This report hopefully has provided the reader with a better understanding of DoD's Total Quality Management strategy and has provided a useful illustration of how one depot implemented it's methodology.

This was CSC's first attempt to create a TQM "continuous process improvement" environment and many of the application of tools need to be refined and incorporated with the establishment of Quality Improvement Teams. The concept of generating interest in TQM by first gaining a success to win management support was CSC's method of obtaining "Top Down" commitment. The contents contained in this report are not meant to be a set of instructions to be followed step by step. Many more criteria exist in the TQM master plan to fully implement this strategy. This report only provides some lessons learned that can be reviewed and built upon by the reader.

CSC is utilizing existing work structures and organizations so the expertize of those employees involved in a process improvement effort is an inseparable element of the solution. A "working knowledge from a distance" is not good enough to eminently enhance work functions/tasks. In other words, don't try to fix a process which you are not actively involved. Looking at a flow chart alone and identifying process enhancements without employee input will not work. Process enhancements are not found from a distance but rather in the work area.

The support received from Depot Management and Employees in CSC's first attempt at Total Quality Management was and is outstanding! As indicated many times during this report, the grass roots of any continuous improvement effort is Employee/Management involvement. All personnel must eagerly involve themselves in the identification and eradication of recurring errors.

Our efforts must continue to fully exploit/rectify all Depot identifiable "causes" to ensure that our world-wide MC&G Distribution commitments to the Armed Forces ensures "getting the right product, in the right quantity, to the right place -- at the right time."²² Efforts to date have furthered our readiness to support this mission and have in fact resulted in increased customer satisfaction and employee/management awareness. Internal and external feedback loops are now in place to gauge and control current and future improvement. Again, the data contained herein is a direct result of the ingenuity and sincerity of DOP's work force.

²²Defense Mapping Agency Combat Support Center, Fact Sheet (Washington, Defense Mapping Agency), p.2.

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