



AIR WAR COLLEGE

RESEARCH REPORT

TOP QUALITY MANAGEMENT, RELIABILITY, AND MAINTAINABILITY:

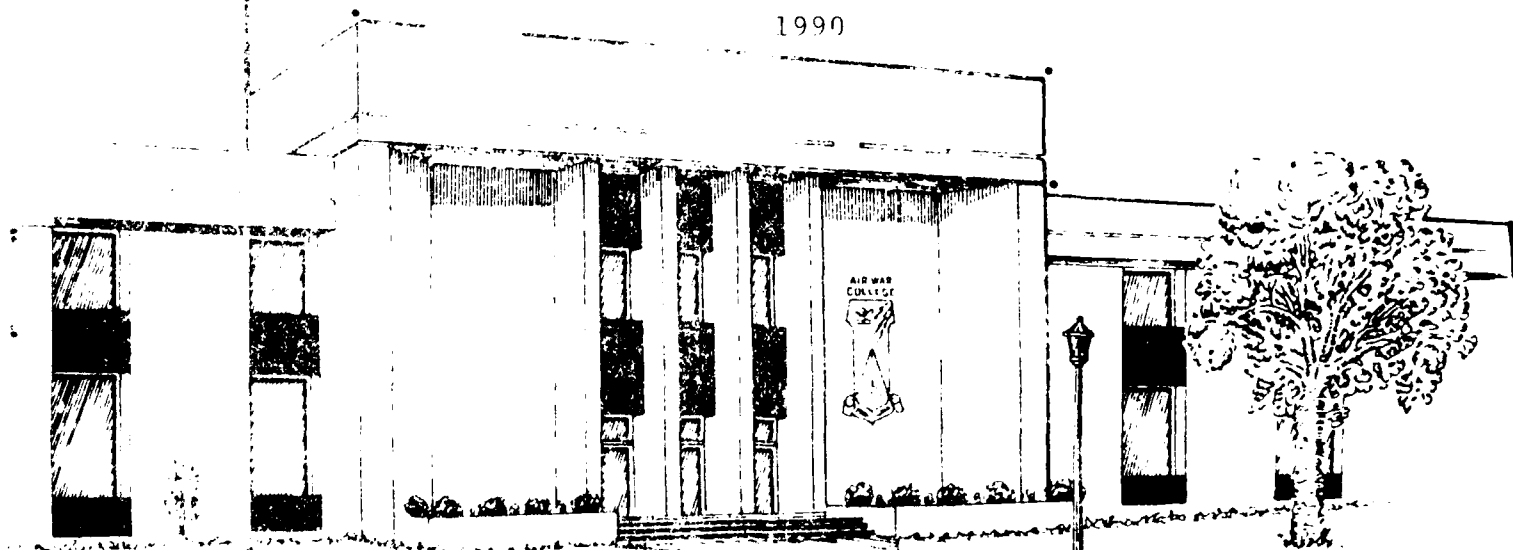
INSTITUTIONAL GOALS WITH BUILT IN BARRIERS

AD-A230 134

DTIC
ELECTE
DEC 26 1990
S B D

LIEUTENANT COLONEL PHILIP B. AITKEN-CADE

1990



AIR UNIVERSITY
UNITED STATES AIR FORCE
MAXWELL AIR FORCE BASE ALABAMA

APPROVED FOR PUBLIC
RELEASE; DISTRIBUTION
UNLIMITED

AIR WAR COLLEGE

AIR UNIVERSITY

**TOTAL QUALITY MANAGEMENT,
RELIABILITY, AND MAINTAINABILITY:
INSTITUTIONAL GOALS WITH
BUILT IN BARRIERS**

by
Philip B. Aitken-Cade
Lieutenant Colonel, USAF

**A DEFENSE ANALYTICAL STUDY SUBMITTED TO THE FACULTY
IN
FULFILLMENT OF THE CURRICULUM
REQUIREMENT**

Advisor: Colonel Robert E. Cochoy

MAXWELL AIR FORCE BASE, ALABAMA

June 1990

DISCLAIMER

This study represents the views of the author and does not necessarily reflect the official opinion of the Air War College or the Department of the Air Force. In accordance with Air Force Regulation 110-8, it is not copyrighted but is the property of the United States government.

Loan copies of this document may be obtained through the interlibrary loan desk of Air University Library, Maxwell Air Force Base, Alabama 36112-5564. (Telephone: [205] 293-7223 or AUTOVON 875-7223).

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



EXECUTIVE SUMMARY

TITLE: Total Quality Management, Reliability, and Maintainability: Institutional goals with built in barriers. AUTHOR: Philip B. Aitken-Cade, Lieutenant Colonel, USAF

In 1984 the Secretary and Chief of Staff of the Air Force set in motion a process to institutionalize their commitment to improve the reliability and maintainability (R&M) of the AF weapon systems. There has been significant commitment on the part of both AF and industry leadership to improve R&M, most recently with the strong emphasis on Total Quality Management (TQM). TQM is the outcome of a complex series of events stretching back over centuries as leaders have searched for a way to ensure victory in their endeavors. Many different approaches and programs have been applied by leaders in an earnest quest of the elusive characteristic of quality that will beget success in the battlefield (or market place).

TQM has been heralded as the process that will finally cause a cultural change throughout government and industry to usher in a new era of continuously increasing quality. Since the system⁶ appears to be slow to react to the change in culture, there may be institutional impediments that are preventing the Air Force from achieving all that it can in R&M and TQM. However, the study concludes that there are no concrete institutional barriers preventing the Air Force from reaching the goal of TQM. There are only opportunities for senior leaders to demonstrate their commitment to the TQM program. All members of the Air Force and industry must work toward

continuous improvement in all facets of the system and the senior leaders must set the pace. Industry has instituted various forms of TQM (after all, TQM is defined in many different ways) and does not need the Government to dictate implementation plans. The success of the Air Force TQM program will depend on the extent to which its senior leaders are prepared to apply the concept of KAIZEN - gradual, unending improvement, doing "little things" better; setting--and achieving--ever-higher standards.

BIOGRAPHICAL SKETCH

Lieutenant Colonel Aitken-Cade (M.S. Engineering, Air Force Institute of Technology) has been directly involved in the actions to institutionalize the commitment of the senior Air Force leadership to improve the reliability and maintainability of the AF weapon systems. He served for four years at the Pentagon in the Office of the Special Assistant for Reliability and Maintainability. He has also served on the engineering staff of the Air Force Acquisition Logistics Division, and Ogden Air Logistics Center and in program management for the F-15 System Program Office, and at the National Aeronautics and Space Administration (NASA) Headquarters. He is a graduate of Squadron Officer School (Correspondence), Defense Systems Management College, and Armed Forces Staff College. Colonel Aitken-Cade is also a graduate of the Air War College, class of 1990.

TABLE OF CONTENTS

DISCLAIMER	ii
EXECUTIVE SUMMARY	iii
BIOGRAPHICAL SKETCH	v
TABLE OF CONTENTS	vi
Chapter	
I. INTRODUCTION	1
Historical Perspective	1
Logistics Burden	4
Trying to Change	5
Economic Pressure	8
II. CONTROLLING QUALITY	10
The Beginning of Modern Quality Control	10
Zero Defects	11
Acceptable Quality	13
Management Responsibility	13
Constancy of Purpose and Setting Goals	16
Continuous Improvement	17
III. IMPROVING QUALITY	19
Quality Management	19
Customer Desires	20
The Government as Customer	21
A Changing Environment	23
Quality Culture	24
IV. INNOVATION IN INDUSTRY	26
Meet the Customer	26
Just-In-Time	27
Improving Distribution	28
Loading Docks	30
Functional Inconvenience	31
Food World	34
V. IMPEDIMENTS TO TOTAL QUALITY MANAGEMENT	36
Frustration	36
Lowest Price Contract	38
Mandatory Total Quality Management	39
Too Much 'How To'	40

	Adopting Commercial Practices	43
	Institutional Inertia	45
	Customer Requirements	48
VI.	CONCLUSIONS AND RECOMMENDATIONS	51
	Senior Leadership Involvement	52
	The Bottom Line	53
	Analysis Paralysis	56
	To Solve a Problem	57
	And Gorby Too	58
	Summary	59
VII	BIBLIOGRAPHY	60



CHAPTER I

INTRODUCTION

The old saying that "If it ain't broke, don't fix it" is not only bad grammar, it is bad advice. Just because "it ain't broke" does not necessarily mean that it is correct.

Historical Perspective

History is replete with stories of great and wonderful battles. There are stories of battles fought by armies with superior skill but numerical inferiority that led to the defeat of great armies and stories of victories that were lost when superior weapons were unavailable for combat because of the inability of the troops to get the weapons to the decisive point of battle. There are stories of amazing feats of valor in the face of failed equipment (that should not have failed) that carried the day for one belligerent over another and stories of horrible failures as a result of shortages of critical supplies. History also holds stories of leaders who recognized problems and changed the environment to accommodate the need, yet others who never recognized their problems and went down in defeat.

Consider for a moment how in ancient times the Greeks and Persians went to war. Armies were supported by large numbers of servants and camp followers. Weapons, shields, and rations were carried by servants and pack animals. Often the support population was as large as the combat force. All mouths had to be fed, so food and fodder had to be considered in war planning. Alexander the Great changed all that for the Macedonian Army. His soldiers were required and trained to carry all their individual equipment and rations. No carts or women were allowed, and only a few servants went along to carry some equipment. The result was a highly mobile force that did not have, nor need, a large support burden.

Without apology for skipping a couple of millennia full of examples of the impact of decisions by senior leaders about quality and logistics on the outcome of various wars, next consider the trouble Germany got into as a consequence of insufficient support for its war machine during World War I (WW I). Much has been written and said about the deficiencies and strengths of the Schlieffen Plan designed to swing German forces through a 400 mile arc southwest from Germany and then east at the heart of France. The huge German force supported by 84,000 horses required an immense quantity of fodder. In August 1914 the German Armies charged across Belgium and on into France. They moved forward at rates between 5 and 13 miles per day, all accomplished on foot with animal-drawn transport supplemented by railroads when available. As the Armies pressed forward, the resupply of 2 million pounds of fodder per day became

impossible and would have taken all the available transport.¹ Horses became weak and sick, unable to pull their loads or even carry their riders. By the time the Germans were halted at the Marne on 5 September, they were prevented from using their heavy artillery because their horses were too exhausted to pull the artillery and keep up with the advancing troops. The lack of fodder resupply denied the Germans their technical advantage in artillery.² They had superior technical capability, but could not apply it where it was needed.

In World War II, after the Normandy landing, the Allies pushed across Europe consuming supplies and fuel at an insatiable rate. Logistic limitations were hampering their progress. This led General Eisenhower to develop the "broad front" offensive versus a breakthrough so as to let the logistics catch up.³ Fuel supply was not a major problem for the Allies, and there were few maintenance problems. However, the Germans suffered severely from both. Spare parts were in such short supply that even new tanks had to be cannibalized. High tank losses were as much a consequence of mechanical failure and spare part shortage as battle damage.⁴

¹ Martin Van Creveld, Supplying War, Cambridge, United Kingdom: Cambridge University Press, 1977. p. 124.

² Ibid. p. 125.

³ David C. Rutenberg, and Jane S. Allen, The Logistics of Waging War, AF Logistics Management Center. U.S. Government Printing Office, 1986. p. 89.

⁴ Ibid, p. 97. (Logistics of the Battle of the Bulge, Army Logistician, Jan-Feb 1985)

Alexander the Great was astute in his requirement for a lean logistic load. His forces were highly mobile and the mobility contributed to his success. Are our forces becoming so incumbered with baggage that we will not be able to move when a crisis confronts us? If it requires more than a dozen C-141s to deploy a squadron of F-15s (with spare parts and test equipment constituting much of the cargo), are we becoming like the Germans in WW I when their war machine required more fodder than ammunition? Have our weapon systems become so complicated or unreliable that the logistic burden to support a war effort may be beyond our reach?

Logistics Burden

The logistic burden is being driven by many forces including system complexity and unreliability. Highly sophisticated electronic systems have fostered a support equipment inventory that rivals the entire weapon system of a previous generation. Weapon system reliability has improved over the years, but it is still so poor in most cases that supplying spare parts is a major undertaking. The maintenance load is often compounded by designs that require the removal of good components in order to reach the defective one. We know that better design can provide very reliable systems and facilitate repair in the event of failure. Better design can reduce the logistic tail and satisfy the customer need for weapon systems that perform their intended tasks over and over again. There needs to be a change in culture to foster continuous improvement in all disciplines including engineering, management, accounting, and operations.

Trying to Change

There have been many attempts by the DoD to improve the reliability and maintainability of our arsenal. In the early '60s, the number of defective parts was perceived to be the major cause of low product reliability. The Zero Defects program was launched and preached with great gusto. Top level management in government and industry got on the band-wagon by endorsing the program. Huge rallies were held in some companies and a lot of effort went into convincing workers that adoption of the program was in everyone's best interest. Posters, pins, and pledge cards were all over the place. Sure enough, there were remarkable improvements in defect reduction. People became expert at eliminating mistakes. They were working "according to the book." Unfortunately this often meant they were doing the wrong thing correctly. Reliability did not necessarily improve.

Weapon system reliability has improved over the years. Specifications and standards have helped instill some uniformity, and technology has been responsible for tremendous gains. However, the new technology has shifted much of the maintenance burden from the flight line to the intermediate repair facilities and depots--large, fixed facilities which are difficult to move and are vulnerable to hostile attack. Regardless of the current changes in political climate, the threat to our repair and supply depots is still very real and they are vulnerable to attack. Concern for the readiness, sustainability, and

operational effectiveness of weapon systems led to the commitment of the senior Air Force leadership to improve reliability and maintainability (R&M). "An effective R&M program can make our weapon systems more available, mobile, and durable, as well as reduce manpower and support costs"⁵

The Air Force senior leadership is committed to improving weapon system reliability and maintainability. In 1985 the Air Force formed the Office of the Special Assistant for R&M to institutionalize that commitment to improvement.⁶ An action plan, R&M 2000, was aimed at ensuring R&M received the same consideration during weapon system development as cost, schedule, and performance. This was revolutionary because R&M had previously been viewed only from cost considerations and was often traded off against performance considerations. Now R&M is being looked at as an operational performance factor.

From the R&M 2000 program came the R&M 2000 Process which described how to increase combat capability while saving resources through good R&M practices. "The defense posture of the United States is based on countering a numerically superior enemy with the combat capability of qualitatively superior weapon systems. .

⁵ Washington, D.C. Department of the Air Force. HQ USAF. Secretary of the Air Force and Chief of Staff. Reliability and Maintainability of Air Force Weapon Systems - ACTION MEMORANDUM. 1 Feb 1985.

⁶ Reliability and Maintainability Action Plan, R&M 2000, HQ USAF, Washington D.C. Feb 1985

. . . Highly reliable and maintainable systems offer the means to defeat a numerically superior force by engaging again . . . and again . . . and again."⁷

As the Military Services were taking steps to improve their weapon system reliability and operational performance, the entire acquisition, support, and operational system was receiving attention. Problems were uncovered and tackled, but sometimes these problems generated high media profiles and attracted public attention. "The President established the Blue Ribbon Commission of Defense Management in part because public confidence in the effectiveness of the defense acquisition system had been shaken by a spate of "Horror Stories . . ."⁸ The Commission did its work, published a report, and made some recommendations, one of the more significant being to create the position of Under Secretary of Defense (Acquisition) with the responsibility to "supervise the performance of the entire acquisition system and set overall policy for R&D, procurement, logistics, and testing."⁹ The report concluded with the point that improvement in the acquisition process would require radical changes accompanied by a new spirit and willingness to change. This commission recognized that improvement came not only from

⁷ Air Force Pamphlet 800-7. USAF R&M 2000 Process. Washington D.C. : Department of the Air Force, GPO, 1 Oct 88. p. 1.

⁸ The President's Blue Ribbon Commission on Defense Management, A Formula for Action. A Report to the President on Defense Acquisition, April 1986. p. 1.

⁹ Ibid. p. 16.

exhorting the workers to do their best, but also required a radical change in the system.

Influencing humans to change is not easy. Changing organizations of humans is even more difficult. Changing an entire industry in an open free-market society is almost insurmountable. However, a shrinking market share, diminishing work force, and a critical public provide strong motivation to pay attention and make changes. The problem has been probed, exhortations to change have been made, but where is the solution?

There is a story about a man in a darkened room who dropped a coin and could not see where it fell. He went over to the open doorway and started looking for the coin. A friend inquired why he was looking there when surely it would be inside the room where he dropped it. The man replied that he was looking where the light was better. The zero defects program was an attempt to search for the reliability and quality solution in the well lit doorways. Defects are easy to find and prevent, but finding the parts of a system that must be changed to improve the product are often in unexpected places.

Economic Pressure

The state of the economy in the United States is causing heightened concern for the cost of our national defense and the loss of readiness due to the unnecessary cost of support. Referring to the

economic condition, Secretary of Defense Dick Cheney noted in the Defense Management report:

Such circumstances compel the utmost attention to prudent management of our defense program--and oblige the Executive Branch, Congress and industry, as seldom before, to join in husbanding available defense dollars, cutting unnecessary costs, and achieving new levels of productivity and quality.¹⁰

There have been many programs and sincere efforts aimed at achieving new levels of productivity and quality. The thesis of this paper is that it is now time for the involvement of all members of the military/industrial complex to work toward continuous improvement in all facets of the system and the senior leaders must be involved and set the pace. If there are impediments to this process, what are they, and what can be done to overcome them? Has sufficient direction and guidance been given so that the entire system can achieve continuously improving levels of productivity and quality?

¹⁰ Dick Cheney, "Defense Management." Report to the President, Department of Defense. Office of the Secretary of Defense, Washington, D.C. July 1989. p. 2.

CHAPTER II

CONTROLLING QUALITY

The long road paved with good intentions

The Beginning of Modern Quality Control

During the 1940's American industry built a reputation for quality and reliability. The efforts in preparation for World War II (WW II) showed quality leadership, innovation, and dedicated workers. Theories of management were developed, refined, and applied. The results were manifest in great products. Dr. W. Edward Deming, a statistician, developed many of his theories as he taught industries statistical methods for process control.

After WW II the U.S. industry grew at a fantastic rate. Consumer demand was huge, driven by consumers who would buy just about anything presented in the market place. The consumer had money to spend and industry was churning out the goods.

The United States recognized that defeated Germany and Japan would be restored to the family of nations a lot quicker with

viable economies, so set about helping rebuild their industries. Initially, many of the Japanese consumer products were scorned as being junk. Deming was invited to Japan where, working as a consultant, he "led Japanese industry into new principles of management and revolutionized their quality and productivity."¹¹

The United States was correct. In a few years trade between Europe, Japan, and America grew as more and more consumer goods entered the market place. Unfortunately, there were a lot of products being turned out that were defective in one way or another and the consumers started to complain. Products which had been known for their durability took on less flattering reputations. For example Ford came to mean "Fix Or Repair Daily." Reliability of products was generally not good. There were exceptions, but the public was not happy.

Zero Defects

In the mid sixties, James Halpin, the Director of Quality for the Martin Company, published a book titled "Zero Defects."¹² This was to be the new dimension in quality assurance. This program was embraced by government and industry with much fanfare, slogans, and lip-service. One needs only to read the first paragraph of Chapter 1 to understand why the program is not held in high regard today.

¹¹ W. Edwards Deming, Out of the Crisis, Cambridge, Mass. Massachusetts Institute of Technology, 1986. p. vii

¹² James F. Halpin, Zero Defects, New York: McGraw-Hill, Inc. 1966 p. 3.

To comprehend fully the basic philosophy of the Zero Defects program, one must first look into the nature of the defect itself. Defects, or worker errors, are caused primarily by three situations:

- Lack of knowledge
- Lack of proper facilities
- Lack of attention

Defects were worker errors! To eliminate defects all that was necessary was for workers not to make mistakes. The responsibility for correcting the sorry state of quality was strapped squarely on the back of the worker.

One facet of the program was to prominently display group quality rates for everyone to see the number of defects being generated. This implied that there was an acceptable level of defects because as Halpin says in his book, "It is a good idea to place an upper limit on the chart to warn workers when their area is getting out of control."¹³ All this was intended to motivate the workers to be competitive, do their best, and take pride in their work.

The workers got motivated and the defect rate went down. "Results surpassed the highest expectations: 54 percent reduction in the defect rate of manufactured hardware in the first year and an additional 25 percent the second year. . . . Obviously, Zero Defects is worthwhile."¹⁴

¹³ Ibid. p. 83

¹⁴ Ibid. p. 207

Acceptable Quality

Then the system settled into a steady state where defects were "within acceptable limits." An example given by Deming illustrates the point.¹⁵ A production line with 24 workers in a certain plant consistently turned out about 11% defective product of the daily run. A consultant investigated and suggested that the workers did not understand the job, so improved operational definitions and examples were introduced. The proportion of defective products dropped to 5%. This operation settled in to a stable process with defect rate hovering around 5%. Was this zero defects? Could the workers reach that goal? Not likely. As Deming points out, "any substantial improvement must come from action on the system." Action by management had to change the system.

Management Responsibility

A key point from this discussion is that pressure on the workers will sometimes get a reduction in defects, but there is a far more fertile field to explore for significant opportunities for improvement. In their article in Quality Progress, Joiner and Scholtes point out ". . . at least 85% of the failures in any organization are the fault of systems controlled by management. Fewer than 15% of the problems are actually worker-related."¹⁶ The emphasis of a quality

¹⁵ Deming, pp. 7 - 8

¹⁶ Brian L. Joiner, and Peter R. Scholtes, The Quality Manager's New Job, Quality Progress, October 1986.

program should, therefore, be on the systems controlled by management, and hence, on management.

The function of management is not simply to solve problems that confront an operation, but is to demonstrate a commitment to the organization and its longevity. A company just maintaining a steady state of production is in fact falling behind the competition, so even to maintain the status quo, there must be increased production. Dr Deming postulates 14 points, the adoption of which and action on by management indicate a commitment to stay in business. The Deming 14 points are:

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 a 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. The aim of supervision 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 a new level of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes for low quality and low productivity belong to the system and thus lie beyond the power of the work force.
- 11 a. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
- b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.
- 12 a. 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.
- b. 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 of management by objectives.
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.¹⁷

These 14 points provide a theory of management which has been successfully used in many Japanese and American companies, and if applied to the Air Force will transform the system and move it toward continuously improved productivity and quality.

¹⁷ Deming, pp. 23 - 24

Constancy of Purpose and Setting Goals

Dr Deming is quick to point out, however, that there are obstacles to the process he describes. A fundamental problem is the lack of constancy of purpose.¹⁸ The Air Force, like American Industry, is driven by short term goals which change frequently. In 1985, the Air Force took a significant step to correct this lack of constancy by committing to the Reliability and Maintainability Action Plan, R&M 2000.¹⁹

This Action Plan set out the fundamentals for causing a cultural change within the Air Force by concentrating on six key management objectives. While this may seem like an immediate violation of Deming's exhortation to eliminate "management by objective", it is not. The Action Plan provides a framework for an ordered approach for institutionalizing the commitment of the senior AF leadership to improve R&M. The paramount objective in the Action Plan is to establish clear direction for R&M improvement through visible goals and policy to increase combat effectiveness and operational supportability.²⁰ Fulfilling this objective led to the publication of AF R&M policy letters and AFP 800-7, The USAF R&M 2000 Process which articulates the Air Force goals for R&M. These Air Force goals are:

1. Increase combat capability.

¹⁸ Ibid. p. 98

¹⁹ HQ USAF, Reliability and Maintainability Action Plan, R&M 2000, Washington D.C. February 1985

²⁰ Ibid p. i

2. Decrease the vulnerability of the combat support structure.
3. Decrease the mobility requirements per unit.
4. Decrease the manpower requirements per unit of output.
5. Decrease costs.

These Air Force R&M 2000 Goals are a statement and prioritization of the Air Force corporate objectives to be accomplished through R&M.²¹

The R&M 2000 Process starts the Air Force down the road charted by Dr. Deming which requires a constancy of purpose. As the old proverb states, "If you don't know where you are going, any road will get you there." By the same logic, if you know where you are going, you should be on the right road. The R&M 2000 Process may start us down the right road, but it is only one tool of many that are needed to move toward continuous improvement in productivity and quality.

Continuous Improvement

In his book "KAIZEN", Masaaki Imai points out that there are many ways to pursue continuous improvement, but the "high road" to KAIZEN has been the practice of total quality control (TQC).²² The problem with TQC lies in its name. Quality control in American connotation has historically been the domain of the quality control engineers and inspectors which harkens back to the era of Zero Defects. This is not what KAIZEN is all about. It is not a control of quality, but rather a management of quality so as to achieve improvement. Total Quality Management (TQM) is a more appropriate

²¹ Air Force Pamphlet 800-7. pp. 2-3.

²² Masaaki Imai. KAIZEN. New York: Random House, p 43.

expression of KAIZEN and in fact, the Joint OSD - Air Force - Industry Process Action Team (PAT) defines TQM as follows:

Total quality management consists of continuous process improvement activities involving everyone in an organization-- managers and workers--in a totally integrated effort toward improving performance at every level. This improved performance is directed toward satisfying such cross-functional goals as quality, cost, schedule, mission need and suitability. TQM integrates fundamental management techniques, existing improvement efforts and technical tools under a disciplined approach focused on continuous process improvement. The activities are ultimately focused on increased customer/user satisfaction.²³

Thus TQM is a management process which is aimed at KAIZEN, continuous improvement. The R&M 2000 Process is an integral part of TQM as are many other tools that are outside the scope of this paper. Even Zero Defects, although considerably modified, is in TQM.

This chapter has briefly traced part of the evolution of the quality management approach called Total Quality Management. Starting with the once highly touted Zero Defects program, proceeding to discuss some of Dr. Deming's principles, through an introduction to R&M 2000, this chapter ends with a preface to TQM. The next chapter will explore TQM in more depth, but is not intended to be an authoritative treatise on the subject.

²³ Report on the Joint OSD - Air Force - Industry Total Quality Management Impediments, Process Action Team Findings and Recommendations. Colonel Darrell W. Grapes, Team Leader. Washington, D.C. 27 Jun 89. p. 4.

CHAPTER III

IMPROVING QUALITY

If the troops suffered because tanners did not cure hides long enough to produce sound leather and shoemakers cheapened the quality of their shoes, they were also victimized by the fraudulent practices of some of the commissaries in the Hide Department.

"Supplying Washington's Army"²⁴

Quality Management

The Japanese word "KAIZEN" means gradual, unending improvement, doing "little things" better; setting--and achieving--ever higher standards. "Moreover it means continuing improvement in personal life, home life, social life, and working life. When applied to the workplace KAIZEN means continuing improvement involving everyone -- managers and workers alike."²⁵ This is quite clearly different from the Zero Defects' concept of eliminating defects and also goes beyond the exhortation of "do it right the first time." KAIZEN applied to government and industry comes very close to the definition of Total Quality Management (TQM) that was presented in Chapter 2.

²⁴ Erna Risch, Supplying Washington's Army, Center of Military History, United States Army, Washington, D.C. 1981. p. 298.

²⁵ Imai. p. xx.

A slightly different definition of TQM is presented in the Draft Guide for implementing TQM, DoD 5000.51-G. "Total Quality Management (TQM) is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization. TQM is the application of quantitative methods and human resources to improve the material and services supplied to an organization, all the processes within an organization, and the degree to which the needs of the customer are met, now and in the future."²⁶ The definition seems straight forward, but what is Total Quality Management? In essence, it is a mind set; a way of thinking; and a systematic, integrated, organized process focused on continuously improving the product of an organization to satisfy the desires of the customer.

Customer Desires

This is not a very revolutionary idea. Producers of goods and services have always tried to satisfy the needs of the customer, however, one of the deficiencies in this last thought is that the customer has not been asked what was necessary for satisfaction. What the customer needs and desires may be two different things. That is the revolutionary aspect of TQM, finding out what the customer desires, then setting about fulfilling those requirements. Customer satisfaction is the ultimate requirement, and the only way the

²⁶ DoD 5000.51-G (DRAFT). Total Quality Management: A guide for Implementation. Washington, D.C. March 23, 1989. p. 1.

customer is satisfied is if the product does what the customer desires, and does so at a reasonable cost.

For years, American industry has turned out products that consumers bought. The system seemed to be working just fine. Markets grew and even some foreign producers entered the game. Consumers started buying the imported products in greater quantities and the American industry found it harder to sell its wares. The competition grew fierce, and many American companies found themselves fighting for their lives. Calls went out from industry to Congress asking for trade protection, but the answer lay, not in protection, but in the customer satisfaction. After all, congress cannot tell the customer what to buy, the customer buys what satisfies the need.

The Government as Customer

Companies doing business in the US military market place were shielded to a large extent from customer market place practices because, for one thing, the US Government applied "buy American" rules in the acquisition process. The government agencies worked with industry in developing weapon systems in accordance with the Federal Acquisition Regulations which fairly well prescribed policies, standards, and procedures to be adhered to by industry. In order to do business with the government, a contractor must meet some general standards. These standards include adequate financial resources; the ability to meet delivery schedule; a satisfactory

performance record; a satisfactory record of integrity; the necessary organization, experience, and technical skills; and otherwise qualified and eligible to receive an award.²⁷

The government as a customer is constrained to do business in a manner prescribed by rules and regulations, but that customer has become more and more dissatisfied. The quotation at the beginning of this chapter indicates that even General George Washington had quality problems. Over the years regulations were written and procurement processes grew in an attempt to eliminate the defects. Unfortunately, many problems remain as the bureaucracy has grown to manage the system.

Regulation, specifications, and standards are all very useful in providing guidance for meeting the customer requirements. Unfortunately, a system driven by blind adherence to specifications which do not conform to the customers real requirements can result in a product not fit for its intended use. Specifications tiered within other specifications, all intended to assure that the customer gets what the customer needs, have resulted in a nightmare of paper-work and confusion in the procurement process. Bureaucracy has grown to manage an ever increasing bureaucracy. In February 1989, the President directed the Secretary of Defense to develop a plan to

²⁷ Federal Acquisition Regulation, FAC 84-18 July 30, Washington, D.C. 1986
Part 9, para 9.104-1

improve the defense procurement process and management of the Pentagon.²⁸

A Changing Environment

In the conclusion of his Defense Management Report to the President, Secretary of Defense, Mr. Cheney noted that to realize the President's objectives, several actions would be required including creating "an environment that promotes steady progress in cutting costs and increasing quality and productivity."²⁹

This environment is being created throughout the DoD and especially in the Services. In October 1988 the Army published Quality Service to the Soldier, "the Army Total Quality Implementation Plan for Acquisition." This plan describes how TQM is to be implemented in the Army acquisition community. In November 1988 the Navy published its TQM implementation plan. A draft DoD 5000.51-G, Total Quality Management, a Guide for Implementation was released in March 1989. The overarching philosophy in all these documents is expressed in the forward to DoD 5000.51-G as follows:

Government and industry have come to understand that previously acceptable norms of goods and services are no longer acceptable.

Customer satisfaction, reliability, productivity, costs, and for industry, market share, profitability, and even survival are

²⁸ Cheney, p. 1.

²⁹ Ibid., p.27.

directly affected by the quality of an organization's products and performance.³⁰

Customer satisfaction is a key to the TQM philosophy. For the Air Force, this translates into combat capability since our customers are the American people who have paid to be protected by a reliable, capable military. The old saying "close enough for government work" is no longer acceptable since that mind set inevitably led to increased costs and waste because it was expected that some items would be serviceable while others would not. The expectation of defects is inherent in that saying.

Close enough is not acceptable. The customer wants, and has every right to expect, a product which will do the job for which it was intended (and hopefully, designed). The customer wants a product which will make him or her a winner and proud to be associated with that product.

Quality Culture

If customer satisfaction is what is wanted, then what has this to do with TQM? Total Quality Management is the process by which the producer achieves customer satisfaction. If this is so clear, then why isn't TQM already part of every DoD contract? In remarks delivered before the DoD National Conference on Acquisition Streamlining (Arlington, Virginia, May 31, 1989), the President of McDonnell Douglas Corporation, Gerry A. Johnson emphasized that TQM

³⁰ DoD 5000.51-G (DRAFT). p. Foreword.

is an attitude, a culture, a way of life, and therefore, the TQM systems, principles and tools should never be detailed contractual requirements.³¹

The DoD senior leadership is convinced that there must be a cultural change. Many Air Force leaders have made bold commitments and are pushing their organizations forward. At the 4th Annual Quality Symposium of the Aeronautical Systems Division (ASD), the ASD Commander, Lieutenant General Mike Loh said,

We have had both a frustrating and exhilarating time with our Total Quality (TQ) initiative. It's been a wild roller coaster ride with many ups and downs. But, we are making tremendous progress and I am personally more committed than ever to our quality journey, and convinced that unless both government and the defense industry change their culture, we will rapidly lose our leadership in defense technology and manufacturing.

General Loh is correct, both the government and the defense industry must change their culture. In the next chapter some of the actions representing the cultural changes in industry will be discussed. While the conversion to a TQM mentality may seem overwhelming, many of the steps are so simple and inexpensive they can be implemented in any organization. Other steps are much harder, but this brings to mind the KAIZEN approach of gradual, unending improvement, taking small steps, but setting ever-higher standards.

³¹ Gerry A. Johnson, Acquisition Streamlining and TQM, Aerospace Industries Association, Volume 2, Number 6, August 1989

CHAPTER IV

INNOVATION IN INDUSTRY

Despite all the evidence supporting flexible approaches to problem-solving, the only-one-way attitude still dominates our society and educational machinery.

Gerald Nadler³²

Meet the Customer

A large sector of American industry is involved in a revolution. Whereas industry used to assume that it knew what was best for the customer, it is increasingly paying attention to the customer. The quote above is giving way at last to more enlightened attitudes as industry is forced to learn what the customer thinks is best, or face an ever diminishing market share. Through market surveys, many industrial giants are trying to learn what the customer wants so that they can set about satisfying those desires.

Finding out what the customer expects from a product can be a lot of work. For instance, when Ford Motor Company was developing the Taurus/Sable line, they set out to identify the key product

³² Gerald Nadler, "Let's look at Design Processes and Their Results." Industrial Engineering, July 1989 p. 46.

features that influenced a customer's decision to buy a car. Over 400 key products features were identified through this enormous undertaking.³³ Nissan, a Japanese automobile maker, used a unique method to get to know its customers. The company arranged for one of its workers to stay with a family in California to learn about American tastes. The members of the family did not know they were being studied. The Los Angeles Times interviewed the Nissan employee and published his story about the family, a copy of which Nissan sent to the family with a "thank you" note. The family has sued Nissan claiming "invasion of privacy, fraud, trespassing, breach of contract and unfair business practices".³⁴ When setting out to identify customer desires, it is necessary to know who the customer is and to understand that customer.

In the market place it is reasonably simple to identify the customer (usually it is the person at the cash register paying for the product). However, in a large organization the customer for your product may be the next step in the production line, the next office in a program review cycle, or it may even be a truck driver picking up a shipment at your loading dock.

Just-in-Time

Regardless of who your customer is, when does that person need your product. It seems reasonable to state that your customer

³³ J.M. Juran. Juran on Leadership for Quality: an Executive Handbook. (New York: The Free Press, 1989) p. 96

³⁴ James R. Healey, "Nissan gets a taste of L.A. law", USA TODAY, December 14, 1989. p.2B.

needs your product when it can be used. Having a warehouse full of your product right next to your customer would satisfy that requirement, but from a practical and economic point of view, this may be too expensive. One facet of TQM is the notion of reducing the amount of inventory needlessly kept on hand by having a the product delivered to its point of consumption "Just-in-Time" (JIT). If the product is not needed until just-in-time for either further assembly into a higher order product or for consumption, then the next logical step is to manufacture the product in time for delivery.

The concept of JIT was used by Toyota car company in the 1950's. It got a home in American industry in the early 1980's as an inventory management system. "The objective of inventory management is to minimize inventory related costs, including three categories: holding or storage costs and even financing costs that result from keeping inventories; reorder costs including for manufacturing, setup costs, and for purchasing, order costs; and stockout costs (*sic*)."³⁵ By reducing the amount of product sitting in the pipeline, some costs can be avoided, and even though perfection cannot be achieved in reality, the process will drive both the producer and the consumer to continual improvement of product quality and inventory control.

Improving Distribution

Just-in-time inventory management will impact several areas of the distribution world. For one thing, it will require an

³⁵ Lance J. Besser, Dayal Kiringoda, and Il-woon Kim, "Effects of Just-in Time manufacturing systems on Military Purchasing," Program Manager, March-April 1988, p. 39.

improvement in the management of the product at the loading dock. Normally a truck is backed up to the loading dock, loaded, and driven off to distribute the load. All very simple. But what if the shipment is destined for several different customers? Will the load be packed in such a manner as to facilitate easy unloading? Some basic communication is necessary at the loading dock to guide the loading of the truck. Through the use of bar codes a major step can be taken toward closing the communication gap.

Many companies have implemented the use of bar codes for information management. Bar codes can be used to store information about the location, quantity, weight, volume, and destination of an item. This information can be electronically distributed, retrieved, and used to help in planning and scheduling inventory movement. A simple computer application can be used by businesses to better communicate with vendors and customers to eliminate paperwork and reduce human intervention in routine matters.³⁶ Economic justification of a bar coding system can be a stumbling block to its implementation. If the bar coding is an integral part of a material handling systems project in the plant or warehouse, its justification can be tied into economic benefits to be derived from the total system.³⁷ Shipments can be organized and marshalled for distribution along prescribed routes. Workers can be scheduled to be at the

³⁶ Christopher Trunk, "Auto. Id and EDI Team up for Dock Productivity," Material Handling Engineering, October 1989. p. 53.

³⁷ Richard B. Meyers, "How to look at Economic Justification of Bar Coding," Material Handling Engineering, October 1989. p. 100.

correct loading docks with the appropriate equipment when the load is ready for handling.

Loading Docks

Just-in-time deliveries can put a tremendous load on the shipping and receiving departments. Bar coding can certainly help, but there is more that must be done. Microsoft Corporation, a manufacturing and distribution plant in Bothell, Washington, "uses more than 1,400 different materials. An average of 80 trucks arrive every day on a just-in-time basis. Moreover, the company ships 15,000 individual software packages per day throughout the United States and 82 countries, in order volumes that range from one to 10,000."³⁸ The volume of material is not the problem. The problem is in the variety of truck shapes and sizes that pull up to the loading docks. To accommodate some of the variation, mechanical levelers and two different height docks were installed as well as an area for small pick-up trucks. To preclude gaps between the truck and the loading dock, vehicle restraints were installed. "Mounted below the leveler in the building's wall, the Dok Lok restrains a truck by extending a hook below the vehicle's ICC bar. The hook grabs the bar and holds the truck securely against the dock threshold."³⁹ In addition to designing the shipping and receiving areas to accommodate "the customer",

³⁸ "Loading docks handle pressure caused by just-in-time deliveries," Material Handling Engineering, October 1989. p.84.

³⁹ Ibid. p. 85.

Microsoft designed the building to accommodate the manufacturing process using a straight-through manufacturing design. Dock confusion is eliminated (deliveries come in one end and shipments go out the other), future expansion can be accommodated without disturbing the production or traffic patterns, and the company is confident that its personnel and equipment can handle the customer needs.

That covers a couple of examples of the mundane aspects of manufacturing and distribution which have responded to total quality management consideration. Obviously not everyone is involved in that type of operation. An interesting example of the application of TQM to another industry workplace is the Steelcase Incorporated Headquarters. In 1954, the company purchased and built on 38 acres in Grand Rapids, Michigan. With only 800 employees, this seemed like enough land. As the company grew more land was acquired until by 1981, with over 10,000 employees, it occupied 300 acres. Steelcase acquired more land south of Grand Rapids and currently occupies 1,300 acres. Growth and land acquisition are not the point. The interesting matter is how the company leadership led the organization.

Functional Inconvenience

When Steelcase announced plans for expansion in 1982, the company took a change in direction from "a relay team to a rugby

team approach."⁴⁰ In a relay team the baton is passed to the next team member. In a rugby team each member is involved in a joint effort. "Designers worked alone, passing their ideas on to engineers. When engineering finished they passed their work on to manufacturing and so on."⁴¹ In designing the new corporate headquarters to be located on the land south of Grand Rapids, Steelcase senior leadership set out to create an environment where planned and spontaneous interaction could take place between management, designers, engineers, and everyone involved in the process. They wanted an environment of "functional inconvenience."⁴² Functional inconvenience means that, for instance, senior management is located in the middle of the building to foster integration of management and staff. Directors offices are located in the hub of a wheel-like structure to foster impromptu meetings and discussion. This also stimulates and facilitates easy communications between departments.

The Pentagon is designed in a wheel-like design. The problem there is that all the senior leadership is on the outer ring, the "E" ring, so that the generals are located as far away from each other as possible. The activities within the Pentagon are isolated and insulated.

⁴⁰ Clyde E. Witt, "Steelcase: Building for the future." Material Handling Engineering, August 1989, p. 47.

⁴¹ Ibid. p. 47.

⁴² Ibid. p. 47.

To continue with some other innovative techniques used by Steelcase. Spontaneous creativity has been encouraged by placing marker boards (on which employees can sketch ideas or write notes) throughout the building in work areas, break areas, rest rooms, and along corridors. Break areas and project team rooms are designed to promote interaction between people. Informal meeting rooms for 2 or 3 people are provided furnished with chairs, a table, and a marker board. Have you ever wished for a quiet place to think? Steelcase has provided isolated rooms where one person can sit in peace and quiet--no phone, no computer, no visitors. A window to the outside world is provided for a view of the surrounding country side.

As company president [Frank] Merlotti notes, the new generation of people entering the workforce and ranks of management view work with a different meaning in their lives from previous generations.

They bring different values and lifestyles. Work has taken on a different meaning, . . . They are looking for more meaning and challenge in their working lives. They want meaningful participation in their jobs and futures.

You create a creative environment by encouraging formal and informal interaction of both people and ideas. Planned and spontaneous communication and teamwork have to be reinforced.⁴³

The United States Air Force cannot build new buildings as beautiful as the Steelcase pyramid, but with some senior leadership encouraging creativity in the workplace environment, who knows what added value could come out of some old buildings. When the AF

⁴³ Ibid. p. 52.

Acquisition Logistics Division at Wright-Patterson AFB, Ohio, remodeled its building (bldg 14, Area B), a lot of thought went into creating a fresh, creative environment. That occurred in the early '80's and that building is still one of the more innovatively designed work places in the Air Force.

Food World

Loading docks and innovative building layout don't sum up TQM. There is a lot more to the cultural change from business-as-usual to world-class-quality. Anthony J.F. O'Reilly, President and Chief Executive Officer of the H.J. Heinz Company noted that "TQM is a process whose only limit is our imagination. . . . There is no single program or project that can encompass it."⁴⁴ This company proposes that it is necessary to provide a systematic way for employees to communicate their concerns and create solutions, otherwise, things like waste and duplication become an accepted way of life. Heinz has established TQM councils of managers who review problems and problem solutions proposed by various teams in the organizations. This is similar to the quality circle concept. Employees are given TQM education and training in problem solving. The main point of the Heinz approach is that each employee is responsible for customer satisfaction. Heinz takes this a step further by applying the same

⁴⁴ Report of Earnings and Activities, 1989 Second Quarter/Six Months, (Pittsburgh: H.J.Heinz Company [1989]), p. 14.

responsibility to its sub-contractors and vendors. They have developed a "Partners in Perfection" program.⁴⁵

Has Heinz benefited from its TQM mentality? It has adopted it on a global scale in all its organizations. A better match of label and can production and improved sales forecasting helped save \$300,000 in production costs. In the Star-Kist division, they slowed the fish cleaning line and added a few more workers, which resulted in more thorough fish cleaning and reduced waste. The result was more fish products from the production line.⁴⁶ As Frank Adamson, manager for quality at Heinz U.S.A., said, "Only when you get the top level of management involved can you succeed."

The quote at the beginning of this chapter states that even though there is evidence to support flexible problem solving, the "only-one-way" attitude still dominates our society. However, this chapter has shown, there is a lot of innovation out there in industry. Everything from computer software manufacturing facilities to fish cleaning plants. TQM has taken hold. Great things are happening. In the thesis of this paper I suggested that there are impediments to institutionalizing TQM. In the next chapter some of these barriers will be investigated.

⁴⁵ Ibid. p. 14.

⁴⁶ Ibid. p. 15.

Chapter V

IMPEDIMENTS TO TOTAL QUALITY MANAGEMENT

**--a Problem is a Problem is a Problem:
that all problems are alike and can be
approached in the same way**

Gerald Nadler⁴⁷

Frustration

An anonymous letter to the editor of the "Journal of Electronic Defense", October 1989, makes some very strong statements against TQM and sums up with "The quickest way to reduce cost in the defense business is to fire all new vice presidents and directors and all people who work in the new departments not related to the basics: Accounting, Engineering, Manufacturing and Inspection." A lot of people are voicing opinions about how to reorganize industry and many more about how to reorganize the DoD. There appears to be a certain amount of frustration with the klaxon call to reorganize or to implement the newest management program. The Zero Defects program, as mentioned in chapter 2, had a lot of public promotion and not much enduring support. There have been other programs, introduced with a lot of fanfare, that fizzled. There are books written

⁴⁷ Nadler, p. 44.

about these programs and what made them succeed or fail, however, TQM is the new program and this chapter will look at the impediments to TQM institutionalization.

It should come as no surprise that I am not the first person to investigate the impediments to developing the fullest benefits from TQM. In fact, in December 1988 a joint Office of Secretary of Defense (OSD), Air Force, and Industry Process Action Team (PAT) was formed to identify impediments to sound quality management practices. The PAT conducted its study during the first few months of 1989 and published its findings in June 1989.⁴⁸ In addition, three military Research Fellows at the Defense Systems Management College (DSMC) completed a joint research project, "Using Commercial Practices in DoD Acquisition." The report investigates industry management practices that are good for business and identifies inhibitors to applying those practices in the DoD that are correctable at the DoD and Service policy level.⁴⁹

The PAT report identifies 26 impediments to government-contractor TQM relationships that do not add value to the products or services. The impediments identified are grouped into categories: commitment, consistent ideology and application, contractual issues,

⁴⁸ Joint OSD - Air Force - Industry TQM PAT Report.

⁴⁹ Bruce D. Sweeny, Charles A. Perkins, Alan C. Spencer, Report of the Defense Systems Management College 1988-89 Military Research Fellows, "Using Commercial Practices in DoD Acquisition." Defense Systems Management College, Ft Belvoir. 1989

and training. There is no benefit gained by restating the findings and recommendations of the PAT in this paper, however, a review of four of the findings and some comments are pertinent.

Lowest Price Contract

The first impediment identified by the PAT is that "DoD Contracting Policy and Process Emphasize Low Price in Lieu of High Quality"⁵⁰ The dominant role that pricing plays in the acquisition process does militate against innovation by contractors who are competing in a market where specifications dictate the minimum acceptable characteristics of a product. Any improvement over the minimum or deviation from the specification which may significantly improve the product is thus discouraged.

While it may be true that most contract awards go to the lowest price bidder among qualified offerers, the Federal Acquisition Regulation (FAR) does not require contract award to the lowest bidder. The following is taken from FAC 84-18, July 30, 1986, Part 9, Contractor Qualifications:

9.103 Policy

(c) The award of a contract to a supplier based on lowest evaluated price alone can be false economy if there is subsequent default, late deliveries, or other unsatisfactory performance resulting in additional contractual or administrative costs. While it is important that Government purchases be made at the lowest price, this does not require

⁵⁰ Joint OSD - Air Force - Industry TQM PAT Report. p. 8.

an award to a supplier solely because that supplier submits the lowest offer."

This clearly encourages consideration of more than just price in the award of a contract. AFLC has developed a contracting process, "Blue Ribbon Contracting," which includes as a basis for contract award past performance and technical capability as well as price. AFSC has developed a process for rating contractor's past performance called "Contractor Performance Assessment Reports (CPARs). "In six recent source selections at ASD, General Loh said, "contractor past performance was a significant factor in all but two, and they were early on, when we didn't have enough CPARs written.""⁵¹ In commercial practice, past performance is very important. Manufacturers cannot afford to deal with vendors who do not provide the required products with the desired quality and on schedule. A vendor's track record can determine continued existence or disaster for that vendor in the commercial market place.

Mandatory Total Quality Management

Another impediment identified by the PAT is "Strict Contractual Requirements for Total Quality Management (TQM)." As stated previously, TQM is a philosophy, not an item that can be measured and put on contract. This point is emphasized by many people in industry and government including the Manager for Customer Requirements,

⁵¹ John T. Correll, "A Choice of Roads to Procurement Reform," Air Force Magazine, August 1989, p. 29.

Quality, Reliability, and Operations at Texas Instruments Incorporated, Mr. Calvin C. Coolidge, who in his 26 Sept 1989 letter to me stated:

One of our central messages is that TQM should not be legislated nor regulated into existence. The whole idea is to develop a culture that does not restrict elimination of costly checks, audits, and inspections.⁵²

Texas Instruments (TI) has instituted a process of continuous improvement. They are doing software integration, design robustness, process capability, variability reduction, and more. To require some form of contractual process for these changes would impose needless government oversight. The PAT is correct in its recommendation that "DoD should not implement TQM via contract clauses."⁵³

TI has also developed long term partnerships with its vendors where past performance is a key to continued partnership. The Competition In Contracting Act passed in 1984 makes it difficult for the Government to enjoy partnership arrangements similar to those of commercial business. Never-the-less, AFLC Blue Ribbon Contracting and AFSC CPARs are a move in that direction.

Too Much 'How To'

"Too Much 'How To' in DoD Acquisition" and "Cumbersome Military Specification (MIL SPEC) and Standard (MIL STD) Change

⁵² Calvin C. Coolidge, letter to the author, 26 Sep 1989

⁵³ Joint OSD - Air Force - Industry TQM PAT Report. p. 10.

Process" are also significant impediments identified by the PAT. In typical DoD programs the contract usually includes a System Specification, Statement of Work, Contract Data Requirements List, and Terms and Conditions. These documents call out regulations, specifications, and standards which in turn call out tiers of additional documents. To substantiate this point, the President of McDonnell Douglas Corporation, Gerry A. Johnson, cited an example of a DoD contract requirement at the beginning of full scale development. The DoD program would mandate between 24,000 and 30,000 contractual documents. In contrast, Boeing and Douglas commercial aircraft programs enter full scale development with fewer than 50 contractual documents. ⁵⁴

In addition to the vast number of contractual documents mandated by DoD, Mr. Johnson cited the array of management guidance levied on industry by DoD. In a typical unstreamlined DoD program, the contract will impose about 30 "how-to-manage" systems. This may facilitate a system for auditing a contract for compliance, but it is sure to inhibit innovation and continuous product improvement. As General George S. Patton is reported to have said, "Don't tell the people how to do it. Tell them what to do, and you will be surprised at the ingenuity they exhibit to get it done."⁵⁵

⁵⁴ Gerry A. Johnson, Acquisition Streamlining and TOM, Aerospace Industries Association, Volume 2, Number 6, August 1989

⁵⁵ Ibid.

Even when a particular specification is identified as having too much "how to", the process of consensus building required to change the document is protracted. For example, MIL-S-8879A, General Specification for Class 3 screw threads, contains not only the data on screw thread characteristics but also direction on what type of gauges to use to check for dimensional compliance. Technical errors in the specification brought to the attention of the Air Force caused the process of rewriting it to begin in 1986. Following a complete rewrite (incorporating TQM ideas such as process control to obviate the need for post production inspection, and identifying what is required and not how to) and coordination throughout the Air Force, the responsible engineering office for development and technical maintenance of the specification issued an "Air Force only" version in July 1988 (MIL-S-008879B). This document was then distributed to other Services for coordination and to other Government agencies and some industry associations for comment. As of December 1989, the MIL-S-8879C for use by all DoD has not been approved because a senior technician in the Navy had "philosophical" concerns with the new format but could identify no technical dispute.⁵⁶ The consensus building process can be slow.

The impediment to TQM identified by the PAT is not just that there has been a proliferation of "how to" regulations, specifications,

⁵⁶ This material is from personal experience of the author who has been directly involved with the development of MIL-S-8879C.

and standards, but is also the bureaucracy which makes changing the offending documents so difficult and drawn out.

Other impediments identified by the PAT include: DoD's Quality Assurance System is Based on Inspection; Lack of Multi-Year Contracts; Lack of TQM recognition; Number and Complexity of Government Audits, Inspections and Reviews; Competition in Contracting Act (CICA); Insufficient Skills Training; Mandatory Work Measurement Systems; TQM is Viewed as Synonymous with a Quality Assurance (QA) Program; and others. It is not within the scope of this paper to analyze the Joint OSD-Air Force-Industry PAT findings and recommendations so I will leave that task to others.

Adopting Commercial Practices

The research done by the 1989 DSMC Fellows about using commercial business practices in DoD acquisition involved literature review and personal interviews. They interviewed representatives of twenty companies and "developed seven commercial case studies comprising twelve successful, major, new product and capital plant/equipment programs by commercial business entities"⁵⁷ They also developed a case study concerning one of the Defense Enterprise Programs, the Army's Mobile Subscriber Equipment because it used commercial-like acquisition practices.

⁵⁷ Report of the Defense Systems Management College 1988-89 Military Research Fellows, p. 7.

In their study of the commercial acquisition environment, the DSMC Fellows found little new or different from what has been widely espoused as good management practice. Much of what they found falls right in line with TQM. For instance,

Finding 1. Active involvement of top corporate managers is essential to program success."

Finding 5. Price is but one element in the purchase decision.

Finding 6. Companies are adopting more cooperative relationships with their suppliers.⁵⁸

These are not particularly revolutionary, and the Fellows are quite candid in noting that "There are no 'gee-whiz' answers." Active involvement of top corporate managers is a cornerstone of TQM success. The concern about price as the driving force of contract award has been addressed above as one of the PAT findings.

Partnership between a company and their vendors is a difficult option for a Government department to embrace because of the Competition In Contracting Act and the Competition Advocate responsibilities to increase competition. The tension between the good business practice of fostering a few top quality vendors and the intent of Congress to foster competition as a way to assure reasonable prices presents a challenge to government purchasers and program managers. The use of past performance can be used to cull from the competition those vendors who do not have a good track record.

⁵⁸ Ibid. pp. 10 - 15.

Institutional Inertia

In their discussion of improvements, inhibitors and implementation, the DSMC Fellows point out that "overcoming institutional inertia is a major impediment to successful application of good ideas across a huge bureaucracy."⁵⁹ The SAB also noted that in their field visits and interviews, they "found too many people with low regard for the way "the system" worked, . . . that it is a system with many good aspects and good people, but it is a cumbersome, often suboptimal, system, with little feedback and a slow response."⁶⁰ This is corroborated in an example of the frustrating bureaucracy which was provided to the author by Mr. Frank J. Matulonis, the Manager of Government Technical Liaison for Monogram Aerospace Fasteners.⁶¹ Monogram Aerospace Fasteners tried to introduce an improved version of their fastener (Visu-Lok II and Composi-Lok II) to the Air Force. These fasteners are used in structural aircraft components which require a high degree of joint integrity. The performance characteristics of the new fasteners are identical to those of their predecessors which are already qualified and in the Air Force inventory. However, Visu-Lok II and Composi-Lok II have "a new driving feature (Drive Nut) which simplifies installation, eliminates the

⁵⁹ Ibid. p. 16.

⁶⁰ Report of the United States Air Force Scientific Advisory Board Ad Hoc Committee, Aircraft Infrastructure - Subsystem and Component Reliability Improvement Research and Development Needs "F-A-C-T-S", Washington D.C., AF/LE-RD, September 1989. 16

⁶¹ Frank J. Matulonis, letter to the author, 20 Nov 1989.

potential of damaging fasteners (cam out), and utilizes existing tooling."⁶²

Extensive testing by the manufacturer and field experience by Air Force personnel demonstrated that the new fastener met the performance claims cited in the previous paragraph. Maintenance units wanted them, so submitted documents ordering the new fasteners. Since the new fasteners did not have National Stock Numbers (NSN), users ordered under the manufacturer's part number. Supply, however, would issue the old fasteners as a suitable substitute. The reason there was no NSN for the new fastener was because the Defense Industrial Supply Center (DISC) will not issue an NSN unless there are three user requests within a 180 day period. Thus supply could not issue a part without an NSN, DISC did not receive the orders for the new parts because supply was issuing a suitable substitute, so the new fasteners would never receive an NSN.

The following factors are quoted from Mr Matulonis's letter and clearly demonstrate the bureaucratic inertia in the Air Force:

1. Second line supervisors and planners perceived "no problems" and therefore did not see any need to try anything new.
2. There is a great reluctance on the part of individuals who have been with the system for any length of time to make a change. They are unwilling to try anything new.

⁶² TechTIP Number: TT 89036. Air Force Office for Logistics Technology Applications, Wright-Patterson AFB, Ohio. Sep 1989.

3. Several individuals submitted actions for the new fasteners as a value engineering suggestion. When these were turned down and they could not receive monies for their efforts, they dropped the action.
4. Several individuals stated that they were unwilling to associate their name with anything new. They were close to retirement (3-5 years) and did not want to "rock the boat" as it were.
5. There is no coordination of effort at the ALC for improvements of this type. It became necessary therefore to convince a group of people to take action, rather than sell the merits of the product to the group and have one individual take action.

DISC eventually took action to issue NSNs when the Navy and ALC started action which would have taken management responsibility away from DISC. It took almost three years to obtain NSNs for the new fasteners during which time the Air Force, Navy, and Army continued to use an obsolete product whose replacement would save time and money.

Mr Matulonis concludes that "there is no incentive for anyone in the system to look for improved methods or products that involve low dollar items. While it is readily apparent from an overview position that a savings of 5 minutes during installation of a nut multiplied by 1 million nuts is a substantial savings, the players along the way do not see this. It also appears that the system is prejudiced to maintain the status quo."

A point not mentioned in Mr Matulonis's letter is that involvement of senior Air Force leaders finally caused the system to

respond. During a visit by the Air Force Scientific Advisory Board (SAB) Panel on Non-Glamorous Mechanical Parts to Lakenheath AFB in November 1988, the Wing Commander there pointed out that "Jo-Bolts" were a significant maintenance burden to his aircraft maintenance troops. The installation tool tended to "cam out" thus preventing satisfactory installation of the fastener. The fastener then had to be drilled out, and another one installed, sometimes with the same unsatisfactory result. When the SAB panel reported this finding back at the Pentagon, several people became involved including BGen Collins, AF/LE-RD and Col Rissell, of the FACTS Process Action Team at Wright-Patterson AFB. With the support from senior leaders, the Item Managers, Equipment Specialists, and other managers took action to make the change happen.

Overcoming institutional inertia is a major impediment to TQM, however, the KAIZEN approach can do the job. A quick revolution will not happen, and probably could not. Continuous improvement over all disciplines is a slow process, but need not be bogged down by inertia. There are many simple changes that can be made quickly such as improving the process for introducing better fasteners.

Customer Requirements

In a letter to the author from Mr. Robert R. Johnson, Hughes Aircraft Company Manager, Quality Management, Radar Systems Group Quality Directorate, another impediment to TQM is identified.

This impediment is directly related to satisfying the customer desires as discussed earlier in this paper. The contractor needs to know and understand what the customer (the Government in this case) wants and should be involved in developing the statement of operational needs. Mr. Johnson makes the following observations:

- (a) Contractors are not always coordinated with when defining operational needs.
- (b) Operational requirements are not visible or consistently identified. Goals such as 20 consecutive sorties without failure, 20 minutes MTTR for 85 percent of failures, and technician transparency requirements are not provided. Instead, R&M requirements are being manifested as MTBCF and MTTR allocations.
- (c) Warranty requirements and incentive options are not clearly established or flowed down.
- (d) It is not clear that there are sufficient and consistent DoD field collection and assessment capabilities to support a warranty Program.⁶³

These impediments really strike at the commitment of the senior Air Force leadership to R&M 2000. The first goal of R&M 2000 is increased combat capability which is expressed as operational performance over time and restoral rate as articulated in (b) by Mr Johnson. He also points out that "It has not been made absolutely clear that R&M 2000 is a leading acquisition initiative and that reliability improvement is a prime measure of customer satisfaction or even product acceptance." When the Air Force leadership makes that commitment and is involved to ensure that acquisition program

⁶³ Robert R. Johnson, letter to the author, 21 Nov 1989

funding and warranty requirements support that commitment, industry and Air Force TQM efforts will be more credible.

There are impediments to Total Quality Management in the Air Force. These include contracting processes that favor lowest price over lowest life cycle cost, too much "how to" regulation, lack of multi year funding and program stability, and bureaucratic inertia. Studies, reports, literature searches, and letters from industry representatives bring out many of the same impediments in different formats. These impediments do not seem to be absolute show stoppers and can be overcome by management involvement. The next chapter will sum up the findings of this paper and provide recommendations for implementing TQM in the Air Force and DoD.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Management must adopt a participative management style and foster teamwork and good worker-relationships. Management must drive out fear, shed their authoritarian attitudes and become a valued partner in the company

Bruce Johnson⁶⁴

The thesis of this paper is that there has been significant commitment by the leadership of Air Force and industry to improve R&M, most recently in the strong emphasis on TQM, however, there are institutional impediments that prevent the aerospace industry from achieving all that it can from R&M and TQM. It has been clearly demonstrated in this paper through examples discussed and cases cited that there is significant commitment to improve R&M with strong emphasis on TQM. Also, this paper has provided evidence that there are impediments preventing the aerospace industry from achieving all that it can from R&M and TQM, but there are no impediments that cannot be overcome by senior leadership involvement and a

⁶⁴ Bruce A. Johnson, "Making TQM Work Through the Variability Reduction Process, AIAA/ADPA/NSIA 1st National Total Quality Management Symposium, Technical Papers, AIAA, Washington, D.C. Nov 1989. p. 307.

commitment to a cultural change. Simple problems, such as obtaining stock numbers for preferred spares discussed in a previous chapter, should not require senior leadership involvement. However, if mid-level managers will not respond to the need for change, the problem must be elevated for resolution.

Senior Leadership Involvement and Commitment

Of all the formulae for assuring the success of the DoD Total Quality Management initiative, the one cardinal rule that sears through the fog of ideas and which is the primary recommendation of this author, is that the senior leadership of the organization must be involved and committed to continuous improvement. This senior leadership for the DoD includes the Secretary of Defense, the Service Secretaries, the Chairman of Joint Chiefs of Staff, the Service Chiefs of Staff, the Commanders of the Unified and Specified Commands, Members of the Senior Executive Service, and all the officers down to the rank of Lieutenant Colonel (or equivalent). If any one of these senior leaders is not involved and committed, then that person will be an impediment to TQM.

In the Report of the Secretary of Defense to the Congress, the DoD position is made clear. "TQM is a major DoD strategy that is dedicated to ensuring the highest level of quality and productivity at every step of the design and manufacturing process and at every

management level."⁶⁵ The Secretary of Defense stated publicly his commitment. With that support, there should be a steady move toward continuous improvement. There can be no excuse for any member of the Department of Defense who fails to engage and change a process that needs to be improved. The Secretary of Defense has told them to get on with the program.

The Bottom Line

There is not a single institutional impediment to TQM that cannot be conquered by the involvement of the senior leadership. The Commanders of AFLC and AFSC have demonstrated that when they support the program, actions happen. For years there was a perception that contracts were awarded based solely on lowest price. These two commands now routinely consider a vendor's past performance in awarding a contract. In evaluating a contractor's proposal it is normal to assign a factor for technical risk. Now AFSC will assign "performance risk based on a company's track record of past contracts."⁶⁶ Using the Contractor Performance Assessment Reporting Systems (CPAR, as described in Chapter V), AFSC conducted 306 reviews in one year, which covered 47 contractors.⁶⁷

⁶⁵ Frank C. Carlucci, Report of the Secretary of Defense Frank C. Carlucci to the Congress. U.S. Government Printing Office, Washington, D.C. Jan 1989. p. 120.

⁶⁶ General Bernard P. Randolph, "Air Force Acquisition: Toward the Direct Route." Program Manager, Defense Systems Management College, Ft Belvoir, Va. September-October 1988. p. 3.

⁶⁷ General Bernard P. Randolph, "Total Quality Management: Building the Best for TAC." Department of Strategy and Forces Readings: Book 1. Air University, Maxwell AFB., Oct 1989. p. 125.

The onus for change is not just on industry. Noting that in 1987 the time it took for source selection (from issuance of the request for proposal to contract award) was 175 days, the AFSC Commander looked for ways to improve the process. By 1988 the Command average had been reduced to 148 days with the goal now of 120 days.⁶⁸ Frustrated by a process which previously allowed, even encouraged, an iterative process of submitting proposals then negotiating changes, and finally submitting a "best and final" proposal, the commanders of AFSC and AFLC are encouraging the award of contracts without discussion. This means that the contractor must understand what is desired by the customer and submit the best, most accurate proposal the first time. This process will require the Air Force as the customer to have the requirements correct, clear, and thoroughly written down in the request for proposal.

Actions must begin at the top. Senior leaders must have clear vision of purpose. Middle management in a bureaucracy cannot change on its own. For example, with direct senior leadership, hands-on involvement, and dedication to get the job done, those middle managers responsible for the specifications and standards will either make the changes necessary for total quality management or be moved out of the way for managers who will do the job. Specifications and standards are "like the rigid building codes of the construction industry, they provide a minimum quality standard and, if enforced

⁶⁸ Ibid. p. 126.

properly, keep out frauds and charlatans. But they also can stifle innovation through their long complex, and tedious path of change."⁶⁹

Senior leaders must lead in all matters. This includes the requirements process. They must demand that there be a link between national goals and objectives, threat, defense guidance, doctrine, mission, goals, requirements, design, production, and operation. An impediment to improving R&M and TQM is the way program requirements are stated. As noted in the previous chapter, requirements must be stated in operational terms which clearly convey to the contractor, the clear and consistent desires of the customer. Allocated terminology such as "Mean Time Between Failure" has no place in stating operational requirements. In the case of a fighter aircraft, the operational requirement for a reliable system is stated as the number of consecutive sorties flown under stated conditions without unscheduled maintenance. The stated conditions include a description of the operational environment and the mission essential functions for each phase of that mission. In the event of a failure of a mission critical function, the restoral time is expressed as the maximum allowable time to restore those functions to mission capable status. The key to this change in the way requirements are stated is the use of unambiguous terms that the operator normally uses to express operational performance.⁷⁰

⁶⁹ Report of the U S Air Force Scientific Advisory Board Ad Hoc Committee, p. 11.

⁷⁰ Air Force Pamphlet 800-7. p. 8.

For a host of reasons (among them the ghost of the Zero Defect mentality of a decade ago), few Air Force officers appear willing to take risks in the pursuit of their professional responsibilities.⁷¹ It is time for this to change. TQM cannot be implemented in a system that is bound up by fear of failure and fear of change. Senior leaders will reap a handsome reward by encouraging subordinates to challenge the existing processes and propose alternate methods. Out of the changes improvements will emerge.

Analysis Paralysis

Does management insist on massive efforts to study the opportunity for improvement? Are they bogged down in the analysis paralysis syndrome? It was British Admiral Jellicoe, First Sea Lord in 1916, who even after the results of analysis showed that convoys would provide protection from U-boat attack, told Commander Reginald Henderson to do another analysis. It took the involvement of the Prime Minister to cause the Admiralty to adopt convoying.⁷² How much more analysis will senior leaders demand before they take steps on their own to change? The rewriting of the specification for Class 3 screw threads has taken over three years. There have been no major changes to the draft in the past two years. A senior technician in the US Navy was holding up approval for more

⁷¹ Col Thomas A. Fabyanic, Air University Review Jan-Feb 1986. (p 53 in Force Planning book.)..pp. 2 - 29

⁷² E. B. Potter, "The War Against Shipping," Sea Power, pp. 223 - 228.

analysis.⁷³ This impediment to TQM could have been cleared by direction of a senior leader.

To Solve a Problem

Total Quality Management will not occur solely as a result of exhortations for leaders to be involved and lead. Many leaders are already involved and are trying to improve the quality of their organizations and products. Some are totally committed to the TQM philosophy and are tackling a myriad of problems. It seems that reorganization is a typical first step. The key to TQM does not lie in solving all the problems of an organization at once, but in recognizing that a problem exists, then setting about correcting the problem through small, incremental improvements. "Where there is a problem, there is a potential for improvement."⁷⁴ Improvement will occur when opportunities are identified and everyone gets involved, including top management, managers, and workers. This is not a "cook book" process. How to solve the problems will depend on each situation, however, solutions will be found through gradual improvement and by setting ever higher standards. W. Somerset Maugham once made the observation that "it is a funny thing about life; if you refuse to accept anything but the best, you very often get it."

⁷³ The author has been directly involved in this issue for the past 4 years.

⁷⁴ Masaaki Imai, Kaizen, p. 163

In The Annual Report of the Marine Corps to Congress, the Commandant of the Marine Corps, General A. M. Gray tells how the Corps set about making improvements in their capabilities.

Herein lay our formula for success in institutionalizing change. Our junior leadership generated ideas and identified the basic means to implement them; our senior leadership validated these ideas, and together we committed ourselves to their accomplishment while staying within current resource limits. We avoided the lengthy, bureaucratic staffing process that can so often stifle or kill a worthwhile concept.⁷⁵

A typical Marine approach of taking one beach at a time, one hill at a time, and so on until victory can be declared.

And Gorby Too

It is interesting to note that in the face of serious economic problems, even the leadership of the Soviet Union is committed to change. In 1987, the Central Committee adopted an outline of a radical economic reform. "The purpose of the reform was to create a system in which market forces and individual enterprises would play a major role and in which the traditional stress on quantitative growth would be replaced by an emphasis on productivity of labor and capital, technological progress, material incentives, profit, and quality."⁷⁶ That sounds a lot like TQM.

⁷⁵ General A. M. Gray, The Annual Report of the Marine Corps to Congress. Marine Corps Gazette, April 1989, p 15.

⁷⁶ Seweryn Bialer (Ed.) Inside Gorbachev's Russia: Politics, Society and Nationality. Boulder, Colo: Westview Press, East-West Forum Publications, 1989. p. 167.

Summary

This Defense Analytical Study is by no means an exhaustive treatise on the subject of R&M and impediments to TQM. That was not the intent of the author. Through this study I have tried to determine how industry perceives the R&M 2000 program and TQM. I have also looked for institutional barriers that are preventing the Air Force (and DoD) from reaching the goal of continuous improvement. My conclusion is that industry generally supports both R&M 2000 and TQM as being good business practices. Industry has instituted various forms of TQM (after all, TQM is defined in many different ways) and from my observations, does not need the Government to dictate implementation plans. I found no institutional barriers that are preventing the Air Force from reaching the goal of TQM. There are only opportunities for senior leaders to demonstrate their commitment to the TQM program and some imagination. The success of the Air Force TQM program will depend on the extent to which its senior leaders are prepared to apply the concept of KAIZEN--gradual, unending improvement, doing "little things" better; setting--and achieving--ever higher standards.

BIBLIOGRAPHY

- Besser, Lance J.; Kiringoda, Dayal; and Kim, Il-woon. "Effects of Just-in-Time manufacturing systems on Military Purchasing," Program Manager. March-April 1988.
- Bialer, Seweryn. Inside Gorbachev's Russia: Politics, Society and Nationality, Boulder, Colo: Westview Press, East-West Forum Publications, 1989.
- Carlucci, Frank C. Report of the Secretary of Defense Frank C. Carlucci to the Congress. U.S. Government Printing Office, Washington, D.C. Jan 1989.
- Cheney, Dick. "Defense Management." Report to the President, Department of Defense. Office of the Secretary of Defense, Washington, D.C. July 1989.
- Coolidge, Calvin C. Letter to the author, 26 Sep 1989
- Correll, John T. "A Choice of Roads to Procurement Reform," Air Force Magazine. August 1989.
- Deming, W. Edwards. Out of the Crisis. Cambridge, Mass. Massachusetts Institute of Technology, 1986.
- Fabyanic, Col. Thomas A. Air University Review Jan-Feb 1986.
- Gray, General A. M. The Annual Report of the Marine Corps to Congress. Marine Corps Gazette, April 1989.
- Halpin, James F. Zero Defects. New York: McGraw-Hill, Inc. 1966

Healey, James R. "Nissan gets a taste of L.A. law", USA TODAY,
December 14, 1989.

Imai, Masaaki. KAIZEN. New York: Random House

Johnson, Bruce A. "Making TQM Work Through the Variability
Reduction Process, AIAA/ADPA/NSIA 1st National Total
Quality Management Symposium. Technical Papers, AIAA,
Washington, D.C. Nov 1989.

Johnson, Gerry A. Acquisition Streamlining and TQM. Aerospace
Industries Association, Volume 2, Number 6, August 1989

Johnson, Robert R. Letter to the author, 21 Nov 1989

Joiner, Brian L. and Scholtes, Peter R. The Quality Manager's New Job.
Quality Progress, October 1986.

Juran, Joseph M. Juran on Leadership for Quality: An Executive
Handbook. (New York: The Free Press, 1989).

Matulonis, Frank J. Letter to the author, 20 Nov 1989.

Meyers, Richard B. "How to look at Economic Justification of Bar
Coding," Material Handling Engineering. October 1989.

Nadler, Gerald. "Let's look at Design Processes and Their Results."
Industrial Engineering. July 1989.

Potter, E. B. "The War Against Shipping," Sea Power. Navy League.
1988

Randolph, General Bernard P. "Air Force Acquisition: Toward the
Direct Route." Program Manager, Defense Systems
Management College, Ft Belvoir, Va. September-October 1988.

—— "Total Quality Management: Building the Best for TAC."
Department of Strategy and Forces Readings: Book 1. Air
University, Maxwell AFB., Oct 1989.

Risch, Erna. Supplying Washington's Army. Center of Military History,
United States Army, Washington, D.C. 1981.

- Rutenberg, David C. and Allen, Jane S. The Logistics of Waging War. AF Logistics Management Center. U.S. Government Printing Office, 1986.
- Sweeny, Bruce D.; Perkins, Charles A.; and Spencer, Alan C. Report of the Defense Systems Management College 1988-89 Military Research Fellows, "Using Commercial Practices in DoD Acquisition." Defense Systems Management College, Ft Belvoir. 1989
- Trunk, Christopher. "Auto. Id and EDI Team up for Dock Productivity," Material Handling Engineering. October 1989.
- Van Creveld, Martin. Supplying War. Cambridge, United Kingdom: Cambridge University Press, 1977.
- Witt, Clyde E. "Steelcase: Building for the future." Material Handling Engineering, August 1989.
- AFP 800-7. USAF R&M 2000 Process, Department of the Air Force. HQ USAF, Washington, D.C. GPO, 1 Oct 88.
- DoD 5000.51-G (DRAFT). Total Quality Management: A guide for Implementation. Washington, D.C. March 23, 1989.
- FAC 84-18. Federal Acquisition Regulation. July 30, Washington, D.C. 1986
- Report of Earnings and Activities, 1989 Second Quarter/Six Months, (Pittsburgh: H.J.Heinz Company [1989]).
- Report on the Joint OSD - Air Force - Industry Total Quality Management Impediments. Process Action Team Findings and Recommendations. Colonel Darrell W. Grapes, Team Leader. Washington, D.C. 27 Jun 1989.
- Report of the United States Air Force Scientific Advisory Board Ad Hoc Committee, Aircraft Infrastructure - Subsystem and Component Reliability Improvement Research and

Development Needs "F-A-C-T-S", Washington D.C., HQ USAF,
AF/LE-RD, September 1989.

TechTIP Number: TT 89036. Air Force Office for Logistics Technology
Applications, Wright-Patterson AFB, Ohio. September 1989.

The President's Blue Ribbon Commission on Defense Management, A
Formula for Action. A Report to the President on Defense
Acquisition, April 1986.

Washington, D.C. Department of the Air Force. HQ USAF. Secretary of
the Air Force and Chief of Staff. Reliability and
Maintainability of Air Force Weapon Systems - ACTION
MEMORANDUM. 1 Feb 1985.

Washington, D.C. Department of the Air Force. HQ USAF, Reliability
and Maintainability Action Plan, R&M 2000. Washington D.C.
February 1985