Abstract

In 1984, the Air Force leadership called for the need to improve combat capability through improved performance over time. Today, DoD is calling for a Total Quality Management (TQM) movement to support continuous process improvement. These two movements have successfully come together in a "call for change" and purpose to support the Defense Systems Acquisition Process. The joint "call" focuses attention on "back to basics" in satisfying the customer by designing systems that break less and are easily repaired without a costly and complex support infrastructure. General Bernard P. Randolph, Commander of the Air Force Systems Command stated this relationship as an important command policy: "Reliability, Maintainability and Producibility (RMP) are key building blocks of TQM and continuous quality improvement of our weapon systems". This relationship supports the strategic importance of R&M 2000 in the TQM movement, and clearly supports the five R&M 2000 goals as objectives.

R & M Goals

1. Increase Warfighting Capability
2. Decrease Vulnerability of Support Structure
3. Improve Mobility
4. Lower Manpower Requirements
5. Decrease Costs

The R&M 2000 Goals approach supported by TQM in the acquisition process will be the focus of this paper. The strategic relationship of the R&M 2000 process will be reviewed. To demonstrate the conceptual relationships defined by R&M 2000 process and TQM, the R&M Quality Team concept will be used. The R&M Quality Team Concept is the idea of Major James F. Guzzi and is the first TQM initiative to support the R&M 2000 process. The concept has been successfully used in the design of the C-17A airlifter.

Introduction

In today's U.S. Air Force, the weapon systems of the future are being planned, designed and built. Both the Air Force and industry have been working together in enhancing their capabilities to provide the needed weapon system "Reliability & Maintainability" to meet the mission and cost requirements for the year 2000 and beyond. These requirements include, as a corollary to performance, the aspects of mobility, survivability, manpower, and cost limitations. These added factors demand that the system acquisition process includes plans to enhance our focus on R&M and identify the necessary TQM initiatives to improve the weapon systems' built-in Reliability and Maintainability. To achieve built-in R&M and achieve the R&M 2000 goals, total system R&M design will be emphasized. Total system R&M is the process that includes the sum of the integrated subsystems, support systems and their component parts which will be designed to operate for specific missions and environments.

Background

In 1985, the Air Force established the five R&M 2000 goals that will sustain and broaden the emphasis on Reliability and Maintainability in their present and future weapon systems by formalizing an R&M Action Plan known as R&M 2000. This action plan was developed to institutionalize an "R&M Strategy and Focus" throughout the Air Force and industry. The increased emphasis on R&M by the Air Force has created the atmosphere and challenge that called for the implementation of the R&M 2000 Action Plan. The R&M 2000 Process was developed to help meet this challenge and achieve the stated R&M 2000 objectives. R&M 2000 clearly advocates increased combat capability through designed-in R&M. In the 1950s reliability was related to structural safety. Mechanical reliability was easily solved by designing the system 2 to 2 1/2 times its life. This evolved to the present day structural integrity program with fracture mechanics. In the early 1960s, the first book of reliability engineering was published. RCA and AT&T studied the unreliability of electronics as the "long pole in the tent" for system reliability and solid state physics introduced the transistor with the demise of the vacuum tube. The advent of R&M introduced a new design tool to provide Quality systems that can be repaired and are reliable.

The U.S. Navy introduced systems engineering with a strong R&M influence in its nuclear submarine program. Industry endorsed the R&M engineering principles and Government began to endorse reliability in its standards.

During the 1960s and 1970s, R&M found its home in the organization as a new function. Cost, schedule and system dynamics performance became the real focus. Build better weapons systems that fly higher, go deeper and faster, and driving the technology to get us there were the requirements. TQM philosophy was not widely understood. Ironically, huge system support costs, large infrastructures and fewer dollars have caused the need for "change".

We all have realized that R&M Emphasis of the 1960s with the vision of TQM for the 1990s is the only way to provide the long awaited need for change. R&M has always been a part of quality, and we have understood the lessons learned to incorporate this into our quality movement. The R&M 2000 process has helped lead the way. TQM concepts that focus on the total system with process control have become part of today's successful organizations. "Do it right the first time" and "back to basics" became the philosophies behind the Quality Teams approach that have been getting the job done.
R&M Quality Team Concept: A TQM Approach

In 1985, the R&M Quality Team Concept was conceptualized and developed to focus management attention on the system level R&M process during full scale engineering development. The concept was simple, but well founded, and it provided a powerful means to streamline and enhance the communications and system engineering process in the total organization. This Quality concept provided the capability for a directed response to system R&M problems while creating an atmosphere for positive system change. The approach facilitates design engineers and system designers to work as a chartered "team" under the guidance and direction of an R&M Review Council.

Echoing the importance of system integration and management, Ronald D. Gordon, Director of Operations for Communications Systems Division of GTE's Government Systems Corporation, said that corporate culture has solidified design and manufacturing into two separate organizations for too long. "If we are to make progress against this corporate culture," he said, "the sharp dividing lines between design and its functions, all of them, and manufacturing and its functions, all of them, have got to go away. We've got to develop teams somehow to get synergy."

Supporting this observation, the R&M Quality Team Concept provided an integrated organization quality solution. The Concept's model will be introduced and defined as a structured strategic process that contains four related quality parts. This combination has proven to be very successful in identifying and supporting the strategic R&M 2000 process. The parts include:

1. A charter or standard practice approved by senior management to direct the concept throughout the total organization.

2. An R&M Review Council that meets at least weekly to manage the R&M process and reports directly to the program manager. This council comprised of second tier management whose functional organizations are responsible for some part of the R&M design or related activity and who have decision authority.

3. A problem identification and prioritization process which uses R&M drivers or indicators to focus on the top 20% of the system R&M issues or related problems to affect 80% of the systems performance requirements. The identification process pin-points the areas that require immediate management attention.

4. The Quality Team itself which is chartered and established by the R&M Review Council on an ad hoc basis to solve critical system R&M issues and report back solutions to the council for real-time implementation. The Teams use participative decision making (PDM) and are comprised of individuals from each functional group that is affected by the problem and under control of the R&M Review Council.

The concept process enhances the organizational lines of communication and focus among the functions vertically by the Review Council and horizontally by the Quality Teams. This process strengthens an R&M management network within the existing organization. Activity is managed by the Review Council to insure that the strategic focus is not diluted in the functional team activities. In essence, the concept supports a system/concurrent engineering process that is driven by the R&M 2000 goals to meet the total system level requirements.

System integration provided by this strategic process pin-points the system concerns that affect the total design process and functional organizational structure. By using information that surfaces from the bottom and is summarized at the system level, the council can understand and direct resources to the problem that will derive system solutions. The ability to solve issues that cross functional lines of responsibility as easily as single functional problems is an accepted power of the concept. The solution is a high level team effort that ensures all the principals are a part of the outcome, and that the R&M goals are the focus of the solution. With this concept, top management is in control and has the ability and responsibility to direct the total organization to meet the total R&M design objectives. In addition to the functional problem solving issues, the concept compliments other processes and that are in existence. For example, under the R&M Quality Team concept, enhanced engineering data can be provided to the logistics support analysis (LSA) process which defines supportability requirements and influences early design decisions. The results of this enhanced data will allow the logistics engineers to focus more time on supportability identification and less time on design considerations. The R&M Quality Team Concept supports integration of the LSA process with the engineering design process and allows the optimum results to take place. The total R&M 2000 process is a truly integrated quantity systems engineering approach.

The qualitative value associated with the R&M Quality Team concept is that management has a strategic understanding of the system R&M 2000 process and R&M problems affecting the design process. The R&M process is managed and controlled. This allows the R&M issues to be identified, simplified and addressed on a real-time basis. System R&M priorities can be easily addressed and receive immediate attention. For example, system level indicators were demonstrating that mean time between maintenance (MTBM) was not meeting contractual design R&M requirements. The R&M Review Council assessed the scope of the problem and assigned R&M Quality Teams for each major system. The objective was to review the total design with a focus on MTBM within and across each major system. The capability existed to strengthen the existing design teams through R&M Focused Design Teams to solve the problem. This was credited to the Quality Team Concept and was accomplished without disrupting day to day functional activities. The results of the review enhanced the overall design while improving MTBM across the total system. Some of the resultant improvements on the design included: (1) The number of landing gear hydraulic system hoses, fittings, and connectors was reduced 20%. (2) Digital controllers, with added built-in-test (BIT), replaced hydromechanical controllers. (3) The aerial delivery control system unit was redesigned to be compatible with the hydraulic system control unit. Similar software and specific cannon plugs were integrated to eliminate one black box. (4) The exterior lighting system was redesigned to include 500 hour life lamps with vibration resistant assemblies vice 100 hour lamps. This effort directly improved the inherent reliability and maintainability of the total weapon system while achieving the R&M 2000 goals.

While achieving defined objectives, the concept was flexible yet structured. It did not replace or alter the existing organizational structure or training, but amplified the communications and organizational effectiveness to address system R&M level issues. The concept provided an R&M quality management enhancement that overlaid on the existing process and organization.
and institutionalized the commitment necessary to integrate a total R&M 2000 system engineering solution. Research and study within 20 major companies' R&M/TQM programs over the past five years have provided valuable lessons learned. Through enactment of TQM concepts like the R&M Quality Team Concept, top management commitment to R&M 2000 goals are evident. The results have been very impressive to date demonstrating potential for enhancing the total acquisition process. The concept can be used in all phases of the acquisition process and provide the invaluable ability to manage transitions from development to production. For example, the concept can link design to manufacturing through the Review Councils and Team interactions, and provide an R&M focus throughout the production transition. This can translate to enhanced production quality.

Summary

The Air Force and the aerospace industry have supported Quality concepts and other similar ideas that answer the R&M 2000 call for a new look on how we manage the R&M 2000 process to insure a superior yet cost-effective product. We must continue to manage the R&M process and not let the process manage R&M. And finally we must continue to recognize the strategic importance of R&M 2000 as a cornerstone to the TQM movement.

This paper is dedicated to retired Brigadier General Frank S. Goodell, the first U.S. Air Force, Special Assistant for Reliability and Maintainability (USAF/LE-RD). General Goodell was the individual who successfully advocated, directed, and executed the Air Force R&M 2000 Action Plan.

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References


Biography

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Major James F. Guzzi is presently the Command R&M 2000 Engineer for Air Force Systems Command. He was the past R&M Program Manager for the C-17A aircraft. He has 20 years of Project Management experience including five years with Corning Glass Works. Major Guzzi is an aerospace engineer who holds master degrees in Business Administration and Systems Management. He was selected to attend the Cornell Executive Development Program while in industry and the Defense Systems Management College Program Manager Course while in the Air Force. Major Guzzi has been awarded the Air Force Meritorious Service Medal for outstanding achievement four times during his career.