

Journal Papers on Reliability and Maintainability

THIS special section on reliability and maintainability (R&M) was prepared to illustrate the kind of material that is urgently needed by the increasing numbers of our aircraft development community who must deal daily with R&M. There has been a recent dramatic emphasis on the early inclusion of R&M in the development process, beginning with the design phases. This transcends all phases of aircraft application, both civil and military.

Journal papers on this subject have been very limited, yet such papers can develop the tools and "parametrics" for R&M. They can provide the substance for design and planning decisions. In response to all this, I collected a set of papers

presented at the 1986 Aircraft Design Conference and invited a specific paper on avionics reliability through environmental control. Finally, I asked the Special Assistant for Reliability and Maintainability, Headquarters USAF, Brigadier General Goodell, to address the issue of R&M from an Air Force perspective. His perspective, including brief remarks on the papers that follow, leads off this special section.

Look them over. Then, if you're inspired to develop some aircraft R&M ideas of your own, send them to this Journal for publication.

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R&M by Design: A Blueprint for Success

Introduction

A New Look: R&M as Defined by the Customer

TODAY, the U.S. Air Force possesses a very capable and combat-ready force. This national resource forms a crucial element supporting our country's goal to maintain peace. However, at this time, we find ourselves grappling with both tightening budgets and constrained personnel resources while facing a qualitatively and quantitatively increasing threat. Unfortunately, our present response to this threat requires using aerospace systems that *by design* have compromised the aerospace characteristic of flexibility. Today, the F-15 and F-16 represent the premier fighting machines of the air, but dependencies on extensive support equipment such as the Avionics Intermediate Shop (AIS) render these systems potentially too vulnerable. Fortunately, solutions to this and other related problems are at hand. Today, as designers and manufacturers, we must view the system as encompassing the people, materials, facilities, and information that support the fighting platform.

In the past, the Air Force did not clearly state its customer requirement to industry: *perform effectively over time*. The R&M 2000 initiative, enacted by the Secretary and Chief of Staff of the Air Force in February 1985, rectifies this deficiency by establishing R&M as an essential element of our acquisition process. This broadened process is dedicated to procuring systems that operate long and well while being easily and efficiently maintained by people trained to reasonable skill levels using common tools. Engineers must now design to five specific goals that respond to the realities of today and tomorrow. In order of priority, the R&M 2000 goals are:

- 1) Increase war-fighting capability.
- 2) Increase survivability of the combat support structure.
- 3) Decrease mobility requirements per unit.
- 4) Decrease manpower requirements per unit of output.
- 5) Decrease costs.

These are goals that reflect the needs of our operational commanders, the ultimate customers of aerospace weapon systems. Attainment of these goals requires the concerted and integrated efforts of all engineering design and manufacturing disciplines. R&M considerations can no longer be left in an after-the-fact manner to a select few specialized practitioners. All engineers now bear responsibility for reaching the operational goals of R&M 2000.

Adjusting to Harsh Realities

Increased Threat

An increasingly hostile environment threatens the main operating bases in the principal trouble spots of the world. Soviet weapon systems have shown dramatic improvements benefiting from the flow of Western technology and a defense establishment that absorbs more than ten times the number of scientists and engineers, on an annual basis, than the U.S. defense sector. Qualitative improvements, associated with Soviet tactical fighter bombers and theater surface-to-surface missiles, threaten the Air Force's main operating bases. Current USAF combat aircraft depend heavily on complex support infrastructures of intermediate maintenance facilities found at these bases and the highly trained maintenance specialists required for their operation. Losing the complex support infrastructure can impact combat potential just as seriously as losing the fighting machines.

Too Much Tether

In the past, aerospace forces have always been able to exploit the characteristics of speed, range, and flexibility to a degree far greater than any surface force. Today, flexibility of aerospace power has been constrained by being tethered to a complex support infrastructure coupled with low reliability in the components that make up our systems. For example, one-third of all enlisted personnel, more than 150,000 men and women in 140 different skilled specialties, are required to maintain our systems. Highly reliable and maintainable weapon systems offer the means for returning flexibility to aerospace power.

Reduced Funding

The Air Force is now operating in a more resource-constrained environment in an era of ever-advancing technological change. For the second year in a row, the Air Force will experience negative growth, totaling nearly 15% from a fiscal year 1985 baseline. As General John L. Piotrowski, former Vice Chief of Staff of the Air Force, stated in his keynote address to the December 1986 Second NASA Symposium on Quality and Productivity, "We've gone well beyond fat and muscle and are cutting into bone." The financial and human resources needed to "brute-force" more combat capability from current systems simply are not available, and the high costs of failure in a given system cannot be tolerated, especially when human lives are at stake.