# Lessons in System Reliability

FROM THE QUANTERION ***SYSTEM RELIABILITY TOOLKIT-V***


*The important topics included in this short publication are shared here from the popular Quanterion Solutions' 900+ page System Reliability Toolkit-V. Please give us a call if you need help in any reliability engineering need (315-732-0097).*

*This first edition includes two Toolkit topics: Topic 1.1 Industry Trends Influencing Reliability Needs and Topic 1.2: Customer Expectations.*

## Topic 1.1: Industry Trends Influencing Reliability Needs

A major prerequisite to determining system reliability requirements is possessing a good understanding of the overall environment; i.e., the geographical location where the system will be deployed and operated, the culture of the operating agency (organization), the availability of appropriate technologies/tools, the system acquisition process, the corporate or political structure, etc. Additionally, it should be recognized that the world is highly dynamic, and the need for agility and flexibility in system design predominates.

Although perceptions as to current challenges may differ depending on personal experiences and observations, there are a number of trends that appear to be significant:

**1. Constantly changing requirements.** The requirements for new systems are constantly changing due to dynamic worldwide conditions, changes in mission priorities, and the introduction of new technologies on an evolving basis. There is a need for an open-architecture approach in the design of systems, and for a highly agile systems support capability.

**2. More emphasis on systems.** There is greater emphasis on total systems versus the components of systems. Total system needs must be addressed throughout its entire life cycle to ensure that the necessary functions are being accomplished in an effective and efficient manner. The reliability design and support infrastructure must be (1) considered a major element of the system, (2) in place and reliable, and (3) readily available to impact the mission-related elements of the system.

**3. Increasing system complexities.** The structures of many systems are becoming more complex as new technologies are introduced and evolve. The system must be designed such that changes can be incorporated quickly, efficiently and without significantly affecting its overall configuration. The reliability design and support infrastructure must address these added complexities.

**4. Extended system life cycles** - shorter technology life cycles. The life cycles of many current systems are being extended for many reasons. At the same time, the life cycles of most technologies are becoming relatively shorter. It is necessary to design systems such that a new technology can be inserted into existing systems quickly and efficiently. The reliability design and support infrastructure must remain responsive, recognizing that the reliability program life cycle will be longer due to extended system life cycles.

**5. Greater utilization of commercial off-the-shelf (COTS) products.** With current defense system goals pertaining to ower initial costs and shorter, more efficient acquisition cycles, there has been more emphasis on using best commercial practices, standard processes, and commercial off-the-shelf (COTS) equipment and software. As a result, there is a greater need for a good definition of requirements, and a greater emphasis on the design of systems versus the design of components. Much of the required reliability program activity has shifted from a major producer to one or more suppliers. This shift has increased the complexity of the overall reliability program network, as well as some added challenges in determining detailed reliability requirements for many of the COTS items being utilized in various military system design configurations. A major goal is, of course, to deliver in a short timeframe a product and/or service that is highly reliable, high quality, cost-effective, and with complete customer satisfaction in mind.

**6. Increasing globalization.** The world is shrinking and there is more trading with and dependency on manufacturers and suppliers throughout the world. This has been facilitated through rapid and improved communication practices, the availability of quicker and more efficient packaging and transportation methods, the application of electronic commerce for expediting the accomplishment of procurement and related processes, and so on.

**7. More outsourcing.** There is more outsourcing and the procurement of COTS items (equipment, software, processes, services) from external sources of supply than ever before. Thus, there are more suppliers associated with almost any given program. Consequently, there must be greater emphasis on the early definition and allocation of system-level requirements, the development of a good and complete set of specifications, and a closely coordinated and integrated level of activity throughout the system development and acquisition process. At the same time, a well-integrated reliability program capability must be developed and implemented when required. This can best be accomplished through the effective implementation of the system engineering process and the proper specification of design for reliability requirements from the beginning.

**8. Greater international competition.** Along with the noted trends toward increasing globalization and more outsourcing, there is more international competition than ever before, owing not only to improvements in communications and transportation methods, but to the greater utilization of COTS items and the establishment of effective partnerships worldwide. A major goal is, of course, to deliver in a short time frame a product and/or service that is highly reliable, high quality, cost-effective, and with complete customer satisfaction in mind.

**9. Higher overall life-cycle costs.** In general, experience has indicated that the life-cycle costs of many current systems are increasing. Whereas much emphasis has always been placed on minimizing the costs associated with the procurement and acquisition of systems, relatively little attention has been dedicated to the costs of system operation and support until recent years. As the reliability design and support infrastructure is a major element of the

system, and often represents a high-cost contributor, the various alternative approaches in the design of such must be justified on the basis of total life-cycle cost. Thus, design for reliability must consider not only the "technical" characteristics of design but the "economical" aspects as well.

Although some of the foregoing and related trends have evolved over time, the tendency is to ignore the changes that have taken place and continue with a business-as-usual approach by implementing past practices, many of which tend to inhibit innovation and growth. Since the operating environment has undergone a major transition in recent years, the requirements for reliability design and support have also undergone significant changes (e.g., the increased emphasis on software and human reliability, as opposed to strictly hardware reliability), and it is anticipated that such changes will continue to evolve. In any event, it is the recognition of these changes that forms the basis in determining the requirements in the design for system reliability.

## Topic 1.2: Customer Expectations

Regardless of the product or service being offered, or who the intended customer may be, it is reasonable to assume that the degree to which the product/service is successful directly depends on the ability of that product/service to meet or exceed customer expectations. The challenge to the manufacturer or service provider is twofold:

- How to assess and define true customer expectations
- How to design, manufacture and market products/services to best meet those expectations

Implicit in the second challenge are economic considerations involved with customer expectations:

- The cost of meeting some (and which ones) versus all customer expectations.
- Does "best in class" product/service meet customer expectations?
- The cost of exceeding customer expectations.
  - Short-term costs vs. long-term savings
  - Competitive advantage in marketplace (increased market share)
- The cost of not meeting customer expectations.
  - Short-term savings vs. long-term costs
  - No competitive discriminators (decreased market share)

On the surface, it would appear that ascertaining the customers' expectations for a specific product or service would be a conceptually straightforward task - simply "ask" the customers what they want. Yet cost or scheduling constraints may force many manufacturers to forego this direct approach. Instead, they must rely on:

- Their instincts or perceptions of the customers' needs
- The traditional performance of similar products or services (without fully understanding whether or not customer expectations were met)
- Their ability to create customer expectations for their product/service, where they did not previously exist

A Quality Function Deployment (QFD) matrix can be used to facilitate communications between a customer and his supplier to determine "what" the customer wants (customer expectations) and "how" the supplier can meet those expectations. Table 1.2-1 shows a basic QFD matrix representation between customer expectations and engineering requirements for automobile reliability/durability.

Table 1.2-2 shows a similar matrix for engineering requirements for automobile maintainability.

Table 1.2-3 provides more general methods on how to gather information on customer needs and expectations.

Table 1.2-1: Example Relationship Between Customer Expectations and Engineering Reliability/ Durability Requirements

| Customer Expectations | Engineering Requirements | | | |
|---|---|---|---|---|
| | Designed Useful Life Period | Starting Point of the Designed Useful Life Period | Reliability at the Starting Point of the Designed Useful Life Period | Reliability at the End of Designed Life |
| Last for a long time | ✓ | ✓ | | |
| Consistent performance | | | | ✓ |
| Starts every morning | ✓ | ✓ | ✓ | ✓ |
| Hassle free during ownership | ✓ | ✓ | ✓ | ✓ |
| Well-made car | | | | ✓ |
| Dependable | ✓ | ✓ | ✓ | ✓ |
| No breakdown | ✓ | ✓ | ✓ | ✓ |
| Maintenance free | ✓ | ✓ | ✓ | ✓ |

Adapted from and based on: Wang, C.W., "Concept of Durability Index in Product Assurance Planning," 1990 Proceedings Annual R&M Symposium, January 1990, pp. 221-227

Table 1.2-2. Example Relationship Between Customer Expectations and Engineering Maintainability Requirements

| Customer Expectations | Engineering Requirements | | | | | |
|---|---|---|---|---|---|---|
| | Reliable Built-in Test | Good Accessibility | Standardization | Modularity | Reliability-Centered Maintenance | Human Factors |
| Repairs/Fixes Done Right the First Time | ✓ | ✓ | | | | ✓ |
| Easily Performed Customer Maintenance | | ✓ | | | | ✓ |
| Quick Accurate Diagnostics | ✓ | | | ✓ | | |
| Inexpensive Dealer Maintenance and Repairs/Fixes | ✓ | ✓ | ✓ | ✓ | | ✓ |
| "Long" Intervals Between Scheduled Maintenance | | | | | ✓ | |

Adapted from and based on: Wang, C.W., "Concept of Durability Index in Product Assurance Planning," 1990 Proceedings Annual R&M Symposium, January 1990, pp. 221-227

Table 1.2-3: Potential Methods for Determining Customer Needs and Expectations

| | |
|---|---|
| **QUANTITATIVE** | |
| Questionnaires | Can be mailed, conducted via telephone, or completed via face-to-face interview. |
| Delphi Approach | Solicit and quantitatively assess the opinions of experts in their field. |
| **QUALITATIVE** | |
| Direct Observation | Allows data collection in a natural environment (primarily for characterization of "internal" customers). |
| Document Analysis | Applicable to customers not easily accessible, and well suited to assessing larger groups over longer periods of time. |
| Focus Group | Brings customer cross-section together for intensive and interactive discussions on their needs and expectations. |
| Partnering Workshops | Similar to focus groups, except suppliers are also involved and consensus is reached on how needs and expectations will be met. |

**For More Information:**

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3. Gillespie, L.K. et al, "Quality Function Deployment as a Mechanism for Process Characterization and Control," Allied-Signal Aerospace Co., Kansas City, MO, July 1990, DE90-014755, KCP-613-4276.

4. Guinta, L.R. and N.C. Praizler, "The QFD Book," American Management Association, New York, NY, 1993.

5. Reed, B.M., D.A. Jacobs, and E.B. Dean, "Quality Function Deployment: Implementation Considerations for the Engineering Manager," Proceedings of the IEEE International Engineering Management Conference, Dayton, OH, 17-19 October 1994, pp. 2-6.

6. Schubert, M.A., "Quality Function Deployment - A Comprehensive Tool for Planning and Development," Proceedings of

the IEEE 1989 National Aerospace and Electronics Conference NAECON 1989, Dayton, OH, 22-26 May 1989, pp. 1498-1503.

7. Wang, C.W., "Concept of Durability Index in Product Assurance Planning," 1990 Proceedings Annual R&M Symposium, January 1990, pp. 221-227.

# RELIABILITY NEEDS AND CUSTOMER EXPECTATIONS

*This tech brief is the first article of a new, monthly series from Quanterion Solutions' System Reliability Toolkit-V.*

*The next article in the series is Topic 1.4: Availability and Operational Readiness, which will include a discussion on the relationship between customer expectations and engineering requirements.*

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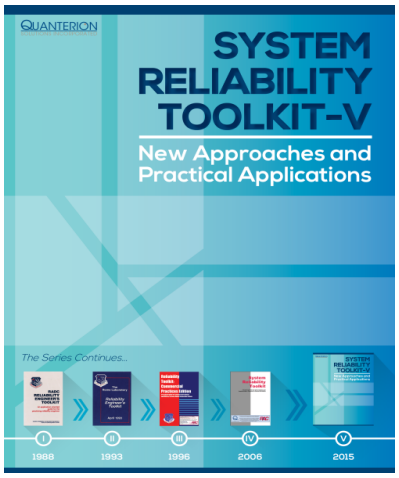


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