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Marrying military and commercial microelectronic production lines

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It's often said that while marriages are made in heaven, they are lived on earth. The same can be said of acquisition policies, which are directed from on high, but are left in the hands of those in the acquisition trenches to implement.

When the acquisition reform initiatives began several years ago, the Department of Defense (DOD) issued policies to increase reliance on the commercial sector to meet its requirements as a way of reducing acquisition costs and time. This increased reliance was not restricted to acquiring commercial off-the-shelf products. The DOD was also to begin looking for dual-use opportunities where commercial firms, using their commercial management and manufacturing processes, could produce military items from their commercial production facilities.

While several acquisition reform initiatives have made progress toward integrating military and commercial production lines, one of the most successful has been the Qualified Manufacturers List (QML) program, which has successfully married government-industry business practices among semiconductor integrated circuit (IC) suppliers. How the QML program was born, how it succeeded, and what lies in its future is the story of a successful marriage between government and industry and a template for other initiatives.

The matchmaker

The idea of uniting military and commercial production lines had great appeal to policy makers from the outset of acquisition reform for three primary reasons:

- to reduce total ownership costs;
- to cut the time it took to design and field new and upgraded systems; and
- to facilitate the rapid introduction of new technology.

But the courtship got off to a tenuous start. Government and industry officials feared a loss of independence if military and commercial production lines were married.

From the government side, there was a fear of losing control of the design and a lack of confidence in the quality and reliability of parts that would be used in harsh military environments. From commercial industry's side, there was a fear they would have to change their internal operations to comply with excessive and burdensome oversight, compliance, and reporting requirements. For the microelectronics industrial sector, the QML program was the matchmaker to bring together government and industry.

What was then called the U.S. Air Force's Rome Laboratory developed the QML program for microelectronics suppliers after numerous recommendations by

industry and defense review panels. The Rome Lab organization today is called the U.S. Air Force Research Laboratory Information Directorate, and is on the site of the former Griffiss Air Force Base in Rome, N.Y.

Prior to QML, military officials mandated the testing and qualification of individual ICs for military use. Every time an IC design changed or the processes at a facility changed, more testing was necessary. However, as IC complexity increased, extensive end-of-the-line mil-spec testing became costly and time-consuming. In some cases, validating IC operation under every possible set of inputs became impossible. With IC technology changing so rapidly, a new innovative process was clearly necessary to avoid building in obsolete technology into our weapon systems and to ensure a robust industrial base to supply the DOD.

The partnership

There is a saying that "nothing makes a marriage rust like distrust." One of the reasons the QML program has been so successful is that its teaming principles have laid a solid foundation of trust. Under QML, supplier validation is provided through a government and industry partnership comprised of a team of experts from the DOD, NASA, and industry. This team conducts an on-site review of a manufacturer's process performance and product characteristics. The assessment reviews processes such as manufacturing processes, configuration control, calibration, testing requirements, material review boards, and inspection.

The QML program also provides a great benefit for original equipment manufacturers (OEMs) by validating the key processes that are crucial to supplier selection, thereby reducing the number of third-party audits at the supplier facilities. In fact, Texas Instruments reports that since being listed on one QML, the number of customer quality system audits dropped from 106 to 3, due to the confidence customers have in the QML program.

For better or even better

Two aspects of the QML approach are key to the program's success:

- it does not separate good items from bad items; and
- it does not seek to test in quality.

Instead, QML seeks to ensure that manufacturers control their key processes so that quality products are a natural outcome. The goal is to take good processes and products and make them even better.

An integral part of the QML philosophy is to encourage suppliers to seek alternative processes that are characteristic of world-class suppliers and to continuously improve their processes based on maturation metrics. At the heart of this philosophy is the DOD-wide performance-based specification, MIL-PRF-38535, "Integrated Circuits (Microcircuits) Manufacturing, General Specification for." The QML program seeks to eliminate government-unique, "how to" requirements by stating requirements in terms of form, fit, function, and performance. Such an approach enables industry to use best manufacturing practices instead of government-prescribed processes. The success of the QML program resulted in its serving as a model for quality improvement in April 1995 by the DOD and Government/Industry Quality Liaison Panel as part of the Roadmap to Quality in the 21st Century report.

Forsaking all others?

Before acquisition reform, it was general practice (although not policy) to forsake commercial items and give preference to military-unique items. Under acquisition reform, commercial items have first preference in meeting DOD system performance requirements. A tendency is growing to forsake military-unique items for commercial ones. But the correct approach should be to use the right parts in the right application regardless of whether they are commercial or military unique. The spectrum of "commercial off-the-shelf" microelectronics products includes consumer, industrial, automotive, and extended-temperature-range products -- each with different design limits, environmental profiles, and life cycle expectations. Designers must understand these characteristics, and must carefully evaluate their impact on performance, supportability, and life cycle cost.

Much debate has taken place in the DOD acquisition community regarding the use of commercial IC products and production facilities to meet defense needs. Commercial IC integration barriers and recommendations for overcoming these barriers were identified in the DOD October 1996 report "Overcoming Barriers to the Use of Commercial Integrated Circuit Technology in Defense Systems." This report identified the insufficiency of defense application information and commercial part performance data as the primary barriers for using commercial ICs in defense systems with confidence.

The QML program is overcoming these barriers by establishing a relationship between the DOD and IC manufacturers that is usually reserved for high-volume commercial customers. The QML validations ensure the use of the latest manufacturing and management techniques to provide technologies that are capable of high performance in harsh military environments. The QML program preserves defense-unique core capabilities by offering radiation-hardened military devices. It also reconciles defense requirements with best commercial practices in packaging by offering commercial packaging options. For example, there are four QML manufacturers certified and qualified to supply plastic encapsulated microcircuits for military market needs. (The latest QML listings and the current technologies offered can be found at [http://www.dscc.dla.mil/Offices/Sourcing_and_Qualification/.](http://www.dscc.dla.mil/Offices/Sourcing_and_Qualification/))

While QML suppliers continue to optimize manufacturing processes and make continuous improvements based on maturation metrics, they also advise the government when these improvements may affect form, fit, function, or performance. In this way, the QML program frees manufacturers to take advantage of changes in industrywide practices, while providing government users with confidence that such changes do not adversely affect the performance of the devices. Through this DOD and IC manufacturer relationship, OEMs have an informed selection of suppliers and parts, design processes, and careful manufacturing process controls. This is particularly necessary when determining the appropriateness of commercial devices for critical military applications. This customer-supplier communication is essential to manage the single biggest concern of system developers --- the misapplication of commercial ICs in applications for which they were not intended.

In sickness and in health

Of great concern to government and industry users is the diminishing manufacturing sources (DMS) issue. Changes to IC design and technology occurs at such a frenzied pace, it is a challenge for all system managers to provide for future spare parts, especially on systems that will be used for 20 years or more. What may be a healthy source of supply situation today can turn sickly in a hurry.

The QML program addresses the DMS problem by ensuring that aftermarket sources produce the same quality parts as those of the original manufacturer, even though they are often produced in lower volumes. The QML program offers improved logistics support through the development and use of Standard Microcircuit Drawings (SMD). A SMD is a technical specification that defines the performance characteristics and quality assurance provisions for an individual IC or family of IC devices, regardless of the manufacturer. MIL-HDBK-780, "Standardized Microcircuit Drawings," defines the format for SMDs. MIL-HDBK-103, "List of Standard Microcircuit Drawings," is a catalog of SMDs with a cross-reference to generic part numbers where they exist.

OEMs and DOD use technical specifications to procure ICs and to track hardware configuration over time. It is not uncommon for commercial IC manufacturers to change specifications without assigning a new part number or notifying customers. A cornerstone of the SMD program is the manufacturer's agreement to notify the Defense Logistics Agency (DLA), which manages the SMDs, of changes. DLA then keeps the SMD current.

The SMD relieves the IC user, typically a defense OEM, of the obligation to develop and maintain specifications for each IC it uses. With the SMD Program, a defense-wide drawing for a given product is developed only once, rather than each OEM developing redundant drawings at DOD expense. The elimination of duplication simplifies DOD's inventory management system and helps avoid excess inventory and supply disruptions.

So long as we both shall live

The future of this nation's security depends on a healthy defense capability. And a healthy defense capability depends on a robust industrial capability. Our futures are inextricably entwined. Many view marriage as an endless series of compromises, but the QML program is just the opposite. It is a series of opportunities for government and industry to work together -- not to compromise, but to optimize the process -- and thereby improve the product. It contributes to a stronger U.S. industrial base by providing greater business opportunities and promoting better management and manufacturing processes. But ultimately, it is a key element in providing the warfighter with weapons that are affordable, yet technologically superior.

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