

# Combating Electronic Component Obsolescence by Using Common Processes for Defense and Commercial Aerospace Electronics

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## The Component Obsolescence Problem<sup>2</sup>

Aerospace electronics has grown steadily in importance since the beginning of the jet age. Although electronic components<sup>3</sup> and systems are not the largest cost elements in military or commercial aerospace vehicles, they are ubiquitous: electronic components are to be found in almost every system, including those that are primarily mechanical, hydraulic, and pneumatic.

The solid state electronics industry has grown in parallel with the jet airplane industry. Both were “invented” in the 1940’s, saw their first significant applications in the 1950’s and have grown to maturity since then. In the early days, military and commercial aerospace manufacturers depended on a well-developed military electronic components and specifications infrastructure to assure long-term availability of components that met their needs. This was possible because the military market sector comprised about 25% of the total market; it was responsible for a good deal of the device innovation, and therefore “owned” many device designs. As a result, military and commercial aerospace electronic design, manufacturing, procurement, operation, maintenance, and support decisions have been based on two assumptions:

1. The supply of electronic components specified to operate in aerospace environments is unlimited; and
2. Component designs will remain stable for long periods of time.

The assumptions are no longer true.

Table 1, and Figures 1 and 2, show that the entire aerospace industry (including both commercial and military) now consumes less than one per cent of the electronic components produced. The major component markets are computers, consumer electronics, and others [3], which do not have the demanding environmental or long production life cycle requirements of aerospace products; so the availability of components specified for aerospace applications is decreasing. Since 1992, at least 12 major manufacturers of electronic components, including Motorola, Intel, and Philips, have exited the military market [4]. For the first time in the history of solid state

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<sup>2</sup> Much of the information in this section is obtained from references [1] and [2].

<sup>3</sup> In this report, the term *electronic components* refers to integrated circuits, resistors, diodes, transistors, and other electronic devices packaged individually, i.e., they are the same as *piece parts*. Higher assembly-level items, such as line-replaceable units, also are called components in some contexts, but that terminology is not used here.

electronics, the aerospace industry has no broad-based access to a vertical supply chain for electronic components.

Figure 3 shows that the life cycles of all integrated circuit technologies are shrinking, almost to the point where the term *component technology life cycle* is meaningless [5]. Even “stable” component designs are modified constantly to reduce cost, improve yields, and enhance performance. The modifications are evaluated and characterized for high-volume applications, such as computers, but the applications of low volume users such as aerospace are rarely considered. The lifetime of a typical jet airplane will encompass many generations of electronic component design, as illustrated in Figure 4.

Furthermore, while the military system assured that components with the same part number would have identical specifications regardless of who manufactured them, this is not true of non-military components [6]. This impacts both new equipment designs and component replacements in existing equipment.

The aerospace industry depends on electronic components, but can no longer count on sources of stable designs that are specified for our specific applications. We must learn how to use components produced for other industries that are quite unlike ours.

### **The Aerospace Response**

The aerospace industry has responded vigorously to the problem of component obsolescence. The topic has been widely discussed in almost every industry forum, industry working groups have been formed, and conferences are being held to decide what can be done to minimize the impact of component obsolescence. The individual activities are too numerous to mention here, but their content seems to fall into one of three basic categories: (1) How to anticipate occurrences of component obsolescence; (2) How to react to occurrences of component obsolescence; and (3) How to reduce the risks of future component obsolescence.

The bulk of activity has been in the first two categories listed above, and some gratifying results have been achieved. While their importance should not be minimized, they are focused mainly on seeking ever-diminishing sources of components that will meet the needs of aerospace users. As a matter of fact, a term commonly used in the defense electronics industry is “diminishing manufacturing sources and material shortages” (DSMS). These approaches will provide only short-term relief for the problem of component obsolescence, and should be viewed as methods to buy time while we pursue other approaches that produce long-term resolution.

Long-term resolution is not easy, but it begins with recognition of a basic fact:

*We will never again have access to electronic components designed and manufactured specifically to meet the needs of the aerospace industry.*

The corollary is:

*We must learn how to use electronic components manufactured for other industries.*

This report describes two activities currently under way in the aerospace industry that will help us work together to minimize the effects of component obsolescence.

## **Industry Cooperation**

Because the aerospace electronics industry is such a small segment of the market for electronic components, we must realize that the benefits of cooperation far outweigh the costs of competition. An example of such cooperation is the banding together of a number of aerospace equipment OEMs in an organization called STACK International. STACK is an organization of industrial users of electronic components based in St. Albans, UK, and has been in existence since the 1970s. Its membership consists of representatives of two major industries: telecommunications and aerospace. Aerospace members include Smiths Industries, British Aerospace (UK), Boeing, Honeywell, Allied Signal Aerospace, Rockwell Collins, Eldec, Litton, and Lockheed Martin.

In addition to maintaining a component specification [7], STACK provides a forum for aerospace companies to discuss relevant component issues and exchange information in a non-competitive forum. Members also are finding that they can communicate with, and receive substantive information from component manufacturers, whereas paths to such communication would be unavailable to them on an individual basis.

Most of the current STACK activity is being conducted by the commercial avionics groups within the member companies. It is not, however, closed to the defense groups, and participation by both groups would enhance our ability to address the problem of component obsolescence.

## **Electronic Component Management**

The aerospace electronics industry has found that, while we cannot control our sources of electronic components, we can manage the processes we use to select and manage components to assure functionality, safety, reliability, and cost-effectiveness, and minimize the effects of component obsolescence. To this end, the International Electrotechnical Commission Quality Assessment System for Electronic Components (IECQ) Certification Management Committee (CMC) has authorized an Avionics Working Group (AWG) to prepare guides for electronic component management [8] and using electronic components outside the manufacturers' specified temperature ranges [9].

About 40 organizations are participating in the AWG, including most of the airframe manufacturers and equipment suppliers in North America and Europe, the FAA, the UK MoD, some component suppliers, component test houses, and others. To date, the emphasis has been on commercial products, but since most of the participants also have significant presence in the defense industry, it is highly desirable for them to use the same practices for both military and commercial products.

Reference [8] is based on a process that has been under way in Boeing Commercial Airplanes and its electronic equipment OEMs since 1992, and described in reference [10]. To implement it, the equipment OEM prepares and implements an Electronic Component Management Plan (ECMP) that documents the processes the OEM uses to accomplish the following objectives:

1. Component Application: Components are applied properly in the design.
2. Component Qualification: Components are qualified for use.

3. Component Quality Assurance: The quality of every individual component is assured.
4. Component Compatibility with the Equipment Manufacturing Process: Component compatibility with, and integrity throughout, equipment manufacturing; equipment assembly; equipment shipping, handling, and storage; equipment test, repair, and rework; and component shipping, handling, and storage are assured.
5. Component Data: A process is in place to collect, store, retrieve, analyze, and act upon data concerning component problems, and to report relevant data from the component, equipment design, equipment manufacturing, and component use in service.
6. Component Configuration Control: Components are selected, substituted, and managed systematically to maintain traceability of components, and configuration control of equipment.
7. Components for Use Outside Manufacturers' Specifications: Component usage outside the component manufacturer's specification is minimized, and done only with documented, controlled processes that assure the integrity of the equipment.
8. Component Obsolescence Management: The impact of component obsolescence is minimized through documented processes that assure availability, functionality, integrity, and certification of equipment.

After the OEM's ECMP is approved by the customer, or by the IECQ, the ECMP becomes the controlling document for component decisions. Components selected and managed according to the processes documented in the ECMP are approved for new designs, or for replacement into existing designs. The IECQ component management Guide encourages OEMs to develop a single ECMP that can be used for all programs, in contrast to some military practices [11, 12], which require a separate plan for each program. It is cost-effective for OEMs to use common processes for all customers.

In response to constant pressure to use components in temperatures wider than those specified by component manufacturers, the AWG is preparing reference [9], to document and control the processes for using components outside component manufacturers' specified temperature ranges. To minimize technical and legal risks, information is being collected from the AWG participants' experience with this practice, and from a research program being conducted by the CALCE Electronic Products and Services Center at the University of Maryland. The result is the most comprehensive process ever defined for using components outside manufacturers' specified temperature ranges.

Recent discussions with the FAA indicate that use of the IECQ Guides [8, 9] will allow the commercial aerospace industry to approve component substitutions by determining that they have gone through processes documented in conformance to the Guides. This will help streamline the process for certification of equipment that must be modified because of component obsolescence.

In recent discussions with companies that currently provide test services for components, the prospect of the test houses receiving certification from IECQ to conduct component qualification and quality assurance processes on component has arisen. In addition, it

also might be possible for the third party test houses to conduct processes to use components beyond the manufacturers' specification ranges. If this were to become a reality, then the test houses could become source facilities for components that require additional processes for use in rugged environments. A necessary condition for this to occur is that the ultimate users (the airframe manufacturers, prime contractors, and defense agencies) would have to agree on the processes, so that the market could be large enough to justify the required investment by the source facilities.

## Summary

The aerospace industry cannot control the sources of most of its electronic components, and the short production lives of components produced for other markets has caused a severe component obsolescence problem. So far, the major response of the aerospace industry has been to seek sources of existing components that meet our needs. This response cannot be the long-term solution; instead, we must learn new approaches to using components manufactured for other industries. Two such approaches, described in this paper, have been the cooperative efforts of the commercial aerospace industry through STACK International, and the IECQ-CMC Avionics Working Group to produce industry guides to facilitate common processes for using existing components. We must work together in these and other efforts to develop long-term solutions to the problem of component obsolescence.

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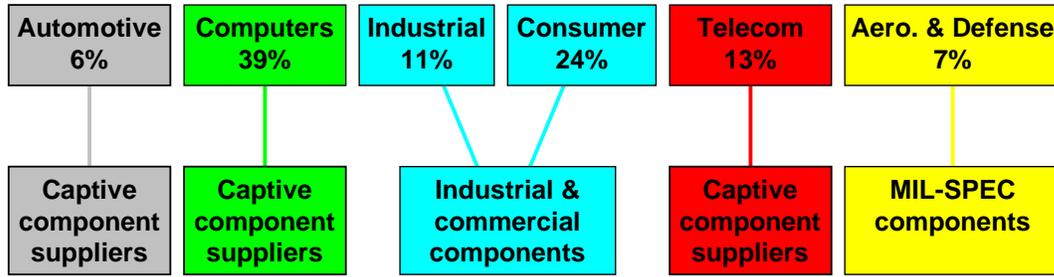


Figure 1. Electronic Component Supply Chains, 1984 (percentages shown are percentages of the total component market).

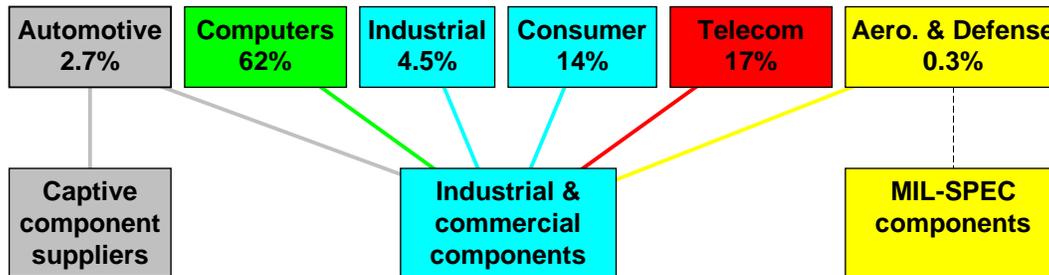


Figure 2. Electronic Component Supply Chains, 2000

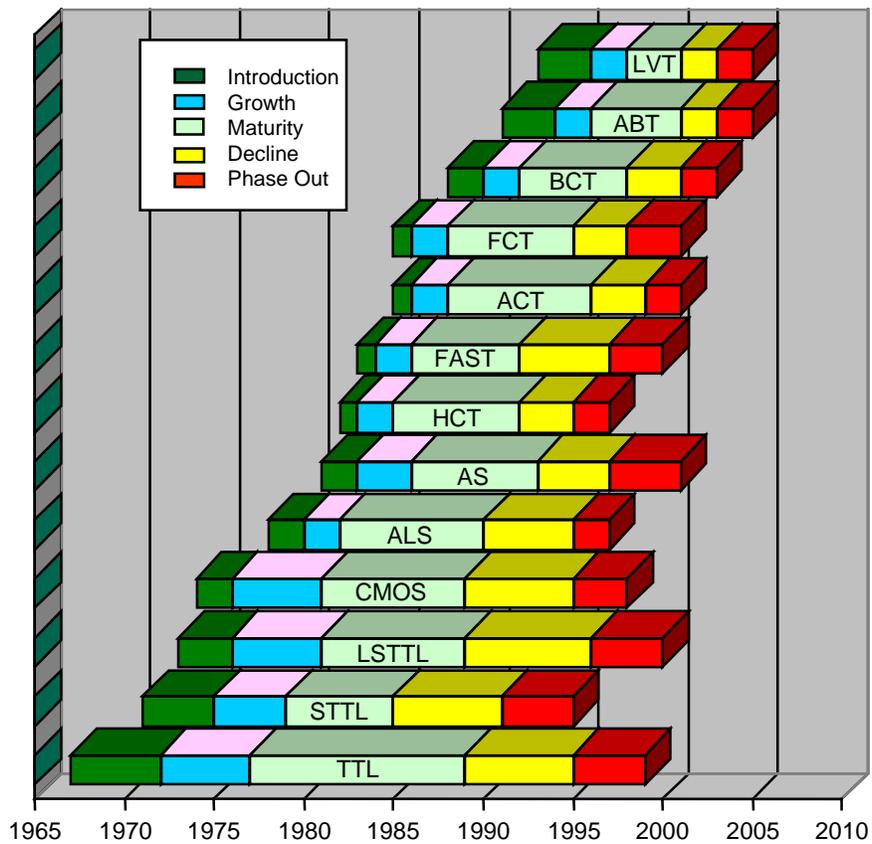


Figure 3. Component technology life cycles are shrinking.

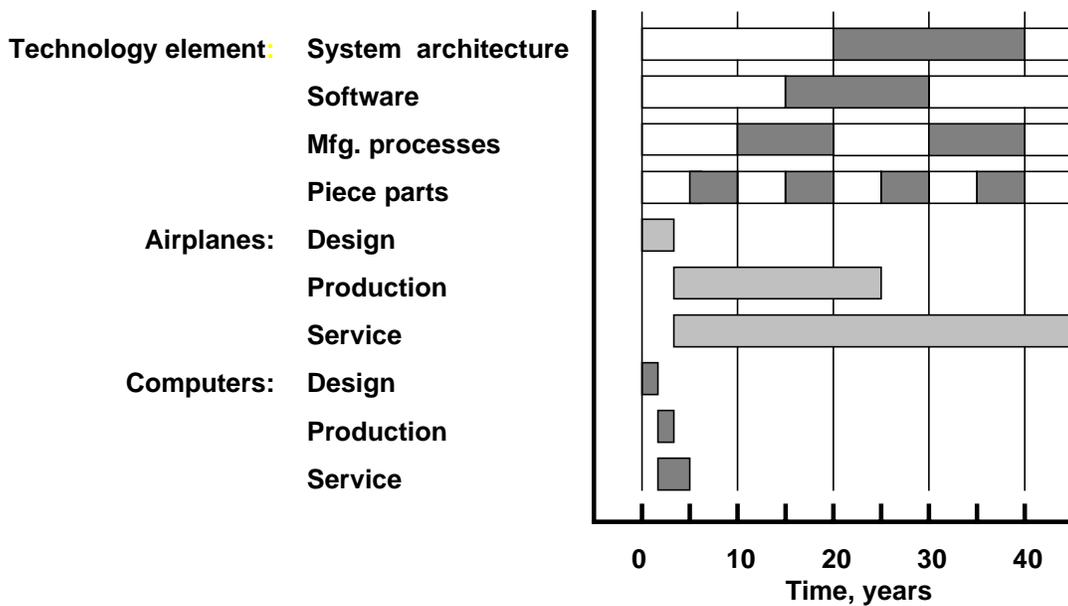


Figure 4. Component technology, airplane, and computer lifetimes.

Part Type	Part Numbers	Annual Volume, pcs.	Annual Volume, \$M	Annual Volume, \$/PN
Microprocessors	60	300,000	22	367,000
Other IC's	780	8,033,000	86	110,000
Discrettes	300	13,500,000	20	66,000
Passives	650	77,000,000	26	40,000
Misc. (drives, displays, etc.)	30	57,000	19	633,000
Aerospace total	1,820	99,000,000	173	95,000
Intel			25,000	

*Table 1. Annual commercial aerospace electronic component consumption, estimated from Boeing data. The volumes represent commercial aerospace, and can be doubled to obtain a rough estimate for all of aerospace, including defense. The total consumption of all of aerospace (including both commercial and military) is less than 0.5% of the total electronic component market.*