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Diminishing Manufacturing Sources and Material Shortages (DMSMS) Management Practices

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EIA ENGINEERING BULLETIN

Diminishing Manufacturing Sources and Material Shortages (DMSMS) Management Practices

GEB1

NOVEMBER 2000

**ELECTRONIC INDUSTRIES ALLIANCE
GOVERNMENT ELECTRONICS AND
INFORMATION TECHNOLOGY ASSOCIATION
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Olin Bray, Sandia Labs	Charlie Minter, Best Manufacturing Practices Center of Excellence
Doug Casanova, Defense Microelectronics Activity	John Nirschl, Rockwell Collins
Joe Chapman, Chapman Enterprises	G. Zell Porter, Boeing Information Space & Defense Systems
Justine Corboy, Sarnoff Corporation	Bill Pumford, GIDEP Operations Center
Frances Crull, Northrop Grumman, ESSD	Kevin Rankin, Defense Microelectronics Activity
Tom Dean, Boeing Company	David Robinson, Defense Supply Center Columbus
Don Gagnon, ITT Aerospace / Communications Division	Ron Shimazu, Defense Microelectronics Activity
Scott Hatch, BAE SYSTEMS	Vernon Singleton, Lockheed Martin Systems Integration
Wes Hubbell, Raytheon	Jack Tarsa, General Dynamics Defense Systems
Mike Jones, Defense Supply Center Columbus	Bahig Tawfello, Honeywell International Defense & Space Systems
Paul Kelley, Litton Aero Products	Walter Tomczykowski, ARINC Incorporated
Henry Livingston, BAE SYSTEMS	
Lee Mathiesen, Lansdale Semiconductor	
Keith Meyer, NWSC DMS Technology Center	

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INTRODUCTION

Diminishing Manufacturing Sources and Material Shortages (DMSMS) is the loss or impending loss of manufacturers or suppliers of critical items and raw materials due to production discontinuance. DMSMS is an increasingly difficult problem for DoD weapon systems because the manufacturing lives of many critical items get shorter while the life cycles of military weapon systems keep increasing. Traditionally, efforts to mitigate the effects of DMSMS have been reactive; that is, the effects are addressed only when they are seen. This reactive approach to DMSMS solutions leads to decisions that put a premium on faster solution paths with attractive short-term gains in order to avoid system inoperability, while ignoring the long-term solution paths that would lead to generic families of solutions or larger-scale solutions with the capability of avoiding future DMSMS issues. In order to solve DMSMS issues with lower overall cost, DMSMS solutions must change from reactive to proactive. The building blocks of effective proactive management of DMSMS are established during the design and development of systems. If systems are designed with the inevitability of DMSMS in mind, early solution paths with large-scale solutions can be started at an appropriately early time to enable intelligent choices without the imminent threat of system inoperability. Such generic large-scale solutions and a consensus on where DMSMS threats are most prevalent can be better forecasted by the use of a standard set of DMSMS management practices used by the foremost members of industry. The creation, dissemination, and widespread use of such a standard can greatly help the cause of proactive management of DMSMS.

This guideline presents a set of management practices that can be used by original equipment manufacturers (OEMs) during the design and development of military electronic systems to mitigate the effects of DMSMS. Such practices will help future builders and modifiers of DoD weapon systems to design proactively to address the issues of future component obsolescence.

Diminishing Manufacturing Sources and Material Shortages (DMSMS) Management Practices

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1 Scope

This document includes a standard set of management practices that can be used, or espoused, by the OEMs for use during the design and development of electronic systems to mitigate the effects of future Diminishing Manufacturing Sources and Material Shortages (DMSMS). While this document focuses primarily on microelectronic devices, the methods described here may also apply to other commodities.

2 Reference Documents

ANSI/EIA-724-97	Product Life Cycle Data Model
EIA JESD48	Product Discontinuance
EIA SSB-1	Guidelines for Using Plastic Encapsulated Microcircuits and Semiconductors in Military, Aerospace and Other Rugged Applications
ANSI/AIAA-R100-1996	Parts Management
IEC CA-AWG/1/DC	Component Management Plans
CENELEC ES 59010	Electronic Component Policy and Management Programme

Perspective and Recommendations on Diminishing Manufacturing Sources, Government Procurement committee of the Semiconductor Industry Association, 1996

Program Managers Handbook—Common Practices to Mitigate the Risk of Obsolescence. Prepared for Defense Microelectronics Activity (DMEA), McClellan Air Force Base, California, by ARINC Incorporated. May 2000.

International Technology Roadmap for Semiconductors (ITRS), International SEMATECH, Inc.

SAND98-1914: 1998 Technology Roadmap For Integrated Circuits Used in Critical Applications, Sandia National Laboratories, 1998

SD-18, Defense Standardization Program Guide for Part Requirements and Application

NAVSEA DMSMS Case Resolution Procedures Guide

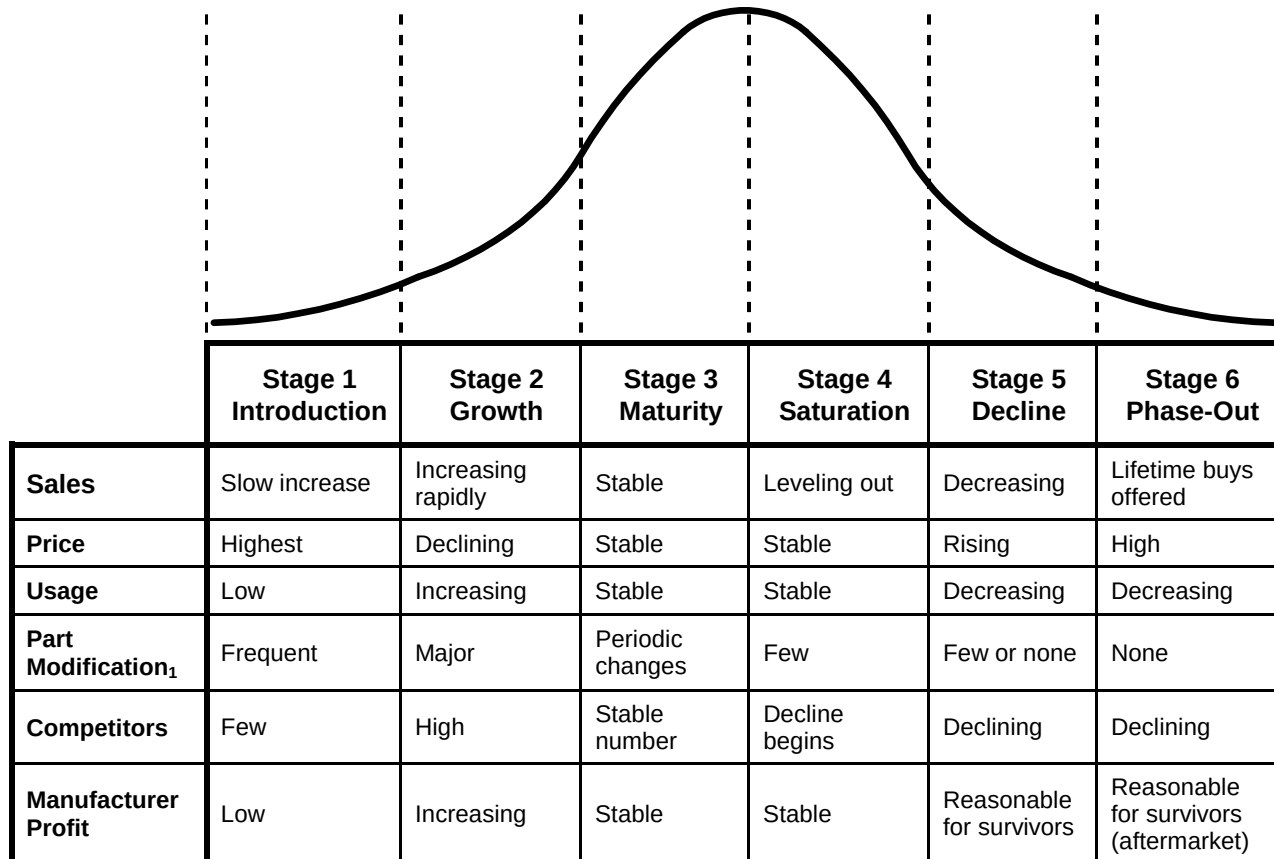
AFMC DMSMS Case Resolution Procedures Guide

3 Microelectronics Product Versus Electronic System Life Cycles

3.1 Microelectronics Product Life Cycle Model

Life cycle curves provide a basis for developing forecasts and planning for technology insertion and product update opportunities. This guideline uses the definitions in *EIA-724, Product Life Cycle Data Model*, for the purpose of describing the life cycle of microelectronics. The following describes the life cycle curve and associated stages found in EIA-724. The table provides a summary of the characteristics associated with each stage¹.

Microelectronics Life Cycle Model



1. Die shrink, mask change, etc.

¹ Onkvisit, S.; Shaw, J. "Product Life Cycles and Product Management," Quorum Books, New York, New York, 1989

- **Introduction (Stage 1):**
Suppliers begin to ramp up the production and can supply a limited quantity. Due to the learning curve, expenses and uncertain market for a new part, prices are usually high, and volumes are limited. The probability for obsolescence of introductory parts being prematurely discontinued from the marketplace is relatively high. Risk analysis and appropriate contingency planning must always be done when selecting introductory stage parts. Parts in this stage must be evaluated against the above restrictions before being considered for use in new design.
- **Growth (Stage 2):**
Sales grow rapidly and attract additional competition, resulting in cost cutting measures being taken. Rapid growth and capacity additions also bring added risks of poor quality control and availability. Suppliers provide additional capacity to meet increased market demand initially, but the rate of growth decreases near the end of this phase. Risk analysis and appropriate contingency planning must also be an integral component of part selection for this stage. The probability of obsolescence diminishes rapidly, but parts in this phase must also be evaluated against the cost and availability limitations prior to being considered for use in new system design.
- **Maturity (Stage 3):**
Sales peak and then start to level out toward the end of the phase. The probability for obsolescence is the lowest in this phase. Depending upon the lifecycle and reliability objectives of the system, the parts in this phase are highly recommended for use in new system design.
- **Saturation (Stage 4):**
Sales level out and suppliers start to cut back on capacity by the end of this stage. Some technology leading suppliers may start to migrate to the next generation technology, and second tier suppliers may need to be qualified to sustain a viable supplier base. Some marginally competitive suppliers may also elect to exit the marketplace. Appropriate use of equivalents in the design and good evolutionary planning may allow parts in this stage to be used in new design depending on the system life cycle requirements.
- **Decline (Stage 5):**
Sales and capacity decline fairly rapidly. Most of the technology leaders are exiting the business in favor of new opportunities with second and third tier suppliers left to support the product lines. Additional, costly qualification efforts may be required to support the product for the near term. Suppliers build only limited quantities. Product in this phase should be avoided for use in new system design unless robust equivalent device qualifications and evolution planning can demonstrate a cost-effective solution.
- **Phase-Out (Stage 6):**
In this phase sales and capacity fall more rapidly to an absolute minimum level. Suppliers start discontinuing parts rapidly. The probability of obsolescence is at its peak for the product-manufacturing horizon. Parts in this phase should be prohibited for use in any new or modified system design.

Not all devices conform to the six life cycle stages described in EIA-724². Some devices undergo a false start and die out, or may be associated with a niche market. Some devices may be revitalized after the decline stage. Other possibilities can also arise due to various economic, social, and environmental occurrences. A false start typically suggests that a device starts out with a strong period of growth only to stall because of one or more of the following factors:

- Introduction of a superior competing part
- Improvement of a competing part
- Identification of a technical problem associated with the part
- Failure to reach the critical mass to allow economies of scale to be realized
- Lack of a unique and compelling application for the part

3.1.1 Microcircuit Life Cycles

Historical data from industry studies shows that the average life span of total microcircuits across all quality ranges is around 10 years overall³. Military microcircuits average greater than 12.5 years while commercial microcircuits (including "mil-temp-only," industrial, and commercial temperature devices) average less than 8.5 years. Certain microcircuit families have different life spans; for example, certain linear devices average less than 14.5 years while some microprocessors and memories average less than 5 years. The following shows the average introduction rate for new generations of commercial integrated circuits⁴:

Device Category	Average Introduction Rate
Logic Families	6 years
Memory Families	9 months
Microprocessors	2 years
Digital Signal Processor (DSP)	3 years
Programmable Logic Device (PLD)	1 year
Linear Interfaces	8 years
Gate Arrays	2 years

Observations from various industry sources indicate that these average introduction rates have gotten shorter in more recent years.

² Pecht, M.G.; Das D. "Electronic Part Life Cycle," IEEE Transactions on Components and Packaging Technologies, Volume 23 Issue 1, March 2000, pp.190-192

³ Bick, E. (TACTech Inc.). "New & Improved Life Cycle Codes Updates - Response To AIM Users Regarding The New & Improved LCCs." ebick@tactech.com (20 Jul. 1999).

⁴ TACTech Inc. "Obsolescence Management In the Year 2000." 28 Oct. 1998. <ftp://tactech.com/pub/overview.exe> (23 Oct. 2000).

In the 1996 publication *Perspective and Recommendations on Diminishing Manufacturing Sources*, the Government Procurement Committee of the Semiconductor Industry Association (SIA-GPC) reported that while the defense-related semiconductor market would continue to decline as a percent of the worldwide semiconductor market, it would still be a viable market for many IC suppliers. The SIA-GPC identified the following factors that would continue to create semiconductor DMS problems for defense manufacturers:

1. Commercial grade semiconductor life cycles of less than five years for products combined with defense system life cycles exceeding twenty years. Thus the decision to use commercial grade ICs in defense systems will carry with it earlier and more frequent onset of DMS problems.
2. The marketplace makes semiconductor devices obsolete, not semiconductor suppliers.
3. Families of devices rather than individual devices will be discontinued based on the transition of one base technology to another.
4. As periods of demand exceed capacity, older product families will be discontinued in favor of newer, higher-revenue families even though reasonable demand may exist for the older generation products.
5. Reduced demand for small-diameter silicon wafers and ceramic packages used for many older products may force the semiconductor manufacturer to declare "End of Life" (EOL) for products earlier than it would otherwise.
6. The use of commercial grade products in some applications will displace and accelerate discontinuance of military grade versions.
7. As the number of semiconductors designed to meet the military temperature range (-55°C to +125°C) declines, the choice of devices for use in harsh environments will become increasingly limited.
8. The rapid transition of commercial applications to lower supply voltages (i.e., 3.3 volts, 1.8 volts, etc.) will accelerate the discontinuance of higher-voltage military grade products.
9. The increasing use of surface mount assembly techniques will eliminate many through-hole package options.

3.2 Electronic System Life Cycle Model

For the purpose of this guideline, the following acquisition phases will be used to describe the life cycle of an electronic system⁵.

- **Phase 0 - Concept Exploration:**
Phase 0 typically consists of competitive, parallel short-term concept studies. The focus of these efforts is to define and evaluate the feasibility of alternative concepts and to provide a basis for assessing the relative merits (i.e. advantages and disadvantages, degree of risk) of these concepts at the next milestone decision point. Phase 0 affords the greatest opportunity to effect reductions in total ownership costs (TOC). Funding and logistics profiles are still fluid, and the widest range of Non-Development Item (NDI) and Commercial Off The Shelf (COTS) choices available.
- **Phase I - Program Definition and Risk Reduction:**
During this phase, the program becomes defined as one or more concepts, design approaches, and/or parallel technologies are pursued as warranted. Assessments of the advantages and disadvantages of alternative concepts are refined. Prototyping, demonstrations, and early operational assessments are considered and included as necessary to reduce risk so that technology, manufacturing, and support risks are well in hand before the next decision point. Cost drivers, life-cycle cost estimates, cost-performance trades, interoperability, and acquisition strategy alternatives are considered to include evolutionary and incremental software development. Significant opportunities exist in the conduct of Trade Studies, make-or-buy decisions, simulation tool usage, design for Built-in-Test (BIT), Pre-Planned Product Improvement (P3I) planning and logistics support alternatives.
- **Phase II - Engineering and Manufacturing Development / Low Rate Initial Production (LRIP):**
The primary objectives of this phase are to: translate the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing or production process; and, demonstrate system capabilities through testing. Continued trade studies, Value Engineering Change Proposals (VECP), design analysis, spares & provisioning strategy development, teaming opportunities and contractor-supplier alliances offer opportunities to avoid DMSMS cases and provide potential technology insertion benefits to the program. Low Rate Initial Production (LRIP) occurs while the Engineering and Manufacturing Development phase is still continuing as test results and design fixes or upgrades are incorporated. The objective of LRIP is to produce the minimum quantity necessary to: provide production configured or representative articles for operational tests, establish an initial production base for the system; and permit an orderly increase in the production rate for the system, sufficient to lead to full-rate production upon successful completion of operational testing. LRIP provides key opportunity to update and validate available knowledge to reflect actual schedules, parts & materials, costs, technology maturities and other factors.
- **Phase III - Production, Fielding/Deployment, and Operational Support:**
The objectives of this phase are to achieve an operational capability that satisfies mission needs. Deficiencies encountered in Developmental Test and Evaluation (DT&E) and Initial Operational Test and Evaluation (IOT&E) are resolved and fixes verified in Follow-on Operational Test and Evaluation (FOT&E). During fielding/deployment and throughout operational support, the potential for modifications to the fielded/deployed system continues. The objectives of Operational Support are the execution of a support program that meets the threshold values of all support performance requirements and sustainment of them in the

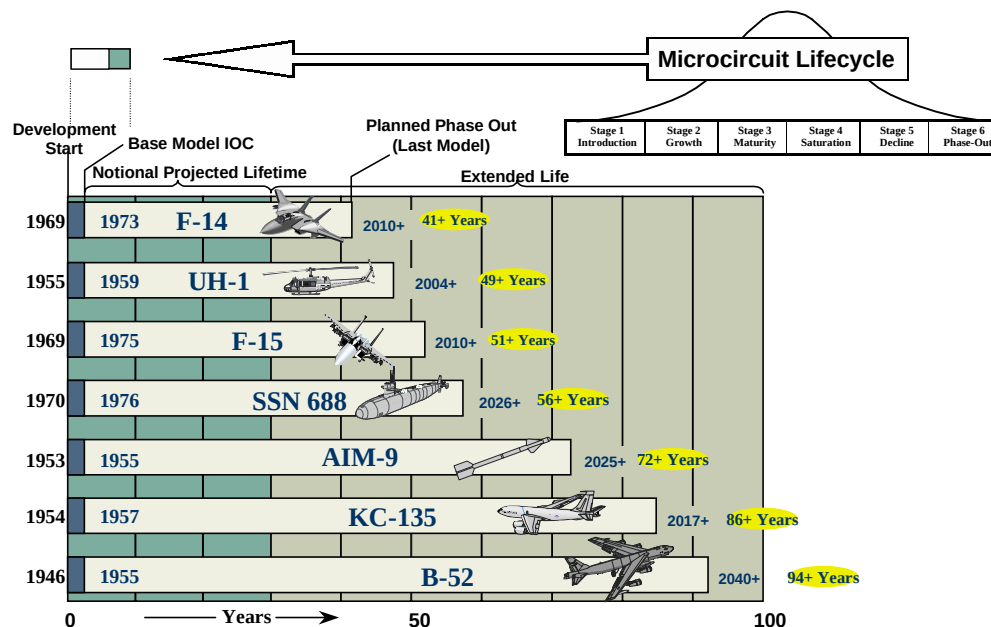
⁵ "DoD 5000.2-R Mandatory Procedures for MDAPs and MAIS Acquisition Programs." <http://www.deskbook.osd.mil/> (23 Nov. 2000).

most life-cycle cost-effective manner. A follow-on operational testing program that assesses performance and quality, compatibility, and interoperability, and identifies deficiencies is conducted, as appropriate. This activity also includes the execution of operational support plans, to include the transition from contractor to organic support, if appropriate. Opportunities still exist for multi-program or multi-product (i.e., one contractor making multiple, related products) parts and materials buys (assessing and benefiting from technology roadmaps in purchase decisions), VECP incorporation and implementing a manufacturing schedule that can obtain benefits throughout the remaining program life cycle.

3.2.1 Weapon System Life Cycles

Obsolescence of subsystems is a risk driver for weapon systems because, as with many low-volume electronic systems, they are intended for use over extended time, leaving them vulnerable to obsolescence of the parts, subsystems, and technologies that comprise the system⁶. Resources have to be committed and combined engineering-business strategies need to be implemented to sustain supply of obsolete parts long enough to permit redesign and requalification.

With the collapse of the Soviet Union, very few new weapon systems are being built, and existing systems are expected to be the front line military defense far longer than planned. Many weapon systems can now expect to see a service life of 40 to 90 years. The B-52, for example, will be operational for more than 94 years. This is long enough to provide the potential for five generations of pilots from the same family to fly this aircraft. Technology obsolescence studies also note that the time period from the start of design to the beginning of production is increasing⁷. As the time from design to production stretches out, many technologies used during the design are obsolete before production starts.



⁶ Dasgupta, A.; Magrab, E.B.; Anand, D.K.; Eisinger, K.; McLeish, J.G.; Torres, M.A.; Lall, P.; Dishongh, T.J. "Perspectives To Understand Risks In The Electronic Industry," IEEE Transactions on Components, Packaging, and Manufacturing Technology, Part A, Volume 20 Issue 4, Dec. 1997, pp.542-547

⁷ Hitt, E.F.; Schmidt, J. "Technology Obsolescence (TO) Impact On Future Costs," Proceedings of the 17th Digital Avionics Systems Conference (DASC), 1998, AIAA/IEEE/SAE, Volume 1, pp.A33-1 - A33-7

4 DMSMS Management Program Development and Implementation

The following matrix identifies the DMSMS mitigation approaches described in this guideline and the program phase(s) that provide the greatest opportunity to apply them. This matrix is presented as a tool for planning purposes; the DMSMS mitigation approaches applied will vary depending on the electronic system involved and applicable acquisition phase of the program.

Electronic System Life Cycle Vs. DMSMS Mitigation Approaches

		Phase 0	Phase I	Phase II	Phase III
		Concept Exploration	Program Definition and Risk Reduction	EMD / LRIP	Production, Fielding / Deployment, & Operational Support
Proactive DMSMS Mitigation Approaches (4.1)	Technology Independence	X	X	X	X
	Software Portability	X	X	X	X
	Technology Road Mapping	X	X	X	X
	Technology Insertion ₁	X	X	X	X
	Planned System Upgrade ₁		X	X	X
	Life Cycle Analysis / DMSMS Monitoring		X	X	X
Response to DMSMS Events (4.2)	Alternate Source			X	X
	Substitution			X	X
	Redefine Requirement to Accept Commercial Item			X	X
	Emulation				X
	Life of Type Buy ₂			X	X
	Redesign / Design Modification ₂			X	X
	Reverse Engineering				X
	Reclamation ₃				X

1. Planning for system upgrades recommended for Phases I & II based upon Technology Insertion Solution.
2. Includes a "bridge buy" to support production until DMSMS induced redesign can be introduced in the future.
3. Reclamation is typically implemented if trade studies indicate that other approaches are not viable.