Electronic Part Obsolescence
(Life Cycle Mismatch)

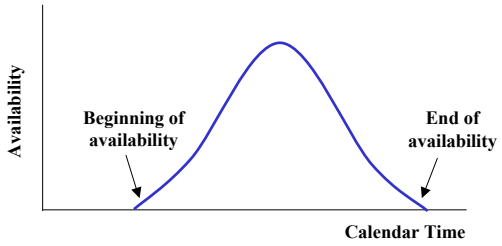
Obsolescence is defined as the loss or impending loss of original manufacturers of items or suppliers of items or raw materials.

Obsolescence Impacts

- Electronic parts (chips and passive devices)
- Technologies (and processes)
- Materials
- Software
- Standards
- Specifications/requirements
- Intellectual property (IP)

The Backend of the Wave
(Roadmapping in Reverse)

- Roadmapping forecasts the beginning of availability (maturity) of *technology*
- Obsolescence forecasting focuses on the backend of the technology wave (loss of availability)



Ideally… roadmapping looks at both when a new technology should be adopted and when it should be phased out

DMSMS

DoD defines obsolescence using the term Diminishing Manufacturing Sources and Material Shortages (DMSMS)

•"DMSMS is the loss or impending loss of manufacturers of items or suppliers of items or raw materials. DMSMS occurs when manufacturers of items or raw material suppliers discontinue production due to reasons such as rapid change in item or material technology, uneconomical production requirements, foreign source competition, federal environmental or safety requirements, or limited availability of items and raw materials used in the manufacturing process. DMSMS situations tend to have a pervasive effect that not only precludes repair of materiel but also precludes procurement of additional systems, equipment, spare assemblies, and subassemblies that depend on the obsolete items and raw materials for their manufacture."

–Department of Defense Material Management Regulation 4140.1-R, 1999

•"DMSMS is defined as the loss, or impending loss, of manufacturers or suppliers of items or the shortages of raw materials. DMSMS cases may occur at any phase in the acquisition cycle, from design and development through post-production, and have the potential to severely impact weapon system supportability and life cycle costs."

–Defense Microelectronics Activity, http://www.mcclellan.af.mil/DMEA/index.html, 1999

•"DMSMS is a condition brought about when the last known manufacturer announces the intention to discontinue production of an item or group of items still required by DoD activities for systems support."

–Defense Supply Center, Columbus, http://www.dscc.dla.mil/programs/dmsms/index.html, 1998

Obsolescence vs. Discontinuance

- Discontinuance occurs when a manufacturer stops producing the part
- The manufacturer may:
  - issue a discontinuance notice to its customers,
  - offer lifetime buy dates and shipments
  - suggest alternative parts or aftermarket manufacturers which might sell the product line
  - Example: Texas Instruments, in September 1998, sold off its entire memory line to Micron
- Device obsolescence occurs when:
  - the technology that defines the device is no longer in existence
    - Example: PMOS technology which has been supplanted by CMOS
  - a technological attribute specific to the device (such as DRAM memory density) is no longer in existence
    - Example: 64K DRAMs have been obsoleted
- Obsolescence is at a technology level; discontinuance is at a part number or part/manufacturer-specific level

When Do Manufacturers Discontinue Parts?

- When something more profitable can be built using the same resources
- The part no longer provides strategic value within the company's portfolio
- The part is non-manufacturable because:
  - raw material is limited or no longer available,
  - there is a manufacturing strategy change, driven by technology evolution or cost considerations,
  - there is a loss of test capability,
  - there are new environmental or safety constraints or regulations.
- Corporate merger causing part lines to be consolidated and "redundant" fabrication facilities to be closed.

Product Deletion

- Product deletion treats the process whereby the manufacturer or supplier of a product makes a decision to stop offering the product.
- Product deletion is considered a critical part of the overall product policy and management of a manufacturer.
- Obsolescence (which is the topic of this presentation) focuses on the management of the consequences to the customer of a product deletion decision made by others, and predicting when a manufacturer or supplier is going to make a product deletion decision.

Avlonitis, G. J., "Product deletion decision and strategies," *Industrial Marketing Management*, vol. 13, pp. 77-85, 1983.

Vyas, N. M., "Industrial product deletion decisions: Some complex issues," *European Journal of Marketing*, vol. 27, pp. 58-76, 1993.

Avlonitis, G. J., S. J. Hart, and N. X. Tzokas, "An analysis of product deletion scenarios," *Journal of Product Innovation Management*, vol. 17, pp. 41-56, 2000.

Understanding the Part Obsolescence Problem

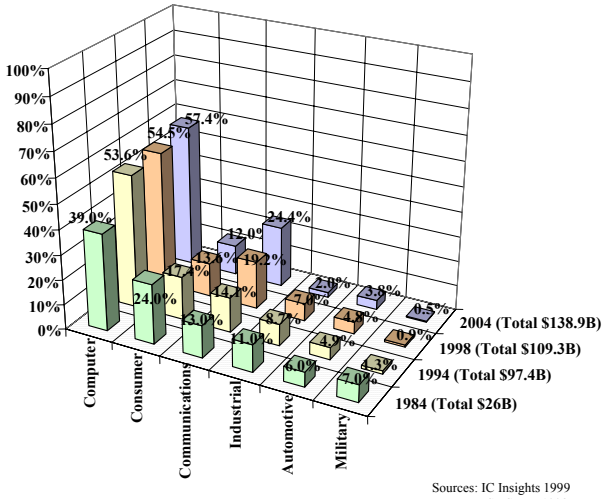
1. The semiconductor market place has changed
2. Technology life cycles are shrinking
3. System life cycles are increasing

(4. Major upgrades that would have mitigated obsolescence problems in the past are more expensive and occurring less frequently)

The Changing Semiconductor Marketplace

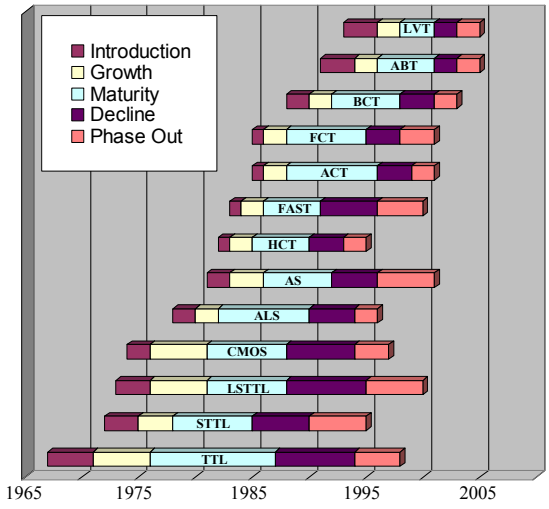
The computer, commercial, and communication industries consume more than 90% of all semiconductors. Their electronics are characterized by

- the latest and greatest advances in technology
- short time between new product offerings
- market driven decisions to continue or stop product lines



Sources: IC Insights 1999
ICE Status 1998

Technology Life Cycles are Shrinking

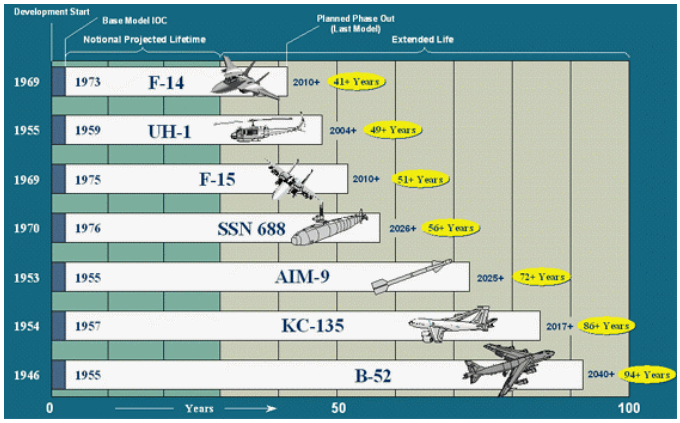


Integrated circuit technologies

L. Condra, "Combating Electronic Component Obsolescence by Using Processes for Defense and Commercial Aerospace Electronics", *Proceedings of NDIA*, 1999.

System Life Cycles are Increasing

- Boeing 737 - introduced in 1965
  - 7 system-wide redesigns to date
- Boeing 747 - introduced in 1969
  - 4 system-wide redesigns to date
  - The last major redesign involved addition of digital avionics controls, winglets, and a new flight deck



R. Stogdill, "Dealing with Obsolete Parts," *IEEE Design& Test of Computers*, pp. 17-25, April-June 1999

Product Service Life

Application	Product	Service life (years)
Avionics	Military and civil aerospace electronic equipment	20-30
Telecommunications	Premises telecom equipment	10-15
	Data communications equipment	3-5
	Desktop terminal equipment	4-7
	Public telecom equipment	6-10
	Mobile communications	3-5
	Broadcast and studio equipment	5-8
	Other telecom equipment	5-10
Medical	Medical equipment	7-15
Automotive	In-car entertainment	3-6
	Body control electronics	5-10
	Power train systems	5-10
	Safety and convenience systems	5-10
Computers	Computer systems	2-5
	Personal computers	2-3
	Supercomputers, mainframe computers, workstations	3-5
	Central processing units	2-3
	Graphics boards	2-3
	Single in-line memory modules (SIMMs)	1-2
	Memory cards	1-2
	Data storage	2-3
	Input/output devices	3-5
	Dedicated systems	3-6
	Other data processing.	2-3
Consumer	Audio equipment	5-10
	Appliances	5-10
	Other consumer equipment	5-10
Industrial	Security/energy management	5-10
	Manufacturing systems/instruments	7-10
	Other industrial equipment	5-10

Cost Impact of Obsolescence

Part obsolescence impacts many system lifecycle sustainment costs:

- Cost of procuring new parts (for additional manufacturing or spare replenishment)
- Cost of storing parts for future manufacturing
- Cost of redesigning the system
- Costs associated with schedule delays in manufacturing
- Cost of qualifying (or re-qualifying) a system
- Cost of upgrading the system
- Cost of people and tools to track obsolescence

Cost Impact of Obsolescence: Avionics

- The Intel 80486 microprocessor, used in the Boeing 777 flight management system, was obsolete before the FAA completed certifying the system.
- For the F-22 program, $81M was spent for obsolete parts resolution
- For a typical avionics manufacturer, greater than 10% of the annual component budget is spent on obsolescence.
- Carrying costs for component inventory are approximately 20% per year (impacts both manufacturer and repair shop).
- Three avionics companies spent over $6 million each with Intel on lifetime buys.

L. W. Condra, presentation to *Boeing Commercial Airplane Group Electronic Component Management program Users' Forum II*, March 5, 1997.

Cost Impact of Obsolescence: Military

- Obsolete parts are expensive.
  - Prices for chips in their afterlife (if available at all) are generally 10 to 15 times the original cost. A $3 semiconductor then; a $30-$35 relic after obsolescence.
  - Depending on the system, a complete redesign can easily cost $500,000 and sometimes as much as $2 to $3 million.
- Procuring obsolete parts can lead to product delivery schedule disruptions.
  - Normal turnaround time averages 14 weeks if the chip is available—six to nine months if reverse engineering is required.

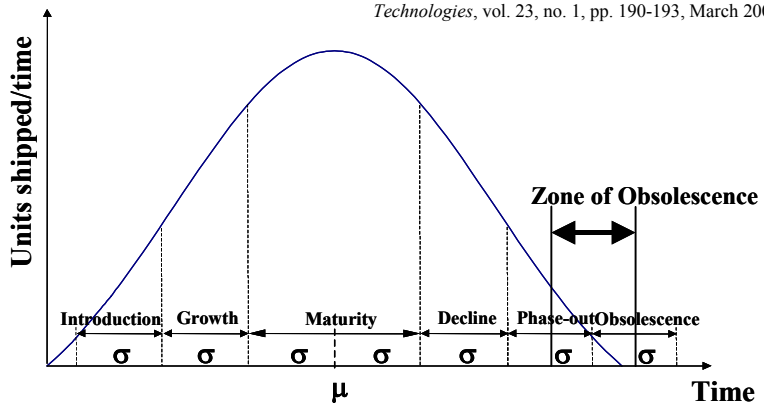
Porterfield, B., "Feature: Mining the Military Market," *TechWeek*, July 10, 2000

Cost Impact of Obsolescence: Computer

- Servers have long enough life cycles to encounter part obsolescence problems.
- The market life of microprocessors and memory is only effectively 2 years
- When computer manufacturers can't accurately anticipate the "death" of a memory and/or microprocessor generation, and the emergence of the next they lose:
  - market share (if they didn't stock enough parts)
  - money on useless stock (if they stocked too many)

Life Cycle Phases of an Electronic Component

M. Pecht and D. Das, "The Electronic Part Life Cycle," *IEEE Transactions on Components and Packaging Technologies*, vol. 23, no. 1, pp. 190-193, March 2000.



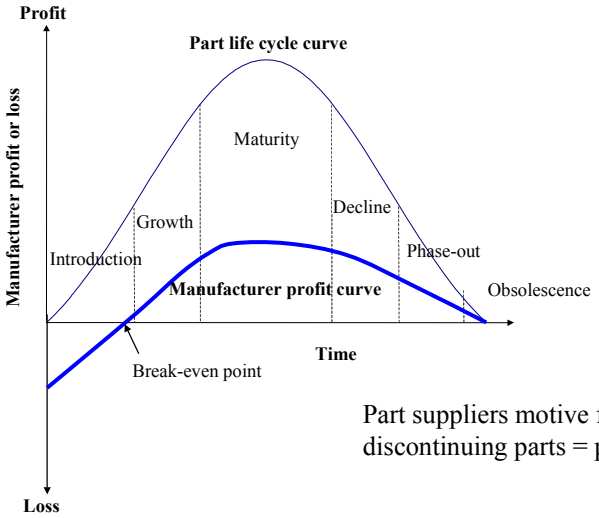
σ = one standard deviation of the sales curve fit

Life Cycle Phase Characteristics

Characteristic	Introduction	Growth	Maturity	Decline	Phase-out	Discontinuance
Sales	Slow but increasing	Increasing rapidly	High	Decreasing	Lifetime buys may be offered	Sales only from aftermarket sources, if at all
Price	Highest	Declining	Low	Lowest	Low	Not applicable or very high if available from aftermarket sources
Usage	Low	Increasing	High	Decreasing	Decreasing	Low
Part modification	Periodic die shrinks, and possible mask changes	Periodic die shrinks	Periodic die shrinks	Few or none	None	None
Competitors	Few	High	High	Declining	Declining	Few
Manufacturer profit	Low	Increasing	High	Reasonable for survivors	Reasonable for survivors	Reasonable for aftermarket

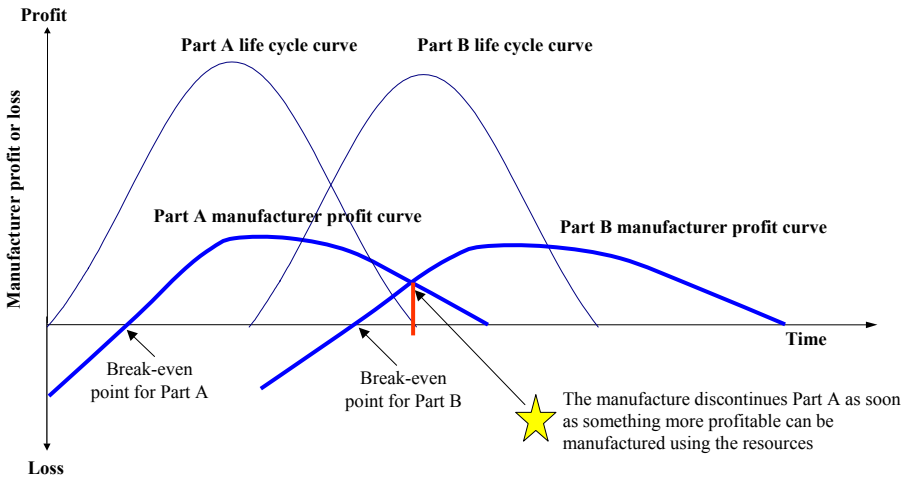
Pecht, M., and Das, D., "Editorial: The Electronic Part Life Cycle," *IEEE Transactions on Components and Packaging Technologies*, Vol. 23, No. 1, pp. 190-193, March 2000.

Life Cycle Phase Characteristics: Manufacturer Profit

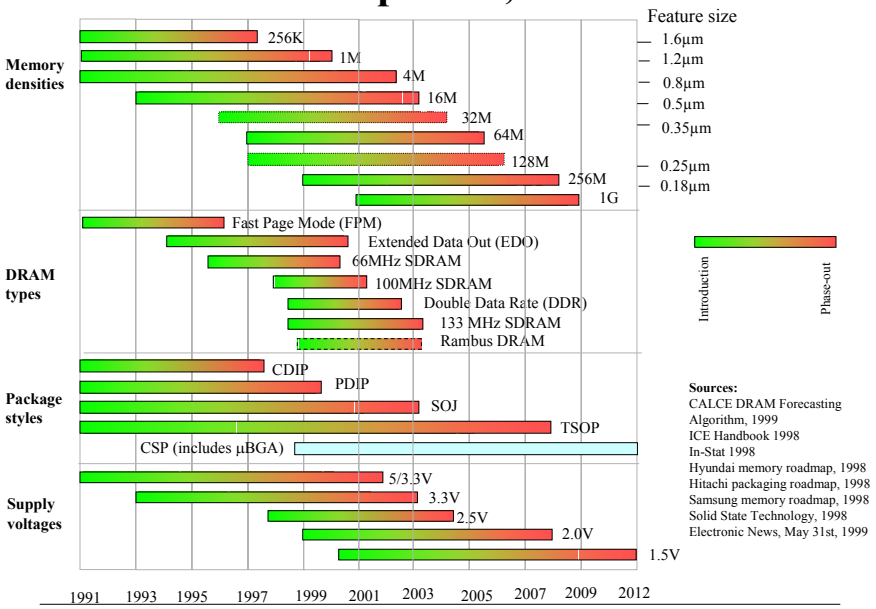


Part suppliers motive for discontinuing parts = profit

Life Cycle Phase Characteristics: Manufacturer Profit (continued)



The DRAM Roadmap: Past, Present and Future



Sources:
CALCE DRAM Forecasting Algorithm, 1999
ICE Handbook 1998
In-Stat 1998
Hyundai memory roadmap, 1998
Hitachi packaging roadmap, 1998
Samsung memory roadmap, 1998
Solid State Technology, 1998
Electronic News, May 31st, 1999

What Happens When a Part Goes Obsolete?

1) Procurement is told by the distributors* it uses that a part is obsolete
   - Verify this! Obsolete to a distributor may just mean they aren't going to stock it anymore
2) Customers receive a notice from the manufacturer* that production of the part will be discontinued and final orders for parts must be received by a specified date
3) The manufacturer stops producing the part without notice or opportunity for a last time buy, or your procurement organization simply does not find out until it's too late
   - Production of the part truly stops
   - Product changes (whether the customer is notified or not) cause the part to become obsolete for your application

*The procedure for advising procurement varies depending on the particular manufacturer/distributor, contractual relationship for part procurement, quantities of parts, and location of the customer.

Mitigation of Part Obsolescence

Mitigation = making the consequences of obsolescence less severe, mitigation does not stop obsolescence from taking place, it only manages it when it happens.

- Existing stock
- Negotiate with manufacturer
- Last time buy (Bridge buy)
- Lifetime buy (Life of type buy)
- Alternate part (equal or better than original part)
- Substitute part (inferior to original part)
  - Uprate (usually thermal)
- Buy from aftermarket sources
- Emulate
- Redesign
- Reverse engineer
- Reclaim (salvage)

Cost of Obsolescence Resolutions in Avionics

Resolution	Low ($)	Average ($)	High ($)
Existing Stock	0	0	0
Reclamation	1000	2000	3000
Alternate	4000	7000	9000
Substitute	15000	19000	24000
Aftermarket	41000	50000	59000
Emulation	55000	72000	89000
Redesign – Minor	82000	117000	153000
Redesign – Major	361000	433000	505000
Life of Type Buy	*	*	*

NRE costs (2001)

Recurring multipliers (1999)

Resolution	Low	Average	High
Existing Stock	1.0	1.0	1.0
Reclamation	Not available	Not available	Not available
Alternate	1.0	2.5	4.0
Substitute	1.6	5.8	10.0
Aftermarket	5.0	7.5	10.0
Emulation	10.0	20.0	30.0
Redesign	1000.0	5500.0	10000.0
Life of Type Buy	Not applicable	Not applicable	Not applicable

J. McDermott, J. Shearer, and W. Tomczykowski, "Resolution Cost Factors for Diminishing Manufacturing Sources and Material Shortages," ARINC, February 1999. (http://smaplab.ri.uah.edu/dmsms98/papers/trunnell.pdf)
Supplemental Report, "Resolution Cost Factors for Diminishing Manufacturing Sources and Material Shortages," ARINC, December 2001.

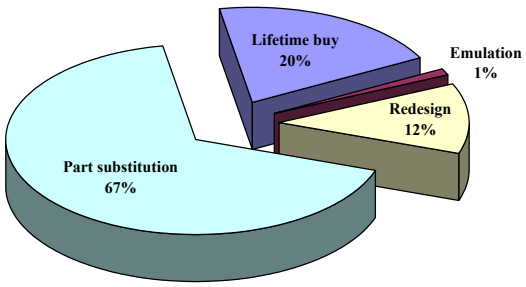
Choosing an Obsolescence Mitigation Strategy

Strategy	Part discontinuance status: End of Life notice			Degree of mismatch		Number of unique products using the obsolete part		Total forecast volume of obsolete part		Number of different parts in systems affected in each product		Continued market for the product		Potential for producibility enhancement		Turnaround time available for resolution			Requal. required?	
	Expired	Issued	Not issued	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	0-20 weeks	20-60 weeks	>60 weeks	Yes	No
Negotiate with manufacturer		X		X****			X**		X	X			X	X				X		X
Lifetime buy		X	X	X****		X*	X**	X		X			X	X			X			X
Bridge buy		X		X****		X*		X		X		X		X		X				X
Buy from aftermarket sources	X			X****		X*	X**	X	X	X		X	X	X			X		?***	
Substitute part	X	X	X	X****		X*		X	X	X		X	X		X	X			?***	
Uprate	X	X		X****	X****	X*	X**	X		X		X		X		X	X		?***	
Emulate	X				X****	X*			X	X			X		X		X		X	
Reverse engineer	X				X****	X**			X	X			X		X			X	X	
Redesign	X				X****		X**		X		X		X		X			X	X	
Reclaim	X				X****	X*		X		X							X		?***	

* Easier to forecast needed quantity but more risk in having "excess" parts
** Spreads out the risk, but harder to forecast needed quantity
*** Depends on part form-fit-function and customer/regulatory requirements
**** Depends on equipment supplier requirements

Electronic Component Obsolescence Resolutions (Boeing Commercial Aircraft)

Based on 259 obsolescence events in a 2.5 year period



Z. Porter, "Strategies for Obsolescence Management in the New Millinium," presentation at *DMSMS Conference*, April 1999 (http://smaplab.ri.uah.edu/dmsms98/presentations/porter.pdf)