Chapter 1

Introduction to Obsolescence Problems

Obsolescence is the status given to a part when it is no longer available from its original manufacturer. The original manufacturer's discontinuance of a part may have many causes, including nonavailability of the materials needed to manufacture the part, decreased demand for the part, duplication of product lines when companies merge, or liability concerns. The problem of obsolescence is most prevalent for electronics technology, wherein the procurement lifetimes for microelectronic parts are often significantly shorter than the manufacturing and support life cycles for the products that use the parts. However, obsolescence extends beyond electronic parts to other items, such as materials, textiles, and mechanical parts. In addition, obsolescence has been shown to appear for software, specifications, standards, processes, and soft resources, such as human skills.

This chapter describes general definitions and the fundamental issues associated with the occurrence of obsolescence and its management in order to build a consistent basis for this topic. Because obsolescence is most prevalent for electronics, this chapter concentrates on the issues associated with obsolescence in relation to electronic parts; however, most of what follows is also applicable for nonelectronic parts as well.

1.1 DEFINITION OF OBSOLESCENCE

The English word *obsolescence* is derived from the Latin term *obsolescere*, which means "to go out of use or fashion." The associated adjective *obsolescent*

Strategies to the Prediction, Mitigation and Management of Product Obsolescence, First Edition. Bjoern Bartels, Ulrich Ermel, Michael Pecht and Peter Sandborn.

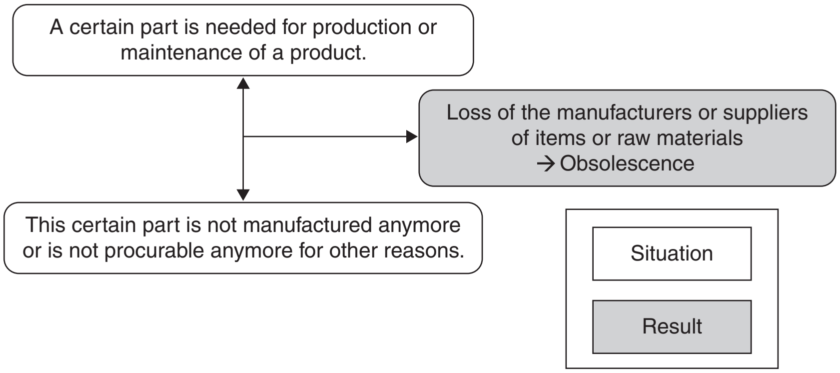


FIGURE 1-1 Appearance of obsolescence.

is derived from the Latin term *obsoletus*, meaning "worn out" (Baer and Wermke, 2000).

Obsolescence, as addressed in this book, refers to materials, parts, devices, software, services, and processes that become non-procurable from their original manufacturer or supplier. As parts become obsolete, users and customers are inevitably faced with a supply shortfall when their demands for the original part cannot be satisfied and no alternate parts are procurable (Atterbury, 2005; Rogokowski, 2007).

Generally, obsolescence is defined as the loss, or impending loss, of the manufacturers or suppliers of items or raw materials, as shown in Figure 1-1 (Tomczykowski, 2001).[1] However, a more realistic working definition of obsolescence is when a part (material or technology) that is needed to manufacture or support a product or system is not available from existing stock or the original manufacturer of the part (material or technology).

There are many possible reasons for obsolescence. Some of the causes of obsolescence include the following:

- Rapid technological development makes a product or part unusable for technical, economical, or legal reasons (Feldmann and Sandborn, 2007)
- The original component manufacturer (OCM) or original equipment manufacturer (OEM) disappears from the market for various reasons (Atterbury, 2005)

[1]This definition of obsolescence is sometimes called "procurement" or "DMSMS-type" obsolescence, where DMSMS stands for Diminishing Manufacturing Sources and Material Shortages. Note: Other definitions of obsolescence that are not relevant to the topic of this book include "sudden" or "inventory" obsolescence, which refers to the obsolescence of an inventory of parts that remain after the demand for the part disappears (Brown et al., 1964). Sudden obsolescence is the opposite of the problem addressed in this book.

- The OCM or OEM is not willing to continue producing a part for economic reasons (usually precipitated by a drop in demand for the part) (Atterbury, 2005)
- Chemical or physical aging processes of parts placed in storage can destroy parts or make it impossible to use existing part inventories in products

Terms such as *obsolescence* and *obsolete* are already used by some companies when they provide a product change notification (PCN) or end-of-life (EOL) notice. In such cases, the part is sometimes still procurable for a limited time; that is, customers may have the opportunity to buy parts one last time and store enough of them to meet their systems' forecasted lifetime requirements. These actions are referred to as life-of-type (LOT) buys, lifetime (last time) buys (LTBs), or bridge buys (see Chapter 7).

1.2 CATEGORIZATION OF OBSOLESCENCE TYPES

The subject of this book is involuntary obsolescence, where neither the customer nor the manufacturer necessarily wants to change the product or the system. Involuntary obsolescence can be categorized as follows (Feldmann and Sandborn, 2007; Rai and Terpenny, 2008):

- *Logistical* Loss of the ability to procure the parts, materials, manufacturing, or software necessary to manufacture and/or support a product.
- *Functional* The product or subsystem still operates as intended and can still be manufactured and supported, but the specific requirements for the product have changed; as a result the product's current function, performance, or reliability (level of qualification) become obsolete. For consumer products, functional obsolescence is the customer's problem; for more complex systems (such as avionics) it is both the manufacturer's and customer's problem. For complex systems, the functional obsolescence of a subsystem is often caused by changes made to other portions of the system.
- *Technological* More technologically advanced components have become available. This may mean that inventory still exists or can be obtained for older parts that are used to manufacture and support the product, but it becomes a technological obsolescence problem when suppliers of older parts no longer support them.
- *Functionality Improvement Dominated Obsolescence (FIDO)* Manufacturers cannot maintain market share unless they evolve their products in order to keep up with competition and customer expectations (manufacturers are forced to change their products by the market). Note that this differs from functional obsolescence in that for commercial products FIDO obsolescence is forced upon the manufacturers and functional obsolescence is forced upon the customers.

1.3 DEFINITION OF OBSOLESCENCE MANAGEMENT

To ensure a constant qualitative performance, an obsolescence management plan should be improved continually. For example, the Plan-Do-Check-Act (PDCA) cycle shown in Figure 1-2 is an appropriate way to satisfy this goal. Developed by Dr. W. Edwards Deming, the PDCA cycle is also called the Deming Cycle or Deming Wheel (Seghezzi, 1996).

To support continuous improvement, obsolescence management organizations must be provided with adequate resources to support necessary activities that are consistent with the organization's business. The company management (for example, the chief executive officer) is responsible for providing these resources and for establishing an obsolescence management plan within the framework of a dependability management system (IEC-62402, 2004).

The management of obsolescence problems is often referred to as "diminishing manufacturing sources and material shortages" (DMSMS) (Saunders, 2006). As addressed in this book, DMSMS specifically refers to the loss of the ability to procure required materials, parts, or technology.

The process for managing obsolescence is illustrated in Figure 1-3 to mitigate or avoid the impact of supply shortfalls for all types of materials, parts, devices, software, services, and processes during the intended life of a product.

Obsolescence management implies life cycle forecasting and other analyses to identify the effects of obsolescence through all stages of the product life cycle. The cost avoidance associated with various management actions must be

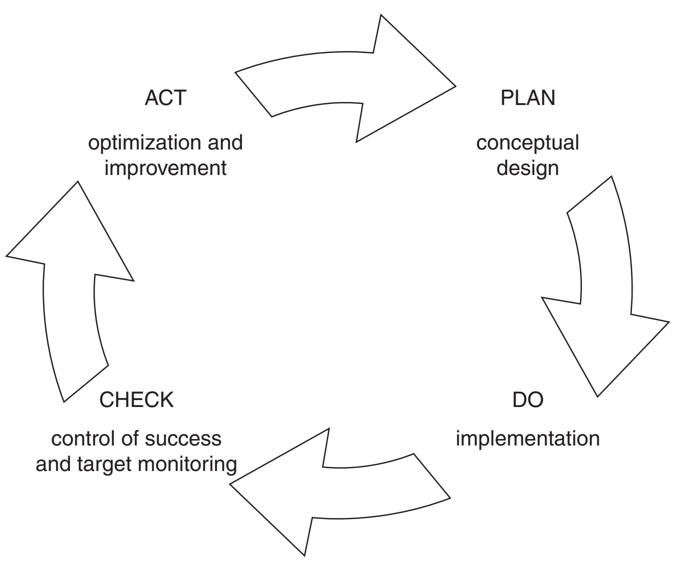


FIGURE 1-2 PDCA cycle.

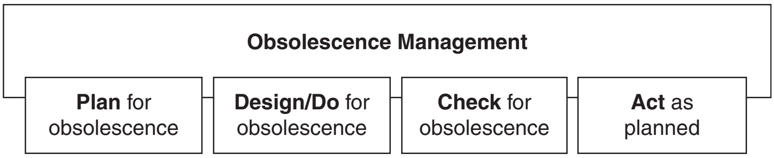


FIGURE 1-3 Process steps for managing obsolescence (adapted from IEC-62402, 2004).

estimated. People must be trained, and resources must be acquired to enable personnel to manage obsolescence. An obsolescence management plan must be developed to ensure adequate selection, timely implementation, and tracking of relevant obsolescence management activities. These activities and other related components and requirements are discussed in the chapters that follow.

1.4 CATEGORIZATION OF OBSOLESCENCE MANAGEMENT APPROACHES

DMSMS require addressing the problem of obsolescence on three different management levels: reactive, proactive, and strategic, as shown in Figure 1-4.

Reactive management (see Chapter 7) is concerned with determining an appropriate, immediate resolution to the problem of components becoming obsolete, executing the resolution process, and documenting/tracking the actions taken. Common reactive DMSMS management approaches include, among others, lifetime buy, bridge buy, component replacement, buying from aftermarket sources, uprating, emulation, and salvage (Sandborn, 2008).

Proactive management (see Chapter 8) is implemented for critical components that have a risk of going obsolete, lack sufficient available quantity after obsolescence, and will be problematic to manage if or when they become obsolete. These critical components are identified and managed prior to their actual obsolescence event. Bill of material (BOM) management regarding obsolete or soon to be obsolete components is an important part of the design and manufacture of any product. Proactive management requires the ability to forecast obsolescence risk for components. It also requires there be a process for articulating, reviewing, and updating the system-level DMSMS status (Sandborn, 2008).

Strategic management (see Chapter 9) of DMSMS means using DMSMS data, logistics management inputs, technology forecasting, and business trending to enable strategic planning, life cycle optimization, and long-term business case development for the support of systems. The most common approach to DMSMS strategic management is design refresh planning, determining the set of refreshes (and associated reactive management between refreshes) that maximizes future cost avoidance (Sandborn, 2008).

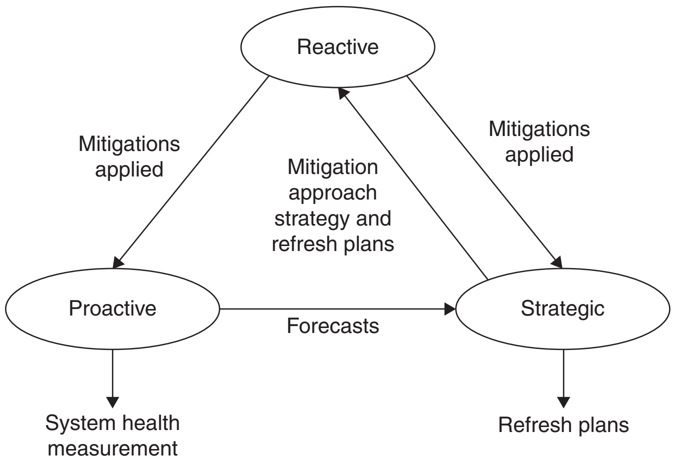


FIGURE 1-4 Three obsolescence management DMSMS categories and the resulting outputs (adapted from Sandborn, 2008).

1.5 HISTORICAL PERSPECTIVE ON OBSOLESCENCE

Although the origins of electronic part obsolescence are often associated with the advent of acquisition reform in the U.S. Department of Defense in the mid-1990s, concerns about general technology obsolescence as it relates to procuring technology can be traced to much earlier times.

It is evident that the concepts associated with procurement obsolescence were noticed in the context of technology as early as the 1970s. In *The Railway Game* (Lukasiewicz, 1976), Lukasiewicz points out that the market environment in which the railway industry operates restricts them to, in many cases, only one supplier, thus creating a plethora of low-volume supply chain problems that include obsolescence issues.

Although the basic concepts of technology procurement obsolescence have existed since 1970 and probably earlier, the first known mention of the problem specifically related to electronic parts was in 1978 (Smith, 1983) and was associated with the transition from vacuum tubes to solid-state electronics.

References to the acronym DMSMS first appeared in the early 1980s when the U.S. Department of Defense began sponsoring electronic part obsolescence workshops and conferences. The usage of the acronym DMSMS is also seen on the cover of the proceedings from the 1983 DMSMS workshop sponsored by the Defense Electronics Supply Center, shown in Figure 1-5.

The first known component obsolescence management guide was prepared for the P-3 Orion, by ARINC in 1984 (Kuehn, 1984).

The commercialization of obsolescence forecasting for electronic parts began at Zeus Components, Inc., and was used to analyze customer parts lists for sourcing support in early 1986. Hughes Aircraft and Westinghouse offered

FIGURE 1-5 Cover of the proceedings from the 1983 DMSMS workshop (courtesy of Walter Tomczykowski, ARINC).

to pay for the service in late 1986. TACTech (Transition Analysis Component Technology) separated from Zeus in early 1987 and became the first commercial provider of obsolescence forecasting for parts (Baca, 2010).

The real shock wave that put DMSMS on everyone's radar screens occurred when Motorola and Intel terminated their military semiconductor businesses in the early 1990s, a move that impacted virtually every U.S. military program (Baca, 2010). This was followed by the Perry Directive (Perry, 1994) in 1994. The Perry Directive states in part:

> We are going to rely on performance standards . . . instead of relying on milspecs to tell our contractors how to build something . . . There will still, of course, be situations where we will need to spell out how we want things in detail. In those cases, we still will not rely on milspecs but rather on industrial specifications [i.e., non-government standards] . . . In those situations where there are no acceptable industrial specifications, or for some reason they are not effective, then the use of milspecs will be authorized as a last resort, but it will require a special waiver.

The Perry Directive does not mandate the use of commercial components; however, in the wake of the Perry Directive, developers of military systems (and systems that relied on the same supply chain as military products), increasingly moved toward commercial off-the-shelf (COTS) parts, thus accelerating obsolescence issues.

Since the late 1990s, many electronic database tools that include obsolescence status and obsolescence forecasting have appeared, as well as other tools for inventory and demand consolidation and strategic refresh planning. These tools will be discussed in the chapters that follow.

1.6 OCCURRENCE OF OBSOLESCENCE

In order to develop an effective plan to combat part or component obsolescence, understanding the nature of the problem is critical. It is essential to understand how obsolescence can occur and the types of obsolescence that exist.

1.6.1 Technological Evolution

A new generation of technology effectively makes its predecessor obsolete. An example of this would be faster microprocessors making slower ones obsolete. Typically, the new generation technology has improved performance and functionality, often at a lower cost than its predecessors.

1.6.2 Technological Revolutions

In a technological revolution, a new technology supersedes (displaces) its predecessor. An example of this is the fiber distributed data interface (FDDI) that is becoming obsolete as the market moves toward adopting fiber channel as the communications technology of choice.

More common examples are the CD-ROM, which has greater storage capacity and speed than the floppy disk, DVD/Blu-Ray discs that have better quality and more multimedia functions than VHS, and the telephone, which enabled audio transmission instead of the coded electrical signals of a telegraph (ComputerInfoWeb, 2010).

1.6.3 Market Forces

Obsolescence due to market forces occurs when the demand for a component or technology falls, and the manufacturer considers it uneconomical to continue production. This is an increasing problem, as low-volume markets no longer have the purchasing power necessary to persuade manufacturers to continue production. Part manufacturers and distributors may not be willing to manufacture or stock parts that have a small market. The cost of managing the distribution of low-volume parts while providing affordable prices is a challenge; hence, the few distributors that do provide low-volume parts charge high fees.

1.6.4 Environmental Policies and Restrictions

Obsolescence can be caused by directives, rules, and other legislation imposed by governments. For example, EC-Directives are regulations of the European Community for all member states to reach specific goals associated with the usage and waste of specific materials.

For example, the following directives have been implemented in recent years:

- The directive on Waste Electrical and Electronic Equipment (WEEE) from 2003 to reduce the electronic scrap going into landfills by increased recovery, reusage, and recycling (Directive 2002/96/EC, 2003)
- The directive from 2003 on the Restriction on Hazardous Substances (RoHS) to ban specific substances in products sold in the EU that could end up in the waste stream (Directive 2002/95/EC, 2003)
- The directive from 2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) to regulate chemicals used in products (Directive 1907/2006/EC, 2006)

To illustrate how these directives affect obsolescence, consider the RoHS directive. Through the RoHS, the usage of lead (Pb) is limited to 0.1 percent by weight for products sold in the EU. Consequently, lead-free solder (for example, SnAgCu) has replaced tin-lead solder (ZVEI, 2008).

RoHS applies to the majority of electronic products. Current exemptions from RoHS include medical devices, monitoring and control instruments, and military and aerospace equipment. The reason for these exemptions is that the long-term effects and reliability of lead-free solder have not been determined.

Because of the RoHS directive, many tin-lead solder finish electronic products have been discontinued (gone obsolete). However, the repair and maintenance of products that were manufactured before the RoHS directive requires tin-lead solder finished electronic parts (Brewin, 2005). The current exemptions from RoHS are largely a moot point because the exempted product sectors (due to their low volume) must use the same supply chains as the non-exempt product sectors.

1.6.5 Allocation

Allocation obsolescence is caused by long product lead time, resulting in temporary obsolescence usually categorized as a short-term supply chain disruption. For example, during the worldwide recession in 2008–2009, many manufacturers reduced production and inventory in order to stabilize their businesses. As customers for parts recover and the demand for parts grows, temporary unavailability of parts can result. In addition, in some cases it appears that chip manufacturers may be delaying capital expenditure while enjoying the higher prices (Allocation Components, 2010).

Beginning in 2010, the reluctance to recommission production lines in response to growing demand led to significant increases in lead times and prices for various parts and materials. An example of 2010 lead times for specific electronic parts is shown in Table 1-1; the impact on prices of raw materials is shown in Table 1-2.

TABLE 1-1 Lead Time Prognosis Overview (March 2010)

Product Group	Lead Time (weeks)	Lead Time Prognosis
Power and Filter (DC/DC, AC/DC, etc.)	Up to 14 weeks	Increasing
Batteries – Primary (Lithium ion, etc.)	Average of 10 weeks	Constant
Batteries – Rechargeable (Lithium ion, etc.)	Average of 12 weeks	Constant
Interconnect (Cables, connectors, etc.)	Up to 12 weeks	Increasing
Electromechanical (Switches, fans, etc.)	Up to 20 weeks	Increasing
Passive (Capacitors, resistors, etc.)	Greater than 30 weeks in some cases	Increasing

(adapted from Avnet, 2010)

TABLE 1-2 Cost of Raw Material Prognosis Overview (April 2010)

Product Group	Advance in Prices within 3 Months (April 2010)	Price Prognosis
Raw Iron	Up 21%	Increasing
Steel Scrap	Up 38%	Increasing
Aluminum Cast Material	Up an average of 13%	Increasing
Nonferrous Metal	Up an average of 18%	Increasing
Lead Alloys	Up 9%	Increasing
Synthetic Materials	Up an average of 13.5%	Increasing

(adapted from Pleyma, 2010)

Allocation, in general, is a double-edged sword. On the one side, it allows manufacturers and suppliers to charge higher prices for their products; on the other side it causes short-term supply chain disruptions that need to be managed.

A further example of allocation issues occurred in mid-2010 when China decreased its exports of rare earth elements. China, with a market share of 93 percent, is nearly the only supplier of rare earth elements in the world. Rare earth metals are used in many electronic components (such as capacitors), and as supplies decreased, long lead times and increasing prices were unavoidable (Zuehlke, 2010).

In addition, natural disasters such as the earthquake that struck northern Japan in March 2011 can cause allocation obsolescence of parts and components. The earthquake and subsequent tidal waves (tsunami) affected electronic component manufacturers' employees, power supplies, and infrastructure and manufacturing facilities, making it impossible to operate as usual. As a result, several electronic component manufacturers had to announce temporary unavailability, longer lead times, and shortages of their parts (Allocation Components, 2011).

1.6.6 Planned Obsolescence

Planned obsolescence refers to an assortment of techniques used to artificially limit the durability of manufactured goods in order to stimulate repetitive consumption (Slade, 2007). In 1954, Brooks Stevens, an American industrial designer, popularized the phrase "planned obsolescence." Stevens's definition of planned obsolescence was, "Instilling in the buyer the desire to own something a little newer, a little better, a little sooner than is necessary" (Milwaukee Art Museum, 2010).

The origins of the phrase "planned obsolescence" go back at least as far as 1932, when Bernard London wrote his leaflet, "Ending the Depression through Planned Obsolescence." He blamed the Great Depression on consumers who used their old products, such as cars, radios, and clothing, much longer than statisticians had expected (Adbusters, 2010; APT News, 2010).

Planned obsolescence, also referred to as built-in obsolescence, is a method of stimulating consumer demand by designing products that wear out or become out-of-date after limited use. Manufacturers increase profits by forcing the customer to buy the next generation of the product after a fixed (planned) useful or functional product life cycle (ComputerInfoWeb, 2010). If the manufacturer has a monopoly, or at least an oligopoly, planned obsolescence or built-in obsolescence may be part of their business strategy (Orbach, 2004).

The majority of examples of planned obsolescence can be found in commercial products. In 2003, consumers expected to use their electronic systems for a maximum of two years before purchasing a replacement or upgraded product. Examples of systems that benefit from planned obsolescence include cell phones, PCs, printers, digital cameras, DVD players, LCDs, gaming systems, mp3 players, and many more (Slade, 2007).

The real problem with planned obsolescence appears when commercial off-the-shelf (COTS) parts designed for use in commercial systems with short procurement life cycles have to be used in systems with much longer product life cycles.

1.7 PRODUCT SECTORS AFFECTED BY OBSOLESCENCE PROBLEMS

Increasing globalization and technological progress make markets and production in different countries dependent on one another and rapidly shorten the procurement life cycles of components and products. In the past several decades, technology has advanced swiftly, causing components to have shorter procurement life spans. Driven by the consumer product sector, newer and better components are being introduced frequently, rendering older components obsolete (Sandborn et al., 2007). As a consequence, the risk of components

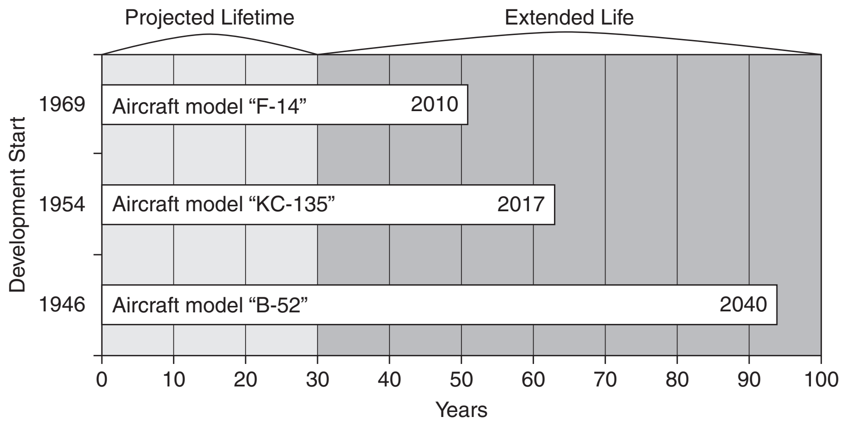


FIGURE 1-6 Extended life of military weapons systems (adopted from Livingston, 2000).

becoming obsolete exists in nearly all product sectors. However, some specific product sectors are affected more than others.

The complexity of the problem is demonstrated in Figure 1-6. This figure shows different military weapons systems that were each designed for a projected lifetime of 30 years. However, many systems for military and defense are being used far longer than originally planned. For example, the B-52 aircraft is projected to operate for more than 94 years, and many weapons systems are expected to have a life span of more than 40 years (Livingston, 2000).

Note that the length of time from the start of design to the beginning of production is increasing. This means that many technologies originally designed into systems are obsolete even before production starts (Hitt and Schmidt, 1998).

The extended life of products and the increasing time period from the start of design to the beginning of production are making it more difficult to supply original spare parts for the whole life span of these products.

Since an increasing number of obsolescence events within the whole product lifetime need to be handled, expenditures on obsolescence management are increasing as well, as indicated by the following examples (McDermott et al., 1999):

- US$81,000,000 was allocated by the U.S. Air Force for the F-22 program to purchase obsolete or soon-to-be out of production parts and to redesign assemblies to accept COTS parts.
- US$600,000 was spent by an avionics manufacturer for commercial airlines to replace an obsolete Intel chip.
- US$500,000,000 was spent to redesign an obsolete radar system for the F-16 program.

- US$264,000 was spent on a life of type (LOT) buy as a resolution for one obsolete logic device for the KC-130F/R program in fiscal year 1997.
- US$250,000 was stated by the deputy under secretary of defense for logistics (DUSD [L]) to be the average cost to redesign a circuit card to eliminate obsolete components.
- US$26,000 to US$2,000,000 is the range reported by the Electronic Industries Alliance (EIA) Manufacturing Operations and Technology Committee as the cost range for redesign of a circuit card.

The longer the product life, the more instances of obsolescence will occur. The product sectors of military and aerospace industries, medical technology, automotive industries, telecommunication industries, and nuclear energy industries are the most affected by obsolescence.

1.8 PARTS AFFECTED BY OBSOLESCENCE PROBLEMS

Obsolescence events are projected to occur more often in the future due to the accelerating pace of innovations. In 1965, Gordon Moore, cofounder of Intel Corporation, noticed that the number of transistors that could be placed on an integrated circuit was doubling about every two years. Furthermore, he predicted that the trend would continue for at least ten years. This forecast (Figure 1-7) is now known as Moore's Law, and advances in integrated circuits still follow it today (Intel, 2010b).

The frequent occurrence of obsolescence in electronics is due to their short procurement life cycles and because the effects on supportability and readiness are generally more immediate and apparent for electronic components. For nonelectronic components, obsolescence problems have generally been slower to develop, and drastic shifts in technology are not as common (Howard, 2002).

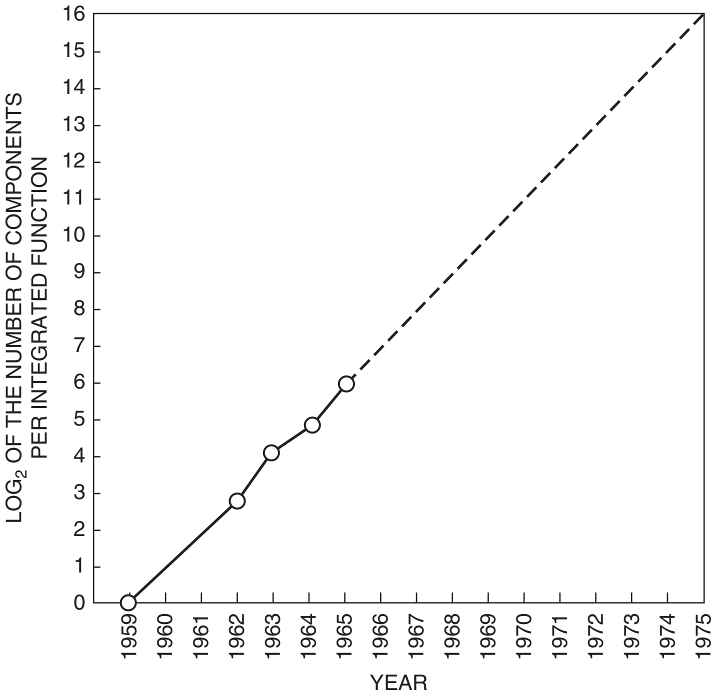
In summary, all types of product groups are affected by obsolescence. However, nonelectronic components typically remain supportable for decades, whereas electronic components may become obsolete in a matter of a few years or even months.

1.8.1 Electronic Part Obsolescence

Electronic part obsolescence is generally a result of the rapid growth of the electronics industry. As a result, many of the electronic parts in products have a procurement life cycle that is significantly shorter than the product life cycle of the system they support.

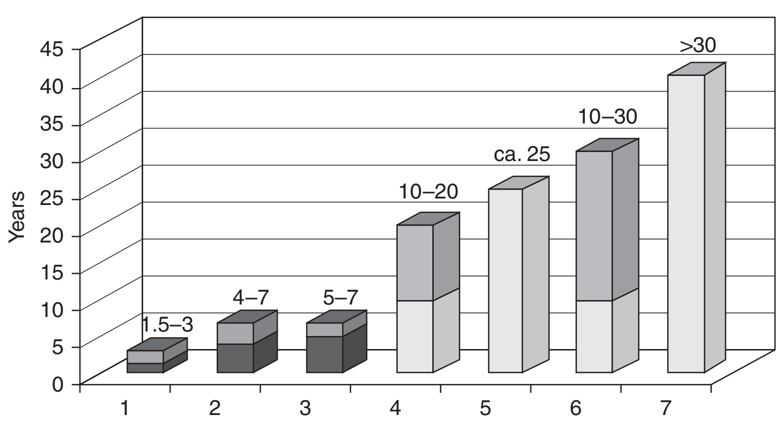
Some examples of the discrepancy between the life cycles of electronic parts and the product lives are shown in Figure 1-8.

The impact of obsolescence can be seen in Figure 1-9, which shows the total number of product discontinuance notices (notices from the original



Number of components per Integrated function for minimum cost per component extrapolated vs time.

FIGURE 1-7 Graph of Moore's Law created in 1965 (Intel, 2010b).



Part Life-Cycle:
1 = Generation of Processors
2 = Technology of Silicium
3 = Semiconductor Production Equipment

Product/Equipment Life-Cycle:
4 = Electronic Devices Production Equipment
5 = Automotive Industries
6 = Machinery and Safety Engineering

FIGURE 1-8 Discrepancy between part life cycle and product life (adapted from HTV, 2009).

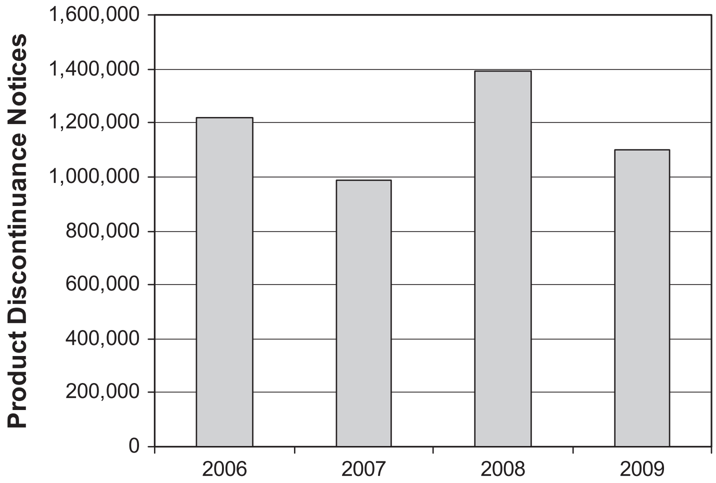


FIGURE 1-9 Numbers of product discontinuance notices for electronic parts (Sandborn et al., 2010).

manufacturer that manufacturing of the part will be terminated) in 2006–2009 from SiliconExpert Technologies, Inc. As of June 14, 2010, SiliconExpert Technologies' parts database consisted of 157,184,671 unique parts (approximately 121.6 million of which are not obsolete), spanning 337 product lines from 11,054 manufacturers. Part count includes all derivations of part numbers based on part family name and generic codes as assigned by their manufacturers. The 1.1 million electronic part discontinuances in 2009 represent approximately 0.9 percent of the electronic parts available in the market (Sandborn et al., 2010).

1.8.2 Software Obsolescence

Software does not wear out, and the cost of generating more copies of software is negligible (IEC-62402, 2004). However, software obsolescence is a significant problem, as the following statement from Bill Gates, founder of the Microsoft Corporation, indicates:

> The only big companies that succeed will be those that obsolete their own products before someone else does. (APT News, 2010)

Software obsolescence is generally due to one of three main causes (Sandborn, 2007):

- Hardware, requirements, or other software changes to the system make the functionality of the software obsolete (functional obsolescence).
- The sales and support for software terminate when the original supplier no longer sells the software as new; when the inability to expand or renew

licensing agreements occurs; or when the software maintenance terminates because the original supplier or third parties no longer support the software (technological obsolescence).

- Digital media obsolescence, formatting, or degradation limits or terminates access to software (logistical obsolescence).

The principles that govern the management of software and hardware obsolescence issues are generally not the same and will be considered later in this book.

1.8.3 Textile and Mechanical Part Obsolescence

Technological change in nonelectronic parts is much slower than for electronic parts and software. However, a comprehensive obsolescence approach has to also contain information on textile and mechanical problems, including the future provisioning of sole-sourced devices. Today, nonelectronic components are also beginning to impact cost and operations through life support issues (Smith, 2000).

Typical symptoms of nonelectronic obsolescence include the following (Howard, 2002):

- For economic reasons, all qualified sources no-bid a component.
- The materials or the manufacturing process become obsolete as suppliers develop stronger, lighter, and more damage-resistant materials.
- Suppliers phase out older materials to meet new production or environmental regulations that have made the use of specific materials illegal.
- The technical data, drawings, or the specifications for procurement are incorrect or incomplete.
- The OEM or OCM goes out of business.
- Specialized tooling, such as casting molds, forging dies, holding fixtures, and sheet metal patterns, required to manufacture the component is unavailable or cannot be refurbished.
- Specialized test equipment is unavailable.

Nonelectronic obsolescence problems for textile and mechanical parts will continue to mount as the systems they support start aging. Inventory within the military, with its product life cycles of over 40 years, is especially affected by this problem (Howard, 2002).

As they apply to software issues, the principles for managing electronic part obsolescence and nonelectronic part obsolescence issues are basically the same. Therefore, the management of textile and mechanical part obsolescence will not be considered further in this book. Management tactics, processes, methods, and procedures referring to electronic parts are comprehensively valid and are also applicable for textiles and mechanical parts.