

Guarding against component obsolescence

THE INDUSTRY LOSES 500 COMPONENTS EVERY WEEK. HOW MANY OF THEM ARE YOURS?



THE PROBLEM OF COMPONENT OBSOLESCENCE has been around for as long as the electronics industry, but it has become a more serious concern in the last decade. In a technology sector in which rapid progress is the norm, new generations of components succeed

the previous ones in only months, and manufacturers cannot keep every variant of every generation in production indefinitely. As the demand for each variant drops below economic viability, the component disappears from production in a more or less orderly fashion. The UK's COG (Component Obsolescence Group) estimates that across the industry, manufacturers withdraw some 2000 components every month. The electronics industry's problem has always been that it designs products whose life cycles regularly far exceed the life spans of the components inside them.

This situation has always been especially true in the military/avionics and other high-reliability sectors, and these areas evolved a detailed methodology to handle it, effectively creating a parallel universe of components that not only meet military specifications, but also are sold under contracts that guarantee prolonged availability. Into this world, over the last decade or so, has come the phenomenon of COTS (commercial-off-the-shelf) supply. Research organization In-Stat/MDR (www.instat.com) and

others predict that COTS purchases will grow to more than 35% of the worldwide military-aerospace-IC market by 2005. Governments judge traditional military supply-chain practices far too expensive, sometimes locking equipment designs to components whose performance is well behind that of other commercially available components. The COTS philosophy decrees that, when you can obtain commercial components and subsystems that meet military specifications, you can use them in military systems.

OBSOLESCENCE COMES WITH COTS

Component obsolescence, however, is the flip side of the COTS coin. Part of that apparently excessive markup for "mil-spec" parts goes into funding the parts' long-term availability, beyond the point at which a commercial part would be discontinued. If you use a commercial part, then commercial rules apply: no special treatment and no guarantees of supply outside normal practices. Component obsolescence has been called the number-one problem for designers of long-living systems.

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However, obsolescence is far from being a problem just for the military sector. It is particularly acute there, where programs extend over decades, and—apart from the need to provide spares for in-service systems—equipment continues in sporadic production for many years and is subject to updates and redesigns extending over several generations. Compare that situation with, say, the commercial-PC environment, in which a given processor variant or motherboard design may have a life of just a few months. Commercial products are also increasingly encountering the obsolescence phenomenon. In particular, the increasing electronics content in automobiles may present a problem. You are used to buying spare parts for vehicles many years after the vehicles' manufacture, which implies that electronic modules may continue in intermittent production long after the manufacturer discontinues the model that employed them. But many other classes of products also require extended production and spare-parts availability beyond the end of the natural life cycle of the components with which they were first designed. And, progress in component technology is by no means the only motivation for making products obsolete (see sidebar "Enforced obsolescence").

Foremost in any discussion about obsolescence are semiconductors; long ago, the industry established a standard protocol for dealing with device obsolescence that still stands. When a device enters the declining phase of usage, it becomes the subject of an LTB (last-time-buy) notice, in which a company alerts you to a time period during which you can for the last time purchase enough of a component to serve the remaining life of your product and its anticipated support needs. (Little-used products may not necessarily find themselves the subject of an LTB notice; if a manufacturer can produce them in a current process, there may be no penalty to keeping them in the catalog, but orders may be costly or require long leadtimes.) When the LTB period expires, the vendor typically estimates the likely remaining demand in the market and turns its holding in the part over to companies such as Rochester Electronics or Lansdale Semiconductor—two of the oldest names in the industry. These companies stock obsolete devices in various forms, most of

AT A GLANCE

- ▶ Large sectors of the electronics industry routinely design products whose life cycles are longer than the lives of the components inside them.
- ▶ Military/high-reliability systems that evolved to handle component obsolescence are coming under strain as the influence of COTS purchasing grows.
- ▶ Long-established procedures for establishing reserves of deleted semiconductors still work well.
- ▶ Software tools are in development to help optimize life cycles with programmed design revisions and redesigns.
- ▶ You can better manage obsolescence proactively than reactively, but there is no substitute for thorough project documentation.

them as unpackaged die stored in controlled conditions (typically, a dry-nitrogen atmosphere, to prevent surface deterioration). Rochester holds more than 200 million finished devices and more than 1.5 billion die. Rochester can package and test the device you require to the appropriate specifications.

END-OF-LIFE FORECASTING

Implicit in forecasting a product's life span is knowledge of the devices' usage; a semiconductor house will decide to move a product to end-of-life status based on known and anticipated usage. If you are purchasing a product from a distributor, the distributor will report sales of a device over a set period—a couple of quarters or a year, for example. If your project critically depends on a device, and you have not bought the device for some time, your administrative systems must make the distributor, the manufacturer, or both aware of your continuing need for it. Doing so may not extend the part's life, but it ensures that manufacturers will invite you to participate in the LTB. Likewise, companies have internal lists of devices they are considering for end of life; keeping in close touch with the supply chain for critical parts may give you early warning of a company's intention to phase out a device.

When discontinuation is a surprise, however, there is a well-worn path to re-

placing the unavailable component, though each step implies more alteration to the original design and a greater degree of desperation:

1. Assume that sourcing from the original supplier has failed.
2. Find out whether any far-flung part of that supplier's distribution network has any stock of the item you're seeking. (And, don't forget, your own company may have some stock in a dusty corner.)
3. If the manufacturer has phased out the item, find out whether the Rochesters and Lansdales of the world hold any stock.
4. Look for direct equivalents of the part in other manufacturers' catalogs.
5. Determine whether more of the item can be manufactured. The same channels that hold final stock may have acquired the mask sets, and, if the semiconductor process is still available, you may be able to procure a new batch. However, keep in mind that phasing out the process is the most likely reason that the product became obsolete in the first place.

For these and other reasons, the Department of Defense set up DMEA (Defense MicroElectronics Activity). DMEA is the Executive Agent for Department of Defense IC Microelectronics DMSMS (Diminishing Manufacturing Sources and Material Shortages). DMSMS is a key abbreviation that you will repeatedly encounter in the obsolescence arena. DMEA provides support for mission-critical semiconductor products in defense applications, including the ability to fabricate small volumes of devices that are no longer commercially available. DMEA has a flexible fab that can produce CMOS devices at 1- and 0.6-micron design rules and bipolar ICs for analog and mixed-signal functions.

Within semiconductors, the obsolescence picture varies with device type. Discrete devices disappear from catalogs from time to time, but, in most cases, you can relatively easily replace them with functional equivalents that require no or minimal redesign. ICs are generally more problematic. Linear devices tend to live longer than logic devices. Analog Devices product-line director for high-speed amplifiers, Bob Esdale, notes that Analog is still running one of its earliest processes, a 36V bipolar process. He adds that linear parts become obsolete more often through shrinking demand than process nonavailability. And, although the move

from 5 to 3V supplies and lower is a concern, Esdale believes that demand primarily drives this trend, noting that Analog continues to supply CMOS parts operating at all voltage levels.

Standard linear functions generally become obsolete because superior performance devices supersede them, as is the case for discretes. In many cases, you can locate an equivalent or superior device. More significant problems arise with complex-logic—and mixed-signal—ICs. Older ASICs and memories present some of the most acute examples.

As silicon technology, whose product families you have come to expect to offer bigger or faster parts with each pro-

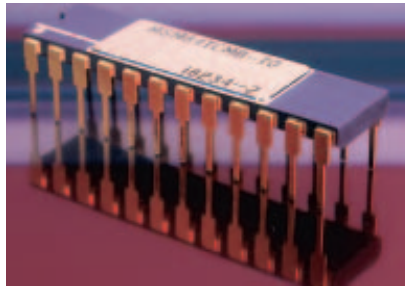


Figure 1

You can replace obsolete memory chips with special solutions. This 4k×8-bit SRAM is a fit, form, and function replacement for a 24-pin, 70-nsec ceramic packaged type. It employs a 32k×8-bit die, the smallest now available, configured as 4k×8-bit; it was built to a limited-quantity requirement and screened to Military Standard-883c.

cess step, moves from generation to generation, vendors are most likely to first delete older devices from their catalogs; for example, many small memories built in older processes are now unobtainable. This problem need not be difficult to overcome, however; using a larger device and addressing only part of the memory is one option. Another phenomenon—package obsolescence—often compounds the problem. A design that is five, 10, or more years old will almost certainly call for dual-inline-packaged devices, and a manufacturer may supply a replacement only in surface-mount format. Numerous specialist suppliers can address these issues. For example, the Apta Group, through its subsidiary HMP

ENFORCED OBSOLESCENCE

Components disappear from the market for a variety of reasons, one of which is the regulatory environment under which they are produced and used. In big slices of the world electronics market, there is a move to eliminate lead from the manufacture and assembly of electronic systems. In Western Europe, it is as a consequence of the WEEE (Waste from Electronic and Electrical Equipment) measure, which seeks to ensure that the industry recycles as much material as possible from electronic products and that material that cannot be recycled is disposed of as safely as possible. As a consequence, lead has to go.

Originally, the target date was 2004; now, lead is due to be eliminated by 2006. Similar measures are shaping markets across the globe. For example, Japan and Australia will be among the first territories to enforce a lead-free requirement. In the early 1990s, the United States first proposed the elimination of lead, sometimes seen as a preoccupation of countries with active environmental lobbies. Now, the Japanese industry is perhaps furthest along the route to lead elimination. Consumer products on the shelf in

your local store are likely already lead-free, even if they are not yet labeled as such.

Perhaps more relevant, the European requirement specifically excludes defense, military, and avionics equipment, and a similar dispensation will likely be available in other territories. This situation recognizes that overall equipment volumes are relatively low and those industry sectors would face a monumental challenge if required to redesign and requalify all designs in continuing to use lead-free components and processes.

A long list of issues surrounds lead-free solder assemblies that impact high-reliability systems. For example, almost all the alloys under development to replace tin-lead solder produce a joint with different mechanical properties; if you convert to such a process, you may need to requalify many environmental specifications. Also, almost all new alloys require a higher temperature profile to make the soldered joint; using a complex hybrid with its own internal soldered joints, as many military programs use, obsoletes the hybrid until you can requalify or redesign that item. (Having an internal die bond fail as you sol-

der the external connections would be embarrassing.)

Do sector exemptions therefore mean that the lead-free issue bypasses military-specified designs? Far from it. The impact of COTS means that many components in your designs may, over time, migrate to variants intended for use with lead-free processes. Basic passive components may no longer have tin-lead plating on leads or contacts but may, for example, shift to pure tin. If a tin-lead variant is offered at all, it will become a new part, but its functional parameters remain unchanged. Will your company's systems recognize it as a new part? It is even possible, though passive suppliers indicate it is unlikely for the foreseeable future, that parts primarily used in high volumes in commercial designs might become obsolete in their tin/lead form. (You wouldn't think that a decoupling capacitor could become an endangered species, but anything is possible.)

The lead-free subject also affects other areas of progress and obsolescence, such as packaging; new chemistries bring new metallurgical effects into play. For example, metallic tin, under certain conditions of use

and storage, can spontaneously grow crystalline "whiskers" that you would not see in tin-lead solder and may pose a problem for certain fine-pitch package types.

Environmental considerations will also change the availability of other staples of the electronics industry. A move exists to eliminate cadmium, which manufacturers widely use as a corrosion-resistant plating on steel, because of its toxicity. Once again, your military design may lean toward continuing to use the metal, but that tendency will be no help to you if the contractor building your metalwork suddenly announces that cadmium is no longer available. This situation can affect even the most mundane components, such as fasteners, and manufacturers of screws and bolts are unlikely to provide last-time-buy notices. Obsolescence is a consideration not only at the higher levels of technology. If your product's original design contains materials that become politically incorrect, its acceptability will vary not only depending on whether it is military or commercial, but also on the countries in which you propose to sell it.

(Hybrid Memory Products), offers a service that focuses on memories. If the device you need is in LTB, you can “bank” die stock with HMP. Alternatively, the company produces custom modules mounting later-generation die, packaged or unpackaged, on a substrate that reproduces the pinout of an earlier memory device. HMP acknowledges that, if you must use a memory with an array much larger than the one in the obsolete part, power demand may be higher than for the original, but the company claims it can almost always configure a fully functional equivalent (Figure 1). HMP can test and qualify the completed modules to the specifications of the original design.

Footprint conversion as a stand-alone offering is also available to counter package obsolescence. One company offering this service is Winslow Adaptics. Adapters can be standard or custom and can be limited to rerouting the pins of a current device to match an older pinout, or they can host a number of components to form a small module that emulates the function of an obsolete device (Figure 2).

Older ASIC designs pose another obsolescence problem—particularly if the overall lifetime volume is low: Manufacturers are likely to have made your original purchase in only one or a few batches, and supplies are now exhausted. Progress in silicon technology means that the process used to fabricate the original devices is likely now unavailable, or a realistic minimum order to run that

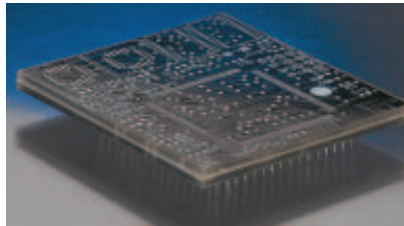


Figure 2 Footprint converters can allow the use of new package styles without requiring a board redesign. When a board design is required, they can provide continuity of production and support a planned upgrade program. This Winslow Adaptics adapter allows several fine-pitch surface-mount devices to mate to a through-hole pin footprint.

process would produce much more than you need. “Older” in this context can mean as little as five years old, with the large ASIC companies already making processes of, say, 0.65 micron obsolete. Redesigning the ASIC to target a current process is an option, although with the NRE (nonrecurring-engineering) costs that include a new mask set, it is likely to be an expensive one. Retargeting an ASIC from, say, 1-micron technology to perhaps 0.25 microns also drastically reduces the die size; if your requirement is numerically limited, an economical minimum order may still present you with far more devices than you will ever need.

FPGAs REPLACE OLDER ASICs

When you need to obtain modest volumes of chips to replace older ASICs, the programmable-logic companies are

waiting in the wings to assist. That obsolete ASIC in 1-micron technology (or older) from five or 10 years ago is likely to have tens of thousands of gates; ambitious for its time, it will now fit comfortably onto one of the smaller devices from Altera, Xilinx, Actel, or the rest. All FPGA vendors report a steady level of interest in ASIC replacement for older designs. Altera’s European marketing director, Paul Hollingworth, notes, “Designs usually convert without much trouble, and today’s programmable parts will accommodate most older ASIC designs.” However, he cautions that difficulties can arise when the original design uses many levels of combinatorial logic. “Conversion is always easiest from a design that was fully executed in HDL,” he claims, “and as with any re-engineering project, the more complete the design documentation, the better.” Hollingworth also notes that you will probably need a board redesign, because it’s unlikely you will be able to duplicate the exact pinout and, perhaps, signal levels of the original device. And, if you are using an SRAM-based device, you will need to provide memory space for the programming bit stream.

Application-support engineers at Actel echo these points, where support for ASIC respins has extended to the company’s repackaging die in special packages to match older formats. With its antifuse technology, Actel has been able to address both the security concerns of the military market and that market’s—for

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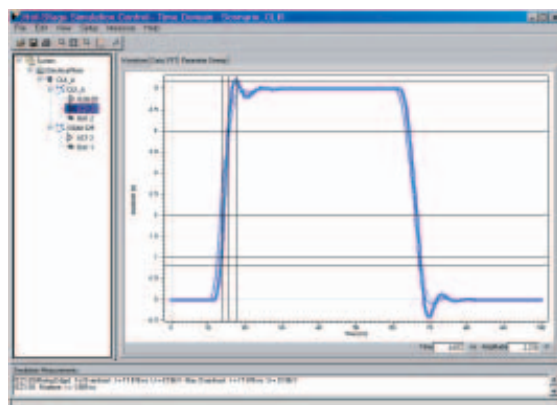
the lack of a better term—distrust of programmable logic.

Lattice chief executive officer Cyrus Tsui notes that his company's in-system-programmable devices have an edge in the military market. Incorporating features that prevent users from viewing the programming bit stream, these devices offer a measure of added security that the market may see as vital.

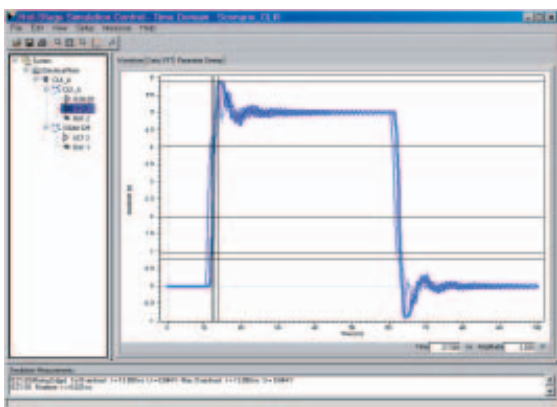
However, if you have encountered reluctance to the use of programmable devices in the past, you may find that the climate is changing. In the United Kingdom, Nallatech has been carrying out work for the Ministry of Defense to examine whether the bias against PLDs is founded in fact or a prejudice based on the perceived "soft" nature of the devices that technology advances have outdated. Senior systems engineer David Shand indicates that Nallatech's results show that users should treat programmable devices as "hard" devices, and they should be acceptable in a wider range of projects.

Programmable logic may also help you overcome another major barrier to switching from one generation of silicon technology to another: voltage levels. Any design built before, say, five years ago or in 0.65-micron or earlier technology almost certainly used only 5V power and logic-signal levels. Interfacing newer parts will mean accommodating power rails at 3.3V or less and different logic-voltage swings. All programmable-logic makers now offer I/O cells that you can program to accept a variety of signal-voltage ranges. Even they may not always support full-5V-TTL signaling; as the PLD makers progress along the technology curve, they are producing devices that will no longer handle 5V. For obsolescence purposes, however, this new generation does not present a problem, because the PLD business still lists parts that conform to device specifications from its earliest days.

In replacing an earlier technology with a later one, a further generic problem ap-



(a)



(b)

Figure 3

Upgrading from one generation of logic to another may trigger a signal-integrity problem, even when your replacement part is a fit, form, and function alternative. This board-level simulation by Zuken simulates a section of pc-board track. In (a), the logic generation is HCT, and the simulated waveform shows a 200-mV overshoot. In (b), only the logic family has changes (now ACT), and the overshoot is 844 mV.

plies, whether you are dealing with ASICs, PLDs, or basic logic families: timing. Newer generation devices perform better, perhaps radically better, than their obsolete counterparts. Any departures from well-structured synchronous design practices—and such departures do exist in older designs—can appear as race conditions where none existed before. Newer device technologies have faster signal transitions with more energy in the edges, and can produce signal-integrity problems where none existed before.

Markus Bucker, EMC-development manager at EDA vendor Zuken, describes two types of engineers with high-speed board problems: those working with the problem and those who don't yet know they have one. Retrofitting a new-generation part to an old design can create an instant signal-integrity problem; **Figure**

3 shows a simulation of a real section of pc-board track in FR4, with a logic driver and a receiver. Simply changing the generation of standard logic parts from HCT to ACT, both with a 0.62-nsec rise time, increases the ringing overshoot on the waveform edge by more than 0.5V, which might be all that you need to disrupt board operation. Retrospectively analyzing a complete board is probably unrealistic during component replacement, but, again, thoroughly documenting the project and retaining all of the pc-board-layout files means that you can examine critical nets to determine whether the proposed obsolescence solution will create new problems.

You may be able to avoid component obsolescence in future designs for long-lived systems by resorting to reconfigurable systems and board-level designs. If you can base a platform on a large amount of programmable logic, you can potentially replace a number of subsystem-level items with one generic unit (a plug-in card or module), which you can program to fulfill a particular role as needed. You could ap-

ply the principle to program maintenance, so that during the continuing evolution of a system's life, you design successive generations of the generic platform in the latest technology. You could also use it to reduce the spares and support burden, so that you could program given functions on the spot using a generic spare. Few products produced with this philosophy are yet in service, but companies such as Chameleon Systems and Nallatech offer an indication of how such systems may be evolving. To implement such a philosophy, you need to abstract the required system function away from a specific hardware implementation and retain all of the project documentation at that IP (intellectual-property) level. If this method sounds familiar, it is similar to the much-hyped effort toward "design reuse," and many of

the same rules apply to making a “soft” systems definition work.

Another option to try when you’re faced with an obsolete component of any kind is an Internet search for the part number. You can also employ the services of numerous brokers, some of which are Internet-based, who will attempt to source supplies of a discontinued part. However, you should approach these alternatives with caution. Not all services are created equal, and you may find yourself with items that are of dubious traceability or even authenticity. No matter what the date codes say, the brokers may give you no information about how the parts have been stored. At the very least, you should retest any components sourced this way to original specifications. If even these measures fail to locate a replacement, you’ll need a commitment to begin a revision or a complete redesign of the board or product.

COST MODELS

Design refreshes or complete redesigns are progressively more costly options, and

those with a need to quantify exactly how costly should look at the models that University of Maryland—College Park professor Peter Sandborn has developed. This work explores the field in minute detail, including such aspects as life-cycle modeling and part-obsolescence forecasting. It also attempts to quantify a matter that has more often been treated as a matter of intuition or necessity: how to optimize the interval between design revisions and redesigns over the life of a long program. In the space available here, it is impossible to do any more than mention the name of this program—the CALCE Center’s MOCA (Computer Aided Life Cycle Engineering Center’s Mitigation of Obsolescence Cost Analysis) program at the University of Maryland. However, one figure is worthy of note: When you take all factors into account, the real cost of dealing with an obsolescence problem is typically 10 times the cost of replacing a component and includes everything from the cost of revising manuals and handbooks to the loss of time you could be spending on new projects.

The obsolescence problem demands an active approach—managing past products and monitoring their ongoing support needs while organizing new designs to minimize the effects of future changes in component supplies. In part, this approach is administrative; you need systems that are aware of all of the sources of supply at the component level and that continuously monitor their status. A rolling program of length-of-supply commitments from suppliers is valuable but no guarantee. Your suppliers also have suppliers, which can in turn suddenly obsolete materials or components, cutting a supply chain without warning. At the design level, as with so many other aspects of project management, there is no substitute for comprehensive and detailed documentation of every aspect of a product’s design. Replacing a suddenly obsolete component is difficult enough: If the only person who knows all the component’s details left your team months or years ago, the task is infinitely worse.

With manufacturers now outsourcing

so much production to contract electronic manufacturers, these contractors have also had to develop management strategies around obsolescence. At Flextronics, for example, part of the task of bringing a design into the company's processes is to "sweep" its entire bill of materials for known and impending obsolescence problems, drawing on the company's knowledge of component purchasing worldwide. (Tools are evolving to automate this process; see **Reference 1** for more information.)

Support is also available through DMEA and other bodies associated with the DMSMS problem. For example, the Teaming Group brings together independent obsolescence-management contractors and government organizations, predominantly in a military context. In the United Kingdom, COG, a commercial/industry initiative, has published a booklet that briefly outlines how to develop an obsoles-

cence-management strategy (**Reference 2**). COG and the UK's Department of Trade and Industry have also set up the National Obsolescence Center. Among other functions, this center collates LTB notices for subscribers.

FUTURE PROBLEMS

It appears that the component-obsolescence problem can only get worse; the pace of progress in semiconductor technology shows no sign of slowing, and older processes will be left behind at a similar—if not faster—rate than in the past. Those anticipating an upturn in the business environment in 2003 should also note that, when orders for current production parts are growing and wafer-fab loadings are increasing, older processes suddenly become unavailable. You already know about the proliferation of voltage levels in logic parts in the last few years; similarly, the industry has gone from

having essentially one signaling level to now having tens of possible logic-signaling alternatives. This situation is bound to lead to a proliferation of device variants, and, over time, not all of them will continue to be available. Concern also exists over the advanced silicon processes soon to become available at less than 0.10-micron design rules. Research is still underway on their long-term reliability, extending to some fairly esoteric questions. For example, these extremely fine geometries present new, unexplored metallurgical effects. If you store die under established conditions against future requirements, even if they were inactive during their years of storage, will they still be "fresh" when you bring them into use? □

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