The Problem with Aviation COTS

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ABSTRACT

Commercial Off the Shelf (COTS) has become a byword for acquisition reform, but there are significant risks associated with the use of COTS products in military systems. These risks are especially acute for aviation systems. This paper explains how COTS can negatively affect military acquisitions and gives ideas on how to plan and resolve COTS caused problems.

To take advantage of the fast pace of technological advances in industry, the Department of Defense (DoD) is acquiring commercial products and components for use in military systems. These commercial items are called Commercial Off the Shelf (COTS). COTS provides the DoD with numerous potential benefits. Primarily, COTS purchasing allows military acquisition to incorporate new technology into military systems more quickly than typical developmental programs. COTS can also reduce research and development costs. Even more importantly, the DoD has looked to COTS purchases to help reduce operations and support costs for military systems. Figure 1, on next page, shows why this is highly desired by the DoD; the cost of operations and support is almost three quarters the overall cost of a typical system. With this in mind, what could be the worst misfortune to befall an item procured as COTS? Could the worst problem be that the item changed and the original was no longer available commercially? What if the commercial replacement would no longer work in the military system for which it was procured? The worst misfortune, which incorporates both of these problems, would be if the item were to suddenly become government unique — no replacement available commercially. Becoming government unique would not entirely defeat the purpose of a COTS acquisition, but it would significantly affect support, the longest tail and as shown in Figure 1, the greatest cost in the acquisition life cycle.

This misfortune could never affect our COTS procurement — or could it? When you have finished reading this article, you will realize that not only can it affect your COTS procurement, but also if you are acquiring aviation parts and systems, it probably already has. In any COTS acquisition, the acquirer needs to have already planned for this eventuality. This article will show you how to prepare for and give you ideas on how to constrain this COTS problem.

"Government unique" is the conceptual opposite of COTS. An item is government unique when the only source or user of the item is the government. An item is a discrete unit that can be individually acquired for the logistical support of a system. A system, in this definition, is the higher-level mission component the item is procured to support. For example, an aircraft and its support equipment is a system; a radio installed in the aircraft is an item. Whenever a manufacturer discontinues or makes a change to a COTS item, the item can become government unique. When the manufacturer changes the item, if the government either does not acquire the variant or does not reflect the change in the systems incorporating the item and the systems' documentation, the original becomes government unique. After a manufacturer makes a change to an item, the

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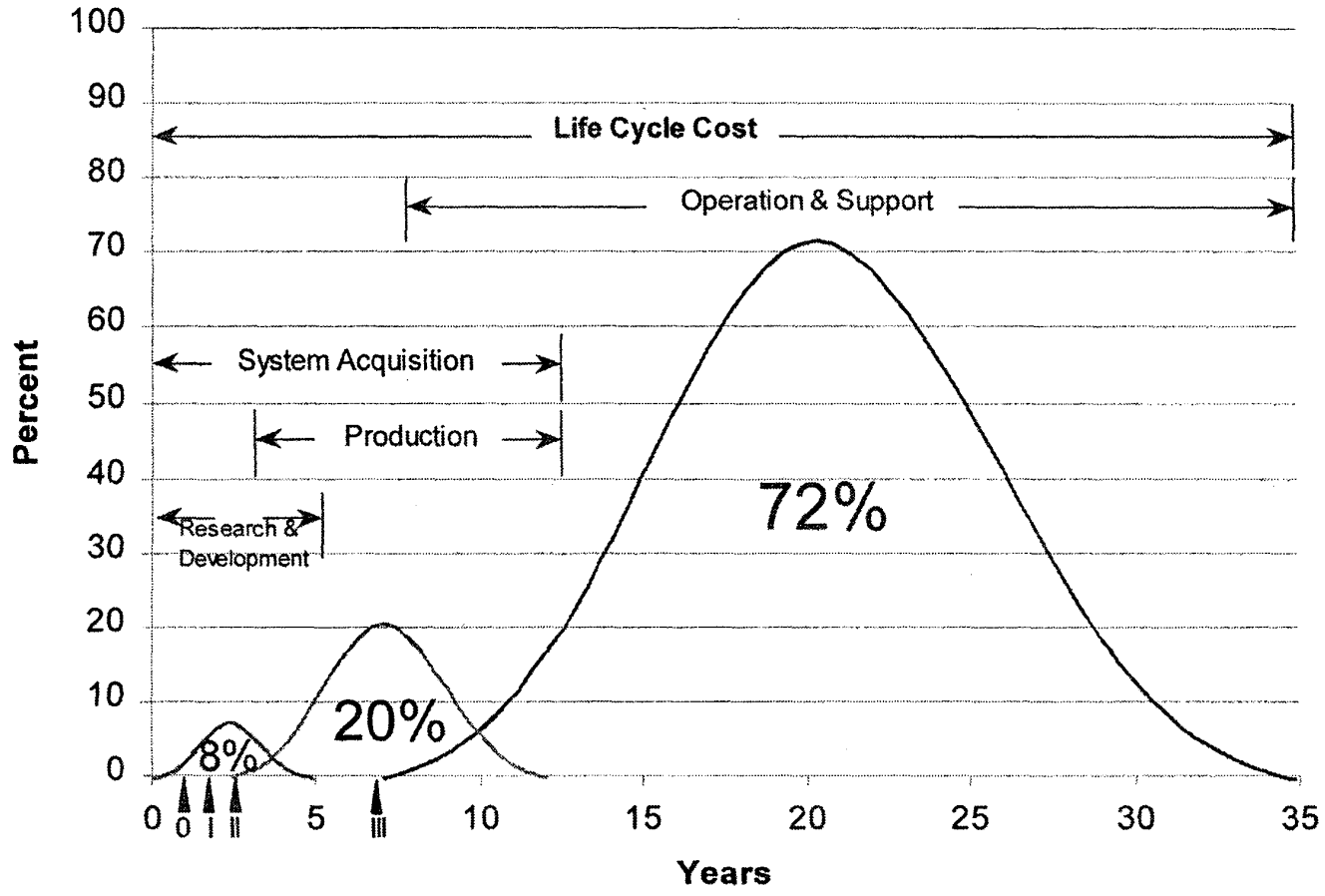

Fig. 1. Typical cost distribution

government might be able to purchase and use the new variant without any negative effect to the system. In this case, though the original item is now government unique, the change did not affect the form, fit, interface or mission characteristics of the device. Unfortunately, manufacturers' changes routinely affect form, fit, interface, and mission characteristics, and the effects of these COTS item changes for systems incorporating them are significant. The problems of changing form, fit, and interface should be obvious; if the variant item is to be installed and operate correctly, these characteristics generally cannot change. To accommodate form, fit, and interface changes, the acquirer must usually make modifications to the system. Modifications are costly and usually result in the original item becoming obsolete. Changes to mission characteristics do not necessarily result in system modifications, but if they affect the overall ability of the system to perform, they can cause significant problems. For example, if the new item has a temperature range less than the original, when it is used outside the bounds of that temperature range, the system could fail.

Although configuration changes can cause havoc in any program, the most devastating cause of government uniqueness occurs when a manufacturer discontinues an item. Figure 2, on next page, shows that for a large number of COTS acquisitions, this result is inevitable. The life of a typical military acquisition exceeds 20 years, yet the life of a typical civil product, especially in electronics is much less. From our own experience, we know it is almost impossible to purchase an "ancient" Z80 based computer, but right now, the IBM 1750 chipset, a 5 MHz Z80 generation processor, lives on in the Air Force's AP-102 computer. This problem is not isolated to the electronics industry. For example, aviation "steam gauges," the mechanical gauges on instrument panels are becoming nearly impossible to obtain — electronic gauges are replacing them.

The above concepts provide the definitive framework under which COTS must be understood: without notice, the manufacturer is free to make changes to or discontinue the

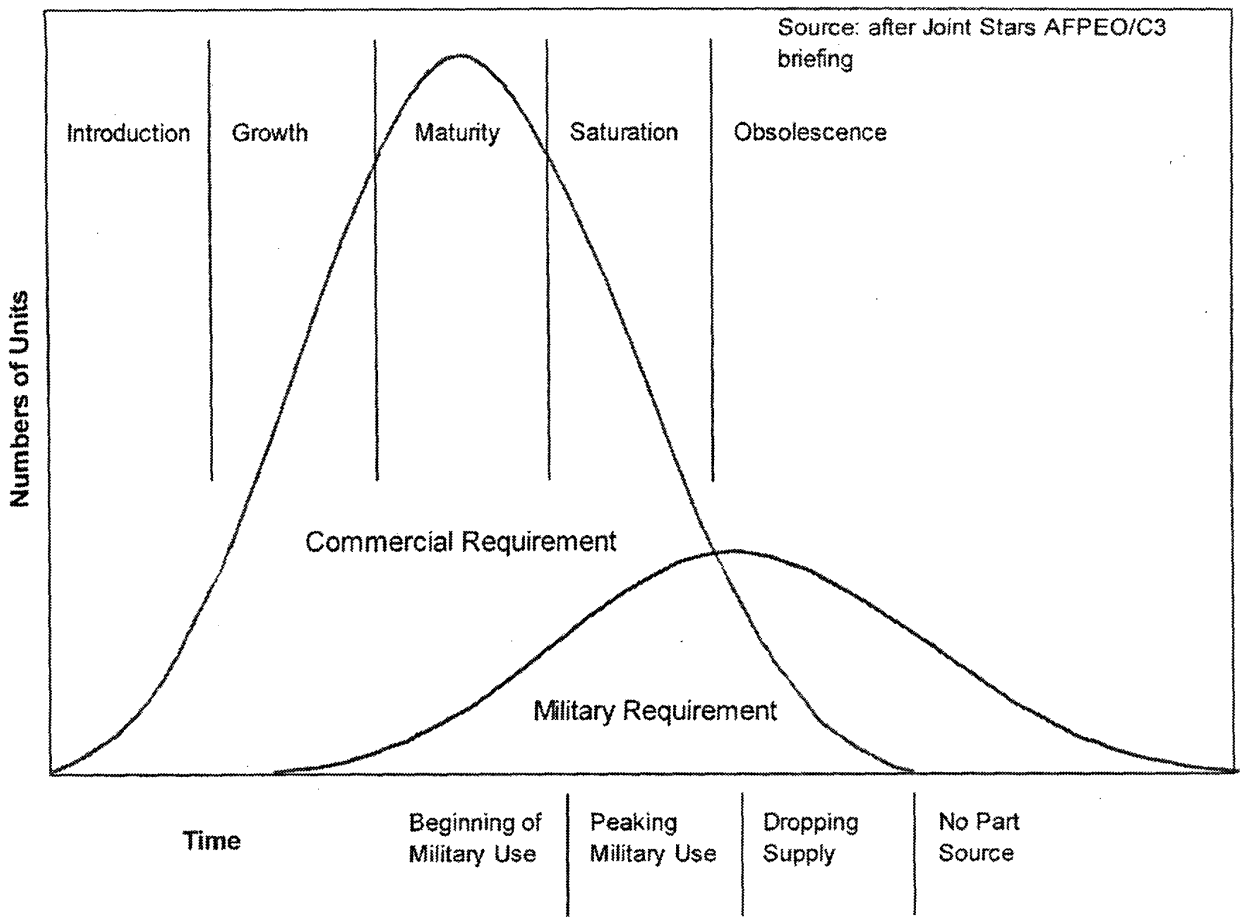

Fig. 2. COTS obsolescence

manufacture of the COTS item. As long the manufacturer's item changes do not affect form, fit, interface, or mission characteristics, the acquirer has no problem. The problem is that the acquirer has no control over these changes. When changes do affect form, fit, interface, or mission characteristics, these changes become a significant problem for any COTS acquisition. This is especially true for aviation COTS.

The effect of a manufacturer's changes to aviation COTS can be boiled down to two specific difficulties: airworthiness and forced modifications. Airworthiness is the primary safety characteristic of any aircraft. It is the primary element proven in the testing of the aircraft. The Federal Aviation Administration (FAA) certifies the airworthiness of most COTS items for aircraft, and these items must be certified in the system as well as individually. In addition, certification is an inherent governmental responsibility that cannot be delegated to a contractor [4]. Because of this, military system certification, except for FAA certified aircraft, is accomplished wholly by the aircraft's configuration management (CM) authority. In the Air Force this authority is the Single Manager (SM). What this means for COTS articles is that a simple change of mission characteristics, including improved functionality, will always drive a recertification of the aircraft. This recertification can range from a paper review to full flight test. The rate of change in COTS items can be significant. This is especially true for aviation COTS. Considering the rate of change of COTS items, frequent recertification is a daunting prospect for the CM authority. In addition, COTS item changes can also drive changes to the specifications and technical data of any system on which these items are installed — also a daunting prospect.

The other difficulty for aviation COTS, which also affects any system, is forced modifications. A forced modification is a system's modification caused by the change of form, fit, interface, function, or mission characteristic of the item. When a change affects a mission characteristic, the acquirer must support the discontinued item or find a replacement. The latter may force a modification. More common in aviation COTS is an FAA directed change to an item called an airworthiness directive

(AD) [2]. Airworthiness directives are Federal Aviation Regulation (FAR) based orders that mandate a change to an aviation item or system. These directives are regulatory in nature and "no person may operate a product to which an airworthiness directive applies except in accordance with the requirements of that airworthiness directive" [2]. The manufacturer has two choices in implementing the AD: discontinue the product or make the required change. The user of the item also has two choices: find a replacement product, if available, or make the changes required by the directive. When the change affects the form, fit, or interface of the item, an AD forces a modification to the system to accommodate the item. For FAA certified aircraft, the system must also be certified by the FAA for flight. For government certified aircraft, to comply with an AD, the CM authority must modify the system and certify airworthiness. However, the government is under no obligation to change its COTS items to accommodate an AD. If the government does not change a COTS item to comply with an AD, the item becomes government unique. Because the government self-certifies, commonly, non-FAA certified government aircraft to not make AD directed changes. Further, because in many cases, the government does not subscribe to technical changes from manufacturers, the CM authority may not be aware of ADs to a system's components. This problem is exacerbated when the CM has established a depot for a COTS acquisition and is, in that case, supporting the component without knowledge of or real commonality with the original item. ADs are not an isolated or uncommon problem. Typically on well-established air vehicles, ADs normally occur more than once per year and thousands of ADs may affect a single aircraft model.

All this boils down to the fact that, for aviation, a COTS item will become government unique in a very short period of time — from a few months to a year following the acquisition of the item. Government uniqueness means forced review, modification, support changes, and recertification when the change is recognized — or blissful ignorance and risk if the change is not recognized.

COTS SUPPORT STRATEGIES

What can be done to prevent these problems for aviation systems specifically and all systems generally? One solution has been hinted at, and this solution has been accomplished with varying degrees of success since the first acquisition of COTS items.

Organic Support

This approach is the acknowledgment of an item's potential government uniqueness before the manufacturer makes any changes. In this strategy, the acquirer purchases spares and builds a government depot activity to support the item. This solution does take advantage of the COTS item commercial development, but the overall cost savings may not be significant because the longest tail — the support tail, is at least as long as any normal government item development. In fact, the support tail may be costlier because the government has not been involved in the item development. Many programs use this strategy; the C-130 improved auxiliary power unit program is one example.

Lifetime Spares

Another similar solution is to purchase enough spares for the total life of the system and item. The AP-102 computer program used this strategy to ensure sufficient IBM 1750 chipsets to support the life of the system. Again, this is not an optimum solution because it usually increases the item's logistics tail. In this case, if the item's life expectancy is less than predicted or the item's life is extended, the government has no other recourse than to entirely replace the item or to develop a support capability.

These two solutions, government organic support and lifetime spares buy, prevent forced modifications and subsequent airworthiness certification requirements, but as discussed above, they also can introduce risk. They defeat two major potential advantages of COTS, those are: the ability to reduce the support tail; and the ability to take advantage of future commercial developments in the item.

Four other solutions exist that take full advantage of the possibilities of COTS acquisition, but they are each fraught with their own risk. Each of these solutions is a variant of what is commonly known as Contractor Logistics Support (CLS). In this context CLS does not refer to basic maintenance support but rather to data and support of modifications to support changes to COTS items.

Purchase Technical Information

In the first alternative, the acquirer can purchase the servicing information support of the manufacturer. This allows the CM authority to make decisions based on changes to the item. If the CM authority knows of a manufacturer's changes to an item, they can choose to acquire a replacement or modify the system as required to allow continued use of the variant item.

The CM has three options:

- **Option 1:** When an item changes, if the decision is made to replace the item, the CM must acquire and certify the new item.
- **Option 2:** If the item is retained with changes, the CM must certify and possibly modify the system.
- **Option 3:** If a decision is made to not make changes to the item, the CM must set up government unique support.

The advantages of retention or replacement (Options 1 and 2) are the continued COTS logistics tail and guaranteed item certification. The CM must still recertify the system. If the item is retained in its original

configuration (Option 3), the decision to support a now government unique item leads to a typical high-cost government logistics tail. To my knowledge, this pick and choose method of systems support has not been used intentionally; however, after a manufacturer has made unexpected changes to a COTS component, many programs have found themselves in this situation.

Purchase Manufacturer Support

The second alternative is that the acquirer can purchase manufacturer support for the item. The risks in this are similar to that of purchasing servicing information support; however, the manufacturer has potentially greater incentive to keep the item within form, fit, and interface configuration for the system. When changes in the system are required to support changes in the item, the manufacturer can aid the CM authority. This is a very common method used to support COTS.

Purchase Manufacturer Modification Support

In the third alternative, the acquirer can purchase the full-integrated support of the manufacturer. This allows the manufacturer to make changes to the system along with changes to the item. The contractor may have some Total System Performance Responsibility (TSPR), but the CM authority must still recertify the system. The AC-130U is using this method to manage COTS in its new Integrated Weapon System Support Program. This is the most successful method used today to support COTS items and systems through CLS; however, it requires a continuing commitment to the manufacturer and to support funding.

Purchase Full Manufacturer Support

Fourth, the acquirer can purchase full system support that would allow an integrator to automatically make the necessary changes to the system to accommodate any item changes. In this scenario, the contractor would have TSPR and a government agency other than the military (the FAA, for example) would certify the weapon system. This fourth option is used now primarily to support FAA certified government aircraft. It could potentially be used to support any government aircraft or system incorporating COTS items. A problem with this method of support is that FAA certification of aviation systems may not fulfill military requirements.

The message should be plain. COTS acquisitions lead the acquirer down two support paths, the government unique high-cost logistics trail and the COTS manufacturer support trail. Both of these paths involve risk and guarantee future costs for any system incorporating COTS items. The potential of COTS acquisitions is embodied in a lower cost development, initial acquisition, and support costs, but that potential must be balanced with the knowledge that COTS acquisitions will either force modifications and recertifications or lead to a typical government unique logistics tail.

COTS for aviation is a viable method of aircraft and aviation acquisition, but it is not a simple solution. It requires careful planning and forethought that must be incorporated into any program contemplating a COTS acquisition.

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