In today's Air Force PPBS process, it is hard to assess high-level trade-offs among AFMC logistics resources, which support the operating commands, and other Air Force resources. This chapter identifies factors that contribute to this difficulty. Any policy recommendations seeking to improve the treatment of AFMC logistics resource issues in the PPBS must address these factors.

The chapter examines each of the following topics in turn:

- A brief overview of integrated supply chain management sets the stage for a discussion of DLR supply chain management in the Air Force.
- It examines the complexity of the Air Force supply chain relevant to DLRs.
- Even though the Air Force does not understand exactly how changes in one part of its DLR supply chain affect performance elsewhere, it must maintain an accountability system good enough to manage the supply chain in uncertain times. It does this by breaking the supply chain into segments and developing well-defined ways to manage each segment. The chapter explains how this occurs.
- This segmentation makes it hard to develop and sustain a systemwide view of the DLR supply chain. The chapter explains why.
- The chapter examines how the current Air Force approach to PPBS complicates these problems.
• The chapter explains why Air Force logistics organizations and personnel are not currently well prepared to participate effectively in the Air Force PPBS process.

• These observations suggest that the principal improvement that the Air Force is pursuing in how it treats DLRs in the PPBS process, the SRRB, will probably not have the positive effects anticipated unless other enabling changes support it. The chapter briefly reviews the SRRB and explains why.

• These observations are much more in tune with those of the ongoing Air Force Spares Campaign. The chapter summarizes the relevant findings of the Spares Campaign and relates these to the approach developed here.

INTEGRATED SUPPLY CHAIN MANAGEMENT

A supply chain is a network of production processes that work together to create the products demanded by its ultimate customers. To understand a supply chain, one needs to know who these customers are and what they demand from the supply chain. What processes produce what they want? What processes support these processes?

For example, if the customers want available aircraft, one process at the base flight line removes and replaces bad parts. Another at the base repairs three-level items. Another provides parts to the base flight line and repair shops. Others repair parts and overhaul aircraft and engines at organic and contract maintenance facilities. Other processes provide parts to these facilities. Other processes move all these parts from place to place.

A bit in the background, still other processes support all of these processes by maintaining facilities, utilities, and equipment for these activities and acquiring, training, and maintaining the people who work at the facilities. Others generate, store, and move information. Other processes decide which parts to move where and which parts

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1 Many excellent references are available on supply chain integration. For more details, for example, see Kuglin (1998). For useful insight into the integration of the AFMC DLR supply chain, see KPMG Consulting (2000).
All of these activities are part of the supply chain relevant to the ultimate customers at the flight line.

Supply chain integration seeks to coordinate all these processes as seamlessly as possible so that they jointly pursue a common purpose. Together, they either minimize the total ownership cost of achieving given levels of flying hours, safety, and flexibility at the flight line or maximize the levels of flying hours, safety, and flexibility achievable from the standing network of processes and the resources they consume.

How does this happen?

- All of the key players in the supply chain view themselves as part of an integrated system with common goals.
- The key players organize themselves around the needs of the ultimate customers. These needs define the common goals of the supply chain.
- Key players in each segment of the supply chain are responsible and accountable for performance against metrics linked to the common goals of the supply chain as a whole.
- Players in each segment of the supply chain are rewarded when their behavior enhances the performance of the supply chain as a whole and penalized when it does not.
- Key players in these segments share information and experience to improve their performance over time.
- Someone is responsible and accountable for ensuring that all the aforementioned actions occur.

All elements of the supply chain need not be in one organization or report to a single authority to achieve the goals above. Quite the contrary. Successful supply chains act as networks whose parts work together over time to improve their joint performance and share the gains from such improvements. Different parts effectively “co-evolve” over time, each affecting how the other changes. But one of
the co-evolving parts must take responsibility for keeping score and tracking the degree of success in moving toward greater integration.

Sweetness and light typically do not prevail in these networks. They are full of hard bargaining and tough demands. In the end, however, they succeed only if the players in the network maintain mutual respect for and trust in one another. Supply chains succeed only if they understand themselves as fostering positive-sum games in which everyone can win over time. Finger-pointing is futile; mutual problem-solving prevails.

Building and sustaining an integrated supply chain is hard to do and harder still, the more complex the supply chain becomes. Integration is not a one-time event. It grows as individual parts of the supply chain find ways to bind themselves to common goals. It typically starts small. Demonstrated success encourages ever more ambitious integration among more players. Integration grows continuously, so long as the players continue to find more ways to build mutual gains together. No one has found a logical end to this process, the point where no further integration is worth considering.

A COMPLEX DLR SUPPLY CHAIN

The simplified process map in Figure 2.1 conveys a sense of how complex the Air Force supply chain relevant to DLRs is. The Air Force DLR supply chain primarily delivers services to its own wings, which in turn can deliver services to combatant commanders and other high-level commanders as needed. It also provides support services to other U.S. armed forces, who in turn serve higher-level commanders, and to foreign customers. The DLR supply chain relies on base-level, regional, and wholesale-level supply organizations and on base-level, depot-level, and contract sources of maintenance. These activities in turn rely on contractor parts providers, Air Force transportation and planning services (not shown, because they are pervasive), and a variety of defense agencies.

We could explode each of the simple nodes and arcs in Figure 2.1 to reveal far more complex relationships. Doing so would show that many different Air Force functional communities interact in each of
these nodes and often in the arcs as well. It would also show that
different MAJCOMs are responsible for individual parts of this supply
chain and, in the end, for finding ways to work together to keep all
the parts synchronized.

A truly integrated supply chain would manage all of these elements
to serve a common purpose—giving the Air Force DLR supply
chain’s customers the best support available from existing resources.
Such integration requires that the Air Force have a coherent and
internally consistent way to define priorities among different customers and have a clear way to link the value added by each element of the supply chain to the values of these customers.\(^2\)

No one in the Air Force has this clear an understanding of how all the parts of the DLR supply chain fit together. Individuals understand each part of the system quite well. No one, however, understands the whole supply chain well enough to optimize it, no one has the effective authority to optimize it, and no one is held accountable to optimize it.

This is particularly important when considering two kinds of scale economies inherent in this kind of supply chain. The Air Force can realize these scale economies only by coordinating the players in the supply chain who must act together to create those economies.

First, key assets in the supply chain in effect provide common capabilities that are greater if players work together than if they work in isolation. For example, large portions of the DLR spares inventory serve all players in the Air Force that rely on these spare parts. Filling the pipeline for an F-16 part benefits not only ACC, but also PACAF, USAFE, and all other parts of the Air Force using this part. Providing safety stock has exactly the same effect. So does filling RSPs when squadrons deployed by any of several players might use them in the future. Similarly, many maintenance test stands can create large-scale economies that allow higher levels of production if they are collocated than if each stands alone. Operators who rely on these stands can realize these scale economies only if they work together to collocate the test stands and use them jointly.

Second, central management of key assets can ensure that they address the most important problems of operators when the assets are in short supply. A given inventory of parts allows higher military capability if it is managed together than if it is split up because, when

\(^2\)Consider the challenge of defining and serving the priorities for two sets of Air Force customers—those flying in the continental United States (CONUS) and those deployed. Priorities would presumably seek to achieve different mission capable rates in these different locations. Today, the Air Force cannot even do this in an internally consistent way for one Mission Design Series (MDS), much less across all MDSs. Creating and serving priorities for foreign military sales and other parts of DoD present even more challenges.
managed centrally, the system can send parts to the places they are needed most throughout the Air Force, not just where they are needed in one portion of the Air Force. Similarly, a repair facility can add more value when information from the whole Air Force drives what parts to induct than when information from only a portion of the Air Force drives this decision. The Air Force can exploit such priorities centrally, of course, only if it can set clear priorities among different customers for the constrained support assets in question.

Important diseconomies of scale are present as well, of course, and they must be balanced against these types of scale economies. The larger an organization gets, the harder it is to manage to a central set of goals. Breaking up an organization can allow each part to run more effectively, even if some poor coordination between parts occurs. The improvement within parts makes up for any diseconomies resulting from poor coordination. In general, though, a falling cost of information and increasingly capable information systems make it easier and easier to coordinate large activities, favoring increased centralization of information about DLRs and of the exploitation of this information.

The Air Force’s inability to explain, to itself and others, how all the segments of its DLR supply chain fit together presents two important kinds of difficulties.

When addressing itself, the Air Force has no common set of metrics it can apply to weigh investments in one segment of the supply chain against another, much less against an investment elsewhere in the Air Force. Therefore, it has difficulty articulating the value of investments in its DLR supply chain, even within its own house.

When addressing others, the Air Force cannot explain important facts that outsiders can easily observe. For example, while the Air Force was complaining that it was short of DLRs in the air war over Serbia, the Air Force performed reliably, with high aircraft availability rates. How could it perform so well if the contentions about DLR shortages were true? The Air Force could not explain effectively that compensatory actions made up for the claimed shortages and that these compensatory actions probably could not have been sustained in a larger or longer conflict. The Air Force is still dealing with negative effects that working its maintenance troops hard had on reten-
tion and training activities, but it has difficulty clarifying the magni-
tude of these negative effects and their root causes in DLR shortages. Similarly, when Congress provides supplemental funds for DLRs, it has difficulty understanding why these funds do not appear to improve readiness much. They do take pressure off personnel in military maintenance activities and give the Air Force breathing room to rebuild its human maintenance capital. But Congress cannot see how such improvements relate to funds for DLRs.

SEGMENTING THE DLR SUPPLY CHAIN TO SUSTAIN ACCOUNTABILITY

Personnel in the Air Force know a great deal more about what happens within each segment of the DLR supply chain that they control than about how these segments work together. Supply personnel in ACC have a common understanding of their mission and use common language, goals, metrics, and data systems to pursue their mission. Maintenance personnel in AFMC have a common understanding of their mission and use common language, goals, metrics, and data systems to pursue their mission. So do inventory management personnel in AFMC. The same could be said of each functional community in each MAJCOM associated with the supply chain, from the traditional logistics functions of maintenance, supply, transportation, and planning to the financial management, manpower, personnel, contracting, and other functional communities that support them.

Each of these communities understands its situation well enough to sign up to specified performance targets and take responsibility for meeting these targets, so long as each community controls the factors relevant to the performance in question. Supply activities focus on targets relevant to the inventories they control directly; base maintenance focuses on activities that it controls, such as cannibalization rates; and so on. Each has a pretty good idea of which

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3 “Cannibalization” occurs when a base maintenance shop takes a part it needs for a particular repair off an MEI that it supports rather than getting the part from the supply system. This occurs only when the supply system cannot provide a part quickly, and waiting for a part would reduce the overall performance level of the activity that the maintenance shop supports. The base maintenance shop directly controls how much of this occurs.
resources are required, with current process arrangements, to meet any set of targets, again so long as they control all factors relevant to that performance. None of them is comfortable performing against a target, such as number of sorties available, more relevant to their immediate customer than to themselves. This is true, in part, because they control only some of the factors relevant to this performance and, in part, because they do not really understand the factors outside their own community relevant to such performance targets.

Under these circumstances, the Air Force has sought performance targets for each segment that meet these criteria. Depot-level maintenance personnel, for example, pursue efficiency targets, defined either in terms of efficiency in the utilization of the existing labor force or, increasingly, of the financial performance of the Depot Maintenance Activity Group (DMAG) fund. Similarly, wholesale supply personnel pursue MEI availability targets defined carefully to reflect only things they control. The dominant outcome metric in this community is the total non-mission-capable rate for an MEI caused by supply (TNMCS) or, even closer to the supply community, the stockage and issue effectiveness it achieves when it passes items to the next segment in the DLR supply chain.

CONSEQUENCES OF SEGMENTATION

Focusing on such goals and metrics has three important effects: First, it makes personnel in each segment comfortable enough to take responsibility for them. Second, it induces personnel in each segment—typically defined by a function and/or a MAJCOM—to think locally rather than globally. That is, it explicitly cuts off each segment from the broader supply-chain-wide picture, which is precisely the intent of such metrics because doing so allows each segment greater control over its own destiny. Third, it makes it most difficult for the senior leadership of the Air Force—which is much more interested in supply-chain-wide metrics that address military combat capability, safety of flight, and cost than it is in each bit of the chain itself—to understand the value of improving performance in any part of the DLR supply chain. In other words, choosing such goals and metrics breaks up the Air Force supply chain in ways that fundamentally separate most segments of the DLR supply chain from
the things the leadership values, such as mission capability and Air Force-wide costs. This, in turn, has two further consequences.

First, such segmentation amplifies the effects of a broader DoD effort to distinguish “tooth” from “tail”—military capability from support capability—and reduce resources in the tail to make them available to the tooth. This simple distinction views support almost entirely in terms of its cost, transforming it into a bill-payer for tooth. In the extreme version of this view, there is no recognition that cutting the size of the tail might reduce effective support to the tooth and thereby damage military capability.

Seen through the tooth-tail lens, the segments of the DLR supply chain outside the Air Force operating commands all fall into the tail and become natural bill-payers. Cost reduction is obviously a valid and important goal in these segments, but the tooth-tail lens transforms that goal into the dominant goal. The dominant guidance the senior leadership gives the AFMC portions of the DLR supply chain in the PPBS process is to reduce their cost to free up resources for modernization. The leadership supported lean logistics, now agile combat support, not primarily for its ability to reduce the mobility footprint or to make the supply chain more robust during a period of increased external uncertainty (both key attributes of lean logistics) but to cut requirements for inventory and thereby reduce cost. The senior leadership has repeatedly mandated performance improvements to achieve specified cost savings without first identifying how such improvements might occur. Because the Air Force has no compelling way to show how AFMC segments of the DLR supply chain contribute to the senior leadership’s military capability goals, AFMC has been unable to move the focus of the senior leadership from the cost of AFMC to the performance of the entire supply chain.

Second, almost everyone in the Air Force thinks primarily about making improvements within a segment rather than in the DLR supply chain as a whole. Even when cross-segment teams and initiatives form, it is easier for them to think about bundles of improvements in each of the segments represented than about improvement in the DLR supply chain as a whole. For example, initial efforts to implement two-level maintenance immediately ran into resistance in the operating commands, which did not want to give up the testing capability that had to be centralized to achieve a
significant portion of the improvements from two-level maintenance. Similarly, initial efforts to implement lean logistics very quickly broke into two efforts, one in AFMC and the other in the operating commands. Each interpreted lean logistics differently. Perpetuating local priorities reduced the benefits that a global implementation would have offered. Operating commands, for example, saw lean logistics primarily as a way to make AFMC more responsive to their needs. AFMC, on the other hand, used lean logistics to pursue initiatives that improved the internal performance of five specific AFMC processes, from AFMC’s perspective. Because lean logistics in effect transferred resources from supply to maintenance, transportation, and planning functions—each normally evaluated separately—the Air Force had great difficulty reaching consensus on how to validate the success of the change. Repeated reductions in headquarters staffs that might take a broader view have eliminated a potential source of broader thinking.

Even in a headquarters where cross-functional thinking is occurring, the lack of common metrics to examine performance in all segments makes consensus-building difficult. For example, consider what happens when operations (AF/XO), plans and programs (AF/XP), and logistics (AF/IL) organizations in the HAF try to work out joint positions on DLR policies and resourcing. AF/XO wants to know how changes will affect its formal war plans and its ability to field sorties in unforeseen contingencies. AF/XP wants to know how changes will affect numbers of people and dollars required throughout the Air Force. AF/IL wants to know how changes will affect the resources at its disposal and its ability to use available logistics processes to meet its targets. Each organization depends on stovepiped organizations throughout the Air Force to feed it information and support negotiations. Each organization thinks in terms of different language, goals, metrics, and databases throughout its supporting stovepipes.

In the absence of a consensus on how the Air Force DLR supply chain as a whole works, negotiations lack facts and tend to become political. High-level negotiations in a large organization can never escape politics, but factual information on how the organization’s processes work together can focus negotiations in ways more likely to produce light than heat. Without a common vision at the top, the Air Force, like any other large organization, will tend to rely on
agreements reached at lower levels, where local visions (within segments) are more complete and concrete. It will bundle tactical agreements from below to avoid the difficulty associated with reaching strategic agreements at the top.\(^4\)

**MANAGING UNCERTAINTY IN A SEGMENTED DLR SUPPLY CHAIN**

Since the fall of the Soviet Union, the external threat to the United States and the Air Force’s role in mitigating that threat have become more uncertain. At the same time, the private markets that the Air Force relies on for goods and services have become more dynamic. So, over the past 15 years, the Air Force has faced greater uncertainty in the nature of the mission it will be expected to perform and in the nature of the external sources it will rely on to perform that mission.

The Air Force has responded to this rise in uncertainty by changing key policies to make itself more agile. This has simultaneously improved the Air Force’s ability to accommodate the increased external threat and increased the uncertainty that its own DLR supply chain, internal and external, must accommodate.

For example, the EAF concept is designed to allow the Air Force to deploy quickly to deal with unanticipated contingencies without causing undue turmoil in day-to-day operations in the Air Force. The Air Force hopes that, by demonstrating its ability to meet unanticipated contingencies quickly, it will actually deter such contingencies, thereby reducing the uncertainty it must contend with each year. To make this possible, it needs a supply chain that can reliably execute and sustain a wide variety of unanticipated contingencies. In fact, the EAF concept is meaningless without a new view of the DLR supply chain. The deployed supply chain must become lighter and more agile, and the supply chain at home must become more responsive to unanticipated demands. The supply chain must sustain this ability to deal with unanticipated demands, whether they

\(^4\)Properly implemented, a balanced scorecard provides a disciplined method for framing strategic agreement at the top and driving it down through an organization. Chapter Four provides a brief discussion of ongoing Air Force efforts to implement a balanced scorecard to improve the performance of its logistics system.
materialize or not. By definition, individual segments of the supply chain cannot make such improvements without reference to a broader vision.

Similarly, matching depot repair actions to demand is an attempt to recognize that specific demands on the depot are so hard to predict that the depot should, to the full extent possible, wait until it is sure a demand will materialize before repairing a particular DLR. Matching repair actions to demands became even more important as uncertainty in the Air Force’s external environment rose. Matching repair to demand can reduce costs by reducing the number of repairs performed and by reducing the safety stock required to cover demands when repair priorities depended on other factors, such as prenegotiated quarterly production rates. But it can also increase costs by moving resources from buying DLR spares to buying repair capacity that will be available to meet any demand. The Air Force needs a sophisticated view of its DLR supply chain to do this cost-effectively; it has had great difficulty justifying its move in this direction, choosing the right algorithm to use to predict actual demands, and choosing the degree of matching—between repair and demand—most appropriate for different kinds of DLRs.

Other Air Force policies have introduced uncertainties to the DLR supply chain that were not necessarily generated by an increasingly uncertain external environment. For example, the methods the Air Force uses to set internal transfer prices and cost factors for budgeting have led to repeated surprises when the cost factors do not generate enough money in an organization’s budget to cover the internal transfer prices it must pay in the year of execution. This has occurred repeatedly for exchanges between the DMAG and the Supply Management Activity Group (SMAG) and for exchanges between AFMC and the operating commands. These surprises increase uncertainty for the buying organizations. Similarly, internal transfer prices between AFMC and the operating commands have led the operating commands to change their demand patterns for AFMC services in ways that reduce the level of services demanded and increase the cost to AFMC of each service provided from those that AFMC anticipated. These responses increase uncertainty in AFMC. All of these increases in uncertainty are direct consequences of segmentation in the Air Force DLR supply chain and a lack of understanding of how segments relate to one another.
Analytic models should help the Air Force manage such problems.\(^5\) The Air Force has maintained sophisticated logistics models to support resource planning in the PPBS process for many years. The Aircraft Availability Model (AAM) and Aircraft Sustainability Model (ASM) are of greatest importance to DLR spares planning.\(^6\) The Logistics Composite Model (LCOM) is the dominant model for base maintenance. Other models exist for other parts of the DLR supply chain.

They have major shortcomings, however.\(^7\) Even though current Air Force models often dominate analogous models in the commercial world in terms of sophistication, when faced with the challenge of linking readiness-related outcome measures to logistics resource level, these existing models face severe challenges. For example:

- The models break up the DLR supply chain and address each element of it in isolation, using simple assumptions about remaining portions of the supply chain. For example, LCOM focuses on detail on the base while using very simple assumptions about the performance of the supply system that supports the base. AAM, on the other hand, makes very simple assumptions about base maintenance and focuses on the details of the system that delivers DLR spares support to the base. No models are currently available to look at base-level maintenance and the supply system together to predict how they interact or support trade-offs between them. More generally, no models exist to portray the entire DLR supply chain.

- In each segment of the DLR supply chain, models link only a portion of all logistics resources to readiness-related outcomes. For example, AAM includes only DLR spare parts for which it can model a direct relationship between flying hours for the planning period and associated demand for spares. The Air Force has no

\(^5\)Repeated discussions with Randy King and Ginny Mattern of the Logistics Management Institute helped us deepen our understanding of the current state of the analytic supply models that the Air Force relies on most heavily.

\(^6\)For basic information on how these models work and what decisions they can support, see O’Malley (1983) and Slay et al. (1996).

\(^7\)The summary statements here are based on Mary Chenoweth’s unpublished analysis of several major supply-oriented Air Force models.
simple analytic way to link large portions of its expenditures on maintenance—for example, Programmed Depot Maintenance (PDM)—to readiness.

- The models used in each segment of the DLR supply chain do not match actual behavior well. For example, the basic functional forms in models like the AAM and ASM are not compatible with uncertainties associated with contingencies and other quantum changes in flying-hour programs. Also, although the evidence suggests that several factors often drive failures of reperables, Air Force models can only consider one at a time. This in effect increases the variability of outcomes around expectations, inducing the Air Force to invest in more safety stock and adaptability than is necessary. A third example is that current Air Force models cannot accommodate even simple constraints on repair capabilities. Finally, the optimization characteristics of most Air Force models are not consistent with the more ad hoc methods used to manage the real DLR supply chain. Therefore, the models cannot predict how the supply chain actually performs in practice. Perhaps ironically, as the Air Force learns to manage its supply chain in a more systematic way, simple models based on optimization assumptions will become more realistic and hence more useful.

- The models use unrealistic assumptions to simplify computations. For example, the models use simplifying assumptions about how bases differ, how activity levels change over time, how parameter values persist over time, and so on. Backward-looking models for estimating parameter values fail to capture likely increases in stress associated with upcoming contingencies. Even though analysts have long known that the negative binomial probability distribution does not capture state-of-the-world uncertainty in real Air Force settings, Air Force models continue to use this distribution. This assumption understates the real uncertainty the Air Force faces and discourages appropriate investments in DLR spares whose demand levels are likely to rise in a contingency.

- More perniciously, under pressure to provide support within severe resource constraints, the Air Force has often used over-optimistic assumptions to calibrate key parameters in the models. For example, the ASM assumes that major theater wars will
stress the Air Force less than objective modeling would suggest. The AAM assumes that pipeline segments will meet Air Force standards that remain significantly more demanding than current performance, despite recent improvements.

- The data used to feed parameter estimation remain incomplete, despite years of efforts to improve them. For example, LCOM offers such a detailed view of the maintenance process that it instills confidence, but the Air Force has been unable to provide the data required to keep such a detailed view up to date.8

- The Air Force has made only limited efforts to validate the models it uses in the PPBS process and, more broadly, in logistics resource management. It has not carefully tested and validated the AAM, for example, since 1978. That validation was reassuring.9 But even in this case, it focused only on the portion of the DLR supply chain that AAM modeled directly, not on all the resource decisions that the AAM might influence, because no other model is available.10 Experience in recent contingencies has revealed discrepancies between assumed and appropriate levels for many parameter values and more basically between the assumed and appropriate structures of the models used.11

So, the Air Force has created and maintained extremely sophisticated models—models that no commercially available product has been

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8For more information, see Dahlman, Kerchner, and Thaler (2002).

9The test collected observed parameter values from several Air Force data systems, calculated aircraft availability to be comparable to the definition used in AAM, and then compared the observed availability with the availability AAM estimated based on the observed parameter values. LMI found that the predicted level of availability tended to be lower than the actual, which one would expect because the Air Force can take management actions to enhance availability not reflected in the AAM. A simple regression would have allowed the Air Force to predict the actual availability rates from the estimated rates with an R-squared of 0.93. A less formal but more recent LMI assessment in 1997, using data from 1990 to 1996, found that the AAM did not perform as well in turbulent times, when full funding could not be relied on, as it did in the fairly stable period examined in the 1978 assessment (O’Malley, 1997).

10The validation focused on safety stock associated with the peacetime operating stock (POS) buy requirement for those items that have flying-hours demand drivers. To put this in perspective, Mary Chenoweth’s analysis shows that in September 2000, this portion of the POS buy requirement accounted for 14 percent of the total POS buy requirement.

11See, for example, Pyles and Shulman (1995).
able to rival in the applications where they are used. Despite that, these models do not give the Air Force a strong analytic ability to link readiness-related outcomes meaningful to the Air Force leadership—and hence the PPBS process—to logistics resources. As a result, personnel in any particular segment of the DLR supply chain are unwilling to make commitments based on analyses and metrics that extend beyond their own segment—for example, commitments to the warfighter based on metrics of readiness on the flight line or in the fleet as a whole. And these problems reduce the general level of confidence that senior leaders have in analyses of the DLR supply chain in support of decisions that involve more than one segment—in particular, more than one command or function. Because the leadership cares most about military capability, shortfalls in models that link segments of the DLR supply chain to military capability present serious problems. Such shortfalls give the senior leadership more confidence in analyses conducted within a segment than in those that span segments. Cost is fairly easy to compute within a segment; effects on military capability are not. So shortfalls in Air Force models of its supply chain make it easier for the senior leadership to sustain its tooth-tail focus. This focus effectively induces the leadership to think about many segments of the supply chain, especially those in AFMC, more in terms of cost than in terms of readiness.

Closed-loop planning and execution could also help the Air Force manage the uncertainties relevant to its DLR supply chain. A closed-loop system proposes an action, expecting the action to yield a particular result. It then takes the action and monitors the result. If the result is different from what was anticipated, it assesses the shortfall and proposes a second action likely to achieve the result, takes the second action, and monitors the result. It continues this cycle until it achieves the desired result or determines why the result cannot be achieved.

For example, simple air-to-ground attack with a “dumb” bomb identifies a target, chooses settings to place a munition on the target, and fires, assuming the target will be hit. This is an open-loop system. A guided weapon identifies a target, chooses settings to begin a course toward the target, monitors progress relative to the target, and
continually adjusts settings until the target is hit. This is a closed-loop system.\textsuperscript{12}

Closer to home, think about driving a car. A driver sees a squirrel dart across the road and decides not to hit it. An open-loop driver would quickly choose a path to steer in the road and then execute, shifting his attention to the next section of road. A closed-loop driver would choose a path to steer and then watch the squirrel to ensure that the car did not hit it. If the squirrel behaved as expected, the driver would execute his planned path and continue. If the squirrel jumped in front of the car, the driver would choose a new path to steer and look at the squirrel again. This would continue until driver and squirrel disengaged safely.

Such closed-loop systems must be able to make appropriate adjustments in a local area but do not need a systemwide model to choose settings once and for all to achieve success. By continually monitoring progress toward a target, they can learn from experience and update settings in a way that keeps a system on course. Such closed-loop planning and execution is especially useful when uncertainty makes complete understanding of a task impossible.

When making policy changes, the Air Force has a strong tendency to design a change, implement it, assume success, and then move on to the next change. It is reluctant to monitor the initial change relative to its goals and manage the change until it gets as close to the goal as possible. The most obvious example is when the Air Force implements such a change as lean logistics or a new working capital fund, takes the savings expected from the change and spends it elsewhere, and then assumes the change succeeded in future planning. The Air Force has done this repeatedly in changes relevant to the logistics system since the Cold War.

\textsuperscript{12}Control loops can exist within control loops. For example, bomb-damage assessment (BDA) can be understood as a second way to close the loop on air-to-ground attack. The Air Force expects an outcome from an attack and uses BDA to monitor whether the outcome occurred. If it did not, this "outer" loop allows the Air Force to schedule a subsequent attack. The Air Force can apply this outer closed loop around an inner open-loop process using a dumb bomb or closed-loop process using a guided weapon. Loops within loops increase the reliability and hence the effectiveness of outcomes.
SOME EFFECTS OF THE CURRENT PPBS PROCESS

The PPBS process, by itself, complicates the consideration of high-level trade-offs among AFMC logistics resources used to support the operating commands and other government resources. This is true for several reasons.

Most obvious, it takes a long time to complete. Air Force planners must make decisions over three years before some of the resulting obligations of funds in the year of execution. Related expenditures can occur even later. That was a long time in the Cold War and is even a longer time in today’s uncertain security and commercial environment. To manage uncertainty effectively, the Air Force must be prepared to update its decisions through the course of any cycle and use established milestones in the PPBS cycle to ensure that these updates shape the final product sent to the President.

Doing this in the context of the externally imposed PPBS schedule and coordinating updates across all overlapping PPBS cycles to ensure that they remain consistent among themselves are challenging enough. Simply coordinating input from all Air Force parties and interaction among all Air Force parties interested in the services that AFMC provides to the operating commands is a further challenge. Getting such mechanisms right can easily absorb Air Force attention and divert it from the substantive task at hand, which is developing the best program and budget possible for the year of execution.

OSD defines a few key dates in the PPBS process. The difficulties discussed below flow almost entirely from Air Force decisions on how to operate within the broad outlines of OSD policy on PPBS.

Updating its decisions through the course of any PPBS cycle becomes more complex and demanding as more players participate. If data must repeatedly flow from MAJCOMs to the HAF to OSD and back to complete an update, all players’ inputs and responses must

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13 Uncertainty induced by the commercial environment is more important to the Air Force today than in the past for two reasons. First, global commercial competition has become more fierce, product life cycles have shortened, and process improvement has accelerated. Second, the Air Force has increased its dependence on external commercial providers as it has decreased in size, use of commercial standards has increased, and dependence on commercial sources has increased.
be coordinated in time and in intent. Suppose, for example, that several MAJCOMs participate to reflect the joint effects of a simple updated plan for a modification or RSP. The update affects the use of AFMC’s resources, changing the mix of direct and indirect costs. This in turn affects AFMC’s prices for different items. Because these price changes cannot be fully reflected in MAJCOM budgets today, the pricing change affects users unequally and typically in unpredictable ways. This happens if everything works as planned; no one makes any errors. Even without errors, the potential for misunderstandings and inconsistencies in databases or assumptions is significant. Errors simply compound these problems. By the time someone detects them, other changes have occurred, making it difficult to determine which databases should be corrected and how. The more players involved in a significant update, the more costly the update is likely to be and, hence, the less flexible the Air Force’s use of its PPBS operating environment.

Through the 1990s, the Air Force decentralized this process internally, effectively giving the MAJCOMs more and more authority to frame the majority of the POM, which is the centerpiece of the programming effort and the critical starting point for developing a detailed budget in each cycle. The HAF relinquished more and more PPBS-related authority and resources to the MAJCOMs. This decentralization gives the final Air Force users of Air Force support services—the primary “customers” of the DLR supply chain—an exceptional opportunity to define the programs that they value most.

At the same time, the Air Force has removed effective authority from AFMC to influence the DLR-related programs that AFMC must execute to support the operating commands. The operating commands develop their own programs for DLRs. The HAF then reviews these command inputs in panels that focus on mission issues, not support issues. AFMC tends to give most attention to activities that it still programs in this process. Without effective input, AFMC has difficulty ensuring that the programs proposed by the operating commands can in fact give the operating commands the support they want. Today, the BES is the point at which the PPBS receives information on what resources AFMC believes will be required to support the POM developed earlier by the MAJCOMs and on the likely cost to AFMC (and hence the operating commands) of the program in the POM.
Planning for resources with significant scale economies becomes especially difficult in this decentralized setting. Because scale economies associated with spare parts inventories, test stands, central induction of parts for repair, central distribution of repaired parts, and so on often affect multiple MAJCOMs, these MAJCOMs must find a way to coordinate their actions to ensure that the Air Force realizes these economies. To date, the operating commands have not been able to do so. When short of funds to meet all of their high priorities, they are reluctant to pay for assets they effectively never see, such as pipeline and safety stock that sits primarily under AFMC control. They are even reluctant to pay for spares they value highly, such as RSPs, because the current logistics system does not guarantee that they have first call on these assets in a contingency. Any inventory control system that provided such an assurance would sacrifice scale economies in its RSP investments. When AFMC uses its models to argue the need for central pipeline and safety stock to support the operating command programs, the operating commands question the validity of AFMC’s models.

In sum, placing programming primarily at the MAJCOM level makes the PPBS process feel like a zero-sum game. Each player looks for a way to extract whatever it can, from beyond its assigned budget constraint, to support its program. In such a setting, it is natural to expect an operating command to look for a free ride on the investments it hopes others will make in the common assets that build scale economies. Unfortunately, no one has an incentive to invest. It is natural for operating commands and AFMC to point fingers at each other, seeking to induce the other party to invest to improve its own performance. Unfortunately, neither side has an incentive to invest. The result is the Air Force has a great deal of difficulty achieving consensus on an internally consistent plan of PPBS roles and responsibilities for the MAJCOMs (including AFMC). Without agreement on such a consensus, the Air Force has difficulty funding investments with effects that extend across MAJCOM lines. Investments in spares, test stands, and central control mechanisms that could benefit many players simultaneously are particularly at risk.14

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14 Better visibility of the supply chain as a whole at the Air Staff level could help the Air Staff reduce and arbitrate disagreements among MAJCOMs in the interests of the Air Force as a whole. However, it would not resolve such disagreements effectively until
As responsibility for programming AFMC services for the operating commands has shifted more and more toward the operating commands, another problem has gained attention. When the operating commands program for AFMC support activities, the operating commands bear the full brunt of the resource constraint imposed by the PPBS process. They are forced to choose between getting AFMC support services and getting something else they value, such as MEI modifications or improvement of the quality of life on base. AFMC faces no similar budget constraint. Rather, preparing for the BES in each PPBS cycle, it calculates the costs it expects for particular maintenance and repair tasks and uses these to build cost-based prices that it will charge the MAJCOMs when they ask it to execute these tasks. If decisions made in the PPBS process constrain what the operating commands are willing to spend on AFMC services, and AFMC charges cost-based prices for these services, budget pressure in an operating command or loss of productivity in AFMC tends to reduce the level of service the operating commands can buy and presumably affects their performance. That is, constraints tend to bind and hurt the operating commands more than they hurt AFMC.

Such asymmetric treatment of AFMC and the operating commands in the PPBS process further angers those in the operating commands who believe AFMC has not downsized as aggressively as the operating commands have since the end of the Cold War. Anger increases when updated AFMC prices enter the PPBS schedule in the BES, through no fault of AFMC, after the operating commands have submitted their programs based on earlier prices. Because such updates generally increase prices, they automatically reduce the level of support to the operating commands. The resultant anger complicates efforts to sustain cooperation between AFMC and the operating commands it serves.

A critical element of coordination within the Air Force that might address such issues is the development of the APPG that sets the stage for writing the POM.\textsuperscript{15} With planning input from the MAJCOMs, the HAF develops the APPG early in the PPBS cycle. The guidance tells the MAJCOMs explicitly what the HAF expects to see in

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\textsuperscript{15}See, for example, U.S. Air Force (2000b).
their POM submissions. It provides an opportunity to state specific roles and responsibilities for each player in the POM-development process and to define the metrics that will be used to justify proposals included in the POM. This element of the PPBS process presents three serious problems with regard to programming and budgeting AFMC support for the operating commands.

First, recent APPGs have framed guidance for AFMC support service primarily in dollar terms. Some guidance requires MAJCOMs to fund a certain percentage of established requirements for such line items as procurement of aircraft and missile initial spares, programmed depot maintenance and overhauls, total spares, and vehicles. Some guidance mandates reductions in operating cost and forward support footprint and requires MAJCOM investment in cost-reduction and cost-savings initiatives. None of these mentions potential effects on military capability or other measures of importance to the senior leadership. In all likelihood, lack of such metrics reflects the problems with segmentation stated above: no models are available to link AFMC activities to other metrics that interest the senior leadership more, such as mission capability; AFMC is unwilling to be held accountable for other metrics not entirely under its control; and, given its tooth-tail perspective, the leadership is content to view cost as the metric of primary relevance to AFMC. In all likelihood, the APPG cannot abandon this perspective until this broader context, in which the APPG operates as one statement of general Air Force policy, changes.

Second, the logistics community does not appear to have contributed effectively to the APPGs drafted in recent years, particularly the portions of these documents relevant to AFMC support services. ACC, as the MAJCOM with primary responsibility for framing agile combat support policy in the PPBS process, has primary responsibility for developing input from logisticians to the APPG process. Participants in the Logistics Panel have focused increasingly on topics of internal interest to AFMC only. Broader and better-coordinated input could provide a forum in which to pursue more effective integration of the MAJCOMs on DLR spares and other logistics policies in the PPBS process.

Third, the review of submissions from the MAJCOMs gives the HAF its primary opportunity to shape these submissions into an inte-
grated whole. With clear resource-constrained guidance, the MAJ-COMs could more easily submit material that could contribute to an integrated program. Using the APPG as the first step toward effective HAF review could provide a powerful tool in support of central integration. Today, the APPG is not resource-constrained and hence cannot be used directly to review POM submissions from the MAJ-COMs. Now that almost all Air Force resources have been distributed to the MAJCOMs for programming—the HAF retains less than $1 billion for its own discretionary use—it makes sense for the APPG to be resource-constrained. As noted above, such a change is likely to be most valuable for resources with benefits and costs that flow across MAJCOMs, such as spares, test equipment, and centralized control mechanism for logistics support activities.

As the PPBS process works today, the guidance used in the Air Force has not prevented the AFMC logistics community from spending significantly more than was budgeted in most recent years. Some argue that this is a sign of poor management in AFMC. If it had achieved target levels of productivity, it would not have overspent its budgets. If it had repaired the right items, it would not have wasted a portion of the funds it received. Others argue that AFMC is paying for services that the operating commands need but do not pay for. For example, AFMC may draw down the working capital fund to pay for RSPs that the operating commands cannot buy. Or it may draw down the fund to pay for over-and-above items in programmed depot maintenance actions that the operating commands cannot fund. These pros and cons need not be mutually exclusive. Arguments on both sides may apply in any particular situation.

No matter what drives these overruns, such consistent behavior over time suggests that, unless basic changes occur, the Air Force can expect to build a program and budget during its PPBS cycle that will require significant adjustment in the year of execution. “Adjustment” means three things.

First, the Air Force must decide whether to react to such overspending by cutting its operations in the operating commands. The Air Force prefers to avoid that outcome, but mission capable rates and other measures of aircraft availability have drifted down persistently since 1991.
Second, to avoid this, the Air Force must find other sources for the funds required to sustain operations. Congress is a possibility. The Air Force aggregates a package of additional needs each summer for congressional consideration. Congress is more likely to be receptive if the Air Force can link such a request to the effects of unanticipated duties, such as deployments, or at least to the need to sustain the flying hour program to maintain training and other activities relevant to the readiness of the Air Force. Each year, the Air Force finds additional funds here. In effect, the expectation of such supplemental funding can loosen the Air Force’s resource constraints during the PPBS cycle. If it can always expect Congress to provide supplemental funding for resources critical to readiness, such as DLR spares, it can underfund the resources during the programming and budgeting process without much risk.

Third, if congressional funds cannot cover the full overrun, the Air Force must look internally for opportunities to reprogram funds. This creates turbulence every summer. To date, the Air Force has accepted such turbulence rather than impose controls that would prevent the use of supplemental funding late in the fiscal year.

The main point here is that adjustments during the year of execution appear to be an integral part of the process that the Air Force currently uses to program and budget its logistics activities. Any assessment of how the PPBS process treats the logistics services that AFMC provides to support the operating commands must address what occurs in the year of execution as part of that assessment.

HOW THE AIR FORCE LOGISTICS COMMUNITY PARTICIPATES IN THE PPBS PROCESS

The segmentation of the Air Force DLR supply chain is reflected in how logistics issues enter the PPBS process. For the most part, issues relevant to AFMC support of the operating commands enter the process through the operating commands being supported. These commands bring their proposals for support to the HAF as part of their MAJCOM POM submissions, which are reviewed in the panels of the HAF Corporate Structure responsible for the MEIs supported. Input to these panels then moves up through the Corporate Structure, where major conflicts that could not be resolved at lower levels
are addressed. This process creates a final document for review by the Secretary of the Air Force and the Chief of Staff, where final adjustments occur.

In principle, many knowledgeable observers believe that this provides adequate exposure for AFMC’s support activities and adequate integration across the Air Force. In fact, this process so diffuses issues about AFMC’s support activities that they do not receive high priority in any forum where they are considered. As the issues of greatest importance to each MAJCOM and then each panel absorb the MAJCOMs’ and panels’ attention, AFMC support issues tend to get pushed aside.

Even where these issues are directly addressed, the operating commands tend to focus on elements of AFMC support most visible to them. This perspective tends to undervalue investment in pipeline and safety stock that supports all operating commands but is not visible to them. The operating commands are most concerned with having enough funds to pay for the specific items they asked to be repaired—typically items that require repair because of the activity levels of the operating commands.

In sum, because no one player providing direct input to the POM has responsibility as an advocate for the Air Force supply chain, the players tend to advocate other demands in preference to investment in the DLR supply chain.

THE SRRB CANNOT ADDRESS MOST OF THESE ISSUES

The primary Air Force initiative already under way to improve how the PPBS process addresses logistics resource questions is the SRRB. Emulating the long-standing, annual Maintenance Requirements Review Board (MRRB), the SRRB brings together representatives from all the MAJCOMs, AFMC air logistics centers (ALCs), and the HAF to develop a consensus statement of what the “true spares requirement” is for the Air Force as a whole in any particular PPBS cycle. Although not required to do so by its charter, it will also probably allocate that requirement among MAJCOMs to recommend a “fully funded” requirement for each MAJCOM with programming and budgeting authority.
The SRRB initiative emerged from the observation that persistent downward trends in mission capable rates for all major Air Force aircraft types since 1991 might be the result of a persistent failure to define the requirement for spare parts properly. The SRRB seeks to reverse these trends by defining the total requirement for spares with enough authority to encourage full funding of the “true” requirement in the PPBS process each year.

More specifically, the SRRB will change how the AFCAIG calculates MAJCOM requirements for DLRs each year. Until the Air Force ended free issue of DLRs to the operating commands, the AFCAIG focused on costing weapon systems. AFMC used central requirements computation to determine the requirement for DLRs as part of its standard PPBS submission. When AFMC began to sell DLRs to the operating commands, AFMC could not tell its new customers how much money each of them would need to program to buy DLRs because its models had no detail on MAJCOM demand. The HAF asked the AFCAIG to develop a requirements approach to allocate DLR funds among the MAJCOMs. Applying its standard approach to calculating operating and support cost factors, the AFCAIG observed what the operating commands paid for DLRs each year, looked at expected changes in their operations for the next year, and used these data to estimate expected DLR costs in the next year. For a variety of reasons, this approach systematically missed a significant portion of the Air Force demand for DLRs. Result: the “fully funded requirement” determined by the AFCAIG could not fund the DLRs the Air Force actually needed to maintain its stated mission capable rates. Recommendation from the SRRB Integrated Process Team (IPT): make a technical improvement in the estimation process to include all valid demands.

The observation that the AFCAIG process systematically underestimates demand for spares consistent with any stated total non-mission-capable rate caused by supply (TNMCS) appears to be correct if AFMC’s requirements models are valid. Even if this were true, which of the issues discussed above would this change address directly?

- The SRRB will continue to rely on AFMC requirements models that have been challenged on a variety of grounds, several of which have been discussed above. Correcting the assumptions
in these models will help, but until these models are consistently validated against actual Air Force outcomes, doubts will remain. Those doubts will undermine the general acceptance of any “true” estimate based on these models.

• The new SRRB approach still fails to link spares requirements to actual availability of aircraft. It does so for the old reason—AFMC is unwilling to be held accountable for an outcome over which it has only partial control. Without adequate models, AFMC does not believe its actions on spares can be confidently linked to actual availability on the flight line. So, because of the segmentation of the DLR supply chain, the SRRB will continue to support a statement of spares requirements defined in dollar terms only. Spares will continue to be perceived in the PPBS process primarily in terms of their dollar burden not their contribution to readiness.

• Disagreement among the MAJCOMs about the allocation of the cost of this “true requirement” will continue. Each still has a strong incentive to induce the others to pay for pipeline, stock, and RSP inventories that all users benefit from. The presence of scale economies for these parts means that the SRRB still cannot easily allocate their costs among the relevant beneficiaries of a buy.16

• Hence, it is highly likely that the operating commands will continue to question whether the spares requirements developed by the SRRB are affordable when compared in priority to other things they must pay for each year. And the HAF will have little basis for questioning operating command reluctance to fund the SRRB stated requirement.

• Emphasis on a single “true” requirement, combined with efforts to shift cost to others, will support a low-level, tactical discussion of “eaches” that can be shifted back and forth in a zero-sum

16Scale economies give many players the benefits of relying on the same assets. It is technically impossible to allocate the costs of these assets in a unique way to those who benefit from them. Economists refer to this difficulty as the problem of allocating the costs of joint products. As a consequence, AFMC literally does not know who will receive an asset it buys and holds for future use, so it has no well-defined way to charge for such an asset when it buys it.
Such eaches cannot be known with any confidence in the current uncertain environment the Air Force faces.

- Without serious consideration of the high-level uncertainties associated with the external threat and commercial markets, the SRRB will have difficulty addressing strategic issues relevant to the definition of demand.

- The need to complete the “true requirement” early enough to feed the PPBS process will seriously date this single-point estimate by the time the year of execution arrives, unless the SRRB adds significant effort to update the estimate during a cycle.

In sum, the SRRB effort probably recognizes a legitimate shortfall in the AFCAIG process that should not be allowed to continue. However, a number of other changes will be required for the Air Force to benefit from this correction. Those changes should give closer attention to the issues discussed above.

FINDINGS OF THE SPARES CAMPAIGN PROGRAMMING AND FINANCIAL MANAGEMENT (P&FM) TEAM

The Spares Campaign P&FM Team has taken a broader approach than the SRRB. It found that existing spares programming and budgeting processes fail to fund the DLR spares requirement for a variety of reasons similar to those discussed above. It highlights ten key “disconnects”:18

1. The process fails to enforce APPG guidance in submissions to the POM.

2. AFMC and the operating commands do not coordinate PPBS submissions.

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17In logistics parlance “eaches” refers to individual parts, considered one at a time. In an inventory worth billions of dollars, “eaches” are individual reparable units that may be worth a few hundred or thousand dollars each. An emphasis on “eaches” builds a requirement for billions of dollars of funding from the bottom up, one item at a time.

18The bullets are a direct quotation from Edward Koenig et al. (2001). We benefited from these findings as our work was under way, and the Spares Campaign benefited from ours.
3. The requirements process for DLR spares emphasizes AFMC sales to operating commands [over AFMC expenditures on DLR spares].

4. The process assumes incorrectly that MAJCOM submissions cover all spares needs.

5. The process assumes incorrectly that all funds budgeted for DLR spares go to AFMC via "sales" [when operating commands can use such unfenced funds in many ways].

6. The process does not assure programming to support important spares levels (e.g., pipeline requirements).

7. AFMC’s attempts to fund remaining spares needs in the BES commonly viewed as only a price increase.


9. The process was built around Pre-EAF environment and is poorly designed to operate in a highly uncertain environment.

10. Recursive relationship between SMAG and DMAG confounds budgeting and pricing by preventing the SMAG and DMAG from using the same assumptions when they plan prices and budgets.

The emphasis here is a bit different. For example, this report pays more attention to the broader context of the PPBS process and less to details of how that process treats logistics. On the whole, however, the findings reported here are quite complementary with those of the Spares Campaign.

SUMMARY

The Air Force DLR supply chain is extremely complex. Although the Air Force does not understand exactly how all the pieces of the supply chain fit together, it must maintain an accountability system good enough to manage the supply chain in uncertain times. It does this by breaking the DLR supply chain into segments and developing well-defined ways to manage each segment. This segmentation makes it difficult to develop and sustain a systemwide view of the supply chain. The current Air Force approach to PPBS complicates these problems. Further, Air Force logistics organizations and per-
sonnel are not currently well prepared to participate effectively in the Air Force PPBS process. These observations suggest that the principal improvement the Air Force is currently pursuing in how it treats DLRs in the PPBS process, the SRRB, will probably not have the positive effects anticipated unless other enabling changes support it. The Spares Campaign took a broader approach that touches on many of the issues raised here. The next chapter proposes a package of changes explicitly designed to address the broader set of issues discussed above.