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Seven Ways to Make the LRS-B Program a Success

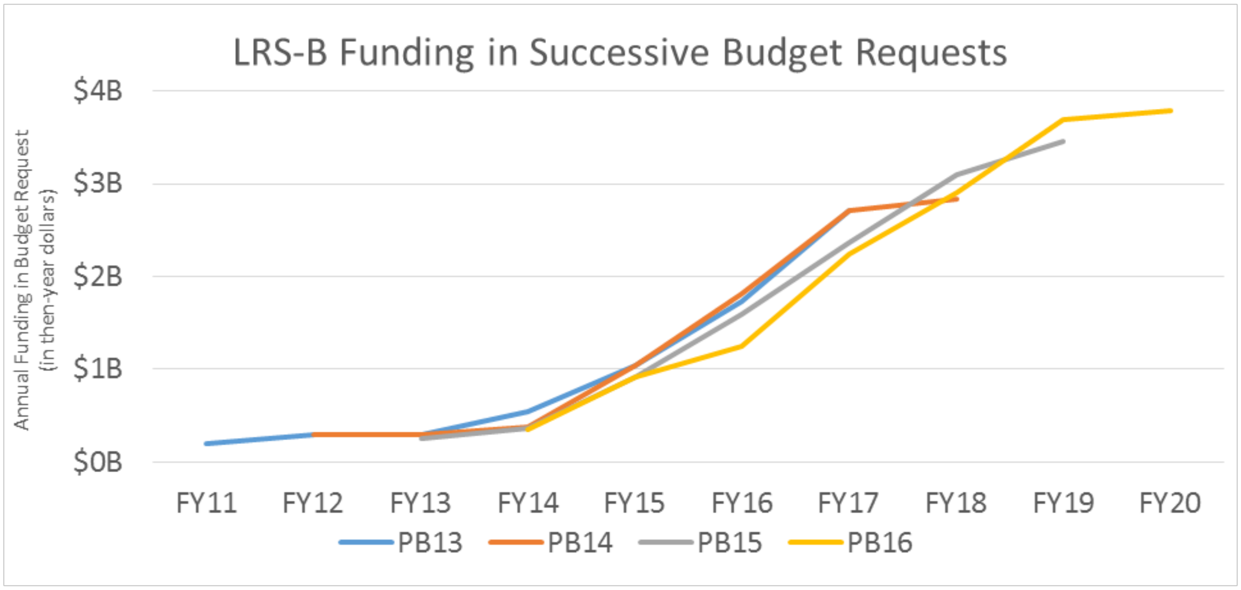
Todd Harrison and Andrew Hunter

The U.S. Air Force announced today that Northrop Grumman was selected to build the next bomber, known within the Pentagon as LRS-B (Long Range Strike–Bomber). This is one of the most consequential new defense programs for the foreseeable future and the only new manned combat aircraft currently in development. The new bomber will be an essential part of the future force, providing the ability to penetrate enemy air defenses and strike targets over great distances—quite literally putting the "global" in the Air Force's global precision strike mission. Barring a successful protest that forces a do over, the LRS-B competition is done, but the long and potentially perilous development phase of the acquisition process is just beginning. Many things can (and often do) go wrong in defense acquisitions, but here are seven things the military, contractor team, and Congress can do to help keep the program on track.

1. Provide clear and stable funding projections. When former defense secretary Robert Gates allowed the Air Force to restart the bomber program in 2010, he did so under the condition that affordability be a key requirement for the program. The Air Force set a cost target of $550 million average procurement unit cost (in 2010 dollars) for 100 aircraft. It did not, however, provide a complete cost estimate that includes development costs and the effects of inflation over the life of the acquisition program. This lack of clarity has led to many erroneous reports in the press that the total price of the LRS-B program will be $55 billion ($550 million per copy multiplied by 100 aircraft).

The Air Force announced today that it estimates the costs to be $21.4 billion for the engineering and manufacturing development phase of the program and $51.1 billion for procurement of 100 aircraft in 2010 dollars. When the effects of inflation and other development costs are included, such as the roughly $2 billion in development costs already incurred, the Air Force's total program cost will likely be more than $100 billion in then-year dollars. To be clear, this is fully consistent with the Air Force's new estimate of $511 million average procurement unit cost in 2010 dollars. With a total then-year cost roughly double what some have been reporting, there could be sticker shock in Congress. Greater transparency in the cost estimate will help set expectations appropriately.

The Air Force must also be careful not to let the new bomber be a bill payer, especially in the current budget environment. The program's early development funding has already experienced several slips and reductions over the past few years, as shown in the chart below. Some of this was due to delays in the contract award process, but if this trend continues after contract award, it can force delays in the program and ultimately raise the total program cost. Any cost overruns could quickly erode support for the program, especially since the Air Force has made affordability a key selling point for the LRS-B.



Source: U.S. Air Force Budget Justification Documents for FY 2013 to FY 2016.

The Air Force should also avoid pinning its cost reduction hopes to high production rates. Increased production rates generally lower costs through economies of scale, but by the same token, when production rates end up lower than expected, unit costs increase. Some past acquisition programs have artificially lowered estimated unit costs by projecting unrealistic production rates. Looking beyond the current constraints of the Budget Control Act of 2011 (BCA), the U.S. Department of Defense (DoD) has a projected a bow wave of modernization programs in the mid-2020s that would be formidable even under the best budget environment. The Air Force in particular plans to be at, or ramping up to, full rate production for the F-35A, KC-46A, and LRS-B nearly simultaneously—not to mention other aircraft fleets, such as JSTARS, Air Force One, and a new trainer (T-X) that are also due for replacement. It is unrealistic to think that the Air Force will be able to support high production rates for the LRS-B during the 2020s, because it would require high annual funding levels at a time when many other programs will be competing for funding. The Air Force should avoid planning high funding rates for LRS-B that are unlikely to materialize.

2. Don't tinker with the requirements. One of the major causes of cost overruns is requirements changes. It is difficult, if not impossible, to accurately predict the kinds of capabilities that will be needed on an aircraft that will be in service many decades into the future. As the program progresses, new threats will be identified, new technologies will emerge, and the temptation to change the program's requirements will be great. But the Air Force must resist these temptations if it wants to keep to its cost target. One way to do that is to reduce the number of people who could think up ways to change requirements by limiting the program office's staff, and the Air Force appears to be doing this by keeping the program office at just 80–100 people. At the same time, however, the program office needs to provide rigorous technical oversight of the contractor to keep them honest. Thus, a major challenge for the program manager will be to provide effective oversight without the needless meddling, endless reports, and reviews that can lead to requirements changes.

Another strategy to resist requirements creep is to begin pushing any new or altered requirements to "LRS-B 2.0," a future version or block of the aircraft. This provides a convenient parking lot for requirements that should be addressed at some point in the future—just not now. This would allow the program manager to acknowledge the many great ideas he or she is likely to receive as the program gets underway without derailing the program by reopening the requirements.

3. Don't oversell technical maturity. A key to the success of LRS-B will be how the Air Force and the Northrop Grumman contractor team identify and address the program's major technical risks. What's that you say? Isn't all the technology for LRS-B already mature? The answer is both yes and no. The language of defense acquisition can be more than a little confusing unless you pay attention to the context. Compared to some past programs at DoD, the technology for LRS-B is relatively mature, with significant prototyping and development done on key technologies. Most of the key technologies for LRS-B have been demonstrated in some way in an environment relevant to what they are likely to face in operations, an important best practice. In this sense, LRS-B has mature technology.

At the same time, the LRS-B is in a very early stage and substantial risk remains. The work of doing detailed design, integration, and test of a large, complex, cutting-edge aircraft still remains to be done. That is why the Air Force will likely spend $25 billion or more designing and testing LRS-B. While individual technologies may be mature and demonstrated to some extent, there remain major risks in how these technologies are linked together both physically and electronically. In this sense, the LRS-B's "maturity" can be misunderstood. Like a young athlete entering a professional sports league, the LRS-B may be mature compared to past and current fellow rookies, but it is still a rookie.

A great example of LRS-B's duality with respect to technological maturity is illustrated by the airplane's engines, always one of the costliest elements of any aircraft program. LRS-B is planning on using an existing engine design. That means this major aspect of the design is very mature. However, these engines must be added into a newly designed airframe that must handle the engines' weight, heat, and vibration inside the aircraft structure. Northrop Grumman must design and manufacture special inlets that deliver proper airflow to the engine while minimizing the bomber's radar signature. And it must design engine exhaust ports that funnel thrust out of the aircraft while again minimizing the signatures that could give away the bomber's presence. Doing all of this engine-related work will require thousands of hours of engineering and testing, a process known as integration, that carries significant technical risks of its own.

4. Focus on systems engineering. Addressing the technical risks for LRS-B requires doing the complex system engineering that identifies the ways in which key subsystems interact and generate new risks as they are brought together. Systems engineering must be done to address both physical and electronic risks in the design. For example, integrating subsystems together on an airframe requires having a detailed weight budget. How weight is allocated to the various subsystems may require modifications to subsystems that can't meet their weight budget as originally designed. Even though weight will be less critical for LRS-B, which is a large aircraft that will use long runways, than it was for the F-35, detailed systems engineering is likely to identify the need for modifications to many subsystems. Each modification takes time to design and build, adds some risk to the program, and adds a requirement for testing to establish that the modified subsystem continues to perform to its specifications. Systems engineering must also be done to integrate LRS-B's subsystems electronically. This includes writing the basic code that allows the aircraft's subsystems to communicate with each other and for the pilot to control them, understanding the complex flow of information through the system, and protecting against intrusions such as attempts to hack the bomber via a cyber attack. These are but a few examples of hundreds of systems engineering analyses the LRS-B's designers will have to perform.

The better the systems engineering done on LRS-B, the fewer problems that will be discovered in test. Quality systems engineering will identify the potential showstoppers in the design, issues that can "crater" the aircraft, and allow those issues to be worked aggressively early in the program, particularly through additional risk-reduction prototyping and testing of those integration issues. Another way of reducing risk is to build in alternatives and off-ramps. For issues identified as potential showstoppers, this means identifying lower risk alternatives and establishing built-in decision points where the higher risk approach can be pulled out of the design and the lower risk approach adopted. In this way, the Air Force can manage risk rather than simply watching risk play out as the program unfolds.

5. Triage high-risk technologies. With the contract award just announced, LRS-B's major technical risks aren't public. However, it is not that hard to make some educated guesses. Certain technologies have been significant problems for aircraft in general, and bombers in particular, in the past. These are areas that the Air Force and those overseeing the program will want to track closely. LRS-B will need to have robust on-board radar, electronic warfare, and significant communications capabilities to perform its assigned missions. Each of these subsystems will require a way to send and receive electrons through the skin of the aircraft, meaning they all require a window, also known as an aperture. In several previous programs, apertures have proven to be very tricky, and at times very costly, to get right. With the B-2, even the most traditional aperture, the windshield that let's pilots see out of the jet, proved to be a surprisingly difficult technical challenge. The Air Force has apparently done a lot of risk reduction work on apertures for LRS-B. This work is absolutely a step in the right direction. It is also a sign that the Air Force understands that apertures are likely to be a significant source of risk.

Electronic warfare (EW) systems have likewise had a spotty history in the bomber force. The digital revolution has led to significant improvements in EW and has increased its importance to the bomber mission, but in part because this technology has changed so much in recent years, it remains a source of potential risk. Software is also an area for concern—it is an axiom of acquisition that software development presents the highest technical risk in any development program. LRS-B is being designed to use an open systems architecture. While this approach should ultimately help mitigate software risk and make LRS-B an adaptable platform, it also suggests that LRS-B will use a lot of newly designed software that meets the newly designed Air Force Open Mission System standards. All of this new software is a source of program risk.

6. Prepare for failures in testing. As indicated by the discussion of risk, there are significant unknowns in the design for LRS-B notwithstanding the relative technological maturity of the program. In some cases, rigorous systems engineering will identify these unknowns, allow for them to be resolved or mitigated, and testing will show that the system performs to specification. In other cases, however, testing will confirm a known problem exists and has not been resolved. For example, the F-35B experienced test issues with the door on the top of the jet that opens up when the aircraft goes into short takeoff/vertical landing (STOVL) mode and engages the lift fan. The possibility that this lift fan door would experience issues with vibration was not in any way surprising. Testing simply confirmed that an anticipated risk was an actual issue. Once the pattern of vibrations occurring in this phase of flight was established, a design fix could be made. In a few cases, testing will uncover problems that were never contemplated in the design process. The difficulty in designing a tail hook for the naval variant of the F-35 is an example. The F-35C's tail hook problems proved much more significant than expected because it resulted from a complex dynamic of interacting forces that were only uncovered through testing.

The purpose of testing is to uncover these kind of issues. Problems will be found on the LRS-B during testing no matter how well the program is managed. It is possible to sit down today and write the future headlines about LRS-B test failures and probably get a fair number of them right. What is important to understand is that for the most part these testing failures are really testing successes, in that these are issues being discovered in testing before they result in problems for the operational fleet. Testing is done to discover these problems and the only way to avoid finding issues in testing is not to test. When it happens, keep calm and engineer on. As part of managing risk, LRS-B's schedule and budget should be constructed with enough margin to address the issues reasonably likely to be identified in testing, with a little extra margin thrown in for good measure. A best practice is to carefully plan complementary developmental and operational testing in the test and evaluation master plan. Constructing these testing activities according to a well thought through master plan will allow the Air Force to identify performance issues as early as possible in the testing process when it is easier and cheaper to resolve them.

7. Avoid excessive concurrency. The reality that design issues will be discovered in testing is an important reason for avoiding excessive concurrency, or too much overlap between the development phase of the program and production. When production begins too early in a program, the first articles produced may have design flaws that have not yet been discovered and could require costly retrofits in the future. By ensuring that development is very advanced before you start production, there is time to resolve most test issues before volume production begins. At the same time, it doesn't make sense to wait until development is fully complete to start production. After all, the only way to test production aircraft is to have the aircraft in production. Generally, the first lots of aircraft production are the ones used for operational testing. This ensures that operational testing is as realistic as possible.

The LRS-B program appears by all accounts to be off to a good start. But the stakes are high, and there is little room for error. Keeping the program on track by following these seven steps will require a sustained and coordinated effort by leaders in both DoD and Congress. While the program's plans and budgets extend more than 20 years into the future, the reality is that Congress reviews acquisition programs and appropriates funding one year at a time. For the Air Force's new bomber to be successful, it has to succeed each and every year.

Todd Harrison is director of defense budget analysis and a senior fellow with the International Security Program at the Center for Strategic and International Studies (CSIS) in Washington, D.C. Andrew Hunter is director of the Defense-Industrial Initiatives Group and a senior fellow with the CSIS International Security Program.