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The F-22

The Right Fighter for the Twenty-first Century?

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Maxwell Paper No. 9

MAXWELL AIR FORCE BASE, ALABAMA

August 1997

Air University

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Foreword

The Quadrennial Defense Review of 1997 may have reaffirmed the need for all three major aircraft modernization programs—the F-22, F/A-18E/F, and Joint Strike Fighter—but the debate is far from over. The F-22, the most expensive of the three programs, stands out as a lucrative target for budget cutters. Critics are quick to point out that the F-22 was designed during the cold war to defend the North Atlantic Treaty Organization airspace against the Warsaw Pact's numerical superiority. With the cold war long over and the Soviet Union relegated to history, many experts question whether the F-22 is still necessary. They point to the United States's overwhelming dominance in the Persian Gulf War using F-15Cs as evidence. F-22 proponents counter that the world is still a very dangerous place, and the United States needs the F-22 to ensure air superiority.

In this study Lt Col Michael J. Costigan, USAF, takes a critical look at the F-22 and its role in our military strategy in the twenty-first century. Although the Soviet Union is gone, the United States may well face regional adversaries who will enjoy numerical superiority while the United States deploys its forces. Use of chemical or biological weapons could slow our deployment considerably while forcing other friendly assets in theater to disperse, further limiting their effectiveness. In this scenario, the argument for the F-22 becomes more compelling. Its innovative technologies provide the F-22 with supercruise, stealth, and integrated avionics, and enable it to guarantee the air superiority so necessary to victory. I encourage each of you to read this review of the aircraft that is planned to form the cornerstone of the US Air Force's air superiority mission in the twenty-first century.

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About the Author

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The F-22

The Right Fighter for the Twenty-first Century?

The United States armed forces are entering what may prove to be one of the most difficult periods in their history. The Soviet Union—the focus for US defense planning for one-half century—is gone, defeated by economic forces rather than Western military might. The breakup of the Soviet Union was hardly complete when Saddam Hussein's army brutally invaded and occupied Kuwait. The war that resulted held several important lessons for US and other military planners. US military might could not be challenged in conventional warfare. It is unlikely that in the future a regional power will challenge the United States in the way that Iraq did. Instead many countries may turn to weapons of mass destruction (WMD) to counter our overwhelming conventional superiority. Postwar investigations in Iraq revealed it is astonishingly easy to hide WMD facilities from international inspectors. Use of such weapons must be considered in any US national defense strategy.

The Gulf War also signaled that, even with the cold war over, the world is still a very dangerous place. The end of the uncomfortable stability of the bipolar cold war has resulted in more regional conflicts as ancient hatreds boil to the surface. The world peace many leaders expected disappeared as Iraqi tanks rolled into Kuwait City. The invasion served as a powerful reminder that the United States can expect to have its vital interests challenged with little warning. In 1994 British Foreign Secretary Douglas Hurd said that "although the world has changed, it remains a deeply turbulent and dangerous place."[1]

Finally, the Gulf War pointed to a change in how wars are waged. The principle of mass, which previously implied large troop formations and long bombing campaigns, may soon mean precision munitions augmented by powerful information systems. This change is fortunate because weapons of mass destruction make any strategy necessitating large troop concentrations very risky.

Even though the United States is in the enviable position of being the world's preeminent military power, as well as the world leader in the technologies that may revolutionize warfare, disturbing trends are on the horizon. Our military budget is shrinking and will continue to do so into the foreseeable future as social programs continue to expand and Congress looks to the Department of Defense (DOD) as a source to balance the budget.[2]

Against this backdrop, the US Air Force is acquiring the most expensive and capable fighter in history, the F-22. With a recently announced cost growth of $1.45 billion added to the $12 to $14 billion already spent on the engineering and manufacturing development program,[3] Congress must soon decide if we will acquire the fleet of 438 aircraft the Air Force desires at a cost of $160 million each.[4] In a Pentagon budget many believe to be underfinanced in the out-years, the F-22 program is expected to consume $73.5 billion.[5] Given tight budgets and a changed world, some critics are asking if the F-22 is the right aircraft for the twenty-first century, or if it is needed at all. Representative Curt Weldon, the Republican chairman of the House Committee on National Security's Research and Development panel recently complained that "we haven't been given a threat that warrants these programs."[6]

The stakes are high. There is frequently a tendency for nations to prepare to fight the last war, with disastrous consequences, as France did following World War I. If the F-22 is a product of a bureaucratic system preparing to fight the Gulf War again—unable to adapt to the realities of the rapidly changing world—then the impact on US military power could be profound. The Air Force cannot afford the development of another air superiority fighter for some time, and even if the money were available, it takes more than 16 years to field a new weapon system.[7] Indeed, planners are counting on the F-22 to carry the air superiority mission into 2050 and beyond. If the F-22 proves poorly suited to warfare in the twenty-first century, it will become one of the most expensive blunders in military history and could leave the Air Force dependent on aging F-15s designed in the 1960s to fight in the next century.

This study examines the relevance of the F-22 in the twenty-first century. First, the F-22 weapon system is discussed to analyze the technologies that are designed to make it superior to other fighters in the world. Second, the changing nature of warfare is explored to investigate the probable scenarios that the United States will encounter in the future and the kind of strategies that make sense for the United States. Third, conclusions will be drawn on how well the F-22 fits into future war scenarios and probable defense strategies, and whether the F-22 is the right aircraft to purchase today.

The F-22

The F-22 can trace its history to the early 1980s as military planners began looking for a replacement for the F-15 to perform the air superiority mission. Defending the North Atlantic Treaty Organization (NATO) against a Soviet Union invasion was still the central theme for military planning. It was expected that the Warsaw Pact would enjoy a sizable numerical superiority over NATO air forces, so planners looked to technological superiority to counter the numerical deficit. Therefore, the F-22 was optimized to fight and win in the European theater against overwhelming numbers of Soviet aircraft.[8]

In order to accomplish this, the F-22 incorporates innovative technologies to provide the aircraft with three characteristics that, in synergy, make it dominant against any current or projected air-to-air threat.[9]

The F-22 is designed to cruise at supersonic speeds in military power, a capability called supercruise. While most current fighters can achieve supersonic speeds, they must use afterburners to do so. The tremendously high fuel consumption while using afterburners means they can only maintain supersonic speeds for very short periods. By using engines that provide very high thrust without having to use the afterburners and moving all weapons to internal bays to reduce drag, the F-22 can cruise at supersonic speeds while using only slightly more fuel than a conventional fighter uses to cruise at subsonic speeds. Along with its low radar cross section, this allows it to penetrate dense

integrated air defense systems (IADS) and makes it much more difficult for enemy fighters to maneuver to weapons firing positions. The low drag and efficient engines also give the F-22 exceptional range, minimizing the need for air refueling assets.

The low radar cross section, responsible for the stealth characteristics of the aircraft, complements the supercruise capability. The incorporation of third-generation, low-observable technologies means the F-22 does not suffer the aerodynamic penalties that previous stealth platforms such as the F-117 and B-2 had to endure. The F-22 not only has a much smaller radar cross section than the F-15 and F-16 but also is more maneuverable as well.

Another innovative characteristic incorporated into the F-22 is an integrated avionics suite. In past aircraft, the pilot had to run the radar, monitor the radar warning receiver, activate the identification friend or foe interrogator, interpret the separate displays to form a mental image of the air battle, fly the aircraft to avoid ground threats, dispense protective measures when needed, and fire the weapons. In a region such as Europe where the ground threat was dense and the air filled with hundreds of airborne targets, even the most experienced pilots could find it difficult to maintain situation awareness.

The F-22 overcomes this problem by using the latest computer technology to accomplish many of the tasks the pilots used to perform. Instead of spending time operating the complex sensors, the pilot becomes an information manager. He or she can observe a bird's-eye view of the air battle on a single large display that shows information from all the sensors in an easy-to-comprehend pictorial format. The onboard computers handle the majority of the sensor taskings, including keeping track of friendly and enemy aircraft, freeing the pilot to fly the airplane and fire the weapons.[10] The sensors, including the radar system, incorporate the latest electronics and allow the F-22 to detect enemy aircraft at greater distances than can conventional fighters. F-22 avionics systems communicate with each other using a data link, allowing all members of a flight to share information on the air battle. Link-16 also allows the

F-22 to receive information from other US fighters and the airborne warning and control system (AWACS).[11]

The combination of supercruise, stealth, and integrated avionics makes the F-22 dominant over all current or projected aircraft. Other fighters will not be able to detect the F-22 before its pilot has already seen a complete view of the air battle and decided how to employ his weapons. In a complex air battle with dozens of aircraft, the integrated avionics and stealth will allow the pilot to choose where and when to engage to maximize survivability while destroying enemy aircraft that are not even aware of the F-22's presence.[12] Simulations using projected threat aircraft for the year 2008 reveal that F-15 losses could be 20 times those of the F-22 in some situations.[13]

One late addition to the F-22's requirements arose from lessons learned in the Gulf War. After establishing air superiority, the F-15Cs could not perform air-to-ground missions and were relegated to performing air defense missions against a nonexistent threat. The F-22 overcomes this limitation by having the capability to carry two JDAM-1000 precision munitions internally, while still carrying a lethal load of radar-guided AIM-120C and heat-seeking AIM-9X air-to-air missiles for self-protection.[14] Thus, after establishing air superiority, the F-22 can attack targets deep in enemy territory with precision in all weather conditions. The same supercruise, stealth, and integrated avionics technologies that proved dominant in air-to-air combat make the F-22 an equally capable air-to-ground platform against even well-defended targets.

Advanced technology also aids the F-22's maintainers. Though complex, the F-22's systems are designed to operate with a mean time between maintenance of three hours, more than twice that of the F-15 it replaces.[15] Mission capable rates are expected to be 92 percent, or 5 percent better than the F-15.[16] Combat turn times[17] for the F-22 are only 20 minutes, a five-minute improvement over the F-15.[18] Those systems expected to fail most frequently are located behind easily accessible panels. All the systems are designed with a high degree of self-diagnostic capability and rely on easily replaced line-replaceable units. The re-

sult is unprecedented mission capable rates in a weapon system that requires much reduced logistics support.

The ability to fight in a chemical warfare environment was also an important consideration for the F-22. The instruments within the cockpit are designed to withstand chemical cleansing agents without degrading their performance. Easily changed charcoal filters purify outside air coming into the cockpit. Air used to inflate the pilot's upper and lower anti-g garments is also purified. A vastly improved face mask specially designed to complement a lightweight helmet does not restrict the pilot's view—a major problem in the current chemical ensemble—and is much more comfortable. A cooling vest worn next to the pilot's upper body prevents the severe overheating pilots can experience with the current chemical ensemble.

Getting the F-22 into theater is also much easier than with previous aircraft. Deploying a squadron of 24 F-22s for 30 days of combat requires only eight C-141Bs to carry the required support equipment and supplies, less than one-half the 18 C-141Bs required to deploy a same-sized F-15C squadron.[19]

While the F-22 will no doubt prove extremely effective against the threat for which it was designed, the question remains whether the cold war scenario that spawned the requirements for the F-22 will still be applicable in the twenty-first century. After all, F-15Cs proved more than enough to handle the best aircraft that Saddam could throw against Coalition forces. The Coalition suffered but a single air-to-air loss versus 33 kills against an air force with some of the best fighters money could buy.[20] The F-22 could undoubtedly do better, but at what cost?

The more disturbing dilemma is that an adversary may decide not to challenge US air superiority with conventional aircraft, but instead turn to other means such as ballistic and cruise missiles. This decision could imply that the F-22 would be unable to perform the air superiority role for which it was intended. Given this reasoning, critics have argued that the F-22 may not be the optimum weapon system on which to spend DOD's increasingly pressured acquisition budget.

Twenty-first Century Warfare

The lesson of Desert Storm is don't mess with the United States without nuclear weapons.

—Gen K. Sandurji
Former chief of staff of the Indian Army

Certainly few tasks can be more difficult than predicting the future, yet this challenge is what defense planners must capture. As discussed earlier and emphasized by General Sandurji,[21] few nations can be expected to repeat Saddam's blunder and take on the United States using conventional forces alone, including tactical aircraft. Instead, "niche competitors" such as Iraq can be expected to try to acquire or develop alternative delivery systems, such as stealthy cruise missiles and theater ballistic missiles (TBM) to deliver WMD, including nuclear, biological, and chemical munitions.

Use of WMD against US forces by a niche competitor entails considerable risks for both sides. The United States will enjoy escalation dominance in the nuclear as well as conventional arena and could reserve the right to use nuclear weapons or punishing conventional attacks against a nation that first uses chemical or biological weapons against US forces. Such a nuclear threat certainly figured into Saddam's reticence to use his huge stockpiles of chemical weapons, even when it was evident he was in danger of losing the war.[22] However, such a strategy is fraught with the potential for miscalculations on both sides, leaving US National Command Authorities (NCA) in a very precarious position.[23]

Nevertheless, even the threat of WMD could dramatically change the decisions by the NCA. A potential adversary could presume that the United States would not become involved if threatened with huge losses, or would at the very least limit its military and political objectives. This was the strategy employed by Saddam Hussein, though it was foiled in this case by US technological superiority. The threat of using WMD could also intimidate regional US allies into denying basing rights, crippling the US power

projection capabilities. Or perhaps an adversary could use the threat of WMD to gain a more favorable settlement.[24]

Even if the political gamble failed and the United States deployed forces, WMD delivered by cruise missiles and TBMs could deny US forces the use of port facilities, airfields, and the logistical bases needed for its high-technology forces. At the very least, the logistical buildup would be delayed, perhaps long enough for a large enemy ground force to overrun critical areas.

With its forces likely to face cruise missiles, TBMs, and possibly both, US military planners must develop approaches to counter these threats. The failure to develop credible defenses would either leave the United States vulnerable to WMD "blackmail" or force policy makers to rely on the risky calculus of nuclear deterrence. Either approach is highly undesirable. The question left to be determined is whether the F-22 adds to a credible defense against WMD.

Is the F-22 the Right System?

The F-22's usefulness in twenty-first century regional conflicts involving WMD delivered by cruise missiles and TBM largely depends on US strategy. One approach is to simply remove US forces beyond the range of adversary delivery systems. Robert W. Chandler suggests the United States invest in long-range bombers and cruise missiles instead of tactical aircraft, mounting attacks from the US homeland.[25] In a similar approach, Jeffery R. Barnett also suggests we develop longer range tactical aircraft that can be based beyond the range of enemy delivery systems.[26]

Both of these approaches suffer fatal flaws. While US personnel may be protected, allies and coalition partners would be open to the threat of WMD used against their cities and populations. Given this strategy, it is unlikely the United States would find many in-theater partners willing to base US ground forces—who would presumably be moved into theater after the air campaign was complete and the WMD neutralized—or even support US objectives. Thus, this strategy, intended to avoid the political problems associated with US casualties, encourages nations

with WMD to threaten their neighbors to achieve their political goals. Rather than strengthening US power, such strategies are destabilizing.

For those airpower advocates who believe that airpower alone can be used to accomplish military objectives, and that ground forces may not be necessary, consider that airpower was applied against Iraq under nearly ideal conditions, yet Saddam's forces did not withdraw from Kuwait until forced out by Coalition ground forces.[27] For the foreseeable future, any US strategy must include provisions for ground forces, which implies a compelling need for regional partners.

Even if the United States were willing to leave regional partners unprotected, it is unlikely the United States could afford the huge arsenals of cruise missiles needed to maintain the operations tempo that US information systems allow, and that have become a cornerstone of US doctrine. Furthermore, because of their long flight times cruise missiles are simply not practical against mobile targets using current technology. Similarly, long-range bombers, while capable of delivering devastating strikes and able to attack mobile targets not hit by cruise missiles, are not available in sufficient numbers to maintain high-tempo operations from the US homeland and, like cruise missiles, have operational limitations. Stealth bombers such as the B-2 are vulnerable to fighters using a visual attack, so it must be flown only at night. This leaves long periods when enemy installations and ground forces would be free from air attack.

It is clear that compelling reasons exist to maintain tactical airpower in theater, including manned fighters. However, the problem remains of finding a strategy to counter the WMD threat against US and friendly forces in theater. Several factors must be considered. The extreme lethality of WMD implies that any defense must be as nearly perfect as possible. Even one cruise missile or TBM that successfully penetrated defenses could have terrible consequences. These factors imply the need for a defense in-depth with multiple systems.[28]

At the same time it must be recognized that no defense can ever be perfect, so US forces must be dispersed. The enormous concentrations of troops, equipment, and air-

craft seen in the Gulf War are simply too risky. While it has been necessary in the past to group aircraft so maintenance operations can be performed efficiently, it is unlikely the United States can afford that luxury in the future. Therefore, future weapon systems must be capable of high-tempo operations from dispersed locations with reduced logistic support.[29]

Finally, the threat of WMD does not mean the conventional air superiority role has diminished. Quite to the contrary, it is more critical than ever before. Tactical fighters and bombers make very efficient delivery systems for WMD, either directly or as a platform to carry cruise missiles. Furthermore, US forces will likely be forced to gain air superiority with fewer aircraft. Not only will the need for dispersal limit the number of aircraft but US planners must also assume that a future adversary will not allow US forces months to flow equipment and personnel into theater. US aircraft may well be forced to fight for air superiority against overwhelming odds, possibly against Russian-built aircraft, in situations not all that different than those for which the F-22 was originally designed.

For these same reasons, all aircraft should be dual or multirole and have low radar signature. It simply may not be possible to mount the thousands of sorties needed to take down an IAD system that will allow nonstealthy fighters to accomplish their missions. Rather, US aircraft will have to rely on stealth and advanced avionics systems to penetrate enemy airspace in small packages to perform offensive counterair missions against enemy aircraft carrying WMD, and to deliver punishing bombardment against WMD storage facilities and delivery systems. Destruction of enemy WMD assets must be a critical pillar of any US strategy to counter the WMD threat.[30]

The F-22 fits very well into this view of twenty-first century warfare, despite the fact it was designed for a European theater Soviet threat. Because of its extreme lethality, high mission capable rates, and low maintenance requirements, small numbers of F-22s operating from dispersed locations can provide the same offensive and defensive capability as many more conventional fighters, such as the

F-15C, provide today. The advanced avionics and ability to data link with AWACS and other F-22s could provide a very effective all-weather defense against cruise missile and aircraft WMD attacks. The F-22's radar is designed to find stealthy targets such as the French Apache cruise missile, that have radar cross sections intentionally reduced to avoid detection.[31] At the same time, the F-22 can deliver air-to-ground munitions against enemy targets.

Although a very capable weapon system, the F-15C may not be effective against overwhelming numbers of enemy aircraft, cannot detect stealthy cruise missiles as well as the F-22, and may be difficult to maintain under dispersed conditions. Furthermore, it is not survivable against an intact IAD. While it performed admirably in the Gulf War, the F-15C is woefully inadequate for the regional conflicts the United States will likely be involved in during the twenty-first century.

However, it is also clear the F-22 only makes sense as part of a larger strategy that contains improvements in passive measures, a defense in-depth of TBM defenses, and point defenses against cruise missiles that may have penetrated the fighter barrier. Furthermore, without an effective shield against TBMs carrying WMD, the F-22— and its pilots and maintainers—are vulnerable while on the ground.

Conclusion

If the United States is to maintain the ability to project power and protect its vital national interests around the globe, it must develop a credible defense against weapons of mass destruction carried on stealthy cruise missiles and theater ballistic missiles. Furthermore, retreating out of theater and relying on very long-range airpower to attack enemy forces is not feasible from either a technical or a geopolitical perspective. To provide basing for ground troops and to maintain the high-tempo operations called for in US doctrine means manned fighters located in theater for the foreseeable future. The F-22 is the right aircraft for warfare in the twenty-first century.

Notes

1. David Shukman, Tomorrow's War: The Threat of High-Technology Weapons (San Diego, Calif.: Harcourt Brace, 1996), 1.

2. Ibid., 5. The US defense budget fell from $300 billion in 1993 to $251 billion in the 1998 request. David A. Fulghum, "Pentagon Budget Suffers New Cuts: Administration Again Breaks Promise to Hike Modernization Funding," Aviation Week and Space Technology, 10 February 1997, 24.

3. David A. Fulghum, "Expanding Roles May Shield F-22," Aviation Week and Space Technology, 6 January 1997, 42.

4. Mark Thompson, "The Sky's the Limit," Washington Times, 17 March 1997, 32.

5. David C. Morrison, "Under Fire," National Journal, 15 July 1995, 1818.

6. Thompson, 32.

7. Jacques S. Gansler, Defense Conversion: Transforming the Arsenal of Democracy (Cambridge, Mass.: MIT Press, 1995), 10.

8. The author worked in the F-22 System Program Office as chief of the cockpit integrated product team (IPT) from 1993 to 1995 and was chief of the avionics IPT from 1995 to 1996. He is extremely knowledgeable about the design and capabilities of the F-22.

9. David A. Fulghum, "Weapons Mix Broadens F-22," Aviation Week and Space Technology, 6 January 1997, 44.

10. Bill Sweetman, "Flying the F-22," Popular Science, August 1995, 44–49.

11. Link-16 is the US standard data link system used to exchange battlefield information.

12. Stanley W. Kandebo and David Hughes, "F-22 to Counter 21st Century Threats," Aviation Week and Space Technology, 24 July 1995, 38.

13. Comparisons between the F-22 and conventional aircraft such as the F-15 using simulations are highly dependent on assumptions and the mission. For example, in a defensive counterair mission over friendly territory with AWACS support, the F-15 may be nearly equal to the F-22. On the other hand, in an offensive counterair mission over enemy territory where the IAD is largely intact, the F-22 may prove vastly superior.

14. Ibid., 42.

15. Ibid.

16. Ibid.

17. Combat turn time is the time needed to refuel, rearm, and perform any maintenance required to return an aircraft to combat status after it returns from a mission.

18. Ibid.

19. Ibid.

20. Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey Summary Report (Washington, D.C.: Department of the Air Force, 1993).

21. Robert W. Chandler, Tomorrow's War, Today's Decisions (McLean, Va.: American Committee on Development Affairs, 1996), 149.

22. Kathleen C. Bailey, "Responding to the Threat of Biological Weapons," Security Dialogue 26, no. 4, 1995, 391–92.

23. Barry R. Schneider, "Strategies for Coping with Enemy Weapons of Mass Destruction," Airpower Journal, Special Edition 1996, 42.

24. Ibid. See 37–39 for a description of adversary strategies using WMD.

25. Chandler, 200–204.

26. Jeffery R. Barnett, Future War: An Assessment of Aerospace Campaigns in 2010 (Maxwell Air Force Base, Ala.: Air University Press, 1996), 96–99.

27. For an excellent discussion of the role air power played in the Coalition victory, see Michael R. Gordon and Gen Bernard E. Trainor, The Generals' War: The Inside Story of the Conflict in the Gulf (Boston, Mass.: Little, Brown and Co., 1995.

28. Schneider, 45–46.

29. Ibid., 44.

30. Ibid., 42–44.

31. Fulghum, "Weapons Mix Broadens F-22," 44.