Stealth Bomber: Evading Flak Over Cost, Mission

The B-2 bomber unveiled last week is being hailed as a technological marvel. But at $70 billion, will the program fly?

THE SUPERSECRET "stealth" bomber shed some of its invisibility on 22 November, when the first of the radar-evading planes was towed out of a hangar in Palmdale, California. Looking like a sinister gray and black manta ray, it made its public debut to the strains of the "Stealth Fanfare," a piece of music composed especially for the occasion. It also got a verbal fanfare from Air Force Secretary Edward Aldridge, who hailed the aircraft's "revolutionary" technology and said it "represents a crucial leap in our strategic modernization program."

But, now that the bomber is emerging from nearly a decade in the hidden recesses of the Pentagon's "black" programs, it is also attracting some political flak. Until recently, the layers of secrecy have shielded the program not only from public scrutiny but also from the criticism that has been directed at virtually every other major weapons system.

Even some of the bomber's supporters on Capitol Hill are beginning to ask whether the Pentagon can afford the estimated $70-billion price tag for a full fleet of 132 planes—especially when cuts of $100 billion to $300 billion will be required in the defense budget over the next 5 years. Some experts are also questioning the need to build a supersophisticated manned bomber to slip through Soviet air defenses, when cruise missiles should be able to penetrate Soviet airspace just as effectively—and far more cheaply.

Although the stealth bomber program has reached maturity during the Reagan Administration, it was begun by the Carter Administration. Its existence was publicly revealed in August 1980 at a press briefing held by then Defense Secretary Harold Brown and Director of Defense Research and Engineering William Perry. The briefing was an effort to counter election-year criticism of President Carter's decision to scrap the B-1, a controversial supersonic bomber that had been under development since the late 1960s. Brown and Perry argued that the stealth bomber would leapfrog conventional aircraft technology and provide the ability to elude Soviet defenses from the late 1980s on. Until then, they said, cruise missiles carried on the venerable B-52 would do the job more cost-effectively than the B-1.

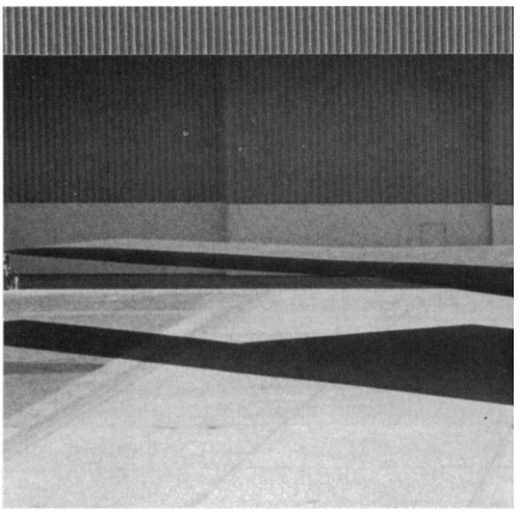
The aircraft made the headlines again in October 1981, when President Reagan reversed Carter's decision to abandon the B-1 and announced that the stealth bomber program would go ahead as well. The new Administration's military buildup called for 100 B-1s to be produced in the 1980s, followed by 132 stealth bombers—now officially called the B-2. The announcement touched off a furor, but the debate focused almost entirely on the decision to resurrect the B-1. The B-2 program slipped back under layers of secrecy; even the annual expenditures were classified.

The veil began to lift a little last January, when the Pentagon disclosed that the complete B-2 fleet would cost $36.6 billion in 1981 dollars (about $56 billion in today's money). Then, in April, the Defense Department made public a drawing of the plane. It confirmed what had long been suspected, that the aircraft is a so-called "flying wing," based on a design originally pioneered by James Northrup in the 1940s. The Northrop Corporation is the prime contractor for the B-2.

The aircraft finally unveiled last month is indeed a radical technological departure from previous bombers. It is carefully contoured to avoid sharp angles that would reflect radar signals back toward the transmitter. Thus, the wings are blended into the fuselage; engines are mounted inside the aircraft, and the intakes are shaped to avoid a radar echo from the turbine fans; weapons are stored internally; the cockpit windows appear to be coated with radar-opaque material; and radar antennas are hidden when not in use.

In addition, extensive use is made of nonmetallic materials such as thermoplastics and carbon fibers in the construction of the aircraft. Radar-absorbing materials are also used to suppress the plane's radar echo. These are layers containing compounds such as iron oxides, arranged so that radar signals reflected from internal layers will cancel incoming signals in the outer layers.

A serious complication in making the B-2—and any other stealth weapon—difficult to detect by radar is that, in general, technologies that work against a particular bandwidth do not work against radar beams at other frequencies. As one expert puts it, "you have to pull lots of different tricks simultaneously." That, of course, greatly increases the cost.



U.S. Air Force

Big bird. *The radar echo from the B-2 coming*

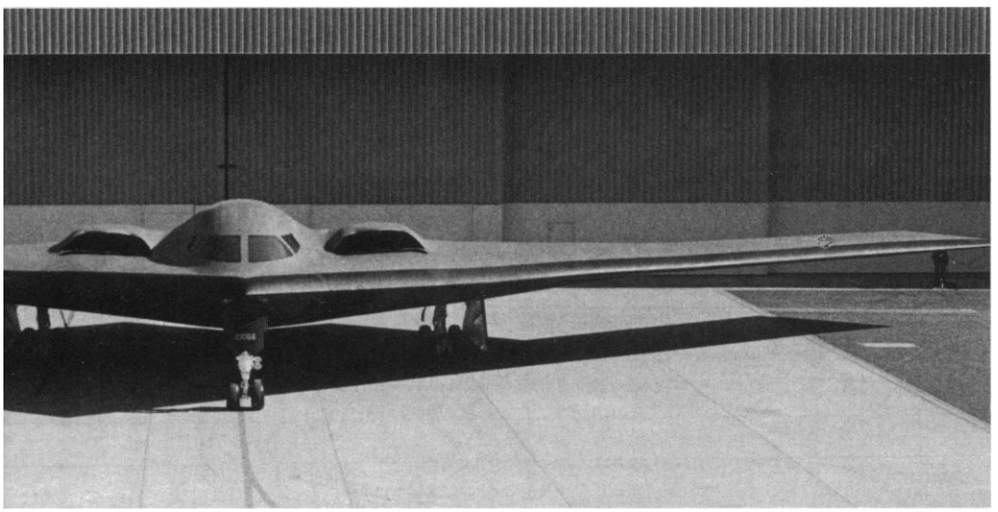
Moreover, the technique of contouring the plane so that radar beams are reflected away from the transmitter may not work so well against so-called bistatic radars, in which the receiver is in a different location from the transmitter. In this case, the signals may in fact be reflected toward the receiver.

Nevertheless, the radar echo from a B-2 coming head-on toward a transmitter is said to be about that of a large bird. The head-on radar image is important because that is the way the plane will generally appear to air-defense radars. The bomber may, however, be more visible to radars that look down at the large expanse of the B-2's wing, such as those on airborne warning and control system (AWACS) aircraft.

Great pains have also been taken to suppress the heat signals from the B-2's engines, to make the plane less visible to infrared detectors. The exhausts are above the wing so they are less visible from below, and cool air is probably mixed with the hot gases before they leave the engine. Although this would be expected to promote condensation, resulting in telltale vapor trails at high altitudes, Air Force chief of staff Larry D. Welch said in press interviews last month that this problem has been solved.

Some capabilities have been sacrificed for the plane's stealthiness. It will be relatively sluggish, with a top speed below the speed of sound, and it is likely to be difficult to fly. Some analysts also believe that it will be able to carry fewer bombs and surface-to-air missiles than the B-1.

All these technological tricks have been difficult to pull off, and the schedule for the



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program has consequently slipped several times. According to Welch, a major redesign was undertaken 5 years ago to increase the plane's ability to withstand stresses in low-level flying. This added $1 billion to the development costs and resulted in considerable delay. Indeed, the first flight of the B-2 was originally anticipated in the mid-1980s, but the plane unveiled last month will not be airborne until some time early next year.

The costs have also escalated. Last month, Air Force officials conceded that the estimate made last January should be increased by perhaps 20%. The new estimate would put the cost of the full fleet at almost $70 billion in current dollars, or about $500 million per plane. At that price, notes John Pike of the Federation of American Scientists, it is literally almost worth its weight in gold.

What justifies all this investment? The bomber's primary mission, according to congressional testimony and public statements from Air Force officials, is to threaten so-called relocatable targets, such as mobile missiles and command centers deep inside the Soviet Union. The rationale, in short, is that the Soviet Union would never risk a first strike against the United States if it faces the prospect of the B-2 subsequently destroying its reserve forces of mobile missiles and wiping out the bunkers housing the nation's military and civilian commanders.

Advocates of the bomber argue that it is uniquely suited to this role because the pilots would be able to seek out movable targets, assess damage from previous strikes, and deliver high-yield nuclear weapons with great precision. Welch, for example, says the B-2 "will ensure that any adversary must face the uniquely effective retaliation potential of the penetrating bomber with large payloads of nuclear weapons, delivered with devastating accuracy on any target anywhere."

But some critics question whether the plane would be capable of carrying out some of these tasks. In separate reports made public a few days before the B-2's public debut, Pike of the Federation of American Scientists and Michael Brower of the Union of Concerned Scientists pointed out that the aircraft would not be able to use its search radars without giving away its location.

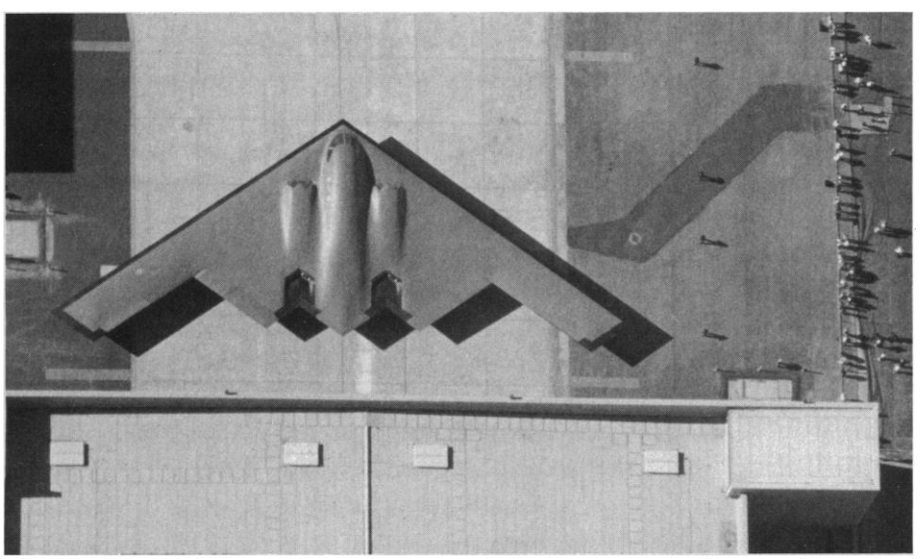
The plane will therefore probably rely to a large extent on data supplied from reconnaissance satellites, such as the radar-imaging Lacrosse satellite that is widely believed to have been launched by the shuttle last week and the KH-12 photoreconnaissance satellites, the first of which is expected to be launched early next year. But, argues Pike, if these satellites are to be used for targeting mobile missiles, the Soviets would have a great incentive to shoot them down early in a conventional conflict, "greatly escalating the scope of combat with potentially incalculable consequences."

Pike and others also argue that the whole notion of building a weapons system targeted on mobile missiles and command centers runs counter to the interests of maintaining stability in a crisis. Bruce Blair of the Brookings Institution says, for example, that the B-2 "is destabilizing according to traditional concepts of stability"—that some nuclear forces should be survivable. Pike notes that if the B-2 does find and attack some mobile missiles, the Soviets would then be tempted to launch the ones that remain.

Some analysts have challenged the need for the B-2 with a different argument: that advanced cruise missiles could provide a retaliatory capability just as effectively, but for much less money. In a report published earlier this year by the Stanford Center for International Security and Arms Control, Sidney Drell of Stanford University and Thomas Johnson of West Point state, for example, "we fail to see the necessity to carry pilots and large, expensive vehicles all the way to strategic targets."

They note that if satellites are to be used for targeting, "there are no electronic signals for redirection that could be given to a bomber that could not also be given to an ALCM [air-launched cruise missile]." Moreover, the supposed advantage of having a pilot search visually for targets is illusory, they suggest, because he would have to slow down and increase altitude in order to scan even a relatively small area, which "would vastly decrease the bomber's survivability."

The Carter Administration justified its decision to cancel the B-1 program largely on the basis that cruise missiles would be



Flying wing. *The B-2's unusual shape is evident in this overhead photograph taken at the rollout ceremony. The engine exhausts can be seen above the wings, where they would be less conspicuous to infrared detectors below.* [*Aviation Week & Space Technology, photo by William G. Hartenstein*]

more cost-effective than penetrating bombers in providing a retaliatory capability. Among the strongest advocates of that position at the time was William Perry. Perry is now one of the leading promoters of the B-2, however.

"It's a mistake to think of stealth as just this airplane," says Perry, who is now chairman of H&Q Technology Partners in Menlo Park. He argues that stealth technologies will "revolutionize" many weapons systems, providing a capability not only to evade warning radars but also to elude radar-guided missiles. The B-2 is "the leading edge of stealth technology. It is important to maintaining our leadership in this field," he says.

Already, stealth technology has been extensively used in the F-117A, a supersecret fighter plane that has been operational since 1981. Last month, the Pentagon released a fuzzy picture of the aircraft, the first official admission that the fighter even exists. The technology is also being applied in the advanced cruise missile, an air-launched missile that is expected to provide even more capability in penetrating Soviet defenses than the already near-invisible standard cruise missiles. Helicopters and even some surface ships are expected to use some stealth technologies in the future.

But all these wonder weapons will carry a high price tag, and that, if anything, could be the B-2's downfall. At $70 billion, the aircraft will certainly be highly visible to Congress's budgetary antennas. Senator Sam Nunn (D–GA), the chairman of the Senate Armed Services Committee and a strong supporter of the B-2, warned recently in a television interview that the program at best would have to be stretched out because of the impending squeeze in the military budget.

Representative Les Aspin (D–WI), chairman of the House Armed Services Committee, recently estimated that, under current plans, strategic bombers are expected to cost $245 billion to buy and maintain between 1981 and 2004, in part because they are expensive to operate. That would be 57% of total spending on strategic weapons systems, including the entire land-based and sea-based nuclear arsenals. Drell of Stanford says, "I don't consider having bombers destabilizing. They are slow fliers and don't pose the same kind of destabilizing element as a prompt counterforce capability." But, he says, "we are committed to a construction program we cannot afford. The question is, what gives?"

Whether it is the B-2 that gives may depend in part on the fate of the troubled B-1. The B-1 has encountered serious technical difficulties, and the Congressional Budget Office recently estimated that it could cost as much as $8 billion to fix the problems and enhance the plane's ability to penetrate Soviet airspace. Whether Congress will be willing to come up with the funds for the B-1 will at least affect the perceived need and timing of its successor.

One well-placed congressional aide says that, so far, political support for the B-2 remains strong, and at this point, "I frankly don't see the B-2 program being killed." However, he notes that over the past few years, public attention has been fixed on only one major defense program at a time. First it was the MX, then the B-1, then the Strategic Defense Initiative. If only because of its cost, the B-2 could be next, he predicts. ■ COLIN NORMAN

Patent Backlog: Solution Pending

The Office of Patents and Trademarks is moving to relieve the backlog of unprocessed patent applications involving inventions based on the use of recombinant DNA and other bioengineering techniques. The agency has added dozens of patent examiners and it claims to be compressing the average processing time for biotechnology patents. The pile of pending applications continues to grow, however, and officials say it could be several years before significant reductions in the backlog are achieved.

Patent examiners in recent years have found themselves falling further and further behind in processing patent applications. Many applications were taking well over 2 years to process. The number of new patent claims has mushroomed as the use of recombinant DNA techniques in medicine, agriculture, and industrial processes has yielded an expanding number of discoveries.

The patent office received 6850 new applications for biotechnology-related patents in fiscal year 1988, an 11% increase over the previous 12-month period. John Kittle, who heads the biotechnology review section, says applications are being handled more quickly this year.

The ability of the patent office to deal with the growing work load has been hampered to an extent by a fragmented organizational structure that had a number of different sections examining biotechnology claims. More troublesome, however, has been understaffing in the biotechnology patent groups and high employee turnover (*Science*, 12 February, p. 723). These latter two problems are the result of "bad judgment on the part of budgeters within the outgoing administration," says Richard Godown, president of the Industrial Biotechnology Association (IBA).

In the wake of industry protests, the agency in April consolidated its biotechnology patent examining groups into a single entity known as section 180. Thirty examiners have been added to the group since then, bringing their total to 97. The new recruits include veteran examiners with scientific training and new hires with doctorates in microbiology and related disciplines. Another 20 examiners will be hired this year. In addition, patent office commissioner Donald J. Quigg plans to have American biotechnology companies play a larger role in schooling patent examiners in new scientific and technological developments in the industry.

This move is an outgrowth of a list of suggestions that Godown sent to Quigg in April. The agency is recasting its current training efforts to create a biotechnology institute to help train new patent examiners and to keep veteran examiners abreast of the latest scientific developments and patent law issues. The institute concept is not very different from the patent office's traditional training program. But it will provide more intense education for examiners involved in the complex world of biotechnology patents.

The institute's curriculum will be shaped by the agency with the advice of a board composed of industry trade groups, bar associations, and scientific societies. These programs will augment the agency's existing activities, which include lectures at local universities, tuition refund programs, and site visits to industry laboratories. IBA has indicated that its members are willing to increase their contributions to the agency's existing examiners' training fund to support these functions as well as to finance the purchase of some extra copies of scientific journals that examiners require.

Despite all these steps, patent attorneys and trade association executives are not expecting the processing of biotechnology patents to improve dramatically overnight. New examiners must be schooled in patent law and have several years experience before they really become productive, notes Iver Cooper, a patent attorney in Washington, D.C. Moreover, if salaries and working conditions do not improve significantly, adds Bertram Rowland, a patent attorney with Leydig, Voit & Mayer of Palo Alto, California, the agency will continue to lose large numbers of examiners to private law firms or biotechnology companies that can pay them far more than the government does now. ■ MARK CRAWFORD