Bomber Number One

The Air Force has finished building its top-of-the-line strategic bomber, but is having trouble fending off critics, computer foul-ups, and pelicans

THE 100th and last copy of the B-1B bomber—"the best warplane in the world," according to General Bernard Randolph, chief of the Air Force Systems Command—rolled off the line at Rockwell International's plant in Palmdale, California, last week. Factory workers, executives, and generals were on hand on 20 January to celebrate the end of the run.

On the same day, Air Force officials met on Capitol Hill with the staff of the House Armed Services Committee to survey the technical fallout from the $28-billion program. Among other things, the committee wanted to know how a single white pelican was able to take out one of these super bombers last fall, obliterating the plane in 3 minutes and killing half the crew. (See box.) The Air Force describes the accident as a fluke and says it will spend $38.5 million to put pelican-proof armor on the 99 remaining bombers.

The accident was the latest twist in the B-1B melodrama, which has been running for more than a decade. Political interest in the plane has been intense, and in the last year the Armed Services Committee has examined it closely for faults. There appear to be a few. The biggest question hanging over the dissecting table is whether the plane's technology was essentially obsolete at birth. Critics say the machine is complex, underdeveloped, and ineffective. But according to General Elbert Harbour, the B-1B program chief, much of this is "baloney."

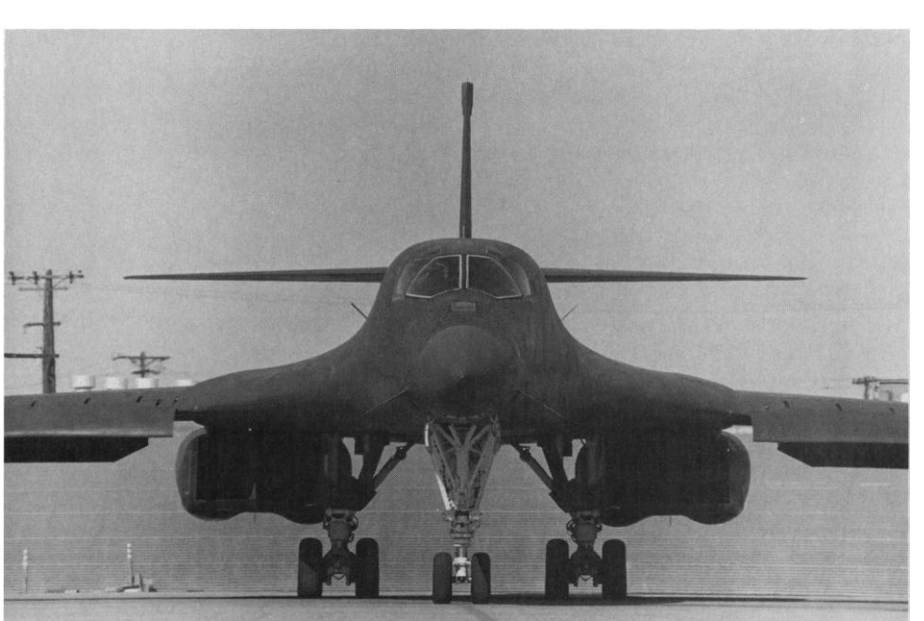
Despite its tragic effects last fall, the bird hazard may be the least of the B-1B's problems. On this, both critics and defenders of the plane agree, although they agree on little else. More significant, the critics say, are some other built-in hazards—the result of poor management by the Air Force and a decision to force the pace of production to save money. It is odd to hear congressmen say the Pentagon spent too few years building a weapon, but that is the charge. The results cited by critics include a botched electronics system that may be incurable and an overweight structure that allegedly is difficult to maneuver and may limit top altitude.

The Air Force agrees the B-1B has had some "teething pains." However, it views all but one—the nonfunctional radar jammer—as routine, the kind that appear in any big machine's first year. (An improved radar jammer will be installed in 1989.) The Air Force claims that glitches have been publicized while the B-1B's strengths as a smooth-riding, low-flying, fast, radar-evading weapon have been ignored. General Harbour says: "History will tell us that this is one hell of a machine; the trouble is, history is terribly slow" in delivering the message.

Congress is annoyed that the good news will arrive so late. The Reagan Administration sold the bomber as a quick, cheap, and easy way to improve U.S. strategic forces, overruling the logic of the Carter Administration, which had argued that it would be easier to proliferate a fleet of cruise missiles and cruise transport planes. So far, the B-1B has not scored well on any of the promises made in 1981, except speed of production. The cost seemed to be under control at first, but many fixes have been ordered and they will push the price higher.

The exact amount of the overrun is a matter of dispute between the Air Force and the chairman of the Armed Services Committee, Representative Les Aspin (D–WI). Aspin says that it will cost an extra $3 billion or more to bring the B-1B up to its promised level of performance. Among the items not paid for, Aspin says, are flight simulators for training, a full complement of spare parts, and mandatory "enhancements" of the B-1B's electronics. Already, the Air Force has asked for $600 million to pay for extended flight testing and remedial work. It also seeks $200 million to begin improving the plane beyond the initial specs.

In response, the Air Force points out that 2 years ago, Congress withheld $1.3 billion in contingency funds because it looked as though the money would not be needed. Now the Air Force must have the money back. But the total cost has not gone above the promised cap of $20.5 billion in 1981 dollars. Not yet. General Harbour also points out that Congress agreed from the earliest days to pay for flight simulators and certain other items in a separate account. To scold the Air Force now for funding them separately, Harbour says, is "like saying to your child, 'Here's your allowance, but re-



U.S. Air Force

The B-1B bomber *is "one hell of a machine," according to General Elbert Harbour, program chief for the Air Force. But the House Armed Services Committee says the plane is not ready to perform its strategic role.*

member, you didn't pay for that overcoat.' "

The Air Force did strip some mandatory items off the plane—such as a forward-looking infrared sensor, a global positioning receiver, and a secondary inertial navigational system—to deflate the price. Without them, the B-1B cannot function reliably, and they will cost more than $1.5 billion to acquire. The full cost of the radar retrofit also is unknown. On the question of cost, history may not bring good news.

As for strategic value, it is doubtful that the B-1B increases the nuclear threat to the Soviet Union as yet because the radar jammer is not working. However, by 1991, the Air Force hopes to have the fleet in a "full-up" condition. At that time, the B-1B will add some muscle to the air-breathing leg (bombers and cruise missiles) of the strategic triad. (The other two legs, land- and sea-based ballistic missiles, are hardly feeble, since they carry close to 8000 warheads.) Whether it has been worth the price of the B-1B to obtain a marginal improvement in nuclear forces is the central question.

In *Wild Blue Yonder*, a new book on the political life of the B-1B, author Nick Kotz argues that if the B-1B seems a misfit, it may be because national security had less to do with its procurement than institutional politics. In judging the technical issues, it helps to know some of this history.

From the earliest days, the Air Force designed the program with politics in mind, awarding contracts in 48 states. President Jimmy Carter nevertheless canceled the prototype B-1A in 1977, calling it unnecessary. He and his Secretary of Defense, Harold Brown, argued that it was better to forgo the aging technology of the 1970s and skip ahead to an entirely new, advanced bomber in the 1990s, to be known as "Stealth." While Stealth was being developed, transport planes could be modified to carry cruise missiles. However, the Air Force wanted a new bomber to replace the 30-year-old B-52, and it wanted one soon.

Ronald Reagan made an issue of Carter's killing the B-1 in the 1980 presidential campaign, promising to resurrect it. In this way, Kotz says, the B-1 became a political totem, a Republican bomber, while the Stealth became a Democratic bomber.

After his election, Reagan put into effect a "two-bomber policy," promising the Air Force both an updated B-1 for the 1980s and a Stealth bomber in the 1990s. However, to keep the B-1 program within bounds and make it more attractive to Congress, Defense Secretary Caspar Weinberger imposed a 100-plane limit on the production run and a $20.5-billion cap on funding. The original B-1A design was modified to become a heavier plane, carrying more cruise missiles, and its flight speed was reduced. The B-1B was to be all things to all people: a low-flying bomber for pilots, a cruise carrier for strategic planners, an example of fast and cheap weapons procurement for the new secretary of defense, a monstrously complex radar instrument for electronics whizzes, and a source of contracts for industry.

In 1981, Weinberger told Congress that "our program will provide much-needed capability in the 1980s and will respond to the congressional mandate to field a new bomber by 1987." The Stealth, he said, would be deployed shortly thereafter, beginning in 1989. On this understanding, Congress approved the project.

After Congress put up the money, there was little news of the B-1B for several years. Then, as the production run drew to a close in early 1986, contractors began lobbying to extend the order to more than 100 copies. At that point, according to a report from the House Armed Services Committee, "advocates of other programs competing for Air Force budget dollars approached the committee with reports of inadequacies in the B-

A Deadly White Blur

"An extremely unlucky penetration" is how General James Meier of the Strategic Air Command describes the impact of a single bird, assumed to be an American white pelican, that slammed into a B-1B bomber over Colorado on 28 September. Meier briefed the press on a staff investigation last week.

Three B-1B instructors and three students took off at 7:57 a.m. on 28 September for a simulated nuclear attack near LaJunta Colorado—their first sortie. They were flying low around the second turn on a plotted course when the pilot, Captain Lawrence Haskell, saw a "white blur" streaking toward the right side of the plane. "The crew heard a loud bang . . . and the aircraft began to shudder and made a groaning and grinding sound."

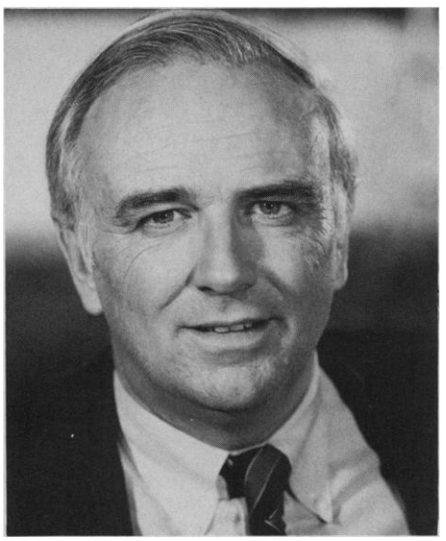
Afterwards investigators concluded that a bird hit an unreinforced section below the right wing near the engine intake. Closing in at 600 miles per hour, the bird penetrated a 4-inch space where fuel and hydraulic control lines come together. A fire began and, within seconds, the airplane began rolling uncontrollably to the

Allan D. Cruickshank/Photo Researchers, Inc.

Pelecanus erythrorhynchos. *Antiaircraft missiles?*

right. After pulling up to 7700 feet and attempting to right the plane, the pilot triggered the ejection system that is supposed to fire four of the six seats out the roof. But the copilot's seat did not work. He died; the other three lived. The two remaining crew members in the rear seats did not have time to bail out the bottom. "The aircraft was totally destroyed."

Aviation standards call for planes to be able to withstand the impact of a 5- to 6-pound bird, Meier said. In this case, the Air Force suspects the damage was done by a 15-pound pelican, common in the area near the bombing run. Because B-1Bs are designed to fly low and fast, they are more likely to meet birds than other aircraft, a fact apparently overlooked by designers. There are some indications that the hydraulic lines were not well placed or well protected. The fleet will be reinforced with Kevlar deflector panels, a task that should be completed by the end of the year. ■ E.M.



Representative Les Aspin, *chairman of the House Armed Services Committee*

1B." The committee's source may have been one of the contractors on the Stealth bomber. The Washington *Post* reported at the time that the Northrop Corporation, the chief Stealth contractor, and Rockwell International, the chief B-1B contractor, were locked in a "dogfight" over the Air Force budget, with Northrop telling Congress the "government should stick to its plan of building only 100 B-1s."

Aspin's committee asked the General Accounting Office (GAO) to investigate and the committee held hearings of its own in February and March 1987. The following problems turned up:

The B-1B, designed to fly fast and very low (200 feet) to avoid Soviet radars, could not hug the terrain at high speed because its guidance radar was not working. Crews were not allowed to rely on it for low-level flight (below 500 feet) or over steep terrain. Today, the Air Force says the terrain-following radar is working. Altitude restrictions were lifted for a time last year, but strict new limits were imposed in the fall for another reason: the need to avoid pelicans.

The B-1B gained 7000 pounds in structural weight and an extra fuel capacity of 25,000 pounds to boost its cruise missile capacity. But loading affects buoyancy and maneuverability. As a result, when fully loaded, this plane must fly at a high angle of attack (nose tilted up) to provide a safe margin of aerodynamic lift. To counter the tail-down drag and to give pilots more room for maneuvering in hostile territory, two flight-control aids are planned that will enable the B-1B to fly close to, and even beyond, the unstable point. One device, called the Stall Inhibitor System, has been reworked several times and a final version is now in hand. The other system, a computerized Stability Enhancement Function, will be added in 1989. Without them, the B-1B's range is diminished and, according to the House Armed Services Committee, its "performance and target coverage will remain limited."

The B-1B is a wet-wing plane, meaning that fuel is pumped directly into wings containing no flexible bladders. In each plane, 290,000 fasteners and 5 miles of metal-to-metal connections must be sealed to prevent leaks. The sealant was not applied properly in the first models, and many were grounded for a while with fuel leaks. The Air Force claims to have solved this problem, although GAO officials say that some planes continue to leak. This problem is likely to reappear later as the wings flex and the sealant deteriorates.

To monitor its nine IBM computers the B-1B has a device called the Central Integrated Test System. In the early days, it reported over 100 part failures on each sortie. But most of these (80%) proved to be false alarms, which could be confirmed only by testing each component. By May 1987, the false alarm rate had dropped to 50% and now the Air Force says it is not a problem. But the GAO still has doubts about the system's "maintainability."

The clear fiasco in the B-1B was the development of its electronic countermeasures or ECM system, the most ambitious part of the project. The Air Force hoped it would be able to do many tasks simultaneously: detect all hostile radar signals from the air or ground, sort them according to severity of threat, respond by sending out false signals, conserve power by radiating only enough energy to counter the worst threats, display all this information on a screen showing the action taken, permit a human operator to override all decisions, and coordinate ECM receivers and transmitters so as to avoid self-jamming. The ECM system weighs 5000 pounds and includes more than 100 interconnected "black boxes" distributed throughout the plane. It did not work in 1987 and is still being tinkered with. General Harbour says the "software was immature, giving the system all kinds of crazy instructions." The first fully standardized, fixed version (known as Mod One) will be flight-tested starting next month. A final version will be tested and installed in 1989, if all goes well. An "enhanced" version capable of dealing with the latest Soviet radars will be installed by 1991.

Former Secretary of Defense Harold Brown told the journal *Military Logistics*: "Our prime reason for canceling [the B-1B] was that it depended too much on electronic countermeasures to penetrate. To reinstate the program and not pay enough attention to that problem is a substantial oversight."

One aerospace designer and Washington consultant with 20 years of experience says, "the B-52, which is an unmaneuverable pig, is far more maneuverable than this plane . . . The B-1B is totally unsuited for flying low." He is not impressed by testimonials on the plane's smooth ride: "Anyone who talks about that is searching for something good to say; that just means it flies like a rock." However, David North, a reporter-pilot for *Aviation Week and Space Technology*, found the plane to have "excellent agility and stability."

The Air Force responds to what one general called the "trashing" of the B-1B by saying that the plane is the best bomber in existence, built on time and close to budget. Even with the ECM turned off, it has a radar image 100 times smaller than the B-52's. The smooth ride makes it easier for the crew to fly at low altitudes, and with improvements, Harbour predicts, the B-1B will be able to fly from Washington, D.C., to San Francisco just a few hundred feet off the ground.

However, a question remains: can the B-1B now carry the out mission for which it was designed—to fly through the world's thickest air defenses and hit targets deep inside the Soviet Union? General Harbour says it can, but "maybe not with the finesse that we could when we're full up" in 1991. He says that by the time the Soviets have deployed new interceptor systems "in depth," the B-1B will have the capability to evade them. In its report last year, the House Armed Services Committee declared that the B-1B "does not now provide the capabilities as a manned penetrating bomber that the Air Force promised would be available" in the fall of 1986. The committee found that the plane would meet the requirements in 1991 only on the "unlikely assumptions" that the pace of testing can be accelerated by 20% and no more problems appear.

If the B-1B fails to work as promised, "from the point of view of the larger mission, does that make any difference?" asks Stephen Meyer, a political science professor and arms control specialist at MIT. He thinks the plane will be able to do its job, but is less than the best solution to the strategic challenge. He calls the plane "a waste of money and a waste of time," especially since the country will need the Stealth bomber anyway. "I happen to be very pro-defense," Meyer says, "but I like to know why we do what we do." He asks, "What can we do now that we couldn't do before we had the B-1? And what will we be able to do in 10 years that we couldn't do otherwise? The answer is nothing."

Like Thomas Longstreth of the Federation of American Scientists, another critic of the B-1 program, Meyer notes that the quality of the penetrating bomber will become more important if the United States and the Soviet Union agree to new ballistic missile limits.

What lessons can be drawn from the record of the B-1B? General Harbour stresses two narrow points. He says the Air Force should have described the terms of its "contract" with the Congress more carefully, making it clear that the promised initial operating capability did not mean that planes would be "full-up" in 1986. Second, he concedes that the Air Force underestimated the task confronting the builder of the radar jamming system, the Eaton Corporation's AIL Division in Deer Park, New York, and overestimated the company's ability. For example, specialized parts had to be built from scratch because a commercial supplier did not want to invest in equipment for a one-time surge in demand. There were many unanticipated problems like this. (Eaton was so shaken by this experience that it has put all of its defense electronics subsidiaries up for sale. So far, it has received no offers.)

Aspin reached other conclusions. The most important lesson, according to the House Armed Services Committee, is that quality suffers if weapons are rushed into "concurrent" development and production schedules. Aspin's investigation discovered, for example, that the development and production contracts for the radar jammer were signed on the same day. This helped save money at first, but may cost more in the long run.

The second lesson the committee cited was that the military needs a lot of help and supervision in spending its money—a self-serving point for Congress. The Air Force was its own prime contractor on the B-1B. The committee decided that the military does not have enough experience or continuity to take on tasks of this kind. General Harbour disagrees, saying that the problems with the B-1B were material, not managerial, and that no private contractor would have done better. Congress nevertheless will remedy the problem by adding a new level of management, its own, demanding bimonthly technical reviews on the B-1B.

In a broader context, there may be no managerial formula for building weapons well. The quick production, fixed-price approach used in this case certainly did not bring good results. A final lesson may be that any machine with as many purposes and as many designers as the B-1B has had will fall short of expectations. ■

ELIOT MARSHALL

Foreign Engineers on Rise

U.S. engineering schools attract their share of the best and brightest to their graduate programs, but about half are drawn from other countries. Academically talented U.S.-born students tend to opt for financially more attractive jobs in industry rather than pursuing research degrees. A new report* sponsored by the National Academy of Engineering examines these trends as part of an effort to identify issues raised by the "increasing prevalence of foreign-born engineers in our society."

Foreign-born engineers are playing an increasingly significant role in American industry, but their impact so far has been even greater on academe, particularly on engineering graduate programs and faculty. Nearly 50% of newly awarded doctorates in engineering go to foreign-born engineers. In 1985, almost two-thirds of engineering postdoctoral posts were occupied by noncitizens.

The future role of foreign-born engineers in the engineering professariat is already staked out. The proportion of noncitizens among engineering assistant professors younger than 35 years increased from 10% in 1972 to 50–55% by 1985. About three-quarters of these noncitizens have applied for U.S. citizenship. U.S. engineering education, therefore, seems to have become a way to qualify for naturalization and for desirable jobs for a select group of well-educated immigrants.

Some 90% of engineering undergraduates still are U.S.-born, but relatively few pursue graduate studies. The report says "one reason for this dearth of U.S. applicants has been the lure of immediate employment at attractive salaries. To overcome this barrier, we recommend the establishment of well-paying graduate fellowships in engineering for U.S. citizens with stipends that would be (nearly) competitive with attractive opportunities for immediate industrial employment."

Stanford S. Penner of the University of California, San Diego, who chaired the group that produced the report, described foreign applicants to U.S. engineering schools as "absolutely the cream of the crop," and noted that the infusion of their talent is a "terrific economic bargain for this country," since most have completed undergraduate engineering training in their own countries.

The report, however, raises concerns about the effects on U.S. engineering education of the growing involvement of the foreign-born as faculty and as teaching and research assistants. The most widely cited problem is the lack of proficiency in English of many of those in teaching roles. Concern has also been expressed that cultural differences may be reflected in attitudes of some foreign-born engineers that discourage women and minorities from pursuing engineering studies.

In addition, national security and export control regulations not only create barriers to employment of foreign engineers in sensitive jobs but also complicate collaborative research by defense industries and national laboratories with university departments that have noncitizen students and faculty members.

Has the influx of foreign engineers resulted in the displacement of U.S. engineers or the lowering of salaries? Penner acknowledged that definitive information on the issues is lacking, but the report says that available data indicate that U.S.-born engineers "have not faced appreciably diminished opportunities in industry."

In making its recommendations, the panel took the pragmatic view that, "without the use of noncitizen and foreign-born engineers, both research universities and industries would have difficulties in handling the educational, research, development, and technological programs that are currently supported. This must be realized in any governmental considerations to limit the inflow of foreign engineering students or graduate engineers."

The report says that the underrepresentation of U.S.-born students in engineering graduate education "clearly reflects faulty policies and serious deficiencies in the U.S. educational and value systems." The long-term solution it urges is "a significant improvement in our entire educational system, from kindergarten through college." Its major short-term recommendation—for an increase in stipends for talented U.S.-born engineering graduate students—is addressed to the federal science agencies which provide most of such funds. What the panel is asking, in effect, is that the market forces that produced pay differentials for engineering faculty work for their grad students as well. ■ JOHN WALSH

*Foreign and Foreign-Born Engineers in the United States: Infusing Talent, Raising Issues."