

The Secret Life of the A-11

DOUGLASS CATER

THERE WAS a measure of jubilation in certain parts of Washington when President Johnson decided last month to release the secret of the fantastic new airplane known as A-11. This manned craft, whose photograph rather resembles a missile lying on its side, can reportedly fly at more than three times the speed of sound, attain heights above twenty miles, and traverse vast stretches of the earth's surface in a single swoop. As a multipurpose weapon (unlike the U-2, which was essentially a spy plane), it seems likely to delay the time when the military must turn irrevocably to the missile—a weapon which, once fired, cannot be recalled. On such postponements, some experts believe, man's fate could depend.

A more immediate reason for the jubilation was the speed and secrecy with which the A-11 arrived on the scene. Conceived in 1959 and then contracted to Lockheed Aircraft, until the President's announcement the veil of security was held to a degree believed possible only during wartime. Dummy corporations handled the subcontracting, and aviation specialists in the press who became aware of the A-11's existence were persuaded to exercise self-censorship. The plane has reportedly been in operation for more than a year, and by now at least eleven or twelve have been completed at a cost rumored to run as high as \$1.5 billion.

Johnson's decision to go ahead with this partial unveiling—the plane and many of its characteristics are still kept tightly guarded—ended a lengthy dispute between Pentagon officials, who favored disclosure, and those in the Central Intelligence Agency who were opposed. A compelling argument was that too many airline pilots had glimpsed the weird monster in flight to keep the secret much longer. But a strong additional motive in the timing of the news release was to beat off efforts in Con-

gress to disregard the administration's defense budget by voting funds for the rich variety of projects for future aircraft boosted by various congressmen. As an immediate consequence, it prompted a House-Senate conference to reject \$40 million allocated to the IMI (Improved Manned Interceptor), approved by the House of Representatives against Secretary of Defense McNamara's wishes. The triumph of the A-11 undoubtedly silenced a number of politicians who have been berating McNamara for failure to speed work on new weapons systems.

BUT it has far from ended the griping in Congress. Senator Gordon Allott (R., Colorado), a member of the Defense Appropriations subcommittee, announced angrily in the Senate chamber that there had not been one word about the A-11 during his group's protracted closed-door hearings on the military budget, adding: "I think every American has a right to ask what is going on in this country, when we in the Senate vote for expenditures of the hundreds of millions of dollars involved in the development of an aircraft about which those who have occasion to know seem to know nothing." Frank J. Becker (R., New York), a member of the House Armed Services Committee, attempted unsuccessfully to challenge the conference's deletion of funds for the manned interceptor. "Despite all of the announcements about the A-11 we have no real information on it," he told his colleagues.

Senator John McClellan (D., Arkansas) joined the attack from a slightly different angle. As chairman of the Permanent Investigations subcommittee, McClellan has waged a long war with Pentagon leaders over their decision to award the TFX (tactical fighter, experimental plane) contract to the General Dynamics Corporation rather than to the

Boeing Company. McClellan was stirred to new fury by President Johnson's statement that "One of the most important technical achievements of this [A-11] project has been the mastery of the metallurgy and fabrication of titanium metal. . . ." One reason McNamara had cited for rejecting Boeing, McClellan recalled, was that it planned to make extensive use of titanium in its version of the TFX.

Though the agitation in Congress may subside, this episode does raise fundamental questions about the way government conducts the secret and not-so-secret business of defense. Not more than ten members in each house, by one insider's estimate, had been told about the A-11. In each of the two Armed Services Committees, the chairman and the ranking minority member were consulted about which of their colleagues would be informed. Apparently it is committee practice for groups of varying size to be briefed on projects, depending on the degree of secrecy.

An even more delicate problem of consultation lies with the powerful Appropriations Committees, which hold the purse strings. Though procedures are kept secret, it is known that Chairman Clarence Cannon (D., Missouri) of the House committee heads a select subcommittee numbering five members who review the top secret spending. In a recent interview, Cannon, a spry man of eighty-five, refused to describe this group's current activities but willingly reminisced about its origins. During the Second World War, he had chanced to discover \$800 million tucked away in various parts of the budget that had not been accounted for. The military officials he queried about this discrepancy refused to discuss it beyond saying that it involved a life-and-death race with the Germans. After considerable soul searching Cannon decided

to grant these funds and, the following year, an additional billion dollars without receiving a word of explanation. He recalls believing that some sort of death ray was in the works.

But when the third year brought still another huge request, Cannon was adamant. "Enough's enough," he remembers telling the military. Next day, a deputation from the Pentagon arranged for the chairman and four of his colleagues to make a midnight flight to inspect the cause of all this outlay—Oak Ridge. The congressmen were impressed by the vast establishment that had been secreted away in Tennessee, but were greatly disappointed to learn that the end product was to be simply another explosive. "Next day, when we met to vote on the funds, we didn't even look at each other," the old chairman recalls. Only public knowledge of the atomic bombing relieved him of his burden of secrecy.

THIS same subcommittee, with replacements for three of the original five members, monitored the funding of both the U-2 and the A-11. By the accounts of those who have appeared before it, the group is hard-working and gives a painstaking review to these activities kept hidden from other members of Congress. Cannon, who remarks cryptically that he has made only one mistake in his choice of members, professes no qualms about such bypassing of the regular legislative process. He states matter-of-factly that it is a question of how to deal with the enemy. "What makes the Russians a menace is the proclivity of members of Congress to talk about everything they know," he commented.

For a good many members of Congress, it is a question whether the business of defense, even when not clothed in secrecy, has not gone beyond the reach of their traditional review process. It has become too massive and many-sided, too dependent on complex judgments of timing and technology. Congress lacks the expert resources to form a truly independent appraisal of what constitutes adequate military preparedness for the nation. Instead, its members often resort to borrowing specialized knowledge from within

and without the Pentagon in seeking to contradict the appraisal reached by the Secretary of Defense and his experts. Subcommittees are apt to ride off on separate hobbyhorses, seldom bothering to reconcile their particular interests with the general defense interest.

The year-long inquest of the McClellan subcommittee into the TFX contract, not yet formally finished, provides a dramatic case study in frustration. Granting certain failures in human relations by McNamara and his deputies, the hearings conducted by the senators have gone beyond all limits of judicious inquiry. They have not produced evidence of either venality or bad judgment that would warrant such a prolonged ordeal. It has become simply a question of who decides. Secretary McNamara, whose original ambition was to save a billion dollars by providing a fighter plane suitable to both Air Force and Navy needs, may well wonder whether it was worth the endless hours of rear-guard action that had to be diverted from management of a defense economy spending a billion dollars a week.

CHAIRMAN MCCLELLAN now threatens to reopen hearings so as to get to the heart of the titanium matter. During an interview conducted outside the Senate chamber as the civil-rights filibuster was getting under way, he asserted that his case against McNamara had not been inspired by animus or self-interest. He would have been quite willing to drop the investigation, he said, if the secretary, instead of resorting to arrogant technical arguments, had pleaded that General Dynamics needed the contract in order to survive. The senator seemed to be claiming that he would have deferred to McNamara's politics but not to his technical competence.

McNamara has had good reasons for his obstinacy. During the latter years of the Eisenhower administration, there was distressing evidence that pressures on the Pentagon were leading to increasingly fragmented decision making. Despite the rigid budget ceilings, there was wasteful proliferation of weapons systems. The ill-fated atomic-plane project, for example, consumed more than a

billion dollars without even producing a prototype. Secretary Neil McElroy could beseech a Congressional committee to "hold our feet to the fire" in order to force a choice between two nearly equivalent missile projects. Amid such competition, mainly focused on super war devices, the urgent need for non-nuclear limited-war capabilities was seriously neglected.

Though McNamara has not spared costs in seeking a more balanced military force, he has also felt obliged, his associates point out, to impose strict limits to prevent his defense budget from getting completely out of bounds. This has meant making ruthless choices among the myriad weapons systems of the future. McNamara has also been ruthless in overriding those in the Pentagon who try to sabotage these choices.

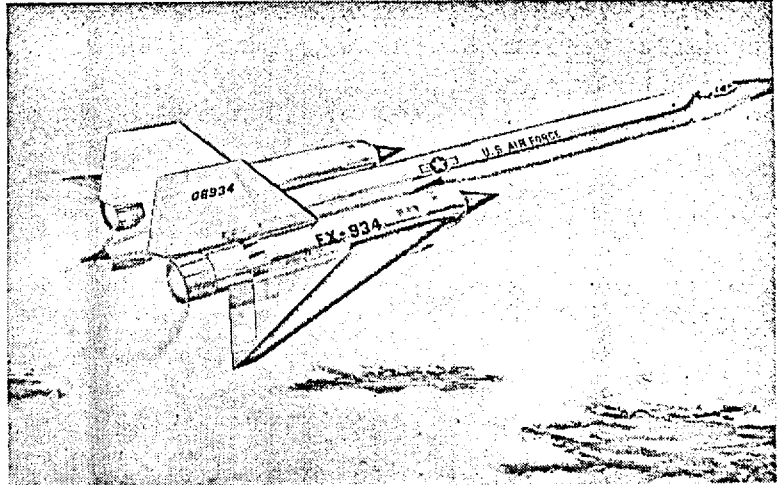
Even among the admirers of this first Secretary of Defense to get on top of his job, there is vague disquiet about what lies ahead. There are too many tough decisions of national strategy and purpose to be left to one man or to a small group of men in the Pentagon. As the defense budget levels off, the pressures of special interest are bound to multiply. As technology becomes ever more intricate, secrets like the A-11, making much of the public argument obsolete, will grow in number and variety.

How does Congress play a role? In the past, a few thoughtful men on Capitol Hill—Carl Vinson, Richard Russell, Stuart Symington, Leverett Saltonstall, Leslie Arends, George Mahon, and Gerald Ford, among others—have performed more valuable service in exerting Congressional control of our military program than all the noisy circuses in the style of the McClellan hearings. There has been a quiet, informal review according to what in their judgment was the public interest, though the public was frequently uninformed as to their activity. This has required more use of political wisdom than matching of technological expertise. As the secret life of the A-11 makes clear, the future state of the defense establishment will depend to an even greater degree on the quality of the men who bear this personal burden.



The official pictures and statements tell very little about the A-11. But the technical literature from open sources, when carefully interpreted, tells a good deal about what it could and, more importantly, what it could not be. Here's the story . . .

A - 11



—Illustration by Gordon Phillips

Born in the Skunk Works, Reared in Secret, It Blazes New Heights in Aircraft Performance

By J. S. Butz, Jr.

TECHNICAL EDITOR, AIR FORCE/SPACE DIGEST

THE dramatic disclosure last month that the United States has manned airplanes that are secretly *cruising* at speeds above Mach 3 was good news to the aviation community.

President Johnson, in revealing the Lockheed A-11 program, showed understandable pride in this important US "first." He said that "several" A-11s were being flown "at more than 2,000 mph and at altitudes in excess of 70,000 feet," and are "capable of long-range performance of thousands of miles." The President added that the A-11 "has been made possible by major advances in aircraft technology of great significance for both military and commercial application."

He mentioned only one specific application. He said that the A-11 was being tested extensively to determine its suitability as a "long-range interceptor." Former White House Press Secretary Pierre Salinger and Defense Secretary Robert S. McNamara stressed the interceptor role in their brief expansions of the President's remarks. However, Mr. McNamara, in response to insistent questioning by reporters, has indicated that the A-11 was not designed originally as an interceptor but that he has considerable confidence that it can be adapted to that role.

Beyond these minimum remarks, the secrecy lid has been clamped on. The Administration opened the door on the most tantalizing aviation news since the X-1 proved there wasn't a sonic barrier. But the door was slammed shut immediately.

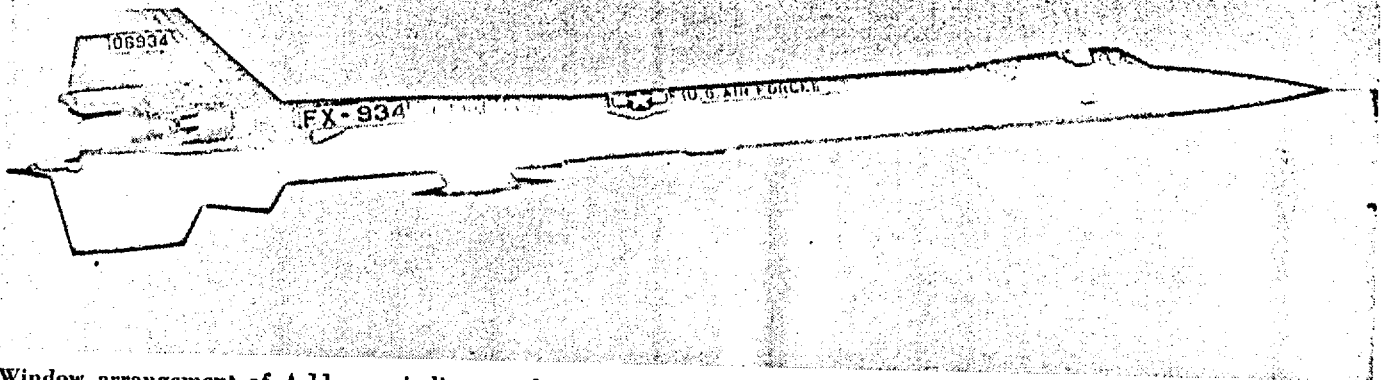
From the technical viewpoint, the A-11 clearly is the most important aircraft since the X-1. It is by far the most efficient airplane yet to fly at supersonic speeds. It is the first to have adequately high aerodynamic efficiency (low drag) and high powerplant efficiency to allow it to carry enough fuel to sustain flight above Mach 1 for more than thirty minutes or so. In the President's words, the A-11 also is extremely important because it led to "the mastery of the metallurgy and fabrication of titanium metal which is required for the high temperatures experienced by aircraft traveling at more than three times the speed of sound."

As reported by Claude Witze on page 16 of this issue, a tight information clamp has forestalled meaningful public discussion of the A-11, its genesis, or its proper role in civil and military aviation.

The following questions are typical of those which should be asked, for the answers concern the use of a very large sum of the taxpayers' money. Congress and the public have a legitimate right to frank answers.

- How much did the A-11 and its engines cost? Judging from previous pioneering programs that fought their technical battles out beyond the "state of the art," the A-11, with its Mach-3-plus performance, titanium construction, and high-temperature engines cost at least \$500 million and possibly \$1 billion. That is \$100 to \$200 million per year for the five years the program has been active. (President Johnson said the

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Window arrangement of A-11 may indicate a three-man crew. The large ventral fin shown here raises the possibility of zero-length launch. This takeoff technique may be used for high-performance aircraft to conserve fuel and increase range. Openings at the rear of the nacelles feed air to convergent-divergent nozzles needed for efficient engine operation.

A-11

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A-11 design work started in 1959. The J58 program was initiated several years earlier by the Navy.) This kind of money is in the cost range of the much-criticized and now-defunct nuclear airplane, and programs of this magnitude should get a thorough working over by the Congress.

• The "obvious" conclusion to be drawn from the information available is that the A-11 was originally developed for the CIA as a high-altitude reconnaissance airplane to replace the U-2. Most reporters reached this conclusion, supported largely by the close secrecy on the airplane, Mr. McNamara's refusal to divulge the original design objective, and the fact that the project was not handled in normal management channels. If this conclusion is correct, several questions arise immediately concerning the past and future expenditure of large sums of money:

(1) Does the fact that a given airplane can cruise at Mach 3 also mean that it automatically has a multi-purpose capability — reconnaissance, interceptor, bomber — without a major design change for each type of mission?

(2) If the answer is no, was there coordination between the CIA and the DoD at an early stage to make certain that the A-11 was not hopelessly boxed into one role?

(3) Can the A-11 development expedite the supersonic-transport (SST) program?

(4) Have reconnaissance satellites eliminated the need for reconnaissance aircraft such as the A-11, and will it therefore end up only as a high-cost experimental aircraft with limited capability?

Precise answers will require the most candid discussion of the current version of the A-11 and its design and development history. Certainly no one can judge the exact performance or mission capability of a supersonic-cruise airplane using only the two side-view photographs and brief statements currently available on the A-11.

Estimates of this type are riskier for supersonic-cruise airplanes than they are for subsonic aircraft or for those that are capable of only short dashes at supersonic speed.

Basically, supersonic-cruise airplanes involve extremely difficult design problems. Their payload-range performance is extremely sensitive to engine weight, structural weight, fuel consumption, and aerodynamic efficiency (lift/drag ratio, written L/D). Small mistakes in predicting these values can lead to large errors in payload and range.

Fortunately, the supply of technical literature concerned with these problems is large. This literature points to some general conclusions about the A-11 and places some broad limits on the possible performance of this new aircraft.

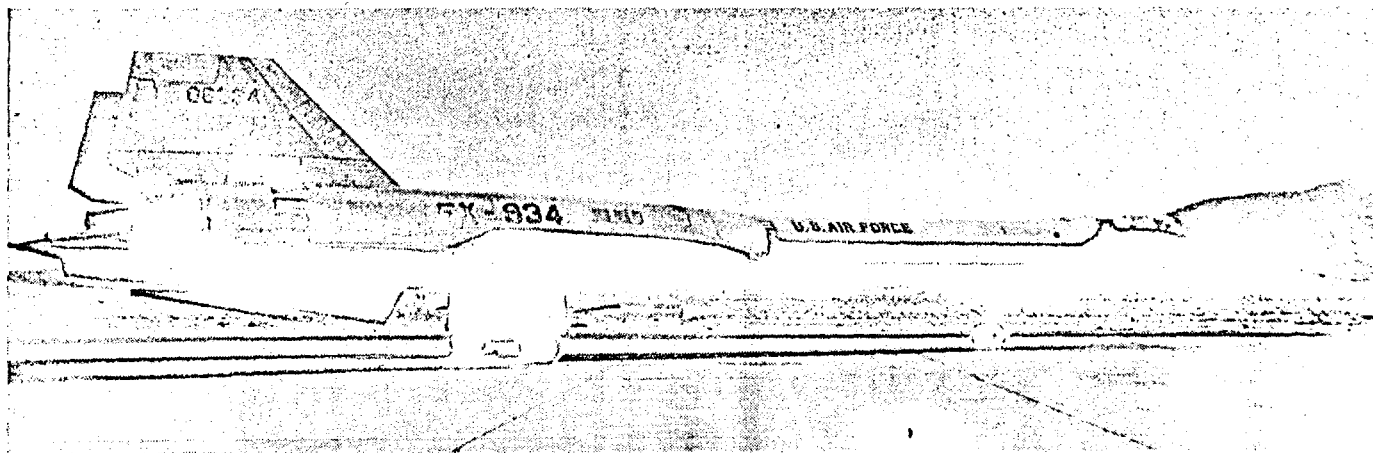
The difficulties described in this literature also provide the best tribute to Clarence L. (Kelly) Johnson and his "Skunk Works" colleagues at Lockheed, who, with the J58 engineers at Pratt & Whitney, led the team that first achieved supersonic cruise.

Here is what can be deduced about the A-11, based on this literature:

• **Size.** The airplane is about ninety feet long based on scaling of the A-11 pictures, using published data on the J58 diameter and estimating the size of the pilot's helmet visible in the front window. There is room in the slim fuselage and in the wing stub areas for more than 70,000 pounds of fuel, with space left over for substantial mission equipment. Since efficient supersonic-cruise airplanes have to carry at least fifty percent of their weight in fuel, the A-11 takeoff weight apparently is more than 150,000 pounds. This is roughly the same as that of the B-58 bomber.

• **Wing.** Densely loaded aircraft such as the A-11 need large wing areas; otherwise their wing loadings will quickly rise above 100 pounds per square foot and severely reduce both cruise altitude and flight efficiency.

The side-view photographs obscure most of the A-11 wing, and published drawings of the A-11 have not indicated a large lifting surface. However, the aircraft must have an effective wing area in the neighborhood of 2,000 square feet. This includes not only the area outboard of the engine nacelles (see drawing on the front cover) but also the area between the engines, and the area of the long, very narrow wings



Twist and camber in outboard wing section is visible in this photo of A-11 configuration rigged for conventional takeoff with standard-length landing gear and minus the large ventral fin shown on model at left. Flight tests of the X-15 revealed that X-15 did not need its large ventral fin for adequate directional stability at supersonic speed.

on the fuselage, which have been referred to in some reports as fairings. The long and narrow wings form the forward section of a large double-delta wing similar to that used by Lockheed in its supersonic-transport proposal. At supersonic speeds these long, narrow wings plus the fuselage area between them generate much more lift than they do at subsonic speeds.

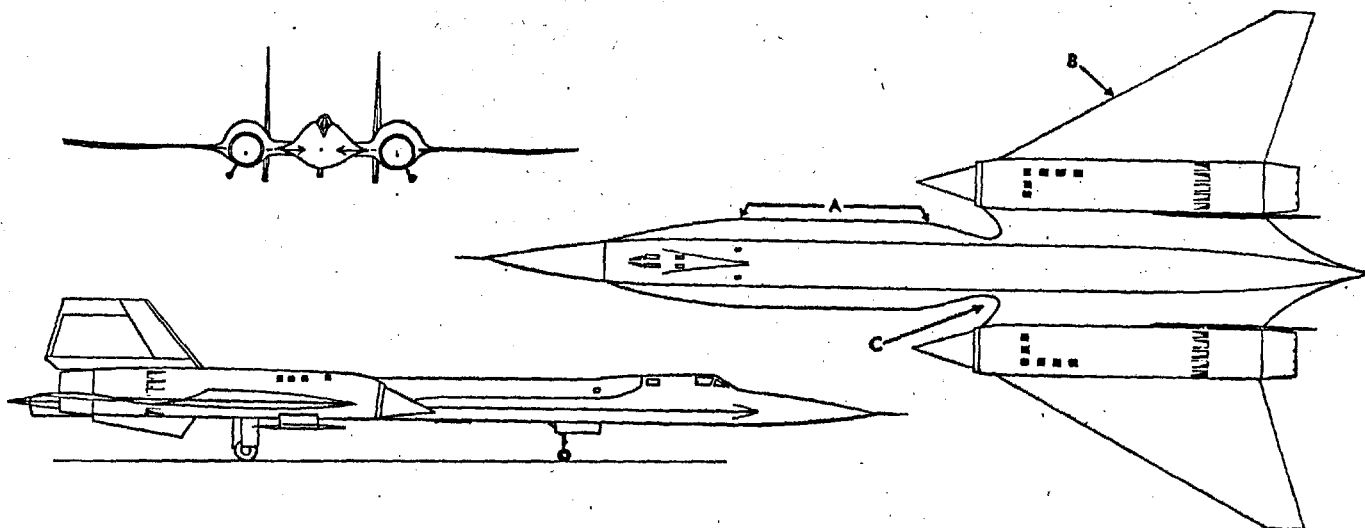
This generation of additional lift up forward is important in maintaining control over the airplane above Mach 1. The controllability problem arises because the rear portion of the double delta acts like a conventional lifting surface at supersonic speeds, and its center of lift moves abruptly aft, a long distance away from the center of gravity. This can make the aircraft so stable that it can't be controlled by a normal-size horizontal tail. In any event, it calls for a large deflection of the tail and an unacceptably big trim drag, which eats into range. On the A-11, lift on the long, narrow wings counteracts the shift of center of lift on the main surface and keeps the center of lift near the center of gravity. On some designs a small canard (horizontal) surface near the nose serves this

purpose. The Swedish Saab Draken, the Mach 2 fighter operational for several years, was the first of the so-called "tailless" (no conventional horizontal tail and no canard) airplanes to use the double-delta planform.

- **Design Mach Number.** The centerbodies of the engine air inlets on the A-11s in the photographs released by the White House appear to have a ramp angle suitable for a maximum economical cruise speed slightly above Mach 3.

- **Cruise Altitude.** Most press reports have placed the A-11's maximum cruise altitude between 90,000 and 125,000 feet. This appears to be a serious error. There is a well-established procedure for checking maximum cruise altitude. It indicates that the A-11 must cruise between 70,000 and 80,000 feet or its range will severely suffer. Thus, the A-11 can be expected to get its maximum range while cruising about 5,000 to 10,000 feet below the U-2. The U-2's superior wing and lower wing loading give it better altitude capability in unaccelerated flight. But in a zoom climb the A-11 would outperform it.

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A-11's modified double-delta wing shows in this three-view drawing. The forward delta extends straight back from just ahead of the pilot's canopy, rearward to the engine air inlets (letter "A"). The rear delta is outside of the engine nacelles (letter "B"). A cutout similar to that shown at "C" must be used to keep low-energy boundary layer air passing along the forward delta from entering the engine inlet, lowering engine efficiency and creating heavy unbalancing forces on the compressor. Such a cutout would be critical in creating favorable flow on rear fuselage ramp.

To figure maximum cruise altitude you have to know two characteristics of any aircraft—the wing loading (written W/S and equal to the gross weight divided by the wing area), and the lift coefficient (written C_L , a dimensionless number indicating the lifting power of the wing) generated when the aircraft is flying at the proper angle of attack for maximum range (maximum aerodynamic efficiency). When the W/S is divided by the C_L , it equals the dynamic pressure required to keep the aircraft in level flight. The dynamic pressure is the term that fixes the altitude of flight for any given speed.

There is enough information on the A-11 to put the above relationships to work. For instance, when the A-11 is flying at Mach 3 at 70,000 feet, the dynamic pressure is nearly 600 pounds per square foot. The lift

its structure could not be any heavier than that of a Piper Cub.

Or, if the A-11 tried to fly at 125,000 feet at a wing loading of about thirty pounds per square foot, corresponding to an end-of-cruise weight, its speed would have to be at least Mach 8 to maintain level flight and to keep it from stalling out.

The same procedures can be used to show that the U-2's altitude during maximum range cruise will vary from about 75,000 feet to a little more than 90,000 feet.

Another check on the operational altitude of the A-11 can be made by examining the engine air inlets which appear to be about six feet in diameter at the most. Therefore, the maximum capture area for both inlets to take in air is between fifty and sixty square

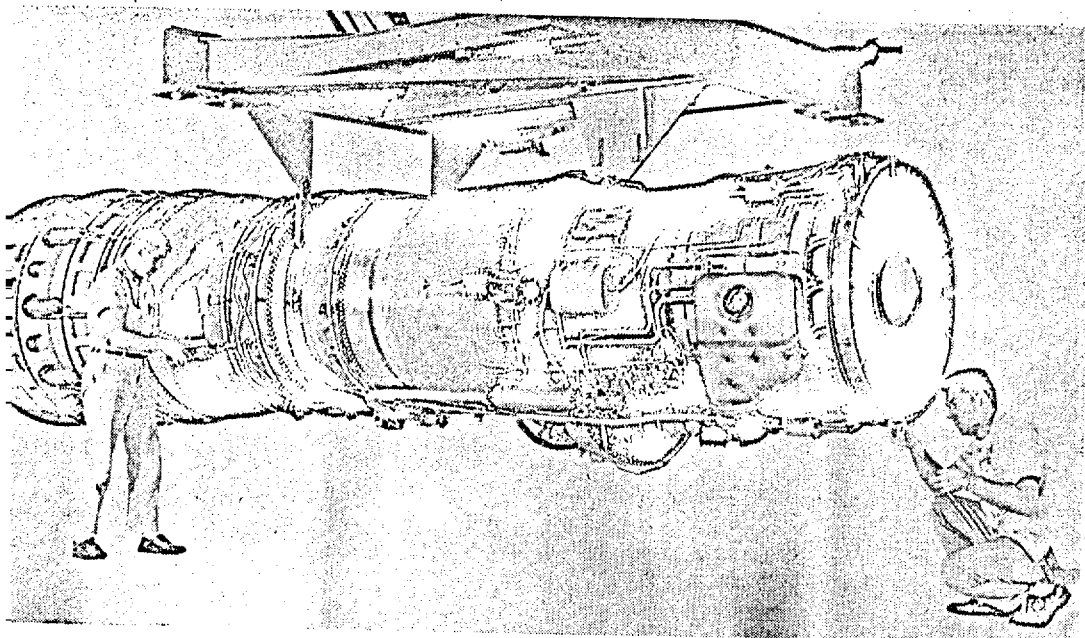


Photo shows early model J58 turbojet. One of few showings of this engine was at AFA's 1959 Convention in Miami. Soon afterward project was highly classified. Thrust is at least 30,000 pounds without afterburner. Efficient use of this engine in a Mach 3 cruise aircraft requires both variable-geometry inlet and exhaust nozzle. A-11 seems to have such systems with a movable centerbody in the inlet and a nozzle that changes the exit area. Altitude performance would improve if the inlet lips opened to enlarge the "capture" area and admit more air.

coefficient for maximum L/D is about .1 (this has been confirmed in many NASA reports on aircraft similar to the A-11). So 600 may be multiplied by .1 to give a maximum possible wing loading of about 60 pounds per square foot. This is about the wing loading the A-11 would have if it had a 2,000-square-foot wing area, weighed 150,000 pounds at takeoff, and burned about one-third of its 75,000-pound fuel load during its climb to altitude.

This procedure can be run through again to show that the A-11's wing loading would be a little better than thirty pounds per square foot once it had burned all its fuel. It, therefore, would end its cruise at Mach 3 at 80,000 feet.

Speed would not change this picture too much. If the A-11 were capable of Mach 4, it would begin its cruise at about 82,000 feet and in the lightened condition at the end of cruise would be flying at nearly 95,000 feet.

The press reports of 125,000-foot altitude completely fall apart under check. If the A-11 flew at that altitude at Mach 4 it would need a wing loading of less than ten pounds per square foot. In other words

feet. This is just about enough to fly an airplane like the A-11 at 80,000 feet at Mach 3. At 100,000 feet at Mach 3 the required capture area goes well over 100 square feet. At 125,000 feet the inlets would become truly gigantic.

In recent years, the ability of Century-series fighters to zoom higher than 100,000 feet has tended to distort the picture as far as maximum cruise altitude and maximum level flight altitude are concerned. Most of the Century-series fighters cruise best between 35,000 and 45,000 feet, and their maximum level flight altitude is around 60,000 feet. Therefore, the A-11's ability to cruise in the 70,000- to 80,000-foot level is certainly not to be disparaged. With the A-11 cruising at Mach 3 at those altitudes, on a gentle dog-leg course, it would be essentially impossible for any operational fighter in the world to intercept it. And it is doubtful that any existing ground-based missile system could down the airplane.

• **Aerodynamic Efficiency.** The A-11 came along in time to benefit from several years of inspired aerodynamic research during the middle and late 1950s. By 1960 the unclassified literature had made it clear that

the old idea that L/D (aerodynamic efficiency) was certain to be less than five at Mach numbers above 3 had to be discarded. There were strong indications that L/Ds of seven and eight and possibly higher could be attained.

These were still well under the L/Ds of eighteen to twenty-three at which subsonic transports and bombers operate. However, an L/D of eight is enough to bring the total flight efficiency (and range) of a supersonic airplane up close to that of the subsonic jet because propulsive efficiency increases rapidly at supersonic speeds. The idea that an economical supersonic transport (SST) was possible grew out of supersonic L/D research in the late 1950s, and the idea of the A-11 undoubtedly had the same beginning.

The basic rules for obtaining high L/D have been discussed exhaustively in NASA reports and the publications of the technical societies. The A-11 appears to use all of them. First, the wing leading edges are as sharp as possible, even sharper than those of the F-104. Second, the fuselage has a fineness ratio (length divided by diameter) of around eighteen, which gives it a very high internal volume for carrying fuel and equipment. Such design was found to be the optimum means for carrying any given weight at supersonic speeds, and the A-11 has the highest fineness ratio yet used on any aircraft.

Third, proper distribution of the pressure forces, the lift and drag forces, is a key to getting high L/Ds with any airplane. Several important techniques which bring pressure distributions closer to the ideal were developed during the 1950s. They primarily involved "twisting" and "cambering" the wing. The side-view photographs of the A-11, both looking endwise at the wing, clearly show its "twists" and "cambers."

Supersonic vehicles offer designers one unique opportunity for reducing drag and improving L/D. This is to arrange the vehicle components (fuselage, wing, tail, nacelles, etc.) so that they "interfere favorably" with each other. At subsonic speeds interference effects are negligible at a distance of more than a few inches away from any surface.

However, at supersonic speeds strong shock waves and pressure fields spread away from all objects. Pressure fields spreading from an aircraft's components can combine unfavorably to make the total vehicle drag much higher than the drag of the components taken separately.

Happily, this situation can be reversed. The components can be arranged so that their pressure fields and shock waves "cancel" out each other and reduce total drag. For instance, an engine nacelle outboard from a fuselage can throw a high-pressure field on the curved aft side of the fuselage to create a "thrust" force and reduce fuselage drag. The "ultimate" in favorable interference is a theoretical supersonic biplane postulated by Adolph Busemann in the 1930s. This was an arrangement of two wings, properly shaped and spaced apart, which canceled all of each other's wave drag at one particular Mach number.

In the 1950s supersonic interference effects were the object of intensive research, notably by Antonio Ferri of the Polytechnic Institute of Brooklyn and A. J. Eggers, Jr., of NASA. Their basic information was applied on the B-70, which is arranged so that a power-

ful positive pressure field is created on the lower wing surface by the engine air duct during Mach 3 cruise to increase lift and improve L/D. Design techniques for favorable interference have been under continuous refinement and are very important in the SST proposals now being evaluated by the FAA.

On the A-11, the area on the back of the fuselage between the engine nacelles is a highly critical flow area in which several strong pressure fields meet. Undoubtedly, the fuselage slopes off continuously in this area and forms a gentle ramp ending in the sharp point visible in the photographs. It would be possible to reduce drag, improve L/D, and increase the effectiveness of the vertical tails by creating favorable pressure fields along this ramp. The slope and contour of the ramp, the spacing and shape of the engine nacelles, the location of the vertical tails, and the flight speed all would be important in creating a favorable flow field and a high L/D. This leads to the conclusion that the A-11 is a single design point airplane. That is, it has a high L/D at its cruise Mach number, but its aerodynamic efficiency falls off at both lower and higher speeds. Consequently, the airplane probably doesn't have much growth potential in speed and would be in serious trouble about making its range if one engine were lost.

- **Structure.** The extent and the manner in which titanium is used in the A-11 has not been disclosed. However, the President's remarks hinted that titanium was the main load-bearing metal. If this is true, the A-11's airframe must be relatively light and efficient for a high-temperature structure. According to data from the SST program, it would have been possible to design the airframe for Mach 4 temperatures with only a slight increase in weight and probably the installation of new leading edges made of higher temperature material. The refractory metal alloys developed in the Dyna-Soar program, for example, would have a long life on a Mach 4 airplane.

After the heating problems the most important structural question about the A-11 is its design load factor. If the load factor were low, say two Gs at cruise, the structure would be extremely light, and amount to only about twenty percent of the airplane's total weight, or even less. Consequently, maneuverability would be sharply limited and the aircraft certainly would be marginal as an interceptor even if its missiles were extremely maneuverable. However, the light structure would result in a low-wing loading and a high cruise altitude, and it would allow a greater percentage of the airplane's weight to be carried as fuel, which would increase range.

If the design load factor were high, to allow seven-G turns, for instance, the structural weight would go up sharply. Such design would make the aircraft very useful as an interceptor or a bomber, but it would substantially reduce maximum cruise altitude and range.

The question of adapting the A-11 to an interceptor or a bomber mission depends largely upon the design

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load factor, which, of course, is a closely held secret. Structural strength is more important in this case than the problem of incorporating the necessary electronics and missiles, for the A-11 is big enough.

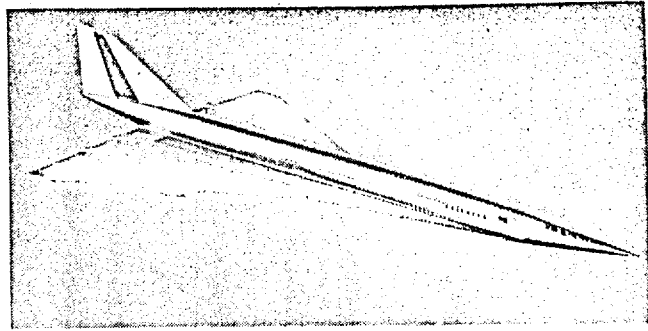
• **Engine.** Official reports dating back several years describe the Pratt & Whitney J58 as a simple supersonic turbojet with an afterburner. An early version lost the B-70 competition to the General Electric J93. If an early version is powering the A-11, the specific fuel consumption (SFC) is high and the range is low. Simple turbojets of the middle 1950s all ran on afterburner at Mach 3, and their SFC was more than two pounds of fuel consumed per pound of thrust per hour, compared to an SFC of about 0.8 for the best fan engines on subsonic jet transports.

However, great strides have been made in engine design, and it seems highly unlikely that a 1955 vintage supersonic engine would still be in the A-11. The J58 undoubtedly has been improved in many ways through higher operating temperatures, the use of advanced turbine-cooling techniques, better compressor blading, and possibly the addition of a fan and new thrust-augmentation systems.

If such engine improvements have been incorporated in the A-11, the SFC during cruise is down near 1.5 pounds of fuel per pound of thrust per hour. Figures almost this low are being quoted for the SST engines. And, in 1962, three Lockheed engineers—F. S. Malvestuto, Jr., P. J. Sullivan, and H. A. Mortzschky—in a most interesting paper before the Institute of the Aeronautical Sciences gave Lockheed's views of what could be done in the way of optimizing supersonic and hypersonic-cruise configurations in the near future. On the key question of achievable SFCs they said, "Propulsive efficiency [Mach number divided by SFC] of 2.0 . . . appears to be a reasonable value for any chemically-fueled pure-turbojet or dual-cycle propulsive system now available or projected in the near future." According to this estimate, the best expected SFC is 1.5 in the near future for Mach 3 airplanes.

One point, continually emphasized in the literature, is that the "match" between airframe and engine on supersonic-cruise airplanes is much more critical than on any aircraft of the past. Engine weight becomes a larger percentage of the total airplane weight, and fuel consumption rises sharply compared to subsonic powerplants, so the engine becomes relatively more important in achieving long range. Consequently, tailoring the airplane to achieve the best possible engine air inlet and exhaust flow conditions has a large payoff. This tailoring must be balanced by airframe considerations, however. On the relatively narrow-span supersonic airplanes the placement of engine nacelles, inlets, and exhaust flows can seriously affect the total flow pattern over an aircraft, which is the determining factor in achieving a high L/D.

On the A-11, the fuselage and the forward and aft portions of the double-delta wing apparently ride at an angle of attack of about four to five degrees during cruise. This angle gives maximum L/D for the A-11 type configuration. The openings of the engine air inlets and the inlet spikes are canted forward through



Lockheed proposed a double-delta wing for its supersonic transport (above). This is a Mach 3 aircraft weighing more than 400,000 pounds and capable of carrying 218 passengers more than 3,500 miles. A-11 can play a vital role in development of the SST by serving as systems test bed.

the same angle to face directly into the airflow and maximize inlet efficiency during cruise. The engine exhaust flow, however, nearly parallels the fuselage and is directed downward at an angle of about four degrees to the line of flight. Therefore, about seven percent of the thrust force is realized as lift to improve L/D and range.

In addition, the A-11 powerplants apparently have been placed so their thrust line is slightly below the airplane's center of gravity during most of the cruise flight. Therefore, the engines produce a nose-up pitching moment and reduce the amount of elevator deflection needed to trim the airplane. NACA reports have estimated that the proper placement of the engine thrust line to reduce trim drag of the elevator can increase range five to ten percent in aircraft of the A-11 type.

• **Fuel.** Several years ago there were reports that the J58 was being tested with boron fuel. If pentaborane were burned in the J58 afterburner—and research has shown this to be possible—then a thousand miles or more could be added to the A-11's range.

US production of borane fuels has been stopped, but Defense Secretary Robert S. McNamara last year told the Congress that enough was stockpiled to satisfy projected needs for the foreseeable future. The boranes are now being used in rocket-engine research, primarily by the Air Force, and conceivably the A-11 could draw from this reservoir.

Borane fuels are expensive compared to the hydrocarbons, and this is a major reason why the use of pentaborane was dropped from the B-70 plans. How-

(Continued on following page)



Air Force Association honored the designer of the A-11 last fall for earlier U-2 work. Here Lockheed's Clarence L. (Kelly) Johnson accepts von Kármán Trophy from USAF Vice Chief of Staff, Gen. W. F. McKee, at AFA Convention.

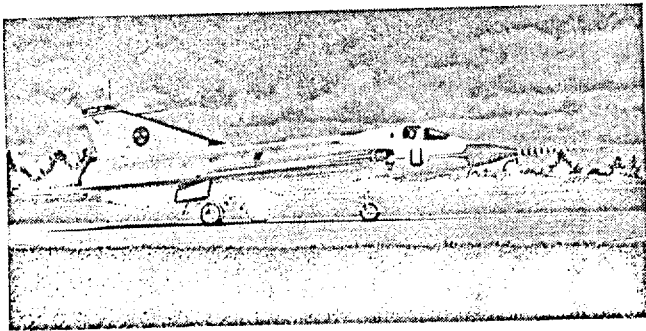
A-11

ever, on a relatively small aircraft such as the A-11, with relatively limited numbers involved, the extra cost could be justified by the large performance improvement.

- **Range.** Maximum range on the A-11, if it is hydrocarbon fueled and powered by a J58 model only slightly better than the original version, probably is around 3,500 miles. This assumes an L/D of six, an SFC of 2.0, and fifty percent of the aircraft weight in fuel, with about one-third of it being consumed in the climb to altitude. Boron fuel would add around 1,000 miles to the range.

If it has been possible to achieve the maximum L/Ds and SFCs suggested in the Lockheed paper mentioned above, the range would go over 5,000 miles on hydrocarbon fuel. This assumes an L/D of eight and an SFC of 1.5. But this level of performance probably will not be achieved for some time.

- **Development Schedule.** It has been reported that the A-11 was delivered and flown for the first time in 1961; that is slightly more than two years after design



The world's first operational double-delta aircraft is the Swedish Air Force's SAAB J-35 Draken, a Mach 2 all-weather interceptor and ground-attack aircraft whose prototype first flew in October 1955. The aircraft, still in production, entered military service in early 1960.

work started. The same report also claims that the A-11 has been operational for two years, meaning 1963 and most of 1962. That would leave about one year, early 1961 to early 1962, for flight testing.

If this report is true, it would have been necessary during this one year to move in relatively small speed increments toward Mach 3 to make sure that all systems were responding properly to all speed, temperature, and vibration conditions. The inevitable "fixes" would have been made and the modified systems rechecked. Finally, it would have been necessary to move slowly toward maximum-range flights, by cruising at Mach 3 for longer and longer periods to ensure that all systems were withstanding the high-temperature "soaking."

Under any conceivable set of circumstances, designing, fabricating, flight testing, and bringing a pioneering, first-generation, Mach 3 cruise airplane to operational status in three years would be an almost miraculous achievement. True, the CIA-type management system is conducive to rapid developments. In effect, the CIA simply says to the contractor, "Bring us one of these." We are making you responsible for performing all tests and making all technical decisions."

The U-2 was designed this way and delivered for first flight in little more than one year. But the U-2 was a completely straightforward project with a well-known type of wing, aluminum construction, and a slightly modified version of a well-developed turbojet. The A-11 designers were breaking new ground in every department, although they did have access to development data from the B-70 and J93 projects.

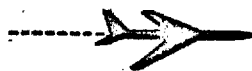
It seems reasonable that design, fabrication, and ground testing of the A-11 and its systems took nearly four years and that the first flight took place in 1963. Less than a year of flight testing probably would have allowed President Johnson to say that the aircraft "has been tested in sustained flight at more than 2,000 mph," and is "capable of . . . long-range performance of thousands of miles. . . ." He didn't say the range had been achieved.

But if the shorter development time reported is true, the SST program certainly bears review. If any Mach 3 cruise airplane can be brought to operational status from scratch in three years, then maybe the FAA is correct in taking the position that SST costs, technical uncertainties, and development time will be much lower than industry estimates.

Development of an economic supersonic transport is a much more difficult problem than the A-11, but if the CIA's hands-off management concept can indeed get us a Mach 3 airplane in three years, this concept certainly should be considered for the SST. And the Pentagon could benefit from this example as well.

- **Supersonic Transport.** The A-11 probably can spell the difference between success and failure in any US Mach-2.5-plus supersonic-transport program. The A-11 provides an immediately available means of getting vital flight-test time on all SST systems. It will yield data on the performance of titanium structure at Mach 3 that could not be obtained by any other means. And, when the SST engines are ready, the A-11 will allow them to be exhaustively tested in flight in a known vehicle and not an unproven SST airframe. By allowing such testing, the A-11 will fill a gap in the government's SST plan that has worried many in industry. The A-11 experience should make it possible to go ahead in an orderly manner and build the SST, which must be a true second-generation, supersonic-cruise airplane that has high aerodynamic and propulsive efficiency at all subsonic and supersonic speeds, and an extremely rugged titanium structure which can last through ten years of airline flying.

By any standard the A-11 is a magnificent technical achievement. Quite obviously it can outfly any known aircraft in the world by a substantial margin. It is a natural for reconnaissance. However, if the A-11 is from the U-2 mold and built with an extremely light airframe, it will not have significant combat potential as a bomber or an interceptor without major redesign. Even if such redesign is not forthcoming, the A-11 will play a key research role in building the technology of Mach-3-plus cruise airplanes of all types—transports, fighters, and bombers. In this role its ultimate importance to aviation and the nation may be as great as any aircraft ever built.—END



AIRPOWER in the news



By Claude Witze

SENIOR EDITOR, AIR FORCE/SPACE DIGEST

Less Than the Whole Truth

WASHINGTON, D.C., MARCH 18

There are substantial reasons why public pressure should be maintained for the revelation of more facts about the new Lockheed A-11 Mach 3 airplane. And none of the facts that should be public property in this democracy will menace national security if they are disclosed. The A-11, like the TFX, the RS-70, and the Skybolt missile before it, is involved in arguments about concept and policy that are properly the subject of public discussion.

The general capabilities of the A-11 and the mission for which it was designed can be aired before Congress and the voters without disclosing any specific information about the technologies involved and the precise threat it presents to a potential enemy. If the A-11 is undergoing tests to determine how good it is as an interceptor, which is what we were told by the White House, the threat to the enemy will not be real until the system is combat ready. The A-11 is far from that state and may never reach it.

Details of President Johnson's announcement that the A-11 exists and an analysis of its technological significance appear starting on page 33 of this issue. Of equal importance is the Administration's insistence that the A-11 is an interceptor aircraft and that it meets the Air Force requirement for an Improved Manned Interceptor (IMI). So long as the news about the A-11 is carefully managed, the Administration is not likely to get a serious challenge to its assertion, but the atmosphere on Capitol Hill is charged with skepticism. When Gen. Curtis E. LeMay, USAF Chief of Staff, was testifying a few weeks ago before the House Armed Services Committee, he said, "We need a new long-range interceptor and we feel that \$40 million this year will move us in an orderly program toward producing it." Asked at what point we are in the IMI program, he said, "We are doing some work in this field, but we are not going fast enough to have an orderly program to produce it." He made a further statement that was deleted from the published record.

Whatever the General told the committee in confidence, the House included the \$40 million in its version of the defense authorization bill. There is no evidence in the record that Chairman Carl Vinson or any of his colleagues knew of the A-11 or considered it the prototype of an interceptor if they did know about it. Chairman Melvin Price of the Subcommittee on Research and Development voted with the majority in favor of granting the money. Three Democratic members of his subcommittee, Representatives Samuel S. Stratton, Jeffrey Cohelan, and Otis G. Pike, voted against it and signed a minority report. In this, they argued the money had not been requested from the subcommittee but indicated they knew of progress made toward an IMI. They then picked up the argument of Defense Secretary Robert S. McNamara that there are several airplanes which could take on the IMI mission, citing the F-106, the F-4, and the TFX or F-111. General LeMay already had said he wants something better.

There was a strange change of attitude in the Senate. The \$40 million item was dropped from the bill. After the A-11 was uncovered Senator Richard B. Russell, floor manager for the bill, bolstered the President's portrayal of it as an interceptor. He said he had been privy to all of its history and that what has been learned has applicability to other types of aircraft. The Senator said the \$40 million was taken out of the bill because the A-11 already is past the research-and-development stage and is undergoing test and evaluation. He said he did not know why the Air Force, meaning General LeMay, asked for the money.

Secretary McNamara was the next witness in Washington. He told a press conference, "The A-11 is an interceptor aircraft, it is being developed as such, and beyond that I have nothing further to say on its use." He said the Air Force naturally knew all about the A-11 and that there was a misunderstanding about what was requested. This was not new money, he said, but a request "to have the authority within the total funds budgeted to reallocate funds to increase the expenditures on the IMI and to reduce expenditures on certain other projects." He said there is no doubt that the A-11 is the plane USAF has in mind for the IMI mission.

One of the more significant sentences in Mr. McNamara's remarks was his comment that "hopefully, we can have multi-use aircraft evolve from the single-purpose designs."

It is this conviction of his, first brought to fruition in the TFX joint USAF-Navy project, that has not been accepted by experienced airmen in any branch of the services. The A-11, it has not been denied, was laid down in 1959 as a high-flying and fast reconnaissance airplane and the undisclosed amount of money that has gone into it would be hard to disguise in USAF's budget. It could have been financed by the Central Intelligence Agency, but that is not as important as the fact that the reconnaissance and interceptor missions cannot be performed efficiently by the same airplane. It is obvious that the technologies overlap in such areas as propulsion, materials, human factors, and aerodynamics, but weapon systems differ according to their missions.

All through the discussion following the A-11 announcement there has been an aura of the half-truth about Administration statements. Asked bluntly whether the A-11 had been designed as an interceptor, Secretary McNamara replied, "I don't think that I said that, and I would rather not say." Nobody asked, "Why not?" It was brought out in General LeMay's testimony that all of the Chiefs of Staff favored going ahead with an IMI and that even the Chairman, Gen. Maxwell Taylor, gave it his endorsement. USAF Secretary Eugene Zuckert testified that "No formal proposal has gone forward from the Air Force, that is, from the civilian Secretary [Mr. Zuckert] to the Secretary of Defense. I did write him a letter in which I said it looked as if we were progressing to the point where we would need a sizable sum of money such as the one General LeMay mentioned [for] 1965."

Continued

Later Rep. Porter Hardy quizzed the Air Force Secretary and asked whether Mr. McNamara showed any signs of "mellowing" or beginning to understand the requirement for an IMI. Mr. Zuckert acknowledged that his boss was not "too encouraging." He added that he favors a larger development program than the Defense Secretary, but "I have not personally proposed that we build a force of any particular size leading toward a full defense capability with an IMI."

Further quotations are not needed to display the status of the IMI project, at least as it stood in February. If we accept the natal date of the A-11 as 1959, it seems clear that nobody called it an Air Force airplane at least until sometime in 1963, by which time the concept probably had been overtaken by more esoteric systems operating in space. If the A-11 was designed as an IMI there was no reason to blanket its existence with any more secrecy than would have surrounded the F-108, interceptor counterpart of the B-70 and also designed by North American Aviation, if that project had not been abandoned a few years ago. It was after cancellation of the F-108 that airmen concerned with the defense mission, most notably Gen. Laurence S. Kuter, first proclaimed the requirement for an IMI. If they knew the A-11 was being developed as an interceptor, which they should have known if it is true, their speeches, in retrospect, make little sense.

Since disclosure of the A-11 by President Johnson, most of the verbiage has been concerned with its place in the history of aeronautical progress and the fact that the story was kept out of the public prints, whether by publicists or patriots. The emphasis has been in the wrong places. The sophisticated observer, be he aeronaut, editor, or military officer, knows that USAF does not develop a new interceptor by starting with a vehicle that flies higher and faster, with limited maneuverability, and then try to determine its capability. The interceptor capability would be built in, starting on the design boards. There is much justification for suspecting that the A-11 has been used for manipulation of American public opinion, possibly to cast aspersions on Air Force competence in an area of Air Force specialization. The outlook for national security is frightening if this kind of manipulation is allowed to continue, making it look as if technology escaped the grasp of the men with the mission.

Why Doesn't Anybody Get Mad?

As we write this, the East Germans, who are Communists, are withholding information on the condition of three USAF officers who were shot down a few days ago when their RB-66 reconnaissance bomber strayed out of its flight path. A compilation by the Associated Press shows that in the past fourteen years at least eighty American military flyers have been killed by Russians in attacks that ranged from the Baltic Sea to the Sea of Japan. The airmen have been from the ranks of the US Navy, Marines, and Air Force.

So far, there has been no sign of official indignation in Washington other than a demand for the release of our men. Our attitude, according to the *Washington Post*, is tempered by our "hopes to avoid having the incident damage the relatively moderate climate of present American-Soviet relations." Indeed, the *Post*, which should know better, peers around the eighty corpses and poses an editorial question: "What is wrong with the Air Force that it cannot prevent its planes from wandering over Communist East Germany and getting shot down?" Then the paper says USAF does not say the airplane strayed but suggests it was lured by phony radio signals.

Somehow, the lives of eighty American flyers seem to have been sacrificed in near silence while the climate of our relations with Russia shows no material change. It should be pointed out that the *Washington Post*, which hesitates to put any blame on the Russians, is a paper that speaks out loud and clear in favor of avoiding escalation in any conflict with the Reds. The response should be nonviolent to most provocation, according to this school of thought, and if it must be violent it should be graduated to the minutest degree possible. The Communists disagree.

Any responsible reporter could learn by asking that USAF pilots have strict orders not to resist challenges in the air, even if they are armed. The Russians, in this case, destroyed an airplane which they could have had intact with its airborne equipment if they had told the pilot to land instead of shooting him down. This indicates they were more intent on murder than capturing the RB-66 to see what reconnaissance equipment it was carrying.

A responsible reporter also could have learned that the pilot was following a filed flight plan for a navigation training mission that was to be flown entirely in France and West Germany. An informed reporter would know that the RB-66 is an obsolescent airplane and it is not likely it would be sent on a sensitive mission so close to the Iron Curtain. Even an editorial writer, lacking all these facts, should be able to recall that in late January a T-39 jet trainer out of Wiesbaden strayed across the border and was shot down, killing the crew of three USAF officers. In this case the Reds merely said it was our fault because we violated their airspace, and they gave us permission to retrieve the bodies and wreckage.

It is not generally discussed, but these violations of airspace have at least one of the characteristics of a cultural-exchange program. The Russians violate airspace too. They have overflown Alaska and are reported to have violated Western airspace in Europe at least twenty times in 1963. They have been intercepted by our airmen and warned to go back. There is no record that they have been fired upon. On top of this, it is no secret in Europe that Aeroflot, the Russian airline, and Polskie Linie Lotnicze, its Polish counterpart, treat airplanes with disdain. On scheduled flights to and from such major points as Paris, their pilots wander far from their routes as assigned by traffic controllers. There is a strong conviction on the Continent that these deviations are not accidental, but are part of the Communist reconnaissance effort.

In view of the record, it is difficult to believe we are dealing with reasonable people concerned in any way about the climate of our relations. It is even more difficult to understand how an American newspaper, in particular the *Washington Post*, can ignore the Soviet trigger finger, the eighty dead, and the nature of the cold war.