EXHIBITS

[1]The numbers in parentheses represent numbering from the beginning of the document. These are the numbers to use when accessing a particular page in the Adobe PDF reader.

Exhibit VF-1. A retyped paper

Brief History and Background of the F14
1955-1970
By George A. Spangenberg

The development of any airplane involves an unending series of compromises. From the earliest conceptual studies to the final design and manufacture of each detail part, designers are faced with the problem of reaching the best compromise between many very real conflicts. For every desirable characteristic achieved, some other desirable feature has been compromised. This truism applies not only to performance items such as maximum speed, maximum range, maximum endurance, minimum landing speed and minimum take-off distance, but also to the obvious trade-off between strength and weight, and to the less obvious interaction between development schedules, testing programs and cost. For the military planner, choices must often be made between buying either more airplanes or more spare parts. He has to choose between continuing to buy aircraft already in production as opposed to investing in a new development. There will be circumstances when larger numbers of less expensive designs are preferable to fewer numbers of more capable aircraft. Unfortunately, in other circumstances, the reverse is true. The well known case of the U-2 illustrates the problem. The thousands of Russian service fighters were unable to prevent the USAF U-2 overflights in the 1950s simply because they could not fly high enough, nor were they equipped with missiles and fire control systems which would overcome that inadequacy. On the other hand, the U-2 had had to sacrifice many features normally considered necessary to achieve its extraordinary altitude and range characteristics. Overall, to repeat, the compromises are unending, and many of the decisions of choice are most difficult.

By the early 1950s, the state of the art had advanced to the point where supersonic combat aircraft were being produced to replace the subsonic jets then in service. At the same time, cruise missile development had advanced with relatively long range, high performance projects under way in this country and abroad. Naval aviation, in planning for the future, obviously took these advances into account, and configured their newest fighter, the F-4 Phantom, with new air to-air radar, and armed it with all weather, radar guided missiles. Although this project was the best that could be done at the time and was able to handle the immediate threat posed by the Soviets, the Navy was concerned about the next step which they might make.

Research efforts in the radar field at about this same time clearly showed that it was possible to build a very long range radar, which could be installed in a moderately sized, carrier based airplane. This opened up the possibility that advanced threats could be

handled by long range air-to-air missiles launched from relatively inexpensive, low performance airplanes, rather than by continuing to increase fighter performance to the levels required. In one of the most extensive operational analyses, code named RAFAD, yet conducted in this field, the Navy studied the problem of how best to meet an advanced threat against a carrier task force, and concluded that a low performance airplane launching high performance missiles, was the most cost effective solution. The concept was then developed as EAGLE-MISSILEER. The missile, EAGLE, and the fire control system were started first since their development times were longer than for the airplane, and firm specifications for those items were needed for the airplane competition. Bendix, with Grumman as a subcontractor, won the EAGLE competition in 1958 with a design for a long range (over 100 miles), two stage missile with mid-course and terminal guidance. The fire control system, using a Westinghouse radar with a five foot diameter antenna, was capable of tracking many targets simultaneously, and firing at the six most threatening. With the missile development proceeding satisfactorily, the airplane competition was held, and Douglas selected to develop the MISSILEER in 1960. The airplane was a 50,000 lb., twin turbo-fan engined, straight wing airplane with a crew of two. It was designed to operate from all attack aircraft carriers, and to stay on station for five hours at 35,000 ft. altitude. The relatively large EAGLE missiles were carried externally on wing pylons.

At about the same time that the Navy was embarking on EAGLE-MISSILEER, the Air Force was developing the other alternative to handle the projected threat. The XF-12 was a very high performance, mach 3.0, airplane, powered by two large after-burning jet engines. Two medium range, single shot, missiles were carried internally, and guided by a Hughes radar and fire control system. The airplane was over twice as large as MISSILEER, and well beyond the limits established by the size of the Navy's carriers. This particular concept was not viable for the Navy, even if it had fared better in the cost effectiveness studies mentioned earlier. Subsequently, the XF-12 and its missile were dropped, but the air frame was produced in a reconnaissance version as the SR-71.

The MISSILEER development was started with a small preliminary engineering contract, but major funding was deferred by the Secretary of Defense until the incoming administration could review the program and make its own determination as to whether or not it should be undertaken. The EAGLE portion of the concept, however, continued on schedule.

Within the Navy and throughout the defense establishment, there was some degree of controversy over the MISSILEER concept. It had great merit in those situations where the enemy came toward it, that is, point defense. It lacked mobility in many other tactical situations, however, and in peace time lacked the ability to accomplish non-lethal intercepts, as were routinely accomplished by conventional high performance fighters. There was also the fact that the concept was totally dependent on the EAGLE missile, with no real back up armament possible. Lesser capability air-to air missiles, while usable, would not be able to handle the projected enemy aircraft, and the overall weapon system would be inferior with these missiles, to the F-4, then in production.

While the Navy was seeking funding for continuing the F6D-1 MISSILEER, the Air Force was in the preliminary stages of a competition for an aircraft designated as TFX, for Tactical Fighter Experimental. It is difficult to imagine two more different "fighter" aircraft. The Navy fighter's primary mission was to destroy enemy aircraft and missiles in the air. The primary mission of the Air Force TFX was interdiction, delivering a nuclear weapon against a ground target. Air Force studies had produced a requirement for a supersonic, low altitude design, which would be capable of a 400 mile high speed, Mach 1.2, sea level, dash to a target, after a 400 mile subsonic sea level cruise to the mid point. Cruise home would be under economical altitude and speed conditions. The supersonic dash speed and distance were overpowering in their effect on the design, and eventually the Air Force cut the distance in half to 200 miles in order to keep the airplane size within reasonable limits.

In early 1961, within a few weeks of taking office, the new Secretary of Defense decided that the Air Force and Navy should build a single airplane to handle the "fighter" needs of both services and also to meet the close air support requirements for all the services. Eventually, the close air support mission was dropped from TFX and fulfilled by the Navy's development of the A-7. Under the mandate of a single aircraft to accomplish air-to-air missions for the Navy and interdiction for the Air Force, the Navy was forced to drop the MISSILEER concept, as it was completely unsuitable for low level, high speed, penetration type of flight. EAGLE, the missile development was then cancelled in the spring of 1961. The Navy, still seeking a solution to the advanced Soviet threat which was being forecast, then proposed a Navy TFX, supersonic design similar in some respects to the Air Force TFX, but with quite dissimilar compromises on other characteristics. The radar and missiles were reduced in capability to be compatible with a supersonic airplane, as well as the endurance time. For the Air Force, the airplane could have accomplished an interdiction mission but with a reduced dash speed and distance. The Air Force proposed their TFX to the Navy modified to carry single shot GAR-9 missiles. The overall length of the airplane (82.5 ft) was much too long for it to be operated on existing aircraft carriers. OSD during this same period proposed compromises of its own which generally offered the services characteristics somewhere between those being advanced by the Navy and Air Force.

In June 1961 SECDEF directed that a single TFX program, under Air Force management, be undertaken to fulfill the needs of both the Air Force and the Navy. Negotiations to reach an acceptable and practical compromise failed and in August 1961, both services recommended to OSD that separate programs be authorized since no single design could meet the minimum requirements established by the two services. OSD, on 1 September 1961, disagreed and ordered the issuance of a Request for Proposal to industry for a design meeting those requirements, and imposing a length restraint of 73 ft. and a take off weight of "approximately 62,000 lb." for the Air Force version. The order was met, despite the strong beliefs of the services that the task being imposed on industry was impossible. At this point, the performance requirements of the Air Force mission were unchanged from their original specifications, but the airplane length had been shortened (by about 10 feet) making it more difficult to meet the Mach

1.2, 200 mile dash. The Navy's requirement for the airplane to be operational from all its attack carriers was compromised by eliminating all but the largest sized ships from consideration. No compromise was left for the Navy from carrier compatibility requirements.

The Navy started development of the new radar, fire control system, and missile at the same time the TFX airplane competition started, and selected Hughes as the prime contractor. The AWG-9 fire control system included a radar with a 36 inch diameter antenna while the system retained the multishot capability of the cancelled EAGLE-MISSILEER. The missile, PHOENIX, was reduced to a single stage semi-active design with a terminal seeker. Overall, the new system had about half the range capability of the original EAGLE-MISSILEER.

The airplane source selection phase turned out to be one of the longest and most controversial in history as it went through four steps, each involving proposals by industry, evaluation and recommendations. Boeing had submitted the best design, but General Dynamics, with Grumman as an associate, was announced as the winner in November 1952 by the OSD.

The Air Force version of the General Dynamics design the F-111A, had been evaluated by the Air Force as having only a 140 mile dash capability, although the contractor had guaranteed 210 miles. Shortly, after development started, the contractor realized that he was going to have problems meeting his guarantee and proposed increasing the weight, length and fuel capacity of the airplane, his normal procedure on past Air Force contracts under similar circumstances. The Navy version of the design, the F-111B, could not tolerate changes of this nature, leaving the contractor in a design predicament from which there was little possibility of escape. During 1963, a substantial growth in the estimated weight of the airplane occurred, although it was not reported until the end of the year when General Dynamics acknowledged a 5000 lb. increase. In fact, the increase then was 3000 lb. greater, but a weight improvement program had been assumed to remove this amount. In early 1969, the Navy conducted a thorough evaluation of the design as it was then defined, and found it unacceptable. It was recommended that the program be stopped pending redesign to solve the problems. The OSD declined to take this step, apparently not believing Navy estimates, and hoping that minor changes and weight reduction efforts would be adequate. The Navy continued to report the airplane as unacceptable on the basis of calculated data through October 1965 when the first Navy flight test data became available, and thereafter until Congress refused authorizing further funds in 1968, leading to contract termination of the F-111B.

Since it was obvious to the Navy from the beginning of the TFX program that its success as a Navy fighter was highly questionable, the Navy continued its study efforts to find some means of procuring a weapon system that would handle the threat and be a successful general purpose, carrier based fighter. With OSD insistence on the F-111B continuing, the Navy looked at many alternatives. The F-111B was most nearly useful

when employed in a fleet air defense role, in effect acting as a MISSILEER but with half the capability. Other fighter missions, such as escorting attack airplanes, had to be done with a higher performance, more maneuverable, and more versatile airplane than the F-111B. Grumman, associated with General Dynamics, had performed F-111 improvement studies, under contract, ranging from minor changes to complete redesigns. McDonnell had also studied, under contract, various improvements to the F-4, including a design with a variable sweep wing. A new airplane, to complement the F-111B, was also under study by everyone. This design finally evolved as a multi-mission airplane, VFAX, capable of performing better than a F-4 as a fighter, and better than the A-7 as an attack airplane. The concept was valid only under the premise that it was complementary to the AWG-9 and Phoenix capability represented by the F-111B. However, as the latter design degraded in attractiveness, by 1967 and 1968, very serious study efforts were undertaken to find a true solution of the Navy's fighter problem. In essence, this finally evolved as upgrading the VFAX to carry the AWG-9 fire control system and the Phoenix missiles. The first definitive studies were completed by Grumman and provided the information by which the Navy convinced itself and the Congress, if not OSD, that a new fighter, VFX, could be produced which was more effective and less costly than continuing the F-111B and providing an adequate complementary fighter. OSD gradually accepted the realty of the VFX concept, but only after the Navy produced confirmatory design studies from Chance Vought, North American, and McDonnell. A formal Navy Fighter Study was convened by the Chief of Naval Operations to produce the quantitative operational analysis results necessary to convince those in OSD who still believed the Navy to be fighting the program on other than conscientious grounds, and also to persuade the Congress to authorize a new program. In mid 1968, approval was granted the Navy to release a Request for Proposal to industry for the VFX, ending about nine years of frustration for those whose only goal had been to provide the country with a means to counter the new aircraft and missiles which the Russians had been producing. The "threat" which had been projected in the mid '50s, was well documented by the late '60s.

The excellent proposals submitted by McDonnell, Vought, North American, and General Dynamics were overshadowed by a better one from Grumman, with the result that a contract for the F-14 was negotiated and signed on 3 February 1969 after a difficult, but successful competition. The fixed price incentive type of contract covered the development of the airplane, the building of the R & D, or test aircraft, and their testing. Also included were firm ceiling price options for production aircraft to be exercised consecutively in the following fiscal years. Under the original plan, a total of 469 aircraft would have been produced at a rate which built up to eight per month. The F-14, the only fighter designed to counter the full spectrum of the projected threat against the fleet, was finally on its way.

Exhibit VF-2. Retype of memo (*with GAS notes added*). The Classification of this memo and its enclosures was cancelled.

MEMORANDUM 8 February 1965

From: RAEV
To: CD-3

Subj: F-111, Review of Project Initiation

Ref: (a) Secret Memo RAEV to R dtd 9 Jan 1963
(b) DDR&E Secret Memo for SecDef dtd 19 May 1961 *(Note: Signed by Dr. Brown)*
(c) BuWeps to CNO Secret R-5:FMG dtd 3 May 1961
(d) SecNav Secret Memo for SecDef Ser 006038P50 dtd 22 Aug 1961

Encl: (1) Table - History - TFX Characteristics dtd 2-2-65
(2) Chart - Unit Cost Data - 1961
(3) Chart - Unit Cost Data - 1964
(4) Chart - Comparative Unit Costs - 1964 vs. 1961
(5) Chart - Cumulative Costs

1. The F-111 program has been a controversial one from at least two standpoints. First, the program decision was made in the face of opposition by both services since neither the Navy nor Air Force believed a single design could meet their stated requirements. Second, the final source selection decision was contrary to the unanimous military recommendations. The role of BuWeps in the selection process has been documented for the record by reference (a). The fact that the first airplane has now flown is being taken as proof that the services were wrong in their prediction of a lack of technical feasibility. Coupled with the technical feasibility, there has been the question of economic feasibility. Large cost savings for a single program were predicted. For the record, a review of the facts on which the early decisions were based is considered necessary.

2. Early in 1961, Project 34 was established by SecDef to review the overall problem of tactical type aircraft in the 1962-1971 time period. The final report on that project, reference (b), recommended a single TFX project, under Air Force administration, to meet the air superiority needs of the Navy, the tactical requirements of the USAF and for CONUS defense. Also recommended was the VAX to be developed by the Navy for close air support after further studies. Prior to issuance of the report, working groups had developed service positions while additional data were generated by a NASA-WSEG-DOD group. The designs of the latter group were considered unreasonably optimistic by the BuWeps

Working Group as reported in reference (c). *(Note: BuWeps "Working Group" - most work done by Gloeckler and his division, I was not yet involved. GS 1990)* The Project 34 report shows that a single compromise design would be one billion dollars less expensive than the individual programs recommended by the Air Force and Navy. Although more studies were conducted prior to the final SecDef decision about three months later, Project 34 appears to be the real starting point of the F-111, and the source of the "Billion Dollar Saving." The basic characteristics on which the Project 34 recommendation was based are tabulated on enclosure (1). The first column shows the Navy recommended design, the second column the Air Force recommended airplane, while the DOD recommended compromise is shown in the third column. The characteristics and costs of the Navy and Air Force designs were provided by the respective services. The characteristics of the compromise design were apparently of DOD origin, while its costs were said to be based on Air Force TFX data. The following characteristics should be noted:

a. All designs used two TF-30 engines.
b. The Navy design emphasized holding size and weight to a minimum. The 56 ft. long airplane with a gross weight of 50,000 lb. carrying 6000 lb of missiles and 17500 lb. of fuel was questioned as being optimistic by DDR&E.
c. The Navy design had a radius of 555 miles on a Lo-Lo-Hi mission with a M1.0 dash of 100 miles when carrying external fuel. This was well below the 800/1.2/200 combination required by the Air Force in their SOR-183.
d. The basic Air Force design provided 50% more CAP time for the Navy mission than did the Navy design. However, the length of 82.5 feet made it impossible to operate on carriers. At 63000 lb. it met the 800/1.2/200 Lo-Lo-Hi requirements with no external fuel.
e. The recommended compromise design showed an Air Force radius of only 340 miles with a Mach 1.2 dash of 100 miles. With 12000 lb. of external fuel, the dash distance was 100 miles, half that specified by the Air Force, at a total radius of 830 miles. CAP time for the Navy was more than required, while the Navy's 56 foot length was claimed to be met by folding 10 feet of the airplane.
f. The technical characteristics of the compromise design appear fairly consistent with the other two models.
g. Cost data for the designs appear grossly inconsistent. The heavier and larger Air Force design with a smaller buy reaches a lower unit production cost than the other two designs.

3. On enclosure(2) are plotted unit "procurement" costs excluding R&D as they are given in reference (b). It is not clear whether those costs are "Flyaway", "Program" or "Investment." The inconsistency in cost data is quite obvious. The much larger and heavier Air Force design is more expensive initially than the

Navy design but reduces rapidly so that its last buy is but 60% as expensive at the same point in production. The compromise aircraft falls between the two other designs as expected but it, too, should not be less expensive than the Navy airplane. On the basis of the cost data used, it appears that a larger dollar saving would have resulted from a buy of the Air Force recommended design instead of the compromise one.

4. By memorandum dated 7 June 1961, SecDef indicated that the Air Force would be authorized to develop a new air superiority aircraft to be used by both services to replace the F4 and F105. Working committees attempted to reach agreement on the characteristics of the single design from that date to 22 Aug 1961 when SecDef was informed that it was considered not technically feasible to meet the stated requirements of the two services, and recommended separate development programs with the Navy taking advantage of the Air Force program to the maximum possible extent. The 22 Aug paper repeated the basic requirements of a 56 ft. long, 50,000 lb. airplane as those which the Navy desired. In a spirit of compromise, a 55,000 lb., 61 ft. design foldable to 56 ft. was offered as the maximum that could be accepted by the Navy. This design would have a Mach 1.2 dash speed capability, but over a 100 mile dash distance capability. The Air Force position remained firm that their full 800/1.2/200 requirement be met. The characteristics of the three approaches are tabulated in columns 4, 5, and 6 of enclosure (1). Additional study data were provided by the Navy showing that the Air Force design with its ASG-18/GAR-9 missile system would be only 37% as effective as the Navy design for fleet air superiority. The Navy offered compromise was calculated to be 78% as effective as the smaller design. Unit production prices of 3.0, 3.3, and 3.5 million were quoted in going from the "basic Navy" to the "compromise Navy" to the "Air Force" design. Details of the latter two designs are somewhat meager in reference (d), but it appears that the Air Force design must have remained essentially the same as tabulated in column 2.

5. On 30 August 1961, DDR&E recommended the single design approach to SecDef who directed implementation on 1 Sep 1961. It seems clear that DOD gave more weight to the more optimistic NASA-WSEG-DDRE studies than to the service positions, but it was recognized that a "challenge" to industry was being presented. The characteristics outlined in the decision paper are shown in the 7th column of enclosure (1). The following points are significant:

   a. SecDef directed initiation of the project within certain constraints, stating that he believed "development of a single aircraft of genuine tactical utility to both services in the projected time frames is technically feasible." Note that only tactical utility was claimed as feasible in the actual decision paper, not the meeting of stated requirements. The DDR&E paper indicated that it was feasible to meet performance requirements within the constraints imposed.

b. The Air Force version was to weigh "approximately 60,000 lbs..." while the takeoff weight of the Navy version was not to exceed 58000 (???? unreadable) 150 mile mission with 6000 lb. of missiles "without the consent of the Navy."

c. A 36-inch minimum antenna diameter was to be provided (???? unreadable) length of the Air Force version was not to exceed 75 ft. In the DDR&E paper this was to give a potential Navy length of 56 ft. by removing a section of the Air Force fuselage and folding the nose.

d. Basic performance requirements of SOR-183 were to be met as "nearly as possible" within the specific constraints imposed.

e. Specific carrier compatibility requirements were not delineated. The Navy had desired limited operation capability from the CVA-19, while DDR&E believed operation from CVA-59 and better would suffice. The controversy, documented in reference (e), resulted in apparent agreement that full operation from the CVA-43 would be required, but this was eventually changed to only limited operation from carriers below the CVA-59.

6. The requirements were incorporated in a "Work Statement" for industry to submit proposals. As detailed in reference (e), none of the proposals met the combined requirements in the first round submission. The designs submitted in the second round failed to meet requirements by an even greater degree, as was predicted by the Navy. After the second round, the Air Force still stated that all requirements could be met by "refining" the winning design. The Navy still considered the task impossible since correction of the deficiencies all tended toward increased weight, already too great, and increased size, already too large. The third round was then arranged to define the differences between Air Force and Navy versions which would have to be accepted if the performance requirements of the two services were to be met. The Air Force also asked the contractors to define the differences between versions necessary to reduce the weight of the Navy version to the original 55000 lb. while meeting the performance requirements. As a result of the third round submissions, it became evident that the Navy airplane would have to be greater than 55000 lb., and other compromises would also be necessary. "Acceptable" levels of compromise were defined for the fourth round for the Navy airplane, while all Air Force generated requirements stayed firm.

7. In columns (8) and (9) are shown the characteristics of the final G.D. proposal as submitted and as evaluated. It can be seen that the airplane failed to meet the Lo-Lo-Hi radius and takeoff distance on Air Force figures. From the originally Air Force recommended airplane (column 2) the weight was up 10% and even with 16% more fuel, the dash distance was down from 200 to 125. The Navy version was 27% heavier and its unfolded length 10 ft. longer than had been originally specified for the Navy. The airplane was not considered fully operational on CVA-43 by BuWeps. In comparison to the characteristics outlined in the SecDef

decision, even with the gross weight constraint exceeded by 16%, the high speed dash distance in the radius problem was low by 37%. Simultaneously, the Navy version was well beyond its weight constraint, and the 56 ft. folded length potential was not achieved.

8. In the course of the development cycle, the Air Force permitted the contractor to increase airplane size and fuel tankage in an effort to meet the Lo-Lo-Hi radius requirement. It seems clear from the airplane's weight growth that both the Navy and Air Force seriously underestimated the penalties associated with the meeting of the dual requirements. It is also clear that the NASA-WSEG-DOD studies lacked any semblance of reality.

9. A strict comparison of costs is not possible without a major amount of research. The readily available position papers lack preciseness of terms in the cost area, and in addition, definitions have changed. It is probable that avionics costs were markedly low in the early estimates. The quantity of aircraft included in the program buys has changed with time. As noted on enclosure (1), the early 1961 estimates showed a 934 airplane program for the Navy, and 779 airplanes for the Air Force. In the 1962 proposal, 1495 production Air Force airplanes were included, but only 231 Navy airplanes. This was an artificially low number, due to the use of a five-year plan. The Navy buy is now programmed at 350 while the Air Force has dropped to 749. Care must be exercised in drawing conclusions based on average costs with such large changes in total quantities, and ratios between individual service buys.

10. On enclosure (3) are shown the current unit costs of the F-111A and F-111B with each plotted at the mid-point of the total buy. The F-111B has more expensive electronic equipment, but is procured later, relatively, that the F-111A. If each model is plotted against its own numbers, rather than the combined numbers, the unit costs of the two airplanes are quite similar. A comparison of the 1961 average curve from enclosure (2) and the 1964 average from enclosure (3) is shown on enclosure (4). It can be seen that the flattened-out costs today are at least double those on which the original Project 34 recommendation was made.

11. On enclosure (5), a cumulative cost plot is shown. The lower dashed line is the original Navy recommended airplane program. Its completion point forms the origin for the Air Force recommended program. The solid line is for the combined program as recommended (and priced) by DDR&E. The billion dollar saving is apparent. A single spot is shown for the Air Force estimate as presented in the 4th evaluation report. It is seen indicated cost is about 2 Billion above the original estimate. Coincidentally, it is about equal to the current total cost, although the number of aircraft has decreased by 35% from 1726 to 1122.

12. The changes in weight of the airplanes must be considered when examining the relative validity of the original cost estimates. A very gross comparison might be

done by comparing the increase in the so-called (????unreadable) unit cost with the increase in weight of the airframe. The following table where such a comparison with the weight reference taken as gross weight (???) and ordnance.

	Navy	Air Force
1961 weight	26500	36000
1961 cost	2.8	1.5
1964 weight	45100	43950
1964 cost	4.4	3.8
Increase weight	70%	22%
Increase cost	57%	153%

It seems evident that the original cost projections of the Air Force (???unreadable) to have been used for a base for the DDR&E estimates for a single aircraft program were grossly optimistic.

13. In summary:

    a. The original DDR&E recommended airplane compromised the Air Force Lo-Lo-Hi radius requirement to a marked degree. The costs of that airplane were substantially lower relative to the Navy airplane than they should have been.
    b. The refusal of the Air Force to compromise its mission requirements resulted in the Navy reaching a conclusion that the single aircraft program was not technically feasible.
    c. Overly optimistic design studies by groups outside the Navy and Air Force led to a technical requirement far more demanding than the original recommendation had contemplated.
    d. The weight limit imposed in the 1 Sep 1961 SecDef decision was treated not as a "constraint" but as a low priority requirement.
    e. Air Force insistence throughout the source selection process that all requirements could be met by "refinement" of the design undoubtedly contributed to the general confusion.

14. Decisions are based on facts. In this case it is clearly evident that inconsistent facts were presented, and time apparently prevented a reasonable analysis of those inconsistencies. This was the fault in the original decision of May and June 1961. As implementation of that decision was attempted, technical over optimism in the design state-of-the-art became dominant. Proper distinctions, due to lack of knowledge, were not drawn between expertise in the theoretical aerodynamic field and the real world of airplane design. Throughout the years, the preliminary design efforts of research organizations have been uniformly more optimistic than those done by groups linked with service experience. This caused no trouble as long as the design decisions were made within the services where full knowledge of the facts existed.

15. For the future, it is obvious that the Bureau must have the ability to make both technical and cost estimates which will be accepted at higher levels. Our estimates in the F-111, criticized because of conservatism, have actually been too optimistic.

G. A. Spangenberg

Copy to: RA-2

Exhibit VF-3. A retyped memo which is now unclassified. Comments added later are in italics.

From: RAEV
To: R
Subj: TFX - F-111A/B Source Selection; Record of (U)
Ref: See Enclosure (1)

Encl: (1) List of References (U)
(2) Summary of Characteristics, RAEV:GS dtd 1-8-63 (SECRET)
(3)Summary of Significant Dates, RAEV:GS dtd 1-8-63 (SECRET)

1. The source selection process for the F-111A/B has required more effort from industry and government than for any previous aircraft program with which the Navy has been associated. Trade publications and some segments of industry have blamed the delays on the Navy, and have indicated that the Navy held out until their contractor choice was made. The source selection process has been closely held, due to Air Force regulations governing such actions, preventing disclosure of the true facts involved. This memorandum, primarily for the record, provides a brief chronology of events in the process and the reasoning for the Navy's actions.

2. The joint Air Force-Navy TFX project was officially started by a SecDef memorandum dated 1 September 1961 to the Air Force and Navy. It stated that "A single aircraft for both the Air Force tactical missions and the Navy fleet air defense mission will be undertaken," and that, "the Air Force shall proceed with the development of such an aircraft." This directive followed a review of service positions on the matter which had been presented by memoranda dated 22 August 1961, which in turn were the culmination of several months of studies and committee actions aimed at resolving the tactical air development program. CNO informed BuWeps of the decision and provided program guidance by reference (a).

3. The TFX followed closely on two other multi-service programs, the "Tri-Service VTOL" and the "LOH," an Army helicopter. Other fairly recent Navy bi-service experience included the "Mohawk," started as a joint Army-Marine effort, and the X-15, a joint Air Force-Navy-NASA administered by the Air Force. In the future, the VAX is scheduled for administration by the Navy. The actions taken by the Navy in the TFX evaluation were based on this background, and were intended to:

    a. Minimize total manpower requirements, by eliminating duplication in detail evaluations.

b. Give authority to administering service for contractor selection, since that service is charged with responsibility.
c. Insure a satisfactory design, regardless of source.

It is important to realize the difference in source selection procedures as practiced in the Air Force, and design competitions normally used for contractor selection in the Navy. The Air Force continually emphasizes that their procedure is "source selection" not "design selection." It is considered normal practice by the Air Force to make major changes in designs after a source is selected. The Navy selects a contractor on the basis of his design, and major changes are not contemplated. In fact, a requirement for a major change is used to eliminate designs from further consideration. Air Force methodology is quite formal with written criteria established by the Source Selection Board, against which an evaluation group rates all proposals numerically. Raw score ratings are adjusted in accordance with a previously prepared weighting schedule by the SSB. Voting members of the SSB, after a briefing by the Evaluation Group, prepare a written recommendation through the Air Force Command structure to the Air Force Council. The Council recommends a decision to the Chief of Staff and to the Secretary. All recommendations are closely held with no feedback to lower levels. The briefings remain basically unchanged from the SSB through the Secretarial level and necessarily contain no conclusions or recommendations, since the presenters are not privy to that information. In a Navy design competition on the other hand, experience is substituted for formality, designs are evaluated, conclusions drawn and recommendations presented by the working level through all review levels. The source decision is the responsibility of the Chief, BuWeps who normally obtains concurrences from OP-05 and the Secretarial level. Reversal of source decisions by higher authority had not occurred prior to the recent VTOL program. *(Note: This was the X-22)*

4. Prior to the SecDef decision of 1 September 1961; the Air Force and Navy had been unable to agree on the characteristics of a design for both services, since no single aircraft could meet the stated requirements of both services. A design which would meet the Air Force requirements was not carrier suitable, while the proposed Navy carrier airplane was designed to lower speed requirements than those of the Air Force. Internal DOD studies by WSEG supplemented by NASA information were much more optimistic and indicated that a single airplane could meet both sets of requirements. The services considered these studies unrealistic. The SecDef decision paper ended the study phase by requesting a firm specification by 15 September for forwarding to industry on 1 October. An intensive effort by both services resulted in the Work Statement being approved by the SSB on 25 September 1961, and ready for pickup by the contractors on 1 October 1961. The Work Statement contained specification requirements for both Air Force and Navy versions, following the SecDef guidelines explicitly. As written, Navy carrier requirements were specified as fully operational from the CVA-43, and capable of emergency recovery from CVA-19. This capability was

detailed as: zero knots wind over the deck for catapulting from the C11-1 catapult and arresting in the Mk 7-2 gear, and maximum folded length of 56 feet. Although these requirements were consistent with the Navy's stated requirements, DDR&E in their review of the Work Statement directed a relaxation of carrier requirements to fully operational from CVA-59 and emergency recovery on CVA-43. This was detailed as zero knots wind from the C7 catapult and 10 knots wind over the deck for arresting in the Mk 7-2 gear. The folded length requirement was deleted. These relaxations were vigorously opposed by the Navy as detailed in the enclosures to reference (b). The arresting requirement, in particular, was considered unsound, providing an insufficient design margin.

5. Air Force Planning for the evaluation effort assumed Navy participation in all areas, with "Carrier Suitability" as an "area" in addition to "Technical," "Operational," "Logistics," and "Production." Navy evaluation personnel were to be at WPAFB for the entire period. With an additive point system used as a primary evaluation tool, the danger of an unacceptable design from the carrier standpoint receiving the highest score was obvious. Equally obvious was the impossibility of detailing the Navy's most experienced design engineers to ASD for the evaluation period scheduled for about six weeks. The position taken was detailed in the SSB Letter of Instruction to the Chairman, Evaluation Group as:

> "In order to prevent duplication and to promote efficiency in the evaluation process, the Navy will restrict its participation to determining carrier compatibility, its unique field of competence, and to providing consultive services. Quantitative weight and performance data developed by the Evaluation Group will be utilized by the Navy as required. The Navy will be furnished three (3) complete copies of proposals for review at the Bureau of Naval Weapons. A qualitative analysis and determination as to overall carrier compatibility will be furnished the Chairman, Evaluation Group by the Navy Program Officer for incorporation in the evaluation report. The Navy will also review team and area results and indicate concurrences or objections within any reasonable time schedule if requested by the Chairman, Evaluation Group. It is the intent of the Navy that the Air Force administer the Source Selection process with the least possible interference (*from the Navy*)."

Details of the evaluation procedures and responsibilities were given to cognizant activities in BuWeps by reference (d). Basically, the Navy's evaluation effort was reported outside the Air Force point score system except for the Navy AMCS. BuWeps was thus able to inform the Air Force as to the acceptability or unacceptability of each design as a naval weapon. It was considered imperative that the design, as opposed to the source, be acceptable before the Navy became committed to the program. The same general philosophy has been followed throughout the source selection process.

6. After a shorter than normal design period, six bidders submitted proposals on 6 December 1961 and made oral presentations on 12-13 December. The Air Force, attempting compliance with SecDef's directive for a 1 Feb. 1962 contract date, scheduled the evaluation to be complete by 17 January. The Navy evaluation results were provided to the Air Force on schedule by reference (c). As noted in part in that document there were several problems encountered:
   a. Weight estimates initially provided by the USAF appeared unreliable, forcing a last minute Navy weight estimation effort. These estimates were then coordinated with the USAF.
   b. No mission performance data had been completed by the USAF by the date that Navy comments were due. This made it impossible to reach a conclusion on the overall acceptability of the design.
   c. Four of the designs were based on a GE engine, which, although listed in the Work Statement, was not considered capable of development in time to meet the airplane schedule. The GE engine characteristics were much more optimistic than either of the other two engines listed, and permitted designers to approach more closely the weight limits listed in the SecDef decision paper. The problem, predicted when the power plant portion of the Work Statement was prepared, was not judged severe by the Air Force. Alternate engine studies had been requested, and an engine selection independent of airplane selection was planned. From the Navy standpoint, an engine selection prior to the airplane competition would have been preferable.

      Of the six designs evaluated, two, Boeing and NAA, were reported as "Acceptable, with changes," and the other four as "Unacceptable without major change." Because of the listing of the GE engine in the Work Statement, the use of that engine in a design, while unsatisfactory, could not be considered disqualifying.

7. On 19 January 1962, the SSB met, heard a presentation of evaluation results, and prepared their recommendations. The Evaluation Group had reported none of the designs to be acceptable without substantial change, but that two, Boeing and General Dynamics were significantly better than the rest. After weighting the scores, and considering the Navy evaluation data, the SSB unanimously recommended Boeing as the source, with the airplane to be changed as necessary to accommodate the larger engine and to correct other deficiencies. [Despite concurrences through the Air Force and Navy commands, the decision was made at the Secretarial level to extend the competition on a partially funded basis between Boeing and General Dynamics.][*Not quite accurate. McClellan hearings revealed that the Air Council recommended Boeing and GD be continued in competition. Chiefs of Staff and Secretarial level then concurred. Navy member of SSB (Adm. Ashworth) was not informed. GS 1990]* Contracts were let with each contractor on 1 February 1962 for $1.0 M. for further development of their proposals.

8. Under ground rules similar to the first evaluation effort, the new proposals submitted on 2 April 1962 were reviewed and results reported to the Air Force by reference (e), meeting the 2 May schedule. Neither of the two designs was acceptable, but Boeing again was the better of the two. The SSB, meeting on 14 May 1962, recommended Boeing as a source, but recognized that neither design was acceptable as proposed. The designs failed to meet requirements by a larger degree than on the initial submission. These facts were brought to the attention of CNO by reference (f), and were subsequently discussed at the Secretarial Briefing on 28 May 1962. It was apparent to the Navy that the requirements were such that no single design could meet them. The only real solutions were either to relax requirements or enlarge the differences between versions. The Air Force considered that all deficiencies were correctable, although specifics on how this was to be accomplished were not presented. References (g) and (h) detailed the decision to allow both contractors approximately three (3) weeks to determine divergence required between versions to allow correction of Navy deficiencies. This exercise ignored the fact that the Air Force was reporting the dash distance on their Lo-Lo-Hi mission to be 142 and 135 miles instead of the required 200. Correction of this would, of course, have a significant effect on the basic airplane.

9. On 5 June a formal briefing was given each contractor to explain the third phase, although an informal meeting at the SPO had given each a go-ahead on 2 June. Each contractor was asked to provide solutions to Navy deficiencies, and to do the same while reducing the weight to 55000 lb. The second request appeared to ask for the impossible and obviously was not originated by the Navy. Divergence to take advantage of the Navy's lower flight strength requirement was encouraged at this time. While this effort was underway, two SecDef memos, references (i) and (j), were received. The first approved the three (3) week study effort, requested specific information on a number of suggested weight reduction items and reiterated the guidelines that divergence should be minimized. None of the weight reduction schemes had merit, as detailed in an internal memo, reference (k).*[GAS: No Navy representation.]*

10. On 15 June, the two contractors made oral presentations at ASD, followed by an SSB meeting on 20 June. The five days permitted something less than a complete evaluation of the proposals, particularly when the contractors' data submissions were incomplete. Boeing surprised by submitting a new design for both Air Force and Navy with a 15% increase in wing area over their previous proposal. It was obvious that this redesign effort had covered most of the period since the April submission. General Dynamics submitted preliminary data on six possible Navy configurations, leaving the Air Force version unchanged. Their submission reflected the short time available for this design effort. The SSB again unanimously selected Boeing as the source, but pointed out that time had not permitted a complete evaluation. Although the changes made to the Boeing

design improved the Navy version, they were expected to degrade the Air Force's Lo-Lo- Hi mission. No explanation for this phenomenon was made. Since General Dynamics had not changed their AF design, their Lo-Lo-Hi radius from round #2 was again quoted. After a briefing to the Secretaries, a decision was reached and confirmed by a SecAF memo to the SSB dated 29 June 1962 to continue the competition through one more full round, with each contractor to be given an additional $2.5 M. The purpose was stated to be to allow each contractor adequate time to establish his design in sufficient detail to enable more precise service assessment and to reconcile disparities between the cost quotes and cost standards. Both contractors had been bidding well below the "standards," both on the fixed price incentive RDT&E and production lots. A 60 day design period to be followed by a 45 day evaluation was announced in a press release dated 30 June 1962.

11. The fourth round was apparently to define designs in detail, and so was regarded as a design competition. The Navy collected the design criticisms from the June submissions and forwarded them to ASD by reference (1), where they were combined with USAF criticisms and given to each contractor in a briefing on 10 July 1962. Reference (1) informed the Air Force that on this round the Navy would check the weight and mission performance for its versions. This step was taken only after the previous three rounds had shown sufficient inconsistencies in Air Force figures that confidence was lacking. Also, at the 10 July 1962 briefing, the Air Force announced that wind tunnel models would be required from each contractor in order that the government could run tunnel tests presumably to determine drag levels. Such a naive approach to the performance prediction problem did not inspire confidence. Each contractor was told in detail what Navy weight and performance estimates had been on his design, and the levels we would accept in the final round. On our figures we informed him that we would accept .5 hr. in lieu of 1.0 hour on the 750 mi. mission, and a buffet limit of 1.7g rather than 2.0g. Other design requirement relaxations were also listed in an attempt to produce useful designs from the exercise. No relaxation of Air Force requirements was indicated to the bidders. Of great concern to the Navy personnel involved in monitoring the program was the rather obvious discrepancy in Air Force radius between the two contractors. General Dynamics was working on the results from round two, (135 mi. dash) while Boeing had been told his radius was "satisfactory." (Checked at 185.) Eventually, the Air Force dropped the wind tunnel test plan as impracticable, but did not resolve the radius inconsistency.

12. The fourth round design proposals were submitted on 10 September 1962 with a contractor oral briefing held 11 September 1962. The Air Force had supplementary studies submitted later on a greater air-to-air capability desired by TAC, as well as contractor studies showing the increased weapon effectiveness of his TFX over service types. The Navy did not evaluate these reports. The increased air-to-air capability requirements were considered by the Air Council

separately and rejected "at this time." Because of the air-to-air study, as well as other technical evaluation problems, the Air Force slipped the completion schedule from a SSB meeting on 23 October to 2 November 1962. Official word was received too late for Navy to take advantage of the increased time in its evaluation so the original deadline of 15 October was met with reference (m). In this, BuWeps reported both designs as acceptable, and expressed the opinion that there was no significant preference between the two designs as submitted. The Boeing design had an advantage in carrier suitability and time on station. These are significant items. In order to save weight, Boeing elected to show a reduced design speed envelope for the Navy version. If the airplane had been procured, it is probable that the envelope would have been expanded. Boeing had also elected to use a large amount of titanium in the wing center section to save weight. Although acceptable, this material usage is less conservative than using steel and aluminum. If the Boeing design had been selected, it is probable that the titanium structure would have been retained. The phrase, "no significant preference," used in the BuWeps evaluation report to ASD has been interpreted by some to mean that the Navy either had no choice, or was unwilling to express it. What was actually meant was that the Navy could, and would, support any strong preference of the USAF, since both designs were now in the "acceptable" stage. The Navy members and alternates on the SSB, in conference prior to the meeting, were unanimous in their selection of Boeing as the Navy choice. The voting member on the board was the spokesman for the Navy in the official proceedings. The unanimous recommendation of the SSB in their letter of 2 November reflected this choice as did the BuWeps and CNO endorsements forwarding it to the SecNav, references (n) and (o). Any other interpretation of the facts is without merit.

13. For reference purposes, enclosure (2) lists a number of characteristics for the two designs as they progressed through the four phases, and enclosure (3) tabulates some of the key dates. The source selection phase of TFX ended with the press release on 14 November 1962 that General Dynamics had been selected as the contractor to develop the F-111A/B. The BuWeps is cooperating with th Air Force in developing firm specifications for the project, and expects to achieve a useful naval fighter. [*We obviously seriously underestimated the incompetence of the Air Force in making rational design compromises. GS 1990*.] The Boeing design would have been a better point from which to start.

14. There are lessons to be learned from the experiences of this program. In general, the Navy method of handling a design competition and making a source decision is considered much sounder than the procedures used in the TFX program. The lack of open conclusions and recommendations from one level to the next is considered the most basic fault of the USAF system.

Enclosure (1)

LIST OF REFERENCES

(A) CNO Secret ltr to BuWeps, OP-506/pep, Serial 006045P50 dated 6 Sep 1961 (BuWeps Control # K 14915)
(B) BuWeps Secret Memo, CD-2:WCB dated 6 Nov 1961 (BuWeps Control #K18586)
(C) BuWeps Secret ltr to ASD, RAEV:GS dated 8 Jan 1962, Serial 0040
(D) BuWeps Conf Memo RAEV:GS dated 15 Dec 1961
(E) BuWeps Secret ltr to ASD, RAEV:FS dated 1 May 1962, Serial 001090
(F) BuWeps Secret 1st End. To CNO, RA:LSC dated 16 May 1962.
(G) ASAF (R&E) Secret Memo for ASN (R&D) dated 1 June 1962
(H) SecAF and SecNav Secret Memo for SecDef dated 1 June 1962
(I) SecDef Secret Memo for SecAF and SecNav, SecDef Control 3491 dated 9 June 1962
(J) SecDef Secret Memo for SecAF and SecNav (enclosing Staff Study) Control 3492 dated 9 June 1962
(K) BuWeps Secret Memo RAEV to R dated 12 June 1962
(L) BuWeps Secret ltr to ASD, RAEV:GS, 001616 dated 9 July 1962
(M) BuWeps Secret ltr to ASD, 002387, dated 15 Oct 1962
(N) BuWeps Secret 1st End. To CNO, RAEV:GS 002630 dated 6 Nov 1962
(O) CNO Secret 2nd End. To SecNav, 007PO5 dated 8 Nov 1962

Exhibit VF-4. A memo unclassified on 22 June 1973. SER 01551 originally. Also follow up memo.

RAEV:GS
5 Feb 1964

From: Chief, Bureau of Naval Weapons
To: Chief of Naval Operations

Subj: F-111B Status (U)

Ref:

(A) SecDef Memo dated 18 Jan 1964 to DDR&E, SecNav, SecAF
(B) Dr. McLucas Conf Memo to SecDef et al dated 23 Jan 1964
(C) SecNav Conf Memo to CNO, CMC, CNN, BuWeps dated 28 Jan 1964
(D) Conf F-111B Program Status Report for F-111 Policy Board dated 22 Jan 1964

Encl:

(1) F-111B Weight and Performance Review dated 3 Feb 1964 (Conf)
(2) Carrier Modification Program Summary dated 3 Feb 1964 (Conf)
(3) Phoenix Weight Control (Conf)
(4) F-111B Air to Ground Capability (Conf)
(5) TF-30 Weight Summary (Conf)

1. In reference (a) the Secretary of Defense requested a review of the TFX program by 15 February. Reference (b) outlined actions taken by DDR&E to comply with the request, including the formation of a team headed by Mr. Joe Jones and including Mr. S.O. Perry and CDR Longquest which is scheduled to complete its report on 8 February. Reference (c) requested that the Navy response to reference (a) be furnished the Secretary of the Navy by 7 February so that it could be made available to OSD by 10 February 1964. Reference (c) also provided guidelines on the material to be covered in the reply. Informal requests have been made that the Bureau of Naval Weapons make its share of the data available to the Chief of Naval Operations on 5 February.

2. Enclosure (1) contains a weight and performance review updated over the 22 January status report as requested by reference (c). A copy of these data is also being provided the joint team. Enclosure (2) contains information on carrier modifications required if the F-111B is to be fully operational on CVA-41 and subsequent as requested by reference (c). These data are necessarily based on assumptions as to the future weight and performance of the F-111B. Enclosure (3) contains a statement of the actions being taken to control the weight of the Phoenix missile system. Enclosure (4) describes the air to ground capability of the F-111B. Enclosure (5) provides a weight summary of the TF30 engine.

3. The Bureau of Naval Weapons review of all government responsible items that have contributed to increased weight has commenced and will be completed by 24 February. It is expected that a substantial amount of weight can be saved through redesign of the MAU-48 launcher.

4. Continuing requests are being received for absolute limits of acceptability in each of many weight and performance areas. Although some absolute limits can be established, a very real danger exists that a design meeting each limit of acceptability, individually, can still be an unacceptable weapons system when considered collectively. As reported in reference (d), the Bureau of Naval Weapons has initiated an operational or cost effectiveness analysis on the F-111B together with alternative programs. This analysis, scheduled for completion by 15 April is expected to provide a sound base for program actions.

5. With the exception of the OPNAV Sea Based Strike Study, the Bureau of Naval Weapons is not aware of any study attempting to justify only twelve (12) F-111B aircraft per carrier. On the contrary, Bureau studies have consistently assumed two squadrons of twelve planes each; this two squadron assumption is supported in general terms by the OPNAV "Naval Aircraft Study," July 1962 and the supporting Bureau work on this study described in BuWeps Report No. R-5-63-8. Any study justifying reduction in this number will be complex and time consuming, and the authoritativeness of the results will depend primarily upon the validity of the assumptions used. Such a study is included in the cost effectiveness analysis described in the preceding paragraph. It is axiomatic that any reduction in the range and endurance of the fighter or effectiveness of its missile system will tend to increase the numbers required. Consideration must also be given in this regard to the necessity of increasing total fighter effectiveness to match the increasing threat with which it must cope.

6. Reference (c) also requests specific recommendations aimed at strengthening the TFX program and insuring that the weapon system delivered to the fleet will offer the best balance between technical risk, operational capability, and cost. It is evident from the data of enclosure (1) that major changes in the Navy version of the TFX are necessary if the airplane is to be an acceptable weapon system. The SPO has been requested to direct the contractor to provide information as soon as possible on the redesign necessary to meet specification requirements. Until this information is available, and the cost effectiveness analysis mentioned above is completed, any further program recommendations would be premature.

Copy to:
CNM, A, RA-2, CD-3

G.A.Spangenberg - 62627
1/5/64
C. Gorrell

Now Unclassified memo:

R/EEF
SER 01793

11 Feb 1964

From: Chief, Bureau of Naval Weapons
To: Chief of Naval Operations
Washington, D.C.

Subj: F-111B Development Program (U)

Ref: (a) BuWeps ltr Ser 01551 of 5 Feb 1964

1. Deficiencies in the F-111B at present state of development were presented in reference (a). Reference (a) also advised that the SPO had been requested to direct the contractor to submit proposed action to improve the F-111B to meet Navy requirements and to consider redesign where necessary.

2. Pending receipt and analysis of the contractors proposed action, it is recommended that the Navy R&D aircraft be delayed until such time as an acceptable design can be produced.

K. S. Masterson

Copy to:
CNM

Exhibit VF-5. A retyped memo, unclassified 6/22/73. (*Notes by GAS in italics*)

RAEV:GS
14 August 1964

From: RAEV
To: R

Subj: F-111 Design Review

Ref:
(a) BuWeps Conf ltr to CNO, RAEV:GS, Serial Q1551
(b) SECAF SECNAV, DDR&E Conf. Memo for SECDEF dated 15 Feb 1964, SECNAV Control No. C-498
(c) BuWeps Conf Memo RAEV to RA-2 dated 6 May 1964
(d) BuWeps Conf Memo RAEV to OD-3 dated 5 June 1964

Encl:
(A) Weight Evaluation - F-111B- Configurations A, C, Y dated 28 July 1964
(B) Performance Evaluation - F-111B - Configurations A, C, Y dated 28 July 1964
(C) Stability and Control Evaluation, Configurations A, C, Y dated 28 July 1964
(D) Cost Effectiveness Summary - F-111B dated 1 May 1963
(E) Summary Data - F-111B, Configurations, A, C, Y dated 28 July 1964

1. In reference (a), the Bureau of Naval Weapons reported on the status of the F-111B and reached the conclusions that major changes were required to make the airplane acceptable. *(Note: This letter not in the record. Although written, it was apparently withdrawn.)* After reviewing the facts, the CNO recommended to the Secretary of the Navy that work on the F-111B be stopped pending a determination of corrective action required. In a joint report to the Secretary of Defense, reference (b), the problem was discussed and a decision reached to continue the program as scheduled but with increased attention to weigh reduction. Also recognizing a possibility that the Navy version could not be made acceptable within the constraints of the program, a decision was also made to:

> "e. Immediately institute design studies to provide options and a "fall-back" design for the F-111B that will assure meeting Navy requirements with a margin for growth. Prepare analyses of the options in terms of schedule and program impact."

2. The contractor, General Dynamics, under the direction of the Air Force System Project Office (SPO) has concentrated his efforts on weight reduction programs, first "WIP," (Weight Improvement Program) then "SWIP," (Super Weight Improvement Program). The Navy has cooperated in such efforts to the maximum practicable extent, while also attempting to convince both the SPO and

the contractor that the problem was real, and would not be solved without a major design effort. Reference (c) packaged weight and performance data together with a cost-effectiveness summary for delivery to the Commander, AFSC at a status meeting at General Dynamics on 7 May. It was apparent at that time that little attention was being given the "fall-back" design, with both the Air Force and contractor expressing the opinion that SWIP would solve the problem; aided, if necessary, with an achievement of a higher maximum lift coefficient. In compliance with requests made at the 7 May meeting, reference (d) put together a more comprehensive summary of the Navy weight position for transmittal to AFSC and SPO.

3. On 8 June, the contractor presented to the SPO and provided data to the Bureau on his solutions to the Navy Problem. On 9 June, he presented the results at the Executive Management Review (EMR) together with his normal status report. Five configurations were discussed:

   a. Configuration A. The current airplane after SWIP with only minor changes in "commonality." A saving of 4644 lb. from the base weight of 46310 lb. was claimed. Costs were stated to be within the current scope of the program.

   b. Configuration C. In addition to the changes of A, 2050 lb. were saved by reducing the design Mach number, deleting the weapons bay and capsule, and incorporating new, lower design Mach engines. Part count "commonality" was reduced from 78.8% to 57.4%, and costs increased by 45M, "R&D,", and 260 M "Total."

   c. Configuration E. This design saved another 987 lb. by reducing the wing strength on the Navy airplane and increasing the thickness of the horizontal tail. Part count "commonality" dropped 2.6 points to 54.8% and costs were quoted as increasing 53M and 344M for "R&D" and "Total."

   d. Configuration X. A substantially new Navy airplane designed by General Dynamics with wing and tail planforms held. Part count "commonality" was reduced to 28.1% while the changes in costs were given as 128M and 480M. The weight was quoted as one pound more than E.

   e. Configuration Y. An airplane with a new Navy fuselage and landing gear designed by Grumman. Part count "commonality" was given by General Dynamics as 29.4%, the weight was quoted as the same as "E" and costs the same as "X."

4. The basic information presented was inadequate for evaluation purposes. All the data on Configurations A, C, and E were contained in one 56 page report. Configuration X, a new airplane, was described in a 47 page report. Only

configuration "Y" was presented in anything approaching the expected depth. The Grumman report on that design was accompanied by a short General Dynamics critique which tended to becloud its status. The total cost data provided are those figures noted above, given at the EMR, while no schedule information was made available. Requests for specific addition information were made both officially to the SPO and informally to the contractor. The latter channel was the most effective with the SPO providing part of the same information from the contractor on a delayed basis. Significant developments during the initial data acquisition period from 8 June to 2 July included:

a. Lift data used for the EMR presentation on 9 June differed from those used in the technical reports submitted on 8 June. At a meeting at the SPO on 24 June, the contractor provided test data on a revised high lift configuration. He confirmed at a meeting on 1 July in the Bureau that the new configuration was considered firm. The inboard two sections of the slat are increased in chord from 12% to 15%, the Kreuger flap on the glove is eliminated, a section of the glove translates forward 14 inches and rotates, the slats are extended inboard to the sides of the nacelle, and the gap between flap sections is reduced from 12 to 7 inches. The contractor also confirmed that the slat chord increase involves a front spar relocation inboard in the wing, while the flap gap change involves actuator cutouts in the rear spar. Weight and fuel changes involved were not reflected in any other reports.

b. In the high lift meeting on 24 June, it appeared to the Bureau representative that the contractor had also restored the missiles to their original positions on the wings. The contractor at the 1 July meeting, however, stated that the "current" airplane is that described as Configuration A, with the external missiles on the nacelles.

c. In reviewing the revised configurations, basic discrepancies in design speeds and load factors were revealed between the "current" airplane and that described in the specifications. For example, a loiter condition maneuver load factor of 6.5 g is required by specification, but the contractor (with SPO concurrence expressed in their message (424-6-176) is actually providing 5.0 g. Speeds described in structural specification (FZM -12 - 0956) as "maximum attainable" have been reduced arbitrarily by the contractor to lower values. In the 1 July meeting, the contractor could not define the structural design envelopes of the "current" airplane, much less those of any of the new configurations. The stability limits are likewise not defined. Information on the current airplane was promised by the contractor (Configuration A), but no attempt was to be made to define the design envelopes on the other configurations.

d. The "loiter" condition was in the process of changing. For the last year, all aerodynamic calculations have been based on a 20^{o} sweep with a 11.4^{o} flap deflection. The contractor's "Structural Criteria", however, has shown the condition as 15^{o} sweep with the same flap setting. In the 1 July meeting, the contractor reported that stability considerations required either a change from the 20^{o}-11.4^{o} condition or a "fix" to the airplane. A change to 5^{o} flap deflection appeared to be the most likely, although other conditions including sweeps of 20^{o} and 25^{o} with no flaps were still being considered by the contractor.

5. The preceding paragraph notes only a few of the problems with which the technical evaluators were faced in this exercise. The extremely fluid state of the basic airplane configuration at this stage of development is unprecedented in the Bureau's experience. Although it was known that Air Force procedures encouraged such design flexibility at the source selection stage, it was not known that the fluidity continued throughout development. Based on the data then available, a review of the five configurations was conducted.

6. The evaluation task of examining the five configurations followed normal Bureau procedures as far as possible. The principal task was to determine the acceptability of the various configurations as naval weapons. Two of the models were eliminated almost immediately:

   a. Configuration X - This design was obviously inferior to the Grumman Y design. Although General Dynamics showed the two to be in the same weight and "commonality" class, and with an identical cost impact, the data available made these conclusions quite questionable. The Y design retained the entire outer wing and tail, of the basic F-111, held the basic engine (modifying only the afterburner and nozzle) and thus should have had cost advantages over "X." A cursory review showed about a 2000 lb. weight advantage for the "Y" as well. The contractor recommended against "spending much time" on Configuration X, recognizing that the design had little merit.

   b. Configuration E - This model reduced the maneuver strength level to nominal values of 6.0g clean and 4.0 for the loiter case. Actually, the restrictions shown are more severe since a "bucket" down to 5.0g occurs in the strength envelope at about M 1.0. This level of strength might be tolerable for the primary CAP fighter mission, but would be unacceptable for the secondary air-to-ground missions. Since the strength change is the source of the principal weight reduction from Configuration C, a correction to increase strength makes the design revert back to "C."

7. The weight, performance, stability and structural data generated on the basis of the 2 July configuration were taken to the SPO on 14-15 July for a coordination

meeting with the Air Force. The announced purpose of defining differences between the SPO and BUWEPS estimates was not achieved. The SPO apparently had conducted no evaluation of Configurations C, E, X or Y, and had only limited weight information available on Configuration A. Navy results were made available to the SPO. ON 20 July, SPO and AFSC representatives met with BUWEPS personnel in RA-2. In this meeting the SPO stated that their evaluation had been conducted on some configuration other than that described in the contractor's reports and as confirmed by the SPO. The SPO stated that the loiter configuration had been changed to 26^{o} sweep with no flap. On 21 July, the contractor presented more data to the Bureau, confirmed the new loiter configuration, and reached agreement with Bureau's engineers that the takeoff and landing configuration would be 19^{o} with missiles in the bay and $22^{o} - 23^{o}$ with no missiles. These changes required almost a complete repeat of the review already completed. Revised data were put together in a briefing for SECNAV on 24 July 1964, which also included the cost effectiveness study previously completed by R-5. A condensation of the weight and performance portion of the briefing was assembled and presented at the Executive Management Review (EMR) on 28 July 1964. At that time, the SPO and contractor presented data which differed significantly from the Navy figures. In part, the differences were due to a reversion to a 16^{o} sweep condition for landing and takeoff (on the assumption that the balance problem would be solved) and to a 20^{o} sweep, 5^{o} flap condition for loiter in order to improve maneuverability.

8. The enclosures to this memorandum present the evaluation data consistent with that given by the Navy at the EMR. Enclosure (1) covers the weight and balance picture, Enclosure (2) the performance, while Enclosure (3) contains an analysis of the stability and control situation. Enclosure (4) is a summary of the cost effectiveness study completed in April and updated with an appendix showing the effect of cost increases over those used in the basic study. Enclosure (5) contains the summary table from the EMR briefing, other summary type information developed during the review, and a "conclusion" chart prepared for, but not used at, the EMR which was consistent with the "Conclusions" presented to SECNAV on 24 July, and earlier to ASN(R&D) on 18 July.

9. The "Conclusions" are discussed in more detail below:

   a. Configurations A and C are unacceptable, due to their weight and performance in reference to the requirements of the specification and the original SOR. Configuration A is slightly heavier and Configuration C slightly lighter than was predicted in February for the best that could be done without major redesign. There has been some misunderstanding of the relationship between the Navy's February analysis and the SWIP program. Some have questioned our conclusion that the "A" configuration is no better than in February when the contractor shows a 4000 lb. weight reduction. It must be noted that both the February and current analyses

are concerned with a projected fleet airplane. The SWIP program, while responsible for weight reductions, is no better than it was anticipated to be in solving the total problem. Catapulting and arresting winds required have increased for Configuration A despite the new high lift arrangement. The increased sweep required for balance has offset the lift improvement. Similarly, single engine climb has decreased despite the better lift and use of a lesser flap setting. With 26^{o} sweep, the loiter speed is increased desirably, but the load factor at buffet onset is reduced. Acceleration to supersonic speeds is worse because of the higher drag missile installation and thrust loss associated with the fixed shroud exhaust arrangement.

b. Configuration Y reaches an acceptable level of performance particularly if the airplane's balance permits use of the 16^{o} sweep position. Evidence available is insufficient to determine this point with certainty. Loiter performance is improved with the reduced weight. The cost assigned by General Dynamics for this configuration is so high, however, that more analysis is required of this and other alternatives before firm program decisions can be made.

10. Recommendations are difficult in this program due to the constraints imposed by other than technical considerations. Some of the factors which should be considered in reaching a final decision are noted below:

a. The cost effectiveness of the F-111B as reported in enclosure (4) showed a slight advantage over the F-4 for fleet air defense on an overall basis. The marked increase in F-111B costs degrade this picture. The same analysis further shows that the replacement of two squadrons of F-4s by one F-111B squadron, as currently contemplated in force level planning, actually decreases the fighter effectiveness of a carrier. The cost effectiveness is, of course, even more drastically reduced. There is obviously no margin in the F-111B for solutions such as reducing the missile load, or reducing the fuel load, as has been proposed on occasion.

b. Although the "Y" design is more attractive than the other alternatives suggested, there is no assurance that it is the best solution available. No comprehensive design study has yet been done on a fighter to meet only the Navy SOR. It has been known that Air Force Lo-Lo-Hi and other requirements had imposed substantial penalties. Studies should be made in sufficient depth that reliable cost data can be provided in addition to engineering information. Certainly, a preferred solution should be available as a standard of comparison.

c. McDonnell has had improved versions of the F-4 under study for some time. Their preliminary results will be available shortly.

d. Grumman has done some preliminary design work on a version of the A-6 with a Phoenix missile system installed. The effectiveness of such a system, similar to the MISSILEER in concept, is high for CAP operations, and relatively low for deck launched. This leads to a question as to the attractiveness of a mix of Phoenix equipped A-6s and Sparrow equipped F-4s relative to the other solutions.

e. Schedule slippages are being discussed which will have the Navy's fully SWIP aircraft, No. 4 and No. 5, delivered in mid 1966. It will only be after flight testing of these aircraft that the fundamental questions on airplane acceptability can be answered with "hard" data. A delay in at least examining other approaches for this length of time appears intolerable.

f. The usual arguments about waiting for flight proof of engineering predictions are less valid in this program than in the normal single service program. The weighing and flight testing of F-111As will provide a firm base from which to assess the F-111B.

11. There have been no developments which would invalidate the Navy's February recommendation to stop the F-111B until a solution was available.

Exhibit VF-6. Retyped Memorandum (*additions by GAS in italics*)

AIR-506:GS

MEMORANDUM 13 March 1967

From: AIR-506
To: AIR-09 *(Note: Then Adm. Fawkes)*

Subj: Lessons from the F-111 Program

1. Several months ago you requested AIR-503 and AIR-506 to prepare data on the problems encountered in the F-111 program so that similar problems could be avoided, if possible, in the next multi-service program. Higher priority work interfered, preventing completion of the project. Recently, however, a similar request from the secretarial level resulted in a number of papers being prepared on very short notice. The "lessons" from that collection of papers were not overly impressive.

2. The enumeration of "lessons" learned is far more difficult than might be expected. Nearly all the "lessons" result from poor decisions, poor management, or poor judgement. If expressed frankly, they appear so controversial that they will not reach the levels where the mistakes must be avoided in the future. If couched in generalized terms, the "lessons" appear as meaningless cliches, and serve no useful purpose. An attempt will be made in this paper to discuss some of the major decisions in the program in such a way that the "lessons" become obvious.

3. The initial program decision to build a single TFX airplane for the Navy and Air Force was made in mid 1961 by SECDEF (Mr. McNamara) following a recommendation by DDR&E (Dr. Brown), who chaired a tactical warfare study, Project 34. That study considered alternatives including the Air Force recommended TFX, the Navy TFX, and a compromise devised by DDR&E and WSEG. The billion dollar saving shown for the compromise airplane was undoubtedly the major factor in the decision to adopt that course of action. As detailed in my memorandum of 8 February 1965, the cost data used were obviously inconsistent between Navy and Air Force estimates, with the latter being grossly more optimistic. The DDR&E compromise design was priced on the basis of the Air Force cost data, and was therefore also most optimistic. In addition to the cost discrepancies, the study assumed that the total buy would be split equally between the services with each getting an identical airplane. In fact, of course, the mission differences decreed differences at least in offensive systems, while the Air Force planned to procure more airplanes than the Navy. It seems clear now that the decision maker was given improper facts. Even a cursory review should have revealed the cost data inconsistencies.

4. The next major decision in the program was on 1 September 1961, by SECDEF (Mr. McNamara) following a recommendation by DDR&E (Dr. Brown), originally prepared by Dr. Stern, on the technical characteristics of the design. This step followed a period in which the Navy and Air Force failed to agree on a compromise design, with both services in agreement that the dual requirements could not be achieved in a single airplane. DDR&E elected to accept the more optimistic prognostications of some NASA, WSEG, and DDR&E individuals, although admitting it was a challenge to industry. In this case, it is clear than an over-optimistic technical projection was given the decision maker. At the same time, the problem was compounded by a dictate that the RFP should be in the hands of industry in one month. This timing requirement showed a total lack of appreciation for the magnitude of the task required to resolve contract, design, data, and demonstration differences between the services. Although relief from the planned schedule was sought at the working level, a "can do" attitude on the part of the USAF Program Director prevailed. The RFP then went to industry setting out the requirements of the two services together with the constraints established by OSD despite their mutual incompatibility.

5. The source selection phase that followed was the longest and most frustrating of any aircraft program in which the Navy has been involved. Details of the problems encountered are contained in my memorandum of 9 January 1963. The Navy working level personnel took actions during the period which attempted to insure a usable Navy airplane design working within the constraints of the Air Force Source Selection process. The strategies employed were considered successful up to the point of the Secretarial reversal of the service recommendations. The impossibility of meeting the combined requirements was demonstrated by the end of the second round of proposals. Divergence between designs, explored as a solution in the third round, was accepted in principle for the fourth round. Unfortunately, the Secretarial level failed to appreciate the detail rules followed by the Air Force in their source selection procedure, and failed to recognize that the detail guidance provided the competing contractors was sometimes at variance with policy statements. The Navy failed to point up discrepancies noted in order not to embarrass individuals of another service. After the better design of the two was first selected and then recommended through the chain of command, it was believed that the Navy objectives had been attained. No consideration had been given to the possibility of the Secretarial level reversing the decision and then justifying the selection on technical grounds using the same facts generated at lower levels.

6. The next problem phase came when contractual specifications, guarantees, terms and conditions had to negotiated. The Air Force used an untried "Specification Tree" set of documentation, with a number of obvious discrepancies. After much discussion, the Navy was permitted to utilize its own data and demonstration specifications as a base for F-111B requirements. The

Air Force failure to define its requirements in these areas resulted eventually in a lack of coverage of their entire flight test program in the definitive contract. Despite the publicity given the program as a fixed-price (incentive) development, the lack of firm specifications made the arrangement, in fact, more nearly cost plus. Although weight and performance guarantees were included in the contract (unlike most previous USAF contracts) the contractual terms were poorly defined in many areas. And will probably lead eventually to litigation for settlement.

7. Detail technical management problems encountered during the development are fairly well known to the current Navy management level. The most disturbing aspect of the program has been the failure of the Air Force to face very real technical problems. By their failure to accept the fact that problems existed, controversy has been engendered, and technical details forced to the top of OSD. Strangely, there was reasonable agreement between Navy and Air Force working level personnel from early 1964 when the weight problems first came to light, but management levels in the Air Force and OSD elected to believe contractor projections, or at least to label all Navy estimates as grossly pessimistic. Time has since proved Navy estimates to be optimistic, as originally labeled. The publicity afforded the program undoubtedly influenced some of the decisions to disregard the problems, to hope for easy fixes, and to hold the schedule at all costs. For example, In February 1964, the BuWeps recommendation to stop development of the F-111B until solutions were found was apparently accepted through the DDR&E level, but rejected at the Secretarial level. The explanation given informally was that by holding the contractor to his schedule more pressure would be exerted on him.

8. In July 1964 when the decision to continue with only the SWIP *(Super Weight Improvement Program)* changes to the F-111B was made, Navy technical projections were again discounted. By this time, the Navy management position had shifted to accept the inevitability of the program, at least until flight tests of the F-111B became available. Not foreseen was the fact that all the early flight tests would, in turn, be discounted as schedule adherence forced construction of "nonrepresentative" airplanes. This problem continues today with the contractor presenting schedules showing the N-1 carrier suitability fixes becoming effective on airplane No. 9 or No. 10.

9. During the past year, the direction of the Navy's technical effort has shifted to Dayton, with a serious lack of communication between the Program Manager and the working level. There must be lessons to be learned from the arrangement as each side has complained about the lack of cooperation with the other. This plan should certainly be avoided in the future. Although the theory sounded good of expanding the Navy side of the SPO and working side-by-side, with the Air Force, in actual practice the disadvantage of loss of daily contact between Navy technical and management levels has been more than offsetting.

10. A serious evaluation should be made of the entire program manager set-up as now being practiced. Program Managers tend to become salesmen for their projects and seem to lose objectivity when dealing with general problems involving other models.

11. In concluding this paper, it should be reiterated that many mistakes have been made in the F-111 program. While there is no single cause, over-optimism seems to be the most common. Groups outside the services contributed most of the early overestimates of capability while the Air Force continued the lack of realism once they were charged with administering the single airplane program. The Navy's lack of forthrightness in criticizing others also contributed.

G. A. Spangenberg

Copy to: AIR-5102, AIR 530, AIR-FM-2, AIR-503

Exhibit VF-7. (Retyped)

AIR-506:GS
27 FEB 1967

To: AIR-05
From: AIR-506
Subj: Lessons Learned in the Management of the F-111 Program

Ref: (a) Executive Asst. SECNAV memo dtd 20 Jan 1967
(b) F-111B Project Manager ltr to CNM, and NASC, PM-2-WEB dtd 3 Feb 1967
(c) NASC memo, AIR-01 dtd 14 Feb 1967

1. The referenced memoranda are typical of the F-111 program and indicate clearly that while there are lessons that could be learned from the program it is unlikely that they will. Note that:
   a. Reference (a) states that SECDEF has asked SECNAV for a listing of lessons learned from the F-111 program, and encloses a starter list of six items. Deadline for submission to SECNAV is given as 8 February.
   b. In reference (b), PM-2 forwards reference (a) to NASC and CNM and requests additional items be forwarded to him for transmittal to ASN(R&D). (Five days before SECNAV deadline). PM-2 also announced an independent study on the same subject with a target date of 15 March for submission to CNM.
   c. Reference (c) requests submittal of additional items, background and examples to AIR-103 by 24 February, who is then to transmit them to PM-2 by 28 February. (20 days after SECNAV deadline)
   d. A copy of the references reached me on 23 February. A draft copy of a proposed AIR-05 reply reached AIR-503 and AIR-530 on 24 February. A deadline of 1000, 27 February was given.
2. It is not clear after reviewing the references whether an item list is still desired for SECNAV or whether the more detailed problem discussion is desired for PM-2. The latter is apparently to be done in the current management style of listing problems, alternative solutions with their pros and cons and finally some recommendations. The effort required appears far greater than is warranted, and I will not attempt to comply. The mere listing of "Lessons," however, is not unreasonable and will be attempted below.
3. It is obvious that there will be no agreement on the "lessons" that the various levels of technical and management responsibility have, or should have, learned from the F-111 program. The view upward from the working level will be different then that of SECDEF. The six "lessons" listed as starters by the Secretarial level, for example, have long been known by those experienced in the art of airplane development. All of them have been considered, debated, and/or used in other development programs. Such experience was not accepted by the F-111

decision makers. The basic "lesson" was expressed by Santayana as "Those who fail to heed history are doomed to repeat it."

4. Other lessons:
   a. Initiate joint programs only after obtaining the concurrence of all involved services as to technical feasibility.
   b. Keep technical decisions at a level where all the issues involved are known and appreciated.
   c. Schedule adherence is no way to apply pressure to a contractor to meet technical commitments.
   d. No amount of management attention alone can solve technical problems.
   e. Problems must be admitted and identified before solutions can be found.
   f. A "Fixed Price" contract is anything but fixed price when specifications are not firm for the full scope of the contract.
   g. The reliability of study results, committee prognostications, and service predictions should be judged on the basis of the past performance of the predictors in the particular specialized field under investigation. (While all predictions were on the optimistic side, some have been shown to be grossly so.)
   h. Determine the rules of the game before getting involved in any joint venture with other services or DOD.
5. The primary lesson for the future in Navy dealings with OSD and the USAF would appear to be to avoid compromise of a Navy position, despite controversy which might ensue. Strong technical positions invariably have been weakened by the Navy management chain in an attempt to not offend another part of the Defense Department. This may have contributed to some of the poor decisions made in the program.
6. There is little doubt but that the F-111 has been the most over-managed program in our aircraft development history. Unfortunately, the management techniques, organization, and theories of the Air Force are being accepted as desirable or mandatory by both OSD and the Navy despite their demonstrated lack of success. Invariably, the Air Force has applied greater numbers of people and pages of documentation to all facets of the development game. The efficiency of the operation has been as low as its effectiveness.
7. No one program has demonstrated so well the adage, "you want it bad, you get it bad." This applies to this memorandum.

G. S. Spangenberg

Copy to:AIR-103, AIR-5102, AIR-510, PM-2

Exhibit VF-8. Retype of Memo on Deputy Secretary of Defense Stationary, from him.

MEMORANDUM FOR SECRETARY OF THE NAVY 7 June 1973

SUBJECT: Navy Fighter Modernization Program

I have recently reviewed studies of the Navy Fighter Modernization program. At my direction these undertakings were conducted in recognition of two factors: first, the choice of aircraft to ultimately replace the F-4 in both the Navy and the Marine Corps, and second, the number of such aircraft that need to have the capability for fleet air defense potentially afforded by the F-14A aircraft. The study gave consideration to the F-14A and to the F-15 aircraft configured for carrier operations with and without PHOENIX capability.

Based on this review, I have concluded that it is not necessary that, beyond an initial number, all of the F-4 replacement aircraft have a PHOENIX capability, and that as a result we need to place immediate emphasis on the identification of follow-on non-PHOENIX aircraft for both the Navy and Marine Corps. In carrying out this decision, the following actions should be taken by the Department of the Navy:

1. Initiate appropriate budgetary action to obtain 50 F-14A aircraft for FY 1974.

2. The F-14A capability will be limited to a force size which will be determined not later than July 1976. In my annual review of this program I will give particular attention to the trend line of cost for this aircraft in my determination whether we will proceed with annual production increments.

3. Prompt action needs to be taken to develop and test alternative aircraft to meet the Navy and Marine Corps fighter modernization needs beyond the initial quantity of F-14As. In considering alternative aircraft I must give particular emphasis to the rapidly aging Navy and Marine Corps F-4 force and to the increasing sophistication of the enemy threat that we face. I do not believe that we have the time nor do I believe would it be efficient to originate a new development program for an entirely new fighter to replace the F-4. For this reason the options that you examine should be constrained to alternative versions of the F-14 and the F-15 aircraft and a modified F-4J aircraft. All versions are to be carrier compatible.

4. In developing plans for the alternative aircraft, the aircraft configuration will not require an avionics production cost in excess of that currently afforded for the F-15 system. A PHOENIX-like capability will not be specified and no emphasis will be given to an ability to carry and utilize the PHOENIX missile.

5. As a first step, the Department of the Navy will develop aircraft specifications and performance for the modernization fighter. Particular emphasis will be placed on design to cost and a cost that is consistent with an austere budget and the number of aircraft needed for modernization. Design to cost ceilings for the F-4, F-15 and F-14 variants will be provided for review by June 13. We want to assure that both contractors are equally well informed on desired characteristics. You should also indicate ranges of acceptable performance. We will, of course, retain the option for cost/performance trades in any aircraft selection. It would be to our advantage and that of both the contractors to understand where these trades could best be made. A basic characteristic of the Navy's plan should be a competitive fly-off between the two different manufacturers' aircraft. It is the responsibility of the Department of the Navy in drafting specifications that they not preclude full consideration of each of these aircraft. I wish to review the Navy specifications before they are provided to the contractors for their review and for the preparation of a formal proposal.

6. The Navy will develop for my approval, management, development, test, production and funding plans for these aircraft which will include the following as a minimum:

   a. The management plans will identify the organization; its authority, accountability and competence adequate to successfully develop the competing aircraft prototypes.
   b. The development of two prototype aircraft of each type (F-4M, F-15N, F-14D).
   c. A testing program, coordinated with DDR&E, which will permit a reasoned decision on the selection of alternatives by 15 July 1976, based on at least six months of flight test data.
   d. A funding profile for this prototype testing and production program recognizing that there will be prototypes from both manufacturers and that there will be a competitive fly-off between these aircraft.
   e. Additionally, in outlining the program, the Navy will proceed on the assumption that subsequent buys of F-14A aircraft will be at a rate of not over 50 aircraft per year. Emphasis will be given to a schedule which will permit continued delivery and orderly use of production facilities at both Grumman and McDonnell Douglas.
   f. Identification of the funding required and acceptable sources therefor in FY 1974 and the out-years for both the level of F-14A production approved in this paper and for the prototype plan directed by this memorandum.

This memorandum establishes the basic policy for the Navy Fighter Modernization program. It is necessary that we have a complete rationale for the Congress which supports this decision and that we be prepared to jointly go before the Congress and outline this program prior to the mark-up on the FY 1974 Budget. I would like to have your initial proposals in response to item 6 not later than 13 June 1973.

/s/
William P. Clements, Jr.

Attachment

Exhibit VF-9. Retyped

AIR-506:GS
11 June 1973

MEMORANDUM

From: G.A. Spangenberg (NavAir-506)
To: SecNav

Subj: Navy Fighter Program

Ref: (a) DepSecDef memo to SecNav dated 7 June 1973

1. This memorandum is intended as a working level protest against the decisions and program plans revealed in reference (a) to curtail production of the F-14A and to seek less capable alternatives. The immediate reaction of all those directly involved in the development and analysis of naval aircraft has been one of outspoken incredulity followed by unprintable expletives. Although the rationale for the decision is not available to me as of this writing, it appears to follow previous concepts espoused by Dr. Foster and Dr. Gardner and others whom I place in the category of speculative theorists. Their advocacy of Prototyping, High-Low Mixes, Designing to Cost, and similar buzz words as solutions to the very real problems of our inadequate naval air budgets ignores completely the lessons of the past.

2. From my admittedly somewhat limited viewpoint, our most pressing problem for the last 15-20 years has been to provide within the naval aviation budget an adequate number of airplanes of sufficient quality to do the job. We have tried to reach the best compromise in the design of our airplanes and weapons between the conflicting goals of cost and effectiveness, and we have attempted to adopt contracting methods to get the most for our procurement dollar. In particular, it must be noted that we stopped the practice of competitive prototypes with no production concurrency because it cost too much, not because of technical undesirability. We stopped buying parallel production models (F9F/F2H, FJ-4/A4D) because we could not afford the multiple development bill. We stopped CPFF development contracting and went fixed price on the CH-46, CH-53, A-7, OV-10, etc. because we could not afford the overruns we experienced on the A3J, A2F, and W2F . A better way to achieve a "Design to Cost Ceiling", or to incentivize a contractor than giving him a fixed price contract is difficult to imagine.

3. It is quite illogical to me that we should now spend our scarce resources to develop a second best type of fighter. It is ridiculous that we are developing

plans to reduce the production rate of our most cost/effective fighter thereby increasing its cost in order to provide "alternatives" which would have been rejected as inadequate at least 10 years ago. The airplane we started in 1954 is still in production, and is now being sold to countries which could use them against us. To start an airplane now with little increase in total effectiveness is incomprehensible.

4. There seems to be a feeling in certain of the less experienced analytic groups that quantity can always be used to prevail over quality, somewhat in the manner that the Lilliputians were able to tie up Gulliver. The fallaciousness of the theory should be readily apparent when one contemplates the problem of stopping a high performance threat such as Foxbat, or even an SST, with an inadequately equipped, but inexpensive, fighter such as the XF-16 or XF-17. A thousand of them would have no effect except to pollute the environment. We made the decision years ago we couldn't afford to build the type of fighter required to match the very high speed threats, then possible, and now existent. We compromised by building an airplane with a superior fire control system but with only enough airplane performance to reach launch positions to fire its missiles. That capability is just as important in offensive missions as in defensive missions. It should be clear that numbers have a significant effect in some contests, but absolutely none in others.

5. In carrier aviation the high/low mix concept has little validity. The basic theory mixes a few high capability machines with a large number of low capability devices. In practice on a carrier, however, the space is constant, and the number of fighters tends to be a constant. So we end up with a mix of 12 capable, and 12 incapable aircraft. A smaller force of machines, each of which has a fair chance of winning a fight, is a far better solution.

6. There seems to be a great tendency on the part of those newly installed in positions of authority to appoint ad hoc study groups to render advice on complex or controversial problems. The ad hoc groups are given such short deadlines that independent analyses cannot be conducted, but reliance must be placed on previous studies, opinions, contractor estimates, etc. The results of years of effort can be overturned by superficial judgements rendered from an inadequate examination of the conflicting views of some of the parties involved. The recent Flax effort on the F14/F-16 effort is typical. Time did not permit the assembling of either data or experts to conduct truly independent cost or performance analyses of the various models under study. It is equally obvious that no independent operational analysis could have been conducted. Great credibility is usually given to the "estimate" produced by an OSD group that turns out to be somewhere between that of the "biased" contractor and the "biased" service. In my experience, Navy estimates of cost and performance tend to err on the side toward those of the contractor because of the very real problem we face of eventually justifying our estimates to the contractor. It appears that those

opponents of the F-14/Phoenix system who have failed to convince the juries over the past several years have finally won the case without allowing us, the defense, to even enter the courtroom. Those of us at the working level feel we were entitled to the courtesy of some form of rebuttal prior to the final decision, if, in fact, the report contains the type of data which I have assumed.

7. The overall plan of reference (a) possesses so many conflicting elements that detail criticism is not warranted. A few basic facts should suffice:
   a. "Prototyping" must have been assumed to be inexpensive. Previous DDR&E studies have alluded to values on the order of $50M. If little enough development is done, this figure is attainable.
   b. T&E elements in OSD are insisting on operational evaluation prior to a production release. If the prototype program is cheap the equipment produced is not suitable for operational evaluation.
   c. Without a full development test program, operational testing cannot be accomplished. A full development program is not inexpensive.
   d. If inexpensive prototyping is done, availability of production aircraft for the fleet would not be available for four years, at best, This hardly gives a production option to the decision maker for the following fiscal year's budget.

8. The possibility of attaining a significant increase in total carrier effectiveness is lost when the AWG-9 capability is legislated out of the F-14. Detail planning had been started to implement a concept, always desirable but now attainable, which would permit an all-weather attack capability without loss of fighter capability. Once achieved, the carrier complement would be reduced by one type, enhancing support and providing a significant increase in flexibility. It is probable that the decision to eliminate the Phoenix capability downstream was made without knowledge of this fact which would have benefitted both carrier and Marine aviation.

9. This memorandum has been prepared and forwarded without the knowledge of my superiors. I am confident, however, that it represents the viewpoints, in general, of all of us who have spent this weekend attempting to implement a decision with which we thoroughly disagree, and which we think is inimical to the best interests of the government. It ranks well up with other money saving decisions originated within OSD, such as TFX and HLH, and probably for the same reasons, erroneous information to the decision maker.

George A. Spangenberg

Copies to: CNO, CNM, OP-05, AIR-00, AIR-01, AIR-05

Exhibit VF-10. Retyped Statement on the Fighter Prototype Program

STATEMENT OF MR. G. A. SPANGENBERG
BEFORE THE
SENATE ARMED SERVICES SUBCOMMITTEE
ON TACTICAL AIRPOWER

June, 1973

Mr. Chairman, I am here today at your request to give my personal views on the fighter prototype program outlined in the Deputy Secretary of Defense's memorandum dated 7 June 1973 to the Secretary of the Navy. Inasmuch as my conclusions on the wisdom of embarking on a prototype program are at variance with those of Mr. Clements, I would assume that we are operating on a different set of facts. The data on which I base my conclusions are estimates made by the Naval Air Systems Command (NavAir) on various alternative fighter programs during the past year or so. I have been involved to some degree in most of the NavAir studies on this subject, have prepared some of the conclusions, and some of the forwarding letters, but rely on price, schedule, and technical estimates made by others in our organization. Those on whom I rely I consider to be the best available source in each particular field. Our cost analysts are responsible for producing estimates for all naval aircraft and their record is excellent. Unfortunately, the quality of their estimating is usually not known outside the Command, since the variances which are publicized are not those between their estimates and actual costs, but between contract or budget figures and actual costs. The same remarks apply to our estimators in other fields, weight, performance, and so on.

From data available, it is clear to me that no money can be saved in following the proposed prototype program, but in fact, more capable airplanes can be produced at a lower total cost using more conventional and proven approaches.

For the record, a brief review of the situation is warranted:

1. In 1971, after the negotiations surrounding exercise of the Lot 4 option in the original F-14 contract, Mr. Packard, then Deputy Secretary of Defense, directed study of a carrier-based version of the USAF F-15A. In September 1971, McDonnell submitted a proposal via the Air Force for the F-15N, a minimum modification of the basic F-15A retaining its single place arrangement and utilizing the identical fire control system. In January 1972, NavAir forwarded a report which concluded that the design was not an attractive option, as it was estimated to cost about 10% more than continuing to buy F-14s for the then planned total of 313 airplanes, and was much less capable.

2. At the same time, the Air Force advised the Navy that a study of a two-place, AWG-9/Phoenix version of the airplane was impractical within time and resources available. An in-house Navy study showed that this approach was far more costly than continuing with F-14As.

3. On 26 March 1973 during hearings before this committee, the Navy was advised that McDonnell had available a modestly priced, Phoenix capable version of the F-15A, involving no major airframe changes. On 30 March 1973, the contractor, in reply to a Navy request, provided the meager data he had available on this design. A NavAir evaluation of the data concluded that the design was at least three years later than the F-14A, was less effective, and would actually cost more through a buy of more than 300 airplanes after the first 131. More detailed study by the contractor appeared unwarranted.

4. On 20 April 1973, the results of the review were given to the contractor in order that he would be fully aware of the Navy's evaluation prior to his expenditure of more effort. The DepSecDef, Mr. Clements, then requested the contractor to submit data to him on a multiplicity of design and program alternatives,

5. On 4 May, the contractor responded by providing technical and cost information on three single seat designs:

   a. F-15N, the Sparrow only design, as proposed in 1971, a minimum modification of the F-15A

   b. F-15 (N-PHX), a new avionic configuration with a multi-shot Phoenix capability. The system traced 12, displayed 6, and shot 4. Overload carriage of 6 missiles was proposed as an option.

   c. F-15 (N-SP), a follow-on to (N-PHX) but with the specific Phoenix auxiliaries and launchers deleted to provide a minor cost saving and a major loss in capability.

   As requested by Mr. Clements, the program plans provided for buying either 179 Phoenix carriers followed by Sparrow only models, or for buying only Sparrow versions.

6. On 7 May, Mr. Clements appointed an ad hoc group, headed by Dr. Flax, to conduct a parallel study of the F-14/F-15 alternatives and to report back to him on 22 May 1973, The Navy Fighter Study was also tasked by the Navy to respond specifically to the request for alternatives, NavAir provided technical and cost analyses to both the Flax group and to the Naval Fighter Study (NFS).

7. On 21 May 1973, NavAir reported the results of its analysis of the McDonnell proposals to the Chief of Naval Operations, concluding with the paragraph,

"It is clear that on the basis of price alone, versions of the F-15 are not attractive as alternatives of the F-14A. The many other significant disadvantages of the airplane then need not be considered, including even the fact that a single-place fighter is considered by the Navy to be totally unacceptable in today's combat environment. The F-14A is more capable, more available, and less costly than the versions of the F-15. Further study of this issue is not warranted."

8. On 22 May 1973, NavAir forwarded technical evaluation data to supplement the cost analysis. On about this date, the Flax committee report was also completed.

9. On 7 June, Mr. Clements issued his directive to the Navy to submit by 13 June for his approval, management, test, production, and funding plans for implementing a program to produce non-Phoenix prototype versions of the F-15, F-4, and F-14 for a competitive fly-off culminating in a production choice in mid 1976. In compliance with the request, the two contractors were given proposals on 11 June. On 13 June, the completed development plans were forwarded to the Deputy Secretary of Defense by a memorandum which included schedules, prototype costs, total development costs, and funding requirements.

10. Production price estimates were also made by NavAir in order to complete the price picture. Summaries of total costs were then developed, but were not forwarded officially.

11. Mr. Clements deleted the F-4 from the prototype program before presenting the plan to your committee.

From this background you can see that many of the recent examinations of alternatives have been done under very short deadlines. The final exercise could not have been priced in the time available without the background of the previous proposals. The designs, fortunately, were similar to others already evaluated, albeit under different assumptions as to schedules, development plans, etc. The splitting of the development into two phases, one through the prototype flyoff and the other following it, is a major complicating factor in making the estimates. The price of the prototype portion can obviously be reduced by deferring development tasks until the second phase if one is willing to accept a time extension and the associated increase in cost. However, if a full operational flyoff is to be performed, most of the development tasks should be done in the first phase.

In brief, the schedules forwarded by the Navy to Mr. Clements on 13 June attempted compliance with his 7 June directive. With an immediate go-ahead, prototypes could be flying in about 2 years allowing six months of contractor flight tests prior to a six-month flyoff, and a full production go-ahead in mid 1976. First production flight occurs in the

second quarter of 1978 with a rapid build up to a 5/month rate through 1979 and 6/month thereafter. Overall the schedule is tight and probably not realistic, but as noted before, any extensions would increase total price.

NavAir estimates of the prototype costs are shown in the attached "Chart 2" as forwarded to Mr. Clements in the Navy's 13 June 1973 response. Examination of this chart will reveal an estimated cost of the F-15, F-4, and F-14 prototype programs at 221.4, 106.0, and 146.4 million, respectively for a total of 473.8 million. Also to be noted on the chart are the costs required to complete engineering development prior to production expenditures. These figures are 214.7, 39.0, and 51.8 million, again respectively. These values should not be totaled, since only one of the three programs would be continued through that phase.

"Chart 3" from the 13 June 1973 memorandum is also attached showing NavAir estimates of the funds required by fiscal years. In 1974, the total estimate for the three programs is 224.5 million.

I have excluded the contractor quotations for their part of the prototype program from this statement, although they were included in the 13 June memorandum. In my opinion, contractor quotes, particularly planning figures to as yet undefined specifications, should not be used in making program decisions. The quotations are used by our cost estimators in arriving at their figures, but are not accepted, necessarily, as a valid indicator of the final price. Inasmuch as no production price estimates were required by Mr. Clements in his 7 June 1973 memorandum, none were included in the Navy's 13 June response. In my opinion, these are necessary in arriving at a proper overall decision on the prototype program. The production prices used in preparing our summary position are again 'best estimates', and are consistent with information provided in the 21 May letter to the Chief of Naval Operations and also to the Flax ad hoc study group.

In Table 1, attached, is a summary of the total program price associated with the various fighter alternatives under considerations. The summary is based on the program as it was proposed on 13 June 1973, viz.:

1. Three prototype programs would be followed with a choice to produce one of them or to continue F-14As.

2. F-14As would be bought at a rate of 50 per year for FY 74 through FY 76. A half year's buy of 24 F-14As was added for delivery in the first half of calendar 1978 to match the introduction of the production choice.

3. For comparison purposes, two F-14A choices were noted, the first of which followed the 50 per year plan through the 174 airplane buy, but then shifted to the 72 per year rate which the other program choices attained. The second F-14A program was one which shifted to 72 airplanes per year starting in FY '75.

4. In all cases, 400 airplanes were priced after the 174 F-14As, making a total of 574 airplanes for comparison.

As can be seen, there is virtually no difference in price between the F-15, the F-14A, and the F-14D with a TF30 engine, following the basic procurement plan. The F-14D with the F401 engine is slightly more expensive, and the F-4 about 25% less expensive. A continuation of the F-14A at a reasonably economical rate of 72 per year is seen to be over a billion dollars less expensive than embarking on the prototype and F-15N route.

The figures presented are as they existed on 13 June 1973. Minor adjustments in the program will, of course, change individual figures, but the overall conclusion will remain that significant savings cannot be expected by shifting to alternatives which require large development and support expenditures.

The price picture so dominates this particular issue that other factors need not be discussed in depth, but a few may be of interest.

1. The capability of the multi-shot AWG-9/ Phoenix may not be required to win every engagement, but it is required to win some. The agenda for engagements with the enemy is seldom available, and never before have we considered it inadvisable to increase our margin of superiority.

2. The ground attack capability of the current AWG-9 fire control system should not be ignored, nor its capability for future development.

3. The necessity for a two-man crew became apparent to the Navy when the F-4 was finally configured in 1955. It was the principal reason for its choice over the F8U-3 in 1958. Recent combat experience has strengthened my conviction that the requirement cannot be relaxed.

4. Despite the emphasis on the fleet air defense mission, one should remember that the F-14A was designed primarily as an air superiority weapon. Its basic flight design gross weight corresponds to the escort mission with Sparrows and accommodates the Phoenix missiles and ground attack weapons as alternate loads. The pilots now flying the airplane are convinced that it is capable of engaging successfully with any known threat in either close-in or long-range engagements.

Before closing, I feel obligated to advise you that many consider me biased in my viewpoint on many of the OSD proposed solutions to our very real problems in weapons procurement. In particular:

1. I'm opposed to fly-before-buy and prototyping in general because of the higher costs involved. We stopped the practice because we couldn't afford it, not

because it was not technically desirable. Prototyping saves money only when projects are failures and must be terminated. Today, the state of the art adequately permits the prediction of failure, it need not be demonstrated.

2. Extensive operational testing prior to production release falls in the same category, it increases the price of our systems without apparent reason.

3. "Design to Cost" is an overstated cliche. Cost has been a primary consideration in all of our new naval aircraft for at least the last 20 years. Cost must be controlled in the initial concept, but cannot be treated as a design variable during development. Change has been the primary reason for cost increases. Good programs have held them to a minimum.

4. High low mixes as a solution to cost problems are not always viable. As this study has indicated, small buys of each may be more expensive than a large buy of the better product.

In summary, my opinion is that we must seek solutions to the F-14 price problem within the program. The preferred solution is to buy the airplanes at a higher rate. If development funds are to be spent they should be applied to the airplane in a way to reduce total program price, and not to develop less capable alternatives.

Exhibit VF-11. Retyped Statement Concerning the F-18 Program

STATEMENT OF

MR. GEORGE A. SPANGENBERG

PREPARED FOR PRESENTATION TO THE

APPROPRIATIONS COMMITTEE

U.S. SENATE

CONCERNING THE F-18 PROGRAM

Prepared 16 October 1975

Mr. Chairman and Members of the Committee:

In this, my first appearance before your committee after a career dedicated to Naval Aviation, I find myself in the uncomfortable position of being opposed to a program which is, on the record at least, being supported by my former colleagues within the Navy. It is my hope that I can help you understand how such differences can exist and also explain in relatively simple terms why I believe it would be a mistake to develop the F-18 as it is now defined.

I am presenting my conclusions on the F-18 from a background of 40 years involvement with Naval Aviation and an intimate knowledge of every new Naval aircraft started in the last 35 years. I was directly involved in the initiation, justification, and source selection of every aircraft design now in Naval service, and believe I know as well as anyone the problems encountered in the acquisition process. I do not claim to know the solutions to all those problems, but I certainly can recognize the non-solutions proposed by many of those speculative theorists with no actual experience in the field. I believe strongly that each new program must be justified on the bases of both cost and effectiveness, as they have been in the past twenty years or so. A low cost program which fails the effectiveness test is obviously no bargain, and no justification exists for a new program such as the proposed F-18 which flunks the effectiveness test and costs more than other fully defined alternatives which already exist.

The Chairman will remember my connection with the TFX and his investigation of that ill-conceived and obviously mismanaged project. One of the lessons I learned from that program was that poor decisions could be made by senior officials in OSD even when they were provided with proper facts. It was also apparent that facts at variance with an OSD established position often failed to reach the decision maker in recognizable form after progressing up the chain of command from the engineering level within the service. I also learned that it is virtually impossible for Congress to obtain a frank opinion from subordinated officers within a service or any data from service spokesman which does not support an OSD position. In too many cases, support is directed from the top under threats which to me appear to be almost blackmail. As I recall, all Navy spokesmen, military and civilian, supported the F-111B in authorization and appropriation hearings for several years, despite clear evidence available to them that a successful conclusion was not feasible. The Congress finally had to direct termination of that program allowing the Navy to escape condemnation for insubordination. Often in the hearing procedure, the OSD spokesman in his initial remarks will emphasize that he has the full support of the service involved, effectively stifling any show of dissent. Within the service, the normal rationale used for justifying those second rate programs which have been directed from above is that, "Anything is better than nothing." This attitude has been apparent within the Navy for the last few years since the completely arbitrary decision by OSD to limit F-14 procurement to about half that which had been justified previously on cost effectiveness grounds to both OSD and the Congress. With the acceptance of the OSD decision, every effort was expended in finding reasonable alternatives while hoping that eventually logic would prevail to reverse the decision before production of the

preferred models ceased. The situation is bad and appears to be worsening as OSD assumes more and more of the authority in the weapons system acquisition process.

The OSD has had what appears to be an obsession with the search for a lower cost alternative to the F-14, and its weapon system, ever since contractual problems were experienced with Grumman in 1971. Two years ago, an OSD plan which originally involved prototyping of an F-15N, a modernized F-4, and a reduced capability F-14 was wisely rejected by the Congress when it became apparent that the final outcome would have been a loss in effectiveness and an increase in costs. Last year, after no acceptable pure fighter alternative had been found which was cheaper than the F-14, a multi-purpose fighter attack concept was suggested which would serve as both an F-4 and A-7 replacement. Congress and the OSD then combined to kill any hope that this VFAX concept could provide an adequate replacement for these types by directing that the design should be a derivative of the Air Force's lightweight fighter. This direction not only limited the competition, but it tended to constrain many of the requirements which were ultimately specified to something less that the levels which the F-4 and A-7 inventory currently possess. After permitting both of the competing contractors considerable leeway in deviating from the original Air Force designs, the Navy selected the McDonnell/Northrop design as the best of those under consideration, designated it the F-18 and is preparing to proceed with its development.

Although the losing contractor in the competition protested the award, there is no doubt in my mind but that the selection process itself was fair and equitable to that contractor and that indeed the best design was chosen. The source selection decision should not be an issue, although one can certainly question the fairness of the entire procurement process when Air Force technology prototypes were allowed to grow into large scale development and production programs without permitting all of the industry to compete. One can also question the adequacy of the analysis and justification, if any, which started the entire exercise.

With some of the background out of the way, let me give you my evaluation of the F-18 program, using data presented by the Navy in previous hearings, or published in trade journals, as my source of technical and cost information. I will try to simplify the situation to the essential ingredients of whether the F-18 is worth buying as either a fighter or as an attack aircraft on the grounds of cost and effectiveness. Starting with the fighter case, we find by interpolating the Navy program cost and delivery data given in your earlier Lightweight Fighter Hearings, that the first 400 aircraft will be delivered between the years 1981 and 1986 at a total program acquisition price of $5.3B in constant FY '75 dollars. This means an average price of over $13M, certainly more than the average cost of an additional 400 F-14s. If one were to extrapolate from the FY '75 price of an F-14, using the same quantity/price relationship used for the F-18, the average cost of 400 additional F-14s would be under $11M. Since no one has disputed the fact that the F-14 has a great advantage in capability, a normal evaluation would end at this point with the showing of greater effectiveness at a lower acquisition cost for the F-14. However, unlike the situation in most competitions, operating costs differ between the

two designs with Navy figures giving an advantage of $.5M per year per operating aircraft to the F-18. If one assumed 18 squadrons of 12 airplanes each, operating cost savings would presumably be 18 x 12 x $.5M or $108M per year, thus allowing the acquisition deficit to be offset after about 8 years of operations. In simple terms then, we start delivering the new fighters in six years, finish in eleven and break even in total cost about the end of the next decade.

Although there has been little public discussion of absolute effectiveness levels of our various fighters, some understanding of relative values can be gleaned from justifications used by the services in starting new programs and them continuing them. As is well known, the capability of a fighter in today's world is primarily a function of its weapons and its missiles rather than pure airplane performance and maneuverability, although these, of course, cannot be completely ignored. Two years ago the Navy testified that the F-14 with its multishot system and Phoenix missiles was equivalent to at least three F-4 aircraft with its single shot system carrying Sparrow missiles against a moderate performance bomber raid. You have also received testimony that against some of the more difficult targets that the F-14 and Phoenix combination is infinitely better than the F-4 with Sparrow since the latter has no chance of killing that type of threat. To understand the importance of the weapon system and missiles to an aircraft, you should also know that operational analysts rate an F-14 with Phoenix as twice as good as an F-14 with Sparrow against most targets in most threat situations. Two years ago, you heard from the Navy that a two man crew was necessary in its all weather fighters in order to maximize cost effectiveness. At that time, OSD expressed its concurrence on the issue of crew size. You also know more radar range gives greater effectiveness. With the above background, it is clear that the ranking of Navy fighters in overall combat effectiveness would be the F-14/Phoenix first by a wide margin, the F-14/Sparrow next, followed by the F-4 and then the F-18. The latter suffers from its one man crew, less powerful radar, and fewer missiles, which combine to offset its predicted better reliability and maintainability characteristics. Overall, the F-18 type of fighter would fail a normal cost effectiveness justification over the F-4, a design initiated about 20 years ago.

In judging the capability of the F-18 relative to foreign threats, one should bear in mind the timing of the program. The six years before production corresponds to the time spent in developing, producing, and deploying the F-14. It is obvious that any enemy has the time to produce a counter threat. The enemy's task is enormously simplified if he has to counter only designs such as the F-16 or F-18. If he chooses, he can easily design a better dog fighter since he has lesser constraints, and can thus defeat the F-18 in the only area in which anyone now claims a superiority over the F-14. To win in an air-to-air war, we must invest in better weapons systems and missiles if we are to have a chance of winning.

Summing up the fighter case, the F-18 has no more capability than an F-4 and costs more; while it has far less capability than an F-14 which costs no more, and is available years earlier. There is no way in which the F-18 can be justified as a Navy fighter.

Having shown that buying the first 400 F-18s as fighters makes no sense, let us now consider the second 400 aircraft which have been proposed as A-7 replacements. Costs in this case favor the A-7 both in quoted acquisition prices and in operating costs. Again using the Navy data for the total F-18 program, we find the unit procurement price for the F-18 attack models to be a little over $6M while the A-7 equivalent price has been quoted at less than $4.5M. Comparable operating prices were quoted by the Navy as $.9M for the F-18 and $.75M for the A-7. Overall, one sees that the F-18 is about half again as expensive as the A-7, so to be justifiable it should have a least hat degree of superiority. It has been stated that the F-18 using three drop tanks has a slightly lower operating radius than the A-7 using two tanks, that the weapon systems are closely comparable, but that the F-18s higher combat speed reduces its vulnerability, making it a better overall attack airplane. Unfortunately, the difference in payload/radius characteristics of the two models is greater than implied by such testimony, particularly if the pilot actually uses his maximum power to achieve the claimed advantage in combat performance. Approximations of the differences in operating radii with the same bomb load and with the same number of external tanks show that the A-7 outranges the F-18 by about 150 miles when the pilot of the latter does not use his potential speed advantage and by about 250 miles when he does. The F-18 does not approach the 600 mile radius on internal fuel with six 150 lb. bombs, which was one of the requirements in the original A-7 competition in 1963, nor does it match the 750 miles strike radius with external fuel estimated for the F-4 early in its development. To the uninitiated, the attack radius quoted for the F-18 sounds not unreasonable, until one realizes that maximum external fuel is used on the least demanding of the many attack radius problems which exist. Its true range characteristics can better be gauged by noting that it is inferior on internal fuel and without combat power usage to what was initially estimated for the A-4 in 1952. It will be recalled that the A-7 was justified in part by the fact that its capability was twice that of the A-4. Although there are other deficiencies in the design as it has been reported, its range performance alone is sufficient to disqualify it for serious consideration as an A-7 replacement. With a 50% higher price and a 50% lower capability than the A-7, the F-18 cannot be justified as an attack airplane.

In previous hearings, the potential use of the F-18 as a reconnaissance type has also been claimed. Its range deficiency would appear to rule out its use in this role, which normally requires greater range than for the fighter and attack models for which it is doing the reconnaissance.

Somewhat as an aside, I might state that it is probable that the logic used for the F14/F-18 choice would carry over to the F-15/F-16 issue, although with no cutback yet required of planned F-15 procurement to accommodate the F-16, the problem is less critical to the Air Force. In your earlier hearings, the Air Force showed equal cost forces to be 650 F-16s or 520 F-15s. If the F-15 is worth buying at all, its capabilities must easily offset the small numerical advantage noted.

Summarizing, it is clear that the F-18 is neither effective, nor cost effective, in either fighter or attack roles. It is vastly inferior in capability to the F-14 at about the same total

cost, somewhat less capable and considerably more expensive than the F-4 and is inadequate in range and more costly than the A-7. The F-18 would have failed to survive any of the cost effectiveness studies conducted by the Navy in seeking F-4 and A-4 replacements in the last 15 years. There is no justification for continuing the program.

Funds now planned for the F-18 should be redirected to first increase and then hold F-14 production at a reasonably efficient level, thus solving the Navy fighter gap problem. Study work and component development should also be started on an adequate replacement for the A-7 when that becomes necessary. The Navy's goal of reducing carrier types is achievable with a mix of F-14s and A-7s far easier, at less cost, and with a greater level of capability than with a mix of F-14s and F-18s.

The questions has been raised as to how the lightweight fighter program managed to obtain so much support in view of the cost and effectiveness arguments against it. In large measure, it seems to me that the basic problem lies with those who propose simplistic solutions to very difficult problems. In this case, the OSD proposed high-low mix concept was the culprit. It was assumed first that we couldn't afford all the first line weapons we needed, and then assumed, second, that buying a mix of first line and second line weapons would cost less than all first line. A primary goal in the lightweight fighter program seems to be to prove this concept, by forcing a mix of F-15/F-16 on the Air Force, and F-14/F-18 on the Navy. Actually, the virtue of a mix of equipment has long been known and practiced in both military and industrial circles when it made sense to do so. In the case of an aircraft carrier, for example, a mix of high price and high capability F-14s with the lower priced A-7s could be considered a realistic implementation of the theory. It is clear that each case needs to be examined on its own merits, with cost and effectiveness both considered.

There has been much talk by OSD of solving the problem of our numerical inferiority to the threat by the lightweight fighter program and the high-low mix concept, but the figures to date belie the rhetoric. It seems clear to me that OSD should reexamine its policies and adopt only those which give us some chance of winning.

Exhibit VF-12. Retyped

STATEMENT OF

MR. GEORGE A. SPANGENBERG

CSA AND CONSULTANT

BEFORE THE

SUBCOMMITTEE ON TACTICAL AIR POWER

OF THE

ARMED SERVICES COMMITTEE

U.S. SENATE

CONCERNING THE F-18 PROGRAM

Revised 3 October 1975
Prepared 14 September 1975
G.A. Spangenberg

Mr. Chairman and Members of the Committee:

I am pleased to be here in accordance with your request to give you my personal views on the proposed F-18 program and related matters. You will recall that I appeared before you two years ago under somewhat similar circumstances to give you my opinion on the 1973 version of the OSD plan to cut in half the number of F-14 aircraft which had been programmed to replace the F-4. That plan which originally involved prototyping of an F-15N, a modernized F-4, and a reduced capability F-14 was wisely rejected by the Congress when it became apparent that the final outcome would have been a loss in effectiveness and an increase in costs.

The OSD has had what appears to be an obsession with the search for a lower cost alternative to the F-14, and its weapon system, ever since contractual problems were experienced with Grumman in 1971. Last year, after no acceptable pure fighter alternative had been found which was cheaper than the F-14, a multi-purpose fighter attack concept was suggested which would serve as both an F-4 and A-7 replacement. Congress and the OSD then combined to kill any hope that this VFAX concept could provide an adequate replacement for these types by directing that the design should be a derivative of the Air Force's lightweight fighter. This direction not only limited the competition, but it tended to constrain many of the requirements which were ultimately specified to something less than the levels which the F-4 and A-7 inventory currently possess. After permitting both of the competing contractors considerable leeway in deviating from the original Air Force designs, the Navy selected the McDonnell/Northrop design as the best of those under consideration, designated it the F-18 and is preparing to proceed with its development.

Although the losing contractor in the competition has protested the award, there is no doubt in my mind but that the selection process was fair and equitable to that contractor and that indeed the best design was chosen. The source selection decision should not be an issue, although one can certainly question the fairness of the entire procurement process when Air Force technology prototypes were allowed to grow into a large scale development and production program without permitting all of the industry to compete. One can also question the adequacy of the analysis and justifications which started the entire exercise.

As many of you must already know, I consider the F-18 development, and in fact the entire lightweight fighter program, to be ill advised and not worthy of financial support. More capable alternatives are available on which to spend this country's limited defense resources. Since my views differ so markedly from the official Navy and OSD positions, I feel some general comments may be in order on how such differences can exist when the basic facts are not a major issue. The members of this committee, I'm sure, are well aware of the problem in obtaining a frank opinion from subordinate officers within a service or any data from service spokesmen which does not support an OSD position. In too many cases, support is directed from the top under threats which to me appear to be almost blackmail. As I recall, all Navy spokesmen, military and civilian, supported the

F-111B in authorization and appropriation hearings for several years, despite clear evidence available to them that a successful conclusion was not feasible. The Congress finally had to direct termination of that program allowing the Navy to escape condemnation for insubordination. Often in the hearing procedure, the OSD spokesman in his initial remarks will emphasize that he has the full support of the service involved, effectively stifling any show of dissent. Within the service, the normal rationale used for justifying those second rate programs which have been directed from above is that, "Anything is better than nothing". This attitude has been apparent within the Navy for the last few years since the completely arbitrary decision by OSD to limit F-14 procurement to about half that which had been justified previously on cost effectiveness grounds to both OSD and the Congress. With the acceptance of the OSD decision, every effort was expended in finding reasonable alternatives while hoping that eventually logic would prevail to reverse the decision before production of the preferred models ceased. The situation is bad and appears to be worsening as OSD assumes more and more of the authority in the weapons system acquisition process.

With that background out of the way, let me give you my evaluation of the F-18 program, using data presented by the Navy in previous hearings, or published in trade journals, as my source of technical and cost information. I will try to simplify the situation to the essential ingredients of whether the F-18 is worth buying as either a fighter or as an attack aircraft on the grounds of cost and effectiveness. Starting with the fighter case, we find by interpolating the Navy program cost and delivery data given in the Senate Appropriations Committee Lightweight Fighter Hearings, that the first 400 aircraft will be delivered between the years 1981 and 1986 at a total program acquisition price of $5.3B in constant FY '75 dollars. This means an average price of over $13M, certainly more than the average cost of an additional 400 F-14s. If one were to extrapolate from the FY '75 price of an F-14, using the same quantity/price relationship used for the F-18, the average cost of 400 additional F-14s would be under $11M. Since no one has disputed the fact that the F-14 has a great advantage in capability, a normal evaluation would end at this point with the showing of greater effectiveness at a lower acquisition cost for the F-14. However, operating costs have been introduced as a factor with Navy figures giving an advantage of $.5M per year per operating aircraft. If one assumed 18 squadrons of 12 airplanes each, operating cost savings would presumably be 18 x 12 x $.5M or $108M per year, thus allowing the acquisition deficit to be offset after about 8 years of operations. In simple terms then, we start delivering the new fighters in six years, finish in eleven and break even in total cost about the end of the next decade.

Although there has been little public discussion of absolute effectiveness levels of our various fighters, some understanding of relative values can be gleaned from justifications used by the services in starting new programs and then continuing them. As is well known, the capability of a fighter in today's world is primarily a function of its weapons system and its missiles rather than pure airplane performance and maneuverability, although these, of course, cannot be completely ignored. Two years ago before this committee, the Navy testified that the F-14 with its multi-shot system and Phoenix missiles was equivalent to at least three F-4 aircraft with its single shot system

carrying Sparrow missiles against a moderate performance bomber raid. You have also received testimony that against some of the more difficult targets that the F-14 and Phoenix combination is infinitely better than the F-4 with Sparrow since the latter has no chance of killing that type of threat. To understand the importance of the weapon system and missiles to an aircraft, you should also know that operational analysts rate an F-14 with Phoenix as twice as good as an F-14 with Sparrow against most targets in most threat situations. Two years ago, you heard from the Navy that a two man crew was necessary in its all weather fighters in order to maximize cost effectiveness. At that time, OSD expressed its concurrence on the issue of crew size. You also know more radar range gives greater effectiveness. With the above background, it is clear that the ranking of Navy fighters in overall combat effectiveness would be the F-14/Phoenix first by a wide margin, the F-14/Sparrow next, followed by the F-4 and then the F-18. The latter suffers from its one man crew, less powerful radar, and fewer missiles, which combine to offset its predicted better reliability and maintainability characteristics. Overall, the F-18 type of fighter would fail a normal cost effectiveness justification over the F-4, a design initiated about 20 years ago.

In judging the capability of the F-18 relative to foreign threats, one should bear in mind the timing of the program. The six years before production corresponds to the time spent in developing, producing, and deploying the F-14. It is obvious that any enemy has the time to produce a counter threat. The enemy's task is enormously simplified if he has to counter only designs such as the F-18. If he chooses, he can easily design a better dog fighter since he has lesser constraints, and can defeat the F-18 in the only area in which anyone now claims a superiority over the F-14. To win in an air-to-air war, we must invest in better weapons systems and missiles if we are to have a chance of winning.

Summing up the fighter case, the F-18 has no more capability than an F-4 and costs more; while it has far less capability than an F-14 which costs no more, and is available years earlier. There is no way in which the F-18 can be justified as a Navy fighter.

Having shown that buying the first 400 F-18s as fighters makes no sense, let us now consider the second 400 aircraft which have been proposed as A-7 replacements. Costs in this case favor the A-7 both in quoted acquisition prices and in operating costs. Again using the Navy data for the total F-18 program, we find the unit procurement price for the F-18 attack models to be a little over $6M while the A-7 equivalent price has been quoted at less than $4.5M. Comparable operating prices were quoted by the Navy as $.9M for the F-18 and $.75M for the A-7. Overall, one sees that the F-18 is about half again as expensive as the A-7, so to be justifiable it should have at least that degree of superiority. It has been stated that the F-18 using three drop tanks has a slightly lower operating radius than the A-7 using two tanks, that the weapon systems are closely comparable, but that the F-18's higher combat speed reduces its vulnerability, making it a better overall attack airplane. Unfortunately, the difference in payload/radius characteristics of the two models is greater than implied by such testimony, particularly if the pilot actually uses his maximum power to achieve the claimed advantage in combat

performance. Approximations of the differences in operating radii with the same bomb load and with the same external tanks show that the A-7 outranges the F-18 by about 150 miles when the pilot of the latter does not use his potential speed advantage and by about 250 miles when he does. The F-18 does not approach the 600 mile radius on internal fuel with six 250 lb. bombs, which was one of the requirements in the original A-7 competition in 1963, nor does it match the 750 mile strike radius with external fuel estimated for the F-4 early in its development. To the uninitiated, the attack radius quoted for the F-18 sounds not unreasonable, until one realizes that maximum external fuel is used on the least demanding of the many attack radius problems which exist. Its true range characteristics can better be gauged by noting that it is inferior on internal fuel and without combat power usage to what was initially estimated for the A-4 in 1952. It will be recalled that the A-7 was justified in part by the fact that its capability was twice that of the A-4. Although there are other deficiencies in the design as it has been reported, its range performance alone is sufficient to disqualify it for serious consideration as an A-7 replacement. With a 50% higher price and a 50% lower capability than the A-7, the F-18 cannot be justified as an attack airplane.

In previous hearings, the potential use of the F-18 as a reconnaissance type has also been claimed. Its range deficiency would appear to rule out its use in this role, which normally requires greater range than for the fighter and attack models for which it is doing the reconnaissance.

Somewhat as an aside, I might state that it is probable that the logic used for the F-14/F-18 choice would carry over to the F-15/F-16 issue, although with no cutback yet required of planned F-15 procurement to accommodate the F-16, the problem is less critical to the Air Force. In the Senate Appropriations Hearings, the Air Force showed equal cost forces to be 650 F-16s or 520 F-15s. If the F-15 is worth buying at all, its capabilities must easily offset the small numerical advantage noted.

Summarizing, it is clear that the F-18 is neither effective, nor cost effective, in either fighter or attack roles. It is vastly inferior in capability to the F-14 at about the same total cost, somewhat less capable and considerably more expensive than the F-4 and is inadequate in range and more costly than the A-7. There is no justification for continuing the program.

Funds now planned for the F-18 should be redirected to first increase and then hold F-14 production at a reasonably efficient level. Study work and component development should also be started on an adequate replacement for the A-7 when that becomes necessary. The Navy's goal of reducing carrier types is achievable with a mix of F-14s and A-7s far easier, at less cost, and with a greater level of capability than with a mix of F-14s and F-18s.

There has been much talk by OSD of solving the problem of our numerical inferiority to the threat by the lightweight fighter program and the high-low mix concept, but the

figures to date belie the rhetoric. It seems clear to me that OSD should reexamine its policies and adopt only those which give us some chance of winning.

Exhibit VF-13. A retyped Memorandum for the Record

DEPARTMENT OF THE NAVY

NAVAL AIR SYSTEMS COMMAND
WASHINGTON. D.C. 20361

AIR-C :GS

21 October 1974

MEMORANDUM FOR THE RECORD

Subject: The VFAX/ACF Program - A Review

1. Under pressure from OSD and the Congress, the Navy is now engaged with the Air Force in an attempt to achieve as near common an airplane as possible to satisfy the requirements for an Air Force "Air Combat Fighter" (ACF), and a Navy fighter attack type (VFAX) in addition to making it attractive in the European fighter market. By direction, the design must be derived from the presently flying Air Force technology prototypes, the General Dynamics YF-16, and the Northrop YF-17. The situation is reminiscent of 1961 when OSD directed the services to develop a single set of requirements for a new design rather than proceeding with separate Air Force and Navy fighters. At that time the OSD decision makers failed to heed service positions first on the impracticability of combining the requirements, and later of meeting them with a common design. Thus far, our current OSD decision makers seem intent on repeating the mistakes of the past, with apparently less resistance from the services than during the TFX preliminaries. It will be recalled that in that case the Navy turned out to be the major loser with its requirement for an advanced fighter deferred until the F-111B could be proved to be as unsatisfactory as the Navy had predicted. The deferral of meeting the total fighter requirement is now being extended while our inadequate resources are expended on another losing venture in "commonality". It is unfortunate that those in OSD fail to recognize that the Navy is fully as conscious of the financial problems in defense procurement as they are, and that many of the OSD "solutions" being suggested have been considered and found wanting.

2. Those engineers now involved in negotiating details with the Air Force recognize that we have been here before and have asked for suggestions on how to avoid entrapment. Advice to the working level, however, is of little help since constraints already established preclude any chance of the problem being solved by their actions. Honest efforts to achieve the best Navy design in negotiations with the Air Force actually are probably harmful to the real needs of the Navy. Gradualism is now obvious in the process, as a fighter capability considered

totally inadequate a few years ago is now the best that can be achieved under present guidelines. Based on the TFX experience, it will probably cost less in the long run if the Navy permits the common airplane to remain as incapable as the current YF-16/YF-17 in order to strengthen the case later against the design as a production item. Navy efforts to improve the F-111B certainly lengthened its life span despite scepticism to the contrary. In this case, if we achieve the full VFAX requirements in negotiation, we still lose the fighter game with a capability actually rated less than that of an F-4 by our operational analysts.

3. The "common" fighter which has been directed impacts on the capabilities of the European nations, the Air Force, and the Navy quite differently. For example:
   a. The European nations have no problem. They are in the market to replace F-104s, and have several designs from which to choose all with more capability than the F-104. With competition between at least Sweden, France, and the U. S., it is probable that they will find a cost effective solution.
   b. The Air Force situation is quite unique. At present, the ACF is being offered to them by OSD as an addition to their programmed force structure. Since it replaces nothing, it can only increase total Air Force capability. The F-15 is still programmed to replace those F-4s not already replaced by F-111s. It is clear that, at the moment, the Air Force has nothing to lose in this program..
   c. The Navy, as so often is the case, is in a position where they cannot win. Their planned force of F-14s has been halved by OSD action leaving half of the current F-4 squadrons to be replaced by a lesser design, either the newly defined VFAX or an even less capable compromise with the Air Force's ACF. Since VFAX as a fighter is less capable than the F-4, it is clear that the Navy is bound to lose fighter capability to a level well below the declared need.

4. For the sake of perspective it may be worthwhile to review how the two services reached their current position in the development game.
   a. The USAF had their TFX program underway when the McNamara regime arrived. The F-111A survived the 1961 common fighter effort only slightly degraded and is regarded as a success by the Air Force as a long range interdiction strike aircraft. (The Navy would have labeled it an attack airplane.) In 1961-1962, the F-111 was to be the F-4 replacement. After the Navy defined its VFX (which became the F-14) in the 1966-1967 era, the Air Force started a definition effort for a FX. After considering all types from very simple designs to very high speed/high altitude interceptors, their choice became the F-15, a design with less weapon system capability than the F-14, but with more than that of their F-4E. In a political sense the choice was sound, the high capability approach had been preempted by the F-14, and so the moderate size, lower cost, single seat design had attraction. The simplistic, very light weight designs, were rejected since

they could not be justified as an F-4 replacement. In 1970-1971, when the "Prototype" philosophy was pushed by OSD, the Air Force responded with their usual alacrity and offered several programs, OSD selected a light weight fighter project which eventually became the YF-16/YF-17 advanced technology prototypes. The Air Force was careful to stress the lack of a production intent since that could impact their F-15 program. The latter has continued as programmed to be an F-4 replacement. To further the OSD desire for a high/low mix concept, they offered the ACF to the USAF as the low end of a mix, but without reducing the high end F-15 program. If OSD considers the ACF to be an F-4 replacement, it brings to three the number of programs which the Air Force will use to replace their F-4 inventory. During the period in question, the OSD and the Air Force also funded the " International Fighter" development, the F-5E/F at Northrop, which was designed for sale in the lower end of the international market

b. At the start of the McNamara regime, the Navy Eagle-Missileer program was canceled in order that a common fighter for the Navy and Air Force could be pursued. The Air Force was given the management job and eventually the F-111 program was started attempting to meet widely divergent requirements. Although initially considered as a complete F-4 replacement, the F-111B gradually lost capability until it was useful only for CAP missions leading the Navy to search for a complementary fighter since OSD was adamant that the F-111B should continue. When no cost effective solution was found to procuring a single squadron of complementary fighters, a combination fighter/attack design, designated as VFAX, was studied and found promising. The F-111E/VFAX approach was dropped when it became apparent that, first, the F-111B could not be made satisfactory for carrier use even for only the CAP mission, and second, studies showed two squadrons/carrier of "VFX" to be more effective and less expensive than the other alternatives. Although this conclusion has been sustained by all the operational analyses conducted since that time, the F-14 program has been cut back by OSD to provide but one squadron/carrier. A lower cost complementary fighter has been directed. When no satisfactory secondary fighter could be found which cost less than buying more F-14s, the VFAX concept was resurrected and requirements written around a single design which could replace both the F-4 and A-7. By increasing the numbers of aircraft, it was hoped that replacement costs could be held to a level acceptable to OSD. Under the current plan, the Navy will thus require two models to replace its F-4 inventory.

5. The rebirth of VFAX was accomplished with no real analysis as to the merit of the idea under current conditions. Fighter Study No. 4 discussed the advantages of a reduced number of types aboard a carrier, but really showed no reduction except under the rather artificial constraint which assumes a single F-14 squadron. A mix of F-14 and VFAX obviously involves fewer models than either F-14 plus F-4 plus

A-7 or F-14 plus "VFX" plus A-7. Intuitively, however, it appears that two squadrons each of F-14s and A-7s will have more capability and cost less than one squadron of F-14s plus three VFAXs. Hence, the total exercise may well be ill-advised on purely cost grounds even assuming that VFAX as now defined is really satisfactory as either an F-4 or A-7 replacement, a question which deserves more investigation.

6. As a fighter, Navy operational analysts would give the current F-4J+ an advantage over the VFAX by virtue of its longer radar detection range and its two-man crew. Although in a one on one close in engagement, VFAX would be considered superior, that advantage is more than offset by the other factors. In range, VFAX is better than the F-4 is now, but worse than the F-4 was when it was proposed. With a design 400-450 nautical mile internal fuel radius, the design will be shorter legged than any carrier airplane started in the last 20 years. Note that the F8U-1 internal fuel radius was 500 n. miles when it started in 1953 carrying either 4-20 mm guns or 60-2 inch rockets, and while using a severe combat fuel allowance of 10 minutes mil. thrust plus 5 min. max.. A/B thrust. As an escort for the A-7/A-6, VFAX would require external tanks to about the same degree (always) as the F-4.

7. As an attack airplane, the VFAX appears significantly less capable than the A-7, especially if one assumes that the VFAX uses its afterburner. In previous studies of afterburning equipped attack types, use of the afterburner in combat was a standard requirement. It seems quite unrealistic to assume otherwise, particularly when the only significant performance advantage over the A-6/A-7 lies in the speed and acceleration at maximum thrust. It may be recalled that after the HIPASS study program, an afterburning engined version of the A-7 was studied in detail, but its increased weight and cost made it unattractive at least until the higher combat performance is shown to be necessary. Even without afterburner usage, the VFAX appears well below the A-7 in radius capability.

8. Overall, my opinions may be summarized as:
   a. VFAX as now defined is not a suitable replacement for either the F-4 or the A-7. If it is pursued, naval aviation must be prepared to cut back its operational strike range to something little better than that represented by the F-4/A-4 combination.
   b. The combination of one F-14 squadron plus three VFAX squadrons will prove to be more costly and less effective than two F-14 squadrons plus two A-7 squadrons.
   c. The ACF will prove to be more costly and less effective for the Air Force than an equal number of additional F-15s.
   d. The common airplane exercise with the Air Force will prove as useless as were the TFX and Tri-Service Transport efforts.

9. A major effort is obviously required to stop the current misdirected efforts in the Navy and in industry. We have available for the buying the world's most capable fighter, and should be able to convince even the OSD staff that a mixed force will cost more and do less. In the attack field we should start a program to at least match A-7E weapon system/payload/range capability in a twin engine two-seat model with other improvements as determined by the attack community to allow survival in the future. Two seat, two engine will be the principal justification.

G. A. SPANGENBERG

Exhibit VF-14. Retyped Statement on NACF and Lightweight Fighters

Statement of G.A. Spangenberg to Sub-Committee
of HASC on 9 April 1975

Mr. Chairman and Members:

I'm glad to be here and hope that I may be of some help to you in your deliberations.

My position is somewhat strange at the moment. I am consulting still for the Naval Air Systems Command and have had access to many of the Navy estimates on the programs which you have under consideration. However, I am speaking today only as a private citizen, and will offer no quantitative figures on either the new or on-going programs, as such figures should come from the Navy. Although my conclusions will be drawn in relative terms, I'm quite sure that you will be able to substantiate them when you get the absolute figures.

Statement of G. A. Spangenberg to Sub-Committee of HASC on 9 April 1975

1. I have been asked to give you my thoughts on the Navy Air Combat Fighter (NACF), lightweight fighters in general, and on the related other tactical aircraft programs.

2. After a career of involvement with naval aircraft design and procurement, I am naturally biased in support of naval aviation. The success record of the designs originated by the Navy has been high, most have been proved in combat, and many have been by other services and other countries. The lessons we learned in the development of the successful aircraft, and from the occasional failures we encountered, were applied conscientiously to the next generation of designs. Each new type was justified as offering a major improvement at a reasonable cost over an existing model prior to initiating its development, as well as being necessary to counter projected threats. It seems obvious that within the DOD we have some individuals who are either uninformed as to this history, or are determined to ignore it by sponsoring projects which fail to meet the requirement for greater effectiveness at a reasonable cost. In this regard, I find that I cannot support the NACF as it is now defined since I believe a greater capability at a lower cost is already available to us.

3. Since the current situation is somewhat unusual, a brief review of the steps which preceded it are in order:

    a. In 1971, the Deputy Secretary of Defense, Mr. Packard, directed the Navy to investigate the possibility of achieving a lower cost alternative, such as the F-15, to meeting its requirements. This action was taken during the period in which Grumman, the F-14A contractor, was having major financial problems in meeting his contractual commitments. A brief study, in collaboration with the Air Force, revealed that a version of the F-15 modified to meet the Navy's requirements would be even more expensive from that point on.

    b. In 1973, Mr. Packard's successor, Mr. Clements directed the Navy to seek a lower cost fighter to complement the F-14A, procurement of which was being restricted to half that initially planned. When the Navy again found no attractive alternative toward buying the full quantity of F-14As, a plan to prototype a number of designs was directed. This plan failed of congressional support when it was shown that the cost of prototyping and building a mixed force would again cost more than the full F-14 force.

    c. In 1974, the concept of a "VFAX" was resurrected in which a versatile new fighter attack design would complement the F-14 and also replace the two

squadrons of light attack A-7 aircraft normally carried on each carrier. Conceptually, this plan had much more merit than did the earlier proposals since the procurement based was broadened, the performance level of the attack force was increased, and some operational flexibility to offset the loss in individual fighter capability by increased quantities was realized. A similar concept existed in the mid '60s when one squadron of F-111Bs on each carrier was being dictated by OSD. At that time, "VFAX" was an F-4 sized airplane utilizing variable sweep wings to achieve a combination of "better than F-4 as a fighter and better than A-7 as an attack airplane." That VFAX was shelved when the Navy was finally able to prove that two squadrons of a new fighter (which became the F-14) and two squadrons of A-7s provided more effectiveness at a lower total cost. Congress agreed and stopped funding the F-111B.

d. The possibility of achieving a VFAX design with sufficient capability to warrant procurement was then eliminated when direction was received from the Congress that only a Navy version of the Air Force's Air Combat Fighter (ACF) could be considered. That design with far less capability than an F-4J in the Navy fighter role, and with far less capability than the A-7E in the Navy attack mission, could not conceivably serve as an adequate replacement for either. Despite the technically obvious, the contractors involve and the Navy have all expended a great deal of effort endeavoring to comply with the requirements levied upon them.

4. With the review above in mind, it is probably that the NACF will be reported to be a feasible design capable of meeting some naval mission requirements. It may, or may not be reported, that the designs, while superficially similar to the ACF, probably represent a far greater divergence from the original YF-16 and YF-17 than any previous growth modification of a basic design. The variances are far greater than those between Air Force and Navy versions of the F-111 or those proposed for the F-15. Both development and production costs will approximate those of a new design.

5. If the NACF were to be procured only as a fighter to complement the F-14, the conclusions reached previously would apply showing a great loss n effectiveness as compared to two squadrons of F-14s and with an increase in funds required from this point on. If the NACF were to be purchased in quantities sufficient to serve as a fighter complement and as an A-7 replacement, both fighter and attack capabilities would be reduced relative to a basic mix of two squadrons each of F-14s and A-7s, while again increasing the funds required from this point forward. Justification for the design appears impossible using criteria formerly regarded as logical.

6. Turning now to other issues which have been raised in the last few years and on which my thoughts may be of interest:

a. The high-low mix concept being strongly pushed by OSD as a means of reducing defense expenditures should be examined critically. With procurements as limited in total quantities as we are now considering, it is probably that any aircraft buy splitting the procurement between high and low capability types will prove more costly than buying only the higher capability designs. A generalized study of the problem was shown in an article in "Astronautics and Aeronautics" (September, 1974), while all the specific studies done in connection with F-14 alternatives support this conclusion.

b. Another argument presented by the high low mix advocates seems to say that we should have high capability types only to deal with high threats, and low capability types to handles lesser threats. Although this argument would probably not be pursued if the costs of the mix were unfavorable, it is still disturbing that anyone should advocate approaching a combat engagement with forces designed more for equality than for absolute superiority. It is a form of gradualism that always leads to failure.

c. There are periodic attempts to force the Navy to use Air Force designs in order to save development funds, and there have even been suggestions that total force levels could be reduced if the Air Force were to operate at times from naval carriers. Those who advocate such ideas are obviously not aware that the catapulting and arresting requirements associated with carrier operation dictate major redesign of any aircraft optimized for land based use. This absolutely precludes use of Air Force designs from carrier operation. If a common aircraft is required, one must start with a design to Navy requirements. This is a one way street.

d. We also face an advocacy of lightweight fighters equipped with short range weapons and optimized for the close in engagement. These advocates fail to recognize that the high incidence of such combat in Viet Nam was a direct result of our self imposed rules of visual identification and that in fact we are bound to lose in such a combat against an adversary with an equal state of the art design. Invariably, he has a lesser range requirement, and hence should always have an advantage. We are forced to longer range weapons if we are to prevail.

7. In summary, I believe that the concept of the NACF is unsound and should not be supported. We should use the funds to increase our procurement of F-14s and to continue A-7 production. In the development area, we should have a higher capability air-to-air missile system started to replace, eventually, the Phoenix already more than 10 years old. New engine developments should have been started several years ago to enable a suitable A-7 replacement to be designed and to allow exploitation of V/STOL capabilities. Our funds are much too scarce

to squander them on any program which fails to meet reasonable cost effectiveness goals.

Exhibit VF-15. Retyped

NFS IV
G.A. Spangenberg
16 Sep 1973

MEMORANDUM FOR THE RECORD

The Fighter Study Dilemmas

The Navy Fighter Study is facing a series of dilemmas as it attempts to comply with mutually incompatible directives, desires, and instructions. It is becoming increasingly clear that a full scale effort is required to present the real facts to higher authority in a manner which will permit resolution of the issues.

Mr. Clements, in his testimony to Congress, made reference to two issues, a general one concerning what total aircraft program was needed to replace the F-4 in view of the **increased** capability of our adversaries, and a second one as to how many F-14A airplanes with Phoenix capability were required. Mr. Clements stated that his decision to seek less costly alternatives after a buy of F-14As for the FAD mission, was based on a study conducted by Dr. Flax in addition to his own review of the situation. Dr. Flax included a similar thought to the effect that even if 313 F-14As were purchased the problem of replacing the rest of the F-4 inventory remained. Dr. Flax concluded with a statement that we need an airplane **considerably more capable** than the F-4J and considerably cheaper than the F-14A. A qualification was added to the effect that unless we could afford all F-14As, the Navy should be encouraged to initiate actions leading to a competitive program.

Note particularly that both Mr. Clements and Dr. Flax stated categorically that the replacement aircraft needs more capability that the F-4. This of course, is the very problem which the Navy has been attempting to solve since the late '50s when Eagle/Missileer was started. That project was superseded by an OSD decision to pursue the TFX, a project doomed to failure from its inception. Before its final demise, the F-111B had been relegated only to the Fleet Air Defense (FAD) role while plans were started for a lower cost, supplementary fighter, then called VFAX, to handle some of the fighter roles and also to serve in the attack role. Briefly, it was planned to be more capable than the F-4 as a fighter and as capable in bomb delivery as an A-7. This approach was a viable one as long as political considerations forced the F-111B on the Navy. Eventually, the characteristics of VFAX and the F-111B were combined into VFX, a project which promised more FAD capability than the F-111B, equal airplane performance with VFAX and for less cost than continuing the F-111B. It is obvious now that almost the same game is being replayed, but with new players on each team and with the roles reversed. Technically, the VFX (F-14) is a success, and has met the original goals of being better than the F-111/F-4, while retaining an A-7 attack capability.

Cost increases, generated by reduced procurements and inflation, however, have combined to create a cost problem in the minds of OSD and the Congress. Internally, the Navy has been convinced that the only logical answer is to buy the F-14A in accordance with the original concept, while the OSD is pushing for other, undefined alternatives, despite the fact that no study has yet shown a more cost effective solution that the F-14A.

Since there is little possibility of a different solution than the F-14A for the "better than the F-4" as a replacement, the advocates of change have now introduced other concepts. The most disturbing is that only a non-Soviet threat should be considered. This, of course, changes the game completely. If one assumes a low enough threat level, obviously we do not need F-4s, much less F-14s. If carried to the limit, we could eliminate all the active services, and all development activities. For fighting non-Soviet threats, perhaps we could buy Soviet equipment, or even better, convince the Soviets to fight the non-Soviets for us. Logic would appear to dictate that we must be prepared to handle the worst threat that can be mounted, or be prepared to surrender our position. It is doubtful that carriers could be justified if usable only against minor threats because of lack of quality. Quantity considerations, of course, are a different matter.

The high-low mix concept of fighters is believed to have originated in OSD after a study showed that the free world would be outnumbered in fighters in all probable areas of conflict. The "solution" then was to buy some cheaper airplanes to mix with first line equipment in order to provide more nearly equal numbers within an assumed budget. This led to the USAF's prototype competition from which the XF-16 and XF-17 emerged. If any real analysis on the merits of the concept was done, it has not been publicized. There is no evidence that the mix would enable even numerical equality, or that the quality of the total force would be greater than investing the same money in the most capable fighters available.

During WW II, the Navy had two levels of fighters, the F6F/F4U series on the major carriers, and the F4F/FM series on the escort carriers. Each fighter, however, was the best that could be designed to operate on the particular carrier class. Obviously, the merit of the high-low concept was recognized within the Navy, as we specialized in carriers. Unfortunately, as the total number of carriers was reduced, it became impracticable to continue the specialization and the CVS and CVA classes have merged again into the CV, so we are back where it all started.

An understanding of the advantages of the mix concept, has also been demonstrated by optimizing the complement from a cost standpoint. The relatively high cost fighters are mixed with lower performance level attack aircraft. The latter, in the Navy, are still subsonic designs, primarily because of the cost problem. A-7 and A-6 airplanes are much cheaper than the F-105, F-4, and F-111 designs used by the Air Force for similar missions.

The number of different airplanes being procured is constantly under attack in the Congress. Minimizing the number of models on a carrier has long been a Navy goal. The complementary fighter concept runs counter to these desires. Minimizing of carrier types, intuitively, will be better achieved by proceeding from the current F-4/A-6/A-7/RA-5C/E-2 complement to an F-14/A-7/E-2 group. The addition of a fighter type needlessly complicates the problem, while another suggested alternative of making the second fighter an A-7 replacement is undoubtedly too costly.

As noted previously, the probabilities are great that the USA will be outnumbered in most engagements in the future. While light weight fighters may have a lower unit production cost, it is quite unrealistic to assume that funds will permit achieving numerical equality. Our only real hope is to maintain a qualitative superiority. This is technically impossible in a pure airframe sense, under assumptions of equal technical ability, since we will always have a greater range requirement, leading to greater weight and reduced performance. Our approach has been the only one available to us, viz., better weapons to outrange the opponent, and a multi-shot system to offset the numerical disadvantage. Training, tactics, and personnel quality considerations are obviously also involved, but these should provide the edge of superiority after equalizing the weapons as nearly as we can.

A final point on the quality issue is that even infinite numbers of some fighters have no possibility of successfully engaging some threats. Most of the "light weight" fighters with their weapons are incapable of bothering currently flying supersonic transports, much less the missiles which could be launched from such platforms. Certainly something better than the F-4 is required.

An issue to be faced in any new development will be the difference in scheduling required to meet the desired '78 budgets, to minimize costs and that *scheduling* (*Ed. My thought on a missing word*) currently required under outstanding test and evaluation directives. If "alternatives" are to be really available to a decision maker, he must have all of his development completed since production lead time alone consumes the time from the budget fiscal year to the next calendar year when deliveries start. Expensive luxuries like "prototypes," "fly-before-buy," and "operational test before production commitments" must be ignored. This is not a problem to the Navy which has successfully practiced concurrent development programs for many years, but it is a problem to certain of the OSD components.

A firm position should be taken by the Navy against compromises at this time which cost money, our most important problem, reduce our capability, already too low, and which will eventually destroy carrier aviation.

Exhibit VF-16. Retyped and note added

Note - This memo delivered to Air 5061 for typing and distribution on 7/16/75. Illness and then vacation delayed a follow up until 8/19 when I learned draft of memo had been given to Adm. Foxgrover, who held it until I picked it up from him on 8/21. He said Adm. Lee had seen it. My lack of support for the Navy Position was criticized, especially since I am a NAVAIR consultant. I offered to quit. — Copy of Draft to Air-05 and Air-501 on 8/21. — Strange game

GS 9/2/75

Drafted 7/16/75

MEMORANDUM FOR THE RECORD

SUBJ: F-18 High Cost/Low Capability

Encl:
(A) Unit Procurement Prices
(B) Cumulative Prices
(C) Program Price - F-18 Total vs. F-14 Add On

1. Until quite recently, the NACF program appeared to have minimal support within the Navy except as the best solution to a problem initiated by the OSD and adopted by the Congress, viz., that only half the required number of F-14s would be authorized because of a belief that their cost was excessive. Working under this constraint, a lightweight complementary fighter was examined (1973) but found to be more costly than simply buying more F-14s. A theoretical solution of a "VFAX", also convertible to a VTOL, was proposed by Fighter Study IV, albeit without technical justification, and included as a budget item after support by the Navy and OSD in the 1974 hearings. A congressional mandate of "commonality" with the selected Air Force ACF was then imposed by the Congress, reducing any real hope that there could be a rational solution. After one of the more formal and protracted source selections run by NAVAIR, the MCAIR version of the Northrop F-17 was picked as the winner, designated the F-18, and congressional authorization sought. Opposition to the program has now surfaced in OMB and in parts of the Congress, while LTV filed the first formal protest on a Navy source selection in modern history. The opposition from without apparently has tended to consolidate internal Navy support so that Navy spokesmen are now in favor of the program not only as the best choice under the OSD direction as to what makes a satisfactory carrier complement, but actually as a preferred solution. Within the last week, the CNO has endorsed the program to the major

congressional committees without qualification. The situation parallels and is even less understandable than was the endorsement of the F-111B by Admiral MacDonald after he replaced Admiral Anderson as CNO in the early '60s.

2. From my knowledge of the evaluation results, there is no question as to the fact that the F-18 was a clear winner of the competition and that the LTV protest is without merit. At the same time, the Navy should not defend the method used in this case to select a contractor for a major program. Restricting the competition to the Air Force technology prototype contractors was contrary to the Navy's practice of allowing all qualified bidders to bid on a new program, and is contrary to my understanding of the ASPR. In the Senate hearings before the Government Operations Committee (Senator Chiles), no Navy condemnation of the total procedure was apparent, despite the fact that the subcommittee claimed to be interested primarily in the method of obtaining competition. Those protesting should really be Boeing, Lockheed, Grumman, and Rockwell who were excluded from bidding on either the ACF or NACF.

3. Supporters of the F-18 program have attempted to justify it on the basis of some combination of the following:
   a. Lower investment costs
   b. Lower operating costs
   c. Higher reliability, maintainability, and availability
   d. Better "fighter" performance
   e. Better "attack" performance
   f. Less vulnerable in combat area as VA
   g. Reduction of types on a carrier
   h. Adequately meets the stated "requirement"

   In fact, of course, the program cannot be justified using the measures used successfully in the past to select new combat types. Any cost advantage for the design as a fighter is grossly overshadowed by its very low overall effectiveness relative to the F-14, while any advantage in combat performance as a VA is grossly overshadowed by its higher cost and inadequate payload/radius capability relative to the A-7. The program offers no reduction in the number of types on a carrier when compared to an F-14/A-7 mix, but only to a never planned F-14/F-4/A-7 complement. Endorsement of the program as a free choice of the Navy in effect repudiates the efforts of those involved in naval aircraft development over the last 20 years, and is the first intentional major step backward in capability taken by naval aviation.

4. Recently, OMB presented an analysis of alternative programs which showed a mix of F-14s and A-7s to be cheaper than a mix of F-14s and F-18s. A Navy check of OMB data showed somewhat less of an advantage, but still indicated that any monetary savings could accrue only in operating costs and then not for many years. Based on the Navy estimates, for example, it appears that we can

buy about 500 F-14s after the approved 390 aircraft program before procurement costs become equal. Under the schedule proposed, the break even point would be reached sometime during FY'85 deliveries, about 12 years from now. It is difficult to imagine that these programs would remain stable for this length of time making it hazardous to count on such long range projections. For assurance that the pricing was being done on a fairly comparable basis, the unit procurement prices for production aircraft are plotted on Enclosure (1). Note that the F-18 curve has an apparent anomaly in the FY'84 price (support caused), but generally is a smooth curve with about an 82% "learning" slope from 300 airplanes to 600. The F-14 figures are quite inconsistent. The unit prices for future buys in the basic 390 aircraft program are all higher than for the '75 budget. The production rate is very low, of course, but in any case, it is difficult to consider the figures optimistic relative to those used for the F-18. (The Iranian buy of 80 aircraft are not included in the F-14 price data). The Navy estimates for an "add on" case in which the F-14 is produced using about the same expenditures as the F-18 is also noted, and shown in comparison to a total program made up the Navy basic case plus the OMB "add on". This slope can be seen to approximate that used for the F-18, while the Navy "basic and add on" contains so many anomalies it is hard to compare directly, though obviously there is some 1-3 M more conservatism in the unit prices for the F-14.

5. Enclosure (2) shows a comparison of the total procurement prices for the F-14 and F-18 in a plot of total price vs. number of production aircraft. For the F-14, "real" dollars are used for the program through FY'75 followed by '75 dollars for the remainder, and for all of the F-18 programs. Strangely, this plot shows that the pricing used for the F-14 show that there is no significant reduction in total cost for 390 aircraft when the production rate is increased, though this result could be anticipated from the unit price data. Using this plot blindly allows F-18 proponents to claim a $4B saving for procuring 800 aircraft. The real comparison is shown on Enclosure (3), however, when the incremental costs of procuring F-14s beyond th current 390 is plotted versus the total F-18 program. Using the Navy estimates for the increased production F-14 program it is seen that about 500 more F-14s can be purchased for the same price as the F-18. If the more optimistic OMB "add on" figures are used, the equal price number increases to over 650. It is believed that these figures are probably on the conservative side for the F-14. The F-18 has many more opportunities to increase in a relative sense. The R&D funding profile is known to be inadequate, and the probability of changes to increase capability is very high.

6. The price of 300 F-18s after 500 fighters have been procured would average about 5.8M, while current estimates for the A-7 range from about 5M at low rates of production to less than 4M at higher rates. A unit cost penalty of about 50% will be carried by the F-18 relative to the A-7. Little data are now available on the relative payload/radius capabilities of the F-18/A-7, but those promising essentially equal capability are probably grossly overstating the case. If the F-18

uses its afterburner to gain its claimed performance advantage in the combat arena, its actual operational radius will be substantially inferior to the F-14, A-6 and A-7. Under such circumstances, it has little potential for reconnaissance use, one of the many uses being proposed for it.

7. As the F-18 advocates attempt to reduce costs by eliminating attack capability from fighter versions, and fighter capability from attack versions, the overall carrier complement capability drops even more. One advantage of a "VFAX" was the capability to field either 3 squadrons of VF or 3 of VA. When specialized versions are produced, we lose that possibility and then have only the VF contribution of the single complementary squadron. Operational analysts for at least 10 years have rated single seat F-18 type aircraft inferior, overall, to the two seat F-4J. The same analysts would also probably rate F-18s inferior to A-7s because of the reduced payload/radius capability. Justification for the program seems to rest entirely on feelings that our currently deployed aircraft are so complex and so unreliable that they will not be usable in wartime. This conclusion is hardly credible to those who remember the days when the F-4, A-6, and A-7 were all considered "too complex".

8. The F-18 is much too little, much too late, and costs far too much to be considered as a part of naval aviation for the next two decades.

G.A. Spangenberg

Copy to:
AIR-506
AIR-501
AIR-503
AIR-05
AIR-00
PMA-265
OP-05
OP-05A

Exhibit VF-17. A retyped Memo to William Clements, then DepSecDef

G. A. SPANGENBERG
1531 DAHLIA COURT
MCLEAN, VA. 22101

22 October 1975

From: G. A. Spangenberg

To: William P. Clements

Subject: Dissents - F-18 and General

1. On 21 October 1975, each of us appeared before, and made a statement to, the Senate Appropriations Committee on the subject of the F-18 program. Included in my statement were references to the impracticability of dissent to OSD established programs from within a service ever surfacing through the staff layers to either your level in DOD, or to the Congress. I'm reasonably sure you felt I was wrong in both the implied, and explicit, criticisms which I made from your remarks to the committee and in particular to the statement that "George was never stifled". You should know that I, and many of us at the working level, have long been frustrated by our obvious inability to get adequate and accurate facts and recommendations to the decision maker before he committed us to programs of dubious, or worse, merit. You should know also that I, personally, have been "stifled" on numerous occasions, and I certainly am not alone in this category.

2. Overall, it seems to me that whoever is preparing your statements on the F-18 issue, and advising you on the general administration of DOD is misleading you as badly as were the staffs of Mr. McNamara on the TFX and Mr. Packard on the HLH program. First I would like to review for you a few cases involving the issues of dissents and/or faulty information:

    a. In the hearing on 19 June 1973 before the Cannon Sub-Committee, when asked about the origin of the prototype plan, for which you had taken credit, you replied, "I think, Mr. Chairman, that I can say in all modesty that they (the Navy staff) concurred unanimously in my recommendation". Prior to that statement the Navy had provided you, on 13 June, schedule, cost, and funding requirements for the prototype program, as you had directed on 7 June. Not included in that package were complete program cost estimates prepared within NavAir which showed that the prototype plan made no sense. These data, needed for an intelligent decision, were not forwarded to you, because they had not been specifically requested, and some officers within the Navy felt that you might consider them an

unwarranted expression of bias against the program. In that instance, I bypassed the "system" and wrote a memo directly to Mr. Warner, then SecNav, informing him of our frustrations, and the absurdity of the prototype plan with copies to those bypassed in my chain of command. Unfortunately, Mr. Warner was out of town, and my memo was withdrawn. On the morning of the 19 June hearing, however, Mr. Warner reviewed the total cost information, on the advice of the acting CNO, concurred in our recommendations, and proceeded to your office to advise you of the facts and the probable conflict which would develop if I were to be a witness as the committee had requested. Mr. Warner passed on your request to me that I not attend the hearing that day. A few days later I retired, and a few days after that I testified at a special hearing on the subject in accordance with an agreement between you and Senator Cannon. There was no reason whatsoever why you should not have had the benefit of all the data available on 13 June, which should certainly have dissuaded you from backing that particular program.

b. At the beginning of the TFX period, Mr. McNamara was grossly misled as to the merits and practicability of a joint fighter program by his OSD staff. He elected to believe that the services were wrong in their estimates, and that the DDR&E staff was correct. They led him to believe that a billion dollars could be saved in a joint Air Force/Navy fighter program. A few years later, the cost estimates on which he relied became available to me and were found to be grossly inconsistent. In this case, both correct data and incorrect data, were available to him, and he chose the wrong ones, presumably with staff advice.

c. With a committal to the TFX program made, the OSD position remained firm that the cost saving would remain despite a continuing technical degradation of the Navy version. Mr. McNamara then elected to believe program manager and contractor claims of forthcoming corrections rather than the"pessimistic" estimates made by Navy technical personnel. Dissent from that level was quashed by management levels in the Navy as well as by OSD staff while awaiting "hard evidence" that the F-111B was unsatisfactory. During part of that period, I was instructed to refrain from visits to the Pentagon for any purpose, and to refuse all requests for discussions with Congressional staffs.

d. In the case of the Army/Marine HLH programs, the issues were grossly misrepresented to Mr. Packard by DDR&E, who in turn presumably was misinformed by his staff. This led to misrepresentation to the Congress and years of delay in the CH-53E Program. A claimed half billion dollar saving in that case was the apparent motivation to combine into a joint program two designs whose gross weights initially differed by a factor of about two to one. A reclama to the joint program decision eventually

reached SecNav who then obtained promise of a review by Mr. Packard if a competition confirmed service estimates. The competition did, and a reversal of the joint program decision eventually resulted. Again, time has proved the claimed saving illusory.

e. At the present time, I have been informed that Navy files and data relating to the F-18 project should not be made available to me in view of my lack of support for the program. Prior to that directive, I had prepared a brief study, intended for internal Navy distribution, which summarized some of the more pertinent technical and cost issues involved. That memorandum was stopped at the first link in the chain of command, depriving others of information which might have proved useful.

f. One of the outgrowths of the well publicized DDR&E innovative prototyping concept was a Navy VTOL venture. Dr. Frosch, then ASN(R&D), took action on a program believing it was fully supported by the technical level in NavAir. A contract was signed before he became aware that technical level reservations had been suppressed. He later directed that in the future all major dissenting views be brought to his attention prior to decision time. He fully understood the hazards of decisions based on incomplete or erroneous data.

3. I believe the issue is a serious one and deserves your consideration. At the present time there seems to be an inadequate check on OSD actions for a balanced output. You serve as judge and jury on a services budget, with Congressional action fairly well limited to killing an item, but not to substituting another.

4. Back to the issues involved in the F-18 itself. Your statement contains a somewhat distorted version of the case. For example:

a. The basis for developing VFAX requirements was not any expressed need by the Navy for an A-7 replacement, but rather an attempt to find something useful after OSD cut back on the planned F-14 buy. As you know, the early OSD alternatives of a modified F-15 or a new lightweight fighter had both been found to offer too little for too much. A VFAX held promise of being a better alternative than either an F-15N or a VFX, but no analysis, to my knowledge, ever showed it to be a superior solution to all known alternatives. As a fighter, the F-18 is about equivalent in overall effectiveness to the 1974 VFX, which was reported in NavAir analyses to be slightly inferior to the F-15N, which in turn had been found to be slightly inferior to an F-4J+. These results are consistent with and performed by the same NavAir analysts who documented the need for Sparrow on the F-18. The same methodology produced results proving the marked superiority of the F-14/Phoenix in the escort role, as well as the significant

inferiority of a Sidewinder only equipped airplane. These general conclusions have not been challenged technically, as far as I know, and the F-14/Phoenix results have not been widely disseminated.

b. The attack capability of the F-18 has not been well defined in public, and to the best of my knowledge, there is no rigorous Navy analysis to support the claim that the F-18 is clearly superior to the A-7, anymore than there is one to prove it superior to the F-4 as a fighter. Under pressure to keep the design small, cheap, and simple, the range capability was actually specified as to be consistent with that of the fighter, which in turn was specified at a level which was believed achievable in a 30,000 lb. class airplane. While the design, as with any recent Navy fighter, has some attack capability, the design is woefully short legged, at least as initially defined. Increased agility does little good if the aircraft cannot reach the target. A cost reduction study on the A-7E a few years ago considered a suggestion for fuel reduction. The suggestion was overwhelmingly rejected by those operating the aircraft, confirming the requirement, in general, of the SeaBased Strike Study in the early '60s which helped establish the original A-7 requirements. In my opinion, the range deficiency is a fatal flaw in the entire scheme. I can't believe the Navy wants to cut back its operational strike ability to the A-4 level, or worse. In an attempt to meet the new high performance attack requirements of the so called HIPASS study a few years ago, afterburning versions of the A-7 were studied by NavAir. Eventually, while combat performance was markedly improved, the cost in range was deemed unacceptable. The geography of the world has not changed, and logic says we certainly should not cut back on our strike radius. Another issue, not yet raised although well understood in the attack community, is whether increased agility in fact solves the problem of vulnerability to ground defenses. Those who believe one can outrun or dodge a well designed missile are badly misinformed.

c. The conclusion as to the lack of space, manpower, and cost affordability of the F-14 is obviously one reached by OSD with no known substantiation. The Navy believed it affordable in 1969 when the contract was signed and the program justified to Congress. On a relative basis, the situation as to alternatives has not changed significantly.

d. Any conclusion that the F-18 will meet a future threat even in the air combat area cannot be supported. It is probable that the claimed characteristics for the F-16 are now superior to those of the F-18 in this regard, and surely these could be exceeded in a new design optimized for this role by our potential enemies.

e. The conclusion on page 5, that the unit cost of the F-14 under the "most optimistic assumptions" is $5M higher than the F-18, even for the 500

aircraft now discussed, is not at all consistent with the Navy estimates shown by Adm. Houser. He shows 500 F-18 aircraft, with no R&D, to cost about $4.3B, while 500 more F-14s cost about $5.6B. This means an average difference of only $2.6M. This creates a credibility gap of $1.2B.

f. Adm. Houser's total acquisition and operating cost differential between his option IA and II thru 1990 only totals about $2.5B including development of a new attack airplane, about half of what you claim without that cost.

5. As you might surmise, I also must disagree with virtually all of your conclusions on the program near the end of your statement. It seems to me that support is being given by those contractors who have something to gain, and by others who desire to reduce the capability of Naval aviation. While I agree that the rationalizations of the past fail to support the F-18, it is those same rationalizations which justified our current operating inventory. The Navy's track record should not be dismissed lightly; it is far better than for the OSD originated projects (TFX, HLH, COIN, TST). The charge of self interest against the opponents of the program is most disturbing. In my experience, I have found losing contractors in competitive situations to be disappointed but generally supportive of programs, providing the competition was fair, and the program enhancing of our defense posture. Protests and widespread opposition are sure signs of an ill-conceived program or an unfair acquisition process.

6. Perhaps it is too much to hope that a project which makes no sense can be quashed by the power of logic.

/s/
G. A. Spangenberg

cc: CNO
OP-05
AIR 00
Senator McClellan

No response from Clements: (or anyone else, for that matter—except that O5 asked if there had been a response from Clements)

Exhibit V-1. A retyped memo

26 January 1977

MEMORANDUM

From: G. A. Spangenberg
To: Radm. C. P. Ekas, Jr.

Subj: XFV-12A Review

Encl: (1) Folder: XFV-12A Program Initiation
(2) Chart: XFV-12A Recap - Performance Estimates

1. In a discussion on 19 January 1977, I agreed to put together, on an informal basis, some of the early history of the thrust augmented wing project and to review with some of the NavAir engineers the current outlook for the program producing a fleet aircraft.

2. For the record, it must be noted that in 1971 - 1972 I opposed the entire "Prototype (with a capital P)" program as sponsored by DDR&E, the Navy's implementation of that program in general, and the XFV-12A project in particular. There are few who will consider me unbiased on the subject.

3. Enclosure (1) has been assembled from correspondence available in AIR-506 files, and, while by no means complete, is intended to show that the program was initiated by means well outside those employed by NavAir in its highly successful normal development and procurement process. Most of the lessons of history were ignored by those who attempted what they believed to be innovative approaches to defense procurement, but which in fact had all been discarded in the evolution of the naval aircraft acquisition process. Another factor involved in the early years of the program, and one which has been a recurrent problem within my experience, is a belief that the engineers who produce NavAir estimates are congenitally overly conservative, while contractor technical estimates can be achieved if adequate management attention is applied. This belief, as you know, was a major factor in the TFX debacle.

4. The merit of a prototype development program can best be judged by the quality of the service product which follows. To the best of my knowledge, no naval aircraft development prior to the XFV-12A had ever been started unless the end product was predicted to be an effective weapon. However, in this case, the service configuration of the thrust augmented wing fighter was predicted by NavAir to have no capability, yet the prototype development was initiated presumably on the basis of the claims by the contractor. Contributing to the problem was the fact that the initial proposals, limited to 20 pages, contained

inadequate information for a normal evaluation, and time constraints were imposed which prevented one, even if the data had been available. Also involved was the fact that two aircraft configurations, the prototype and a service model, had to be considered since substantial weight differences were involved. Enclosure (2) recaps some of the weight and performance predictions over the course of the program. From this tabulation, it can be concluded that there is no possibility of a fleet V/STOL fighter emerging from the program. Note that with the same engine rating, the maximum vertical take off gross weight is the same for both "prototype" and "service" models, while the difference in empty weight and equipment is approximately the same between the two models. The DLI fighter radius can be used as an indicator of capability. On the first Navy check of the design, in 1972, the service model had no capability with approximately 5000 lb. discrepancies between the contractor and Navy estimates of both weight and lift force. Later the differences in lift capability were reduced by eliminating suck down and reingestion effects and increasing the engine rating used. Navy estimates of a future fighter capability peaked at about the end of 1973 when it was estimated that a small amount of fuel could be lifted off in addition to fighter armament, giving a slightly positive radius of action. Since that time it will be observed that the vertical take off gross weight has decreased by about 3000 lb. which would eliminate the fuel allowance, again achieving no capability.

5. In my opinion, there is no need to examine the program in detail when the general conclusion is so apparent. I have found no one in NavAir who believes that a useful fighter can be derived from the program, although nearly all favor continuing the project to obtain actual full scale data. Although I can understand the sentiment, there must be more productive projects available.

6. If a supersonic V/STOL fighter capability is required, it is probable that the lift plus lift cruise configuration is still the most promising. Although some object to carrying the so called dead weight of the lift engines into combat, the fact is that that weight is small compared to the weight penalties associated with the thrust augmented wing. The latter has been estimated to have the poorest T/W ratio for any of the V/STOL propulsion arrangements which have been studied in recent years. As was the case five years ago, however, new lift engine development must precede any L + LC aircraft development.

7. It is clear that the XFV-12A program will not enhance the image of naval aviation. Note that in this case the outcome was not only predictable, but was in fact predicted. As is so often the case, all of the principals in the decision have moved on in both OSD and the Navy. The task of justification will fall on others and will be difficult. It is to be hoped that the same mistakes will not be made again, although the entire V/STOL program certainly has the potential.

/s/
G. A. Spangenberg

Exhibit V-2. A Retyped paper

Model XFV-12A - PROGRAM HISTORY (1971 -72)

1. In 1971, OSD initiated a "Prototype" program. In brief, the program was intended to produce more competitive hardware with less bureaucratic control, reduce costs, and give SecDef more program options. "Requirements", and "Specifications" were to be avoided and innovative approaches encouraged. In the words of one DDR&E official the Air Force enthusiastically supported the program, while the Army and Navy were reluctantly brought aboard. Mat-03 (Vadm. Davies) was the head Navy Prototyper. Some support for the program existed in all segments of DOD by those who believed that "Prototype" funds would be in addition to the normal R&D budget. The more realistic officials recognized that any "added funding" would be small and limited to that one budget.

2. In this same time period, a small "Sea Control Ship" (SCS) concept was being studied with strong support and direction by the CNO (Adm. Zumwalt). The SCS was not well defined, but was known by all to require V/STOL aircraft since there were to be no catapults nor arresting gear.

3. Projects suggested for inclusion in the Prototype program by NavAir were really those which had been inadequately funded in the normal R&D budget, as for example, the COD version of the S-3A. Such projects were not well received. MAT-03 then elected to solicit industry directly for innovative proposals for two general types of aircraft to be based on the SCS, fighter/attack and long endurance sensor carriers. The solicitation was also published in the Commerce Business Daily. (Tab 1). Proposals were to be limited to 20 pages and delivered to the MAT-03 Prototype office.

4. NavAir was tasked to evaluate the submissions and report back to MAT-03 in about two weeks. Tab (2) is the NavAir memo outlining the evaluation task to those divisions who would participate, while Tab (3) gives additional guidance.

5. The evaluation was reported to MAT-03 on 19 January 1972 in a briefing using the charts attached as Tab (4), and later reduced to writing by memorandum, Tab (5). It was recommended in the fighter/attack category that a lift engine be started at once as well as a suitable radar and fire control system. After the SCS missions had been established a competition for a V/STOL fighter was recommended. In the sensor area, one of the recommendations was to start work on the North American sensor carrier prototype. (This was essentially a flying test bed using the OV-10 as a vehicle.)

6. Following the NavAir briefing to MAT-03 on 19 January, the latter revised the briefing and carried forward a recommendation to start the North American thrust augmented wing fighter/attack. Copies of the charts used in that briefing are not available in AIR-506, but some insight into the presentation is available from comments made on some CNO originated correspondence. Tab (6).

7. As more data became available on the North American fighter/attack design (NR-356), evaluation efforts were continued in the primary areas of weight and performance. Tab (7) indicates that a serious weight problem was apparent on the first full estimate.

8. On 1 March 1972, AIR-530 reported on further evaluation efforts. At that time, the combined discrepancy between contractor and NavAir estimates of weight and lift was 9800 lb. Tab (8). Although all calculations were based on a meager data base, the magnitude of the differences was unprecedented.

9. Nearly all the dissent to the program existed within the NavAir technical community, and was kept from the higher decision making levels in the Navy, and OSD. Tab (9) reports on a meeting with ASN (R&D) which was called because of that problem. Also discussed were items relating to the prototype program, and the SCS. It appeared then the augmented wing proposal would be restructured to make it more suitable as a technology base, instead of as a prototype for a new fighter.

10. Despite the technical projections, the project was continued. The Light Weight Fighter Study, (an outgrowth of the older Fighter Study efforts in OpNav which had provided the justification for the F-14) reached the draft stage presenting results which were quite controversial. Tab (10) is one of the memos commenting on that draft. Reference to the study is included here because it provided the base on which much of the over-optimism associated with the V/STOL program has grown.

11. Tab (11) is a DDR&E memo which forwarded a draft Program Memorandum (PM) to ASN (R&D) for use in preparing a final copy. The facts, rationale, and program plans are based on the contractor's proposal with no consideration given to the Navy's own technical estimates.

12. In a memo dated 5 May, Tab (12) comments on the PM as approved by ASN (R&D). All technical objections to the project had been ignored.

13. On 8 May 1972, based on further design data, a new Navy weight estimate was reported, in comparison with NASA, Langley, and NADC estimates. Tab (13).

14. On 11 May 1972, AIR-506 summarized his objections to the Prototype program to clarify issues being raised in NavMat and OpNav. Tab (14).

15. On 23 June 1972, a summary of the weight situation on both the prototype and service versions of the TAW design was presented. The lack of a potential for fleet use was restated. Tab(15)

16. On 7 July, Mr. Paglianete of AIR-530 reported in greater detail on the technical status of the TAW project and included a trip report by Mr. Weissman of OP-098. Tab(16).

17. On 12 July 1972, CNO directed the CNM to establish a Prototype Development Manager in NavAir. Tab(17).

18. On 26 July, CNO directed initiation of an effort to define characteristics and costs of V/STOL aircraft for the SCS. Tab(18)

19. In June and July 1972 NavAir conducted an informal competition for V/STOL VFA aircraft to meet tentative requirements established by CNO. Most of the designs were lift plus lift cruise. Tab (19) is the "Conclusions" chart of the presentation winding up the competition.

20. A letter was prepared on 30 August 1972 outlining the reasons why comparable cost information could not be provided on production versions of a number of V/STOL models including the TAW. The letter was not forwarded. Tab (20).

21. A criticism of the data planned for a Pre-CEB was prepared in October 1972. OP-098 later reported that changes had been made identifying the TAW as a high risk program with no production cost figures presented. Tab (21).

22. At the end of the period noted in this folder, the XFV-12A program was well established. Plans for a formal program review to be held in January 1973 were underway. NAVAIR continued to estimate that the design had no potential for service use.

Exhibit V-3. A Retyped Memorandum

6 DEC 1973

Memorandum for E.V. Heinemann

Subject: Navy V/STOL Program – Comments

1. The meetings of the NRAC ad hoc committee on 17-28 November 1973 in Washington were useful to me in providing a better perspective on the whole problem from Dr. Potter's viewpoint, and in clarifying a few issues which have long disturbed me. At the moment, NAVAIR is working up a comparative performance summary on the three models under discussion together with the current Harrier. I hope these data will be available in a week. Captain Cody has writing efforts underway which attempt to summarize the program, and which I have promised to review. In this memorandum, I will attempt a few paragraphs on those issues which seem to me to need attention, and which could be used in your final report.

2. The first question is one which touches on the advisability or usefulness of ad hoc committees. As a device to focus attention on particular problems, and perhaps to develop programs to solve those problems, the committee approach sometimes makes a contribution. It is seldom really useful, however, in providing any engineering evaluation of competitive proposals due to lack of time, qualified staff, etc. In most cases, the data on which decisions are to be made, must be provided by others. When the data are valid, sound recommendations are, of course, possible, but when the data are not completely comparable, it is obvious that judgments may be impaired. The issue of comparability can be raised by an ad hoc group, but in most cases, the group cannot produce a true comparison within their own resources. It is probable that this fact is not appreciated by those who appoint us.

3. The engineering, cost, and schedule aspects of the Navy's V/STOL programs were presented to the committee by spokesman from each of the individual programs. Most of the data was based on contractor estimates with only occasional references to Navy estimates. It was noted that two of the presenters used close agreement with Navy estimates as a virtue, while the other tended to deprecate the Navy's estimating methods. It would appear that the problem of comparability exists within the Navy itself, and undoubtedly contributed to the necessity for this committee. Historically, it is known that Navy program decisions have been made on the basis of Navy estimates of engineering performance, cost, and schedule rather than on contractor claims. If the Navy's decision makers are unaware of the variance in contractor and Navy estimates, the management system should be revised. If the decision makers are aware of

the difference but refuse to believe the Navy's own estimates, it seems imperative that this situation be resolved either by getting new estimators, or by restoring confidence in old ones. The current fetish of having a single man, the Program Manager, "fully responsible" for a program has obviously contributed to this problem which will continue until a more functional arrangement is restored.

4. The lack of firm "requirements" is obvious in the Navy's V/STOL program, where three very dissimilar vehicles are being considered as competitors despite widely varying capabilities. The Navy's excellent record in producing aircraft for the fleet was based on the establishment of a firm requirement by the "operators", and fulfillment of that requirement by the "material" portion of the organization. There may be some way to produce fleet hardware without having "requirements", but the current material organization is without experience in such an exercise. The design engineers in NAVAIR and in industry must be told with a fair degree of specificity what the design requirements are. Needed are at least minimum levels of speed, payload, range, and operating environment. Two of the V/STOL projects are supersonic and designed primarily for a fighter mission while the other is a subsonic attack aircraft intended for Marine use. It is clear that the advanced Harrier, AV-16, cannot accomplish the mission for which the Convair Model 200 was designed, although the converse is not necessarily true. The FV-12, on the basis of NAVAIR estimates, is incapable of performing either mission. These three projects may be competitive from a budgetary standpoint, but are certainly not from a mission viewpoint.

5. On the subject of budgets, it is clear that none of the programs is being funded at the level needed to insure fleet weapons by late in this decade. With funding such an important factor in all of the Navy's program decisions, it appears imperative that the R&D effort support only those projects which will contribute to meeting the well established Soviet naval threat. Those projects which appear to have little operational promise should not be permitted to drain funds from those that do.

6. Risk assessment is a term which has been given much publicity in recent years. Papers have been written on methods of quantifying risk, yet few of the writers exhibit any real understanding of the total problem. This committee has been asked to discuss the risk of the three programs. Most Navy aircraft programs have virtually no technical risk in the sense of whether they will work or not work. "Risk" has been taken to mean whether or not they will be produced on schedule and within a budget. In my mind there is no risk as to whether we can make operationally usable AV-16s or Lift plus Lift Cruise machines. There is also no question as to the lack of operational usefulness of the FV-12 on the basis of NAVAIR estimates. The "risk" could be considered low in that the outcome is well known. To some, high "risk" seems equivalent to high "payoff". This is true in some gambling situations, but is not applicable to the case of the FV-12. Its one virtue seems to be a lower "footprint" problem, which is important only if the

higher one is intolerable for the operators. The highest risk associated with all the programs is probably that of an adequate budget. Inadequate funding in itself delays programs, which further increase costs, and has a secondary impact by delaying the definition of problems because of inadequate testing.

7. In connection with the formulation of "requirements", one should not ignore the impact of the Sea Control Ship on the entire V/STOL project. Its roles and missions appear to be largely undefined and range from that of a destroyer replacement to a CVS replacement, or perhaps to supplement CVAs. The Navy portion of the V/STOL effort (as opposed to the Marine portion) is almost totally dependent on the definition of the SCS requirement. This problem long recognized in NAVAIR and by industry has not been addressed adequately by the Navy as a whole. (See my 21 April 1972 memo on this same subject.)

8. Further thoughts will be in separate correspondence. Hope this is of some value.

GEORGE A. SPANGENBERG

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Exhibit V-4. A retyped paper that was presented at AEI Conference, Washington, D.C. on October 7, 1977

Overview — Navy V/STOL Aircraft — Rationale Against

In view of the great impact of the V/STOL aircraft program on the future of the Navy, a more detailed review is warranted than has been provided in the papers involved in this session. From the evidence publicly available, it appears that the decision makers have been victimized by overzealous salesmanship perhaps coupled with some disconnects in communications between the Navy's technical community and the program planners.

As now described, the Navy is to transition toward an all V/STOL fleet of aircraft deployed on both aviation and non-aviation ships. A similar goal, believed achievable by some in 10 years, was suggested in the Bureau of Aeronautics in the early 1950s after the success of early developmental tests on "tail sitter" models. The twin problems of capability and cost, which caused abandonment of the plan then, remain, with little hope in the future for a simultaneous solution when compared to more conventional approaches.

First, let us consider the case involving the large carrier and its ultimate replacement. We have the option of continuing to buy carriers with complements of conventional carrier aircraft, which we will call CATOAL, for Catapult Assisted Take-Off and Arrested Landing, or we can buy ships of the same size operating V/STOL aircraft of the same capability but without benefit of catapult and arresting gear. For this case, it can be shown that:

1. Procurement and operating costs for the ship are small compared to those of the air group, on the order of 1/3.
2. The differential in ship costs due to inclusion of catapult and arresting equipment is small, probably on the order of 10%.
3. The differential in air group costs between a new V/STOL group and a new CATOAL group is large, probably at least 50% with individual design variations between 20% and 100%.

With the facts, V/STOL can obviously not be justified. In the real world, one must consider also the possibility of procuring not new CATOAL airplanes, but only more of those already in service. The weight differential between a new V/STOL and an old CATOAL would be reduced. The cost differential is less capable of treatment by broad generalizations due to the different production status of each of the service models. It is probable, however, that unless the total force level is increased, the old airplanes will cost even less than their new and lighter replacements. That issue, however, can be

deferred for handling on a case-to-case basis, since any new carrier could handle the current aircraft.

For non-aviation ships, the issue is almost as clear cut despite the confusion caused by discussion of both V/STOL A and V/STOL C for this application. If "C" were the only VTOL for this application, and designed as the LAMPS III replacement, the decision on its development could be deferred since there is no coupling with the carrier issue or the other V/STOL designs. If V/STOL A is assumed capable of use on modifications of the DD-963 and other larger ships, it must be considered against LAMPS III and other helicopters. The low disk loading helicopters are virtually certain to be more successful within their own operating envelope, but have limitations in speed and altitude. At the present time, it would be difficult to justify the probable cost spread of two or three times between V/STOL A and LAMPS.

In addition to the large unit production and operating cost penalties associated with the V/STOL program, it is burdened with by far the most expensive R&D program ever laid out for naval aviation. That cost, of course, must also be amortized.

The V/STOL program should be drastically revised. With naval aviation already seriously underfunded from its position vis-a-vis the threat for years past, the plan greatly aggravates the situation. The issue of small, medium, or large carriers should be made on the merits of each and not confused with the V/STOL issue. On a positive note, carriers and carrier based airplanes have done their job well. The world's most capable tactical STOL aircraft are now deployed. The concept is proven, sound, and can do the job in the future.

Exhibit A-1. A retype of a 1977 paper for VPI.

Note: A similar paper was written for a "corporate memory" series. (Latter probably never completed.) GAS

HISTORY

NAVY AIRCRAFT ACQUISITION PROCESS

SOURCE SELECTION

1. The Navy's record of success in aircraft development has been acknowledged to be superior to that of any other service or agency. Although the factors which made that record possible were well known to those involved in compiling it, the documentation of the acquisition process as actually employed for naval aircraft is somewhat sketchy, as little of it appeared in official instructions or directives through much of our history. In recent years, under pressure for standardizing all Navy and Defense procurement actions, the documentation has increased greatly, but the procedures now described differ materially from those employed so successfully by NAVAIR and its predecessor agencies, BuWeps and BuAer. This paper will examine the source selection phase of the Navy's aircraft acquisition process as employed in the past and primarily in the period from 1930 to 1970 when the Navy started over 100 designs and produced approximately 100,000 aircraft for its own use.

2. "Source Selection", a term initially applied to one method of selecting a contractor for a new development has become a generic term encompassing all methods of selection. Prior to World War II, design competitions were used by all services as the means by which a manufacturer was selected to receive a development contract for a new aircraft. As the name implies, in a design competition, the government selected a design which best met its objectives from a number of proposals submitted by industry. In the 1950s, the Air Force changed its procedures to select not a "design", but only a "source". This step was taken, it was said, to avoid unnecessary expenditure of technical resources by industry. Conceptually, only brief **management** proposals were to be required, with the major costs associated with making a **design** proposal deferred until after a contract was let. Not unexpectedly, management proposals proved inadequate for making justifiable selections, and eventually "source selection" proposals became equivalent to those required in a design competition. The Air Force, and later OSD, however, retained the terminology of "Source Selection" which now appears in all directives on the subject.

3. The Navy's aircraft selection process evolved over the years modified as necessary to suit changing time, organizations, management theories,

technologies, etc., but always retaining the basic philosophy of selecting that design which was estimated by the Navy's own experts to best satisfy the fleet needs. In the early days of the Bureau of Aeronautics (and incidentally the aircraft industry), the law required, in aircraft competitions, that the government inform all competitors of the criteria and weighting factors to be employed in making a selection. It is presumed from this evidence that numerical scoring systems were in vogue during this period in which both experimental and production contracts were let in competitive bidding procedures similar to those of today's forma advertising. By the 1930s, the procedures and law changed so that design competitions were continued as the method of choice for selecting experimental models, while production contracts were negotiated with the manufacturer who had developed the prototypes. A factor in the procurement procedures of that era was that the entire contractual procedure was actually the responsibility of the Bureau of Supplies and Accounts (Bu S&A), although virtually all the contractual documents were drafted by BuAer. This led BuAer, in the interests of efficiency, to use "informal" proposal requests, competition procedures and pre-contract negotiations before getting officially involved with Bu S&A. By World War II, contracting authority was granted to the bureaus, but the "informal" approach continued for many years with little involvement of "Contract", "Legal", or "Procurement" personnel until firm decisions on contractor selection and contractual action had been made. Major system acquisitions were thus handled differently than other procurements for most of the bureau's history.

4. The organizational structure of BuAer was always a "functional" one with a minimum of "project" personnel. Under pressure from management theorists, a "matrix" organization has now evolved with a continuing trend toward larger numbers of management personnel and comparatively fewer functional specialists. There has been a concurrent trend toward greater reliance on field station or contract personnel to provide the technical expertise formerly resident within the basic organization. Under the old functional arrangement, there was little or no need for administrative instructions covering the normal work of the bureau, since each organizational entity's responsibilities had long been established and were regularly performed. One of the functions delegated by the Chief of the bureau was that of conducting design competitions for new aircraft and missiles to a small group once called "Design Coordination" in "Engineering" and now designated as "Evaluation" in "Material Acquisition". The responsibility for evaluating new designs was written into the duties of each of the bureau's function entities, and into virtually all of the position descriptions of individual engineers. With a single division in charge of all competitions, and with each technical division participating in the evaluation process, there was obviously no need of administrative paper work detailing a process continually being practiced. This is the explanation for the lack of documentation within the bureau's operating directives for the competition process. There was no disagreement on the procedures which were described as "well established" and were reported regularly to new officials, investigating groups, congressional committees, and of

course in the memoranda which documented each competition. However, there were occasional recommendations for issuing an operating instruction from groups outside the bureau, usually as a result of management audits or surveys. Invariably such groups supported the Navy's competition procedures, but deplored the lack of a general paper detailing them. In the late 1950s, a routine revision of the general procurement regulations was issued which was then interpreted to include major system acquisitions. This step brought "Contract" personnel into the acquisition procedure from the beginning of the procurement. Until this time, "Contracts" entered the process after the competition was decided, just as "Bu S&A" did in the earlier era. It should be noted that there had been no problems experienced which indicated a need for such action. The greater formality took more time and effort, and although deplored as unnecessary, it has continued. From this point on, it became impossible to draft an operating instruction on which agreement could be reached as to the precise division of responsibilities between the various parts of the bureau organization. For example, at that time "Contracts" insisted that any directive show that contractor selection was their responsibility while in practice it had never been. In each new aircraft acquisition from then on, technical personnel continued to run the competitions in fact, although with greater and greater controls imposed by "procurement" personnel.

5. The reason for using design competitions in the selection process was that, as implied earlier, several manufacturers were both normally available to undertake any new development and were so nearly equally qualified that a justifiable choice between them was impossible. A design competition allowed each bidder to **demonstrate** his competence, and gave the government adequate information for selecting the best design and for justifying that selection to everyone, including the losing bidders. It should be obvious that this type of a competition could succeed only when the rules of the game were understood by all concerned and enforced by those running the event. To this end it was, and is, important that the weapon system be defined as well as possible so that in essence, the airframe was the principal variable. Design competitions were held, therefore, after all conceptual weapon system development had been completed, military worth established, and provision made for budget support. All Navy competitions were unfunded until OSD required compensation for the bidders in the late 1960s. When no funding is provided, marginally qualified contractors normally drop out early, while very small (and unqualified) companies are discouraged from submitting proposals and wasting their resources. When funding is provided, the entire selection process becomes more complex and consumes more time since one must first conduct a preliminary competition to limit the number of bidders, and then defining the tasks to be performed, awarding the contracts, and administering them. There is no apparent benefit to the government to offset the time and cost involved.

6. Returning to the competition process as actually practiced:

a. Initially, simple letters to our major contractors solicited their interest, and these were followed by "invitations" (not requests) to submit "informal proposals", again in letter form. Now, a forthcoming request to industry to submit proposals is first advertised in the Commerce Business Daily and is followed by an RFP.

b. The major ingredients of the "invitations to bid" were: a description of the intended procurement, the "schedule", a type specification for the airplane, and a specification addendum detailing the proposal data required. In the period of "cost plus" contracting, detailed definition of data and flight testing was deferred until after selection of the winning contractor. When "fixed price" contracting was employed, specification addendums covering both data and tests requirements became necessary. Specifications were drafted by a small group charged with that responsibility, but with the assistance of all functional divisions. Coordination with "Requirements" personnel was, of course, a normal routine.

c. During the proposal preparation period, contact with contractors was minimized. Questions from the bidders were directed to the "Evaluation" Division, who answered them immediately, if possible, or if coordination with other divisions was necessary, as soon as practicable. Clarifications and corrections to the specifications, if necessary, were then distributed to all bidders officially.

d. After proposal submission, the evaluation process proceeded with all the functional divisions evaluating each design and reporting back to "Evaluation" their ratings, rankings, and recommendations for necessary changes in design, data, tests, or schedule.

e. On the basis of the evaluated data, the least desirable designs were dropped from consideration. The remaining designs were reevaluated incorporating those changes which would be incorporated if each of the designs were to be procured. This part of the process, unilateral by the bureau, put all competitors on as near an equal basis as possible for final comparisons and selection of a winner.

f. The selection decision originated within the "Evaluation Division" with the active collaboration of the "Project officer" (or Class Desk). The competition results were then reduced to memorandum form in which the "Assistant Chief, R&D" recommended a course of action to the "Chief", via the other "Assistant Chiefs". In later years a Program or Project Manager, if assigned, became a collaborator in the selection decisions, all of which were reached informally by common agreement.

g. A final step in a design competition was to compare the winning design with other aircraft and with the characteristics which had been used in justifying the project. When the comparison was favorable to the winning design, procurement action was recommended. If the comparison was unfavorable, a rejustification analysis had to be performed.

h. Prior to announcement, competition results were made available to OPNAV (the equivalent of OP-05 today) and sometimes to the Secretarial level. At all levels above that of the bureau "Chief", the competition results were presented for information, but not decision. (At that point in history, a bureau was responsible for material procurement with neither a CNM existent, nor a CNO involvement).

i. After the decision, a procurement request started official contractual action. Specifications, contract terms and conditions were negotiated with the selected contractor. The remaining bidders were debriefed individually by the "Evaluation" Division, and given the bureau's estimates and comments on their own designs.

7. The Navy's practices differed from those of other services in a number of areas, some of which are discussed below:

a. In contrast to the Navy practice of using its entire functional organizations, the other services adopted an ad hoc team concept, sometimes situated at remote locations. The evaluation team leader was normally the "Program Manager", usually conducting his first (and only) competition and utilizing only a small fraction of the total expertise available in that service.

b. Numerical scoring procedures were standard in the other services with all proposals being "raw" scored in detail areas against "standards" and later "weighted" by previously established "criteria". Internally, the Air Force considered the scoring results as a useful tool in reaching a decision, but never regarded them as necessarily conclusive. Secretarial and Congressional levels often regarded the scoring results as absolute, however, as evidenced by the TFX investigation. Numerical systems were found unnecessary by the Navy, and much less efficient than simple comparison and elimination techniques which permit maximum concentration on the best designs. (With quantitative scoring systems, even the poorest designs are scored in the same detail as the best ones.)

c. Much less paper work was involved in the Navy system from start to finish of a competition. A one or two page memorandum to the participating divisions was the only "Source Selection Plan" required. Proposals were evaluated against specification requirements, obviating the need for preparation of generalized "Criteria" and "Standards". Division evaluation results were reported in memoranda running from a single page to an average of perhaps 10 pages. The memorandum summarizing the competition was usually less than ten pages but with enclosures which sometimes produced a ½ inch thick document. In contrast, the Air Force TFX evaluation report was 2 3/4 inches thick, while the Army's HLH evaluation occupied half a file drawer.

d. The other services separated the functions of evaluation and selection, with the latter normally made at the Secretarial level, sometimes without even a recommendation from those who had actually evaluated the

proposals. Few senior defense officials have either the background or can take the time required to perform an actual selection in a major weapons system competition. They invariably must rely on a highly condensed briefing of the competitive proposals and evaluation data given to them by some who are more nearly qualified to make the decision. The lack of a recommendation was required by some officials in order to eliminate any possibility of a "reversal" of a source selection decision.

e. By using personnel from within its own organization, and working within their own offices, elaborate security controls were not needed in the Navy system. All personnel handling the proposals had adequate security clearances and were experienced in safeguarding sensitive information. Written pledges of forthrightness, lack of conflicts of interest, and strict control over evaluation data were never found necessary, since all these factors were part of each individual's normal responsibilities.

f. The other services ability to do accurate independent estimating of weight, performance, cost, etc. was greatly prejudiced by their personnel assignments, ad hoc approach, scoring methods and undue security controls. Without this ability, the design competition process cannot work, as each contractor tends to out promise all others, leading to so-called "lying contests". Only a strong technical group can prevent the problem.

8. After OSD standardized the source selection process along the lines of the Air Force system, the Navy was forced to modify its practices to indicate compliance. An "Evaluation Board" made up of the Division Directors involved in the evaluation was named, while the "Advisory Council" included all the "Assistant Chiefs", and the "Authority" was the "Chief". The basic system remained the same, the appearance was changed. In more recent years, the system has been compromised even more with ever increasing emphasis on legalistic procedures, none of which appear to have been instituted because of actual problems encountered with the older acquisition procedures. Under the simpler methods used, there was never a formal protest of an award in a Navy aircraft competition. LTV 's protest in the F-18 program, although rejected by the GAO, was occasioned in part by a lack of understanding of the rules of the particular game to be played, and would undoubtedly never have occurred under our older, more open and straightforward procedures.

9. The Navy's system worked very well over many years. No other system has been shown to be nearly as effective, or cost effective. Every effort should be made to return the process to as simple a form as possible. Awards should continue to be made on the basis of the best design at a reasonable price to meet real requirements of the fleet.

Exhibit A-2. A retyped paper presented at the "Advanced Planning Briefing for Industry", Columbus, Ohio: 25 September 1969.

NAVAL AIRCRAFT SOURCE SELECTION

G. A. SPANGENBERG
Director, Evaluation Division, NAVAIR

Introduction

My task today is to tell you something of the system and procedures we will use in determining which of our major contractors will be selected to develop the new weapon systems described by earlier speakers. As some of you know, and as the rest of you will soon discover, I'm a very biased observer on the subject of source selection. I firmly believe that our Navy aircraft selection system has been, and still is, better than that being employed by others. If I didn't think so, I wouldn't be here today, nor would I have remained in the evaluation and selection business for the Navy.

I normally start off these discussions by apologizing to those whose feelings are going to be hurt. These are usually my friends in OSD, the Army, and Air Force, who keep developing new ways to make even the simple tasks more difficult. Our own Navy management friends often collaborate too willingly with such efforts.

This then leads to a brief discussion of the fact the world is made up of the "WEs" and the "THEYs". The "WEs" are always the good guys while the "THEYs" are always the bad ones. "WE" develop the good, the simple, and the inexpensive, while "THEY" force us into unsatisfactory solutions, usually with a great proliferation of paper. In my business, the "WEs" start with the engineers in the Naval Air Systems Command who are always sound, reasonable beings (who agree with me), while the "THEYs" include all those who don't — particularly the system analysts across the river.

To further set the stage, I'd like to quote three paragraphs from a speech made by Mr. Lee Atwood of North American about 15 years ago, after North American had finished second in a competition in which there was but one winner. The principles enunciated were, in fact, those under which we had been operating.

"Although the Government owes the nation an adequate air defense, and such an air defense will assure a measure of continuity in our development and production efforts, I want to emphasize that the Government does not owe the aircraft companies a living. Quite to the contrary it is essential to the success of our development program that the Government award contracts as objectively as possible on the basis of genuine merit. The personnel responsible for procurement must put aside any ideas they may have been encouraged to develop in the past 20 years that they are social planners,

economic stabilizers, or anything else but hard-boiled customers with a job to do and a determination to get the best equipment to do the job.

I am specifically asking for maximum realism in procurement competitions. Our efforts in industry will be most effective if the competition is tough, fair, and clearly oriented toward product quality. There is a disproportionate premium attached to winning a design competition. It is the ticket of admission to the production show, but after all a design is just a list of promises based on calculations, which in turn are predicated on assumptions that can vary with the optimism of the designer. Rarely if ever have there been any real penalties when the glowing forecasts of the design proposal were adjusted downward to the physical facts of the actual airplane. And it is then too late to change. I believe that this is a serious problem that deserves increased study by all responsible officers of both the Air Force and the Navy. If the imposition of financial penalties for non-attainment of performance guarantees is the only workable answer, then I believe such penalties should be invoked.

I believe that most of the responsible airframe, engine, and other contractors would agree wholeheartedly with the principle of awarding contracts objectively on the basis of design realism, economy, efficiency, and whatever other fair and impartial measures of comparison the procurement people can devise. There is really no other effective way to maintain the integrity and effectiveness of American aeronautical development."

As you all know, the stakes are even larger today, making it more necessary that we be not only a tough customer, but a sophisticated one, capable of clearly defining our needs and our mutual obligations.

Objectives

Before getting started on a description of our methodology, let's review our overall objectives. We seek the best product at a fair price. We must accomplish the job in a responsible manner within our own resources, while developing adequate data to justify the course of action we finally adopt. The task must be accomplished with a maximum of competition but with a minimum of expense to both government and industry. In particular there is certainly no single best solution to the overall source selection problem. Flexibility to tailor the methods to suit the individual procurement is essential.

Basic Needs

The basic steps in the procurement process are:

a. Establish the Requirement
b. Define the Program
c. Obtain Program Approval
d. Select a Contractor

e. Contract

While the selection process itself is the subject for this talk, it should be obvious that the success of any project depends upon how well each step is accomplished. A sound requirement is undoubtedly the most important single factor involved. The best of procurement plans cannot compensate for a poorly conceived project with impossible technical goals. The majority of failures in our business can be traced to the overambitious requirement generator, whose motto often has been, "Let's see what industry can do."

Procurement Methods

Now let's define in very broad terms what we are talking about. First, all of our aircraft procurements are made under the "Negotiated" procurement rules of the ASPR, and not under the rules of formal advertising. Unfortunately, this fact is occasionally used as an argument that there is no competition in the aerospace business. In actuality, of course, virtually every new procurement is competitive, with the degree varying from mild to cut-throat.

Within the "Negotiated" arena, we can split the contractor selection methods into a number of categories:

(A) Sole source procurements are the easiest, cheapest, and fastest, but the most difficult to justify. They are used today primarily when we buy a modification of an existing design, e.g., an EA-6B, derived from the basic A-6 series.

(B) "Source Selection" (in quotations) was initiated by the Air Force in the late '50s. In the beginning, it emphasized management proposals, with an aim of selecting the best source, rather than design. The method was highly formalized and was the basis of DOD Instruction 4105.52 covering Source Selection.

(C) Design competitions had been employed by the Navy as the prime selection method for aircraft for over 30 years. The method, modified only as necessary to comply with the DOD directive, allows **qualified** bidders to **demonstrate** their overall **competence** by submitting design proposals. Selection is based primarily on the merit of the **design**.

Design Proposal

A modern design proposal is a comprehensive set of documentation describing not only the design itself, but including enough cost, management, and support information that we can draw up a definitive contract. The A-7 proposal in 1963 consisted of a 16 inch stack of technical reports, 5 inches of management reports, and 9 inches of drawings. These data were adequate for selecting the contractor and negotiating a fixed-price

contract for initial development with fixed-price ceiling options for about 200 production airplanes.

Proposal Shelf Length

The amount of data being submitted has expanded significantly since the A-7. Our last two competitions resulted in average "shelf lengths" of about 7 and 12 feet for a single copy of each proposal. With multiple copies required, the data handling task is obviously formidable for both the contractors and the government. Pressure from higher authority to define all aspects of a procurement for years in advance has caused much of the increase. It is anticipated that some of the paper proliferation studies now underway will provide some relief in this area. [*Later comment — They didn't.*]

As a matter of interest, there is little correlation between shelf length and success in our competitions. As most of you know, it is much harder to write succinctly than to ramble on at length. The more condensed the proposal the more favorably it is received. We get really annoyed when individual proposal reports are too large to fit neatly into standard file drawers.

Evaluation - General

With our proposals in hand, let's now look at what we do with them.

The evaluation job is done primarily by the NAVAIR functional organization with some assistance from our field stations when necessary. We do not use a large ad hoc type of organization as do some of the other services. Our evaluators are the same engineers who helped prepare the RFP, and who will later monitor the development of the aircraft. Since they wrote the detail requirements, they need no separate "criteria" against which to evaluate.

Simple comparison and elimination techniques are used as a basic methodology without resort to elaborate point rating systems. We do quantitative analyses of those characteristics such as weight and performance where numerical results have meaning. Qualitative ratings of design features, installations, and components are provided by the evaluators and left in that form. No attempt is made to transform essentially qualitative judgements into a quantitative score. Experience, and common sense, prove that the step is unnecessary. The **reasons** for relative ratings are necessary to convince those who must review decisions, while numbers in themselves are meaningless. A summation of all results allows elimination of the least promising proposals.

Evaluation Detail

For a little more detail on our methods:

(A) Independent weight estimates are made by our weight control engineers.
(B) Simultaneously, estimates are made on major performance items by our performance specialists.
(C) All divisions review the proposals, rate each one in categories of acceptability, and rank each one relative to the others.
(D) Our cost analysts derive comparable prices from the contractors' quotes.
(E) The least promising designs are eliminated from further consideration
(F) On an individual basis, changes are made in each design, to obtain the configuration which we would put under contract if that contractor were to be selected. Weight, performance, and cost figures are recalculated.
(G) Detail comparisons between the designs remaining under consideration are made and results summarized for a decision.
(H) After the decision, each contractor is debriefed on an individual basis as to the results of the entire evaluation of his design. This enables the contractor to do a better job on his next proposal. It also provides an incentive for each evaluator to do a good job since he must, in effect, justify his estimates or comments on the particular design.

Presentation Scope

When an evaluation is completed, the results must be presented to a series of decision makers. This is normally done in an oral presentation, scheduled for perhaps two hours using 60-70 charts or Vu-Graphs, which includes data on the following:

(1) History of project, the evaluation methodology, personnel involved, and any significant problems encountered.
(2) A detail description of each design, its features and unique solutions to design problems.
(3) NAVAIR weight, performance, and flying quality estimates.
(4) Ratings and rankings by each of our design divisions, Propulsion, Armament, Structures, Maintenance, etc.
(5) Cost summaries, contractor quotes and NAVAIR estimates.
(6) Procurement plan, contract details, and delivery schedules.
(7) Pertinent management issues, and CPE results.
(8) Proposal summaries.
(9) Conclusions.
(10) Recommendations

As the presentation moves up the decision chain it is condensed and tailored to suit the audience. Detail is eliminated and greater emphasis placed on the program and fiscal actions required.

Organizational Levels

My discussion of our procedures up to this point has not defined the formal decision chain. For most aircraft competitions the Commander, NAVAIR is designated as the Source Selection Authority. When this is the case, the Source Selection Advisory Council is chaired by our Vice Commander and made up of the Assistant Commanders. I normally chair the Source Selection Evaluation Board which is made up of the Directors of the various Divisions involved in the evaluation.

The evaluation, recommendation and decision levels are respectively, the SSEB, SSAC, and SSA. Prior to a decision announcement, or program go-ahead, concurrence is normally required through the Navy and OSD Command and Secretarial levels to SECDEF.

In a typical case, these levels are:

(1) CNM
(2) CNO
(3) Navy Secretariat
(4) OSD Secretariat
(5) SecDef

Everyone should realize that intimate knowledge of the proposals exists only at the bottom of this chain. Actions at the top are based on briefings and analyses from the bottom. In the usual case, the review process is aimed at insuring adequacy of the justification, compliance with previously established program control documents and with the budget.

Although levels above SECDEF are not shown as involved in source selection, the higher executive and congressional levels have great interest in these decisions, and control their destiny by budget actions.

Decisive Factors

There is no magic formula for winning one of our design competitions. Among the factors which have been decisive in past competitions are:

1. Weight – A good index of cost, logistics, and handling characteristics.

2. Performance – Usually the most important factor for a combat airplane. For a fighter, we normally compute speed, climb, acceleration, thrust and lift limited maneuverability, range and radius, catapulting, and arresting characteristics. Any one of these items could be decisive. Maneuverability won for the F-8.
3. Flying Qualities – One of the most critical factors, you can't win unless you rate well on this one.
4. Accessibility and Maintainability – If its not maintainable, we won't buy it. One significant factor in the F-14 selection.
5. Design Excellence – With equality in other areas, the detail ratings will win for you as it did for Grumman on the A-6.
6. Cost – A significant factor in most firm-fixed-price competitions. It was determining in the A-7 competition between two designs of almost equal technical merit.

General Problems

Among the questions normally directed at us when we state that we base our decisions on NAVAIR estimates is the one which questions our ability to compete with industry due to the great difference in manpower which exists. That difference is more than offset by the three facts that our data base is greater, we have more experienced evaluators doing the work, and we are more objective.

As you already know, we have been going through a period when nearly all problems had to be offered for solution in a quantitative form, even though the subject matter was not particularly suited to that form. There is a continuing pressure to utilize numerical rating systems in competitions even within the Navy.

In general, the experts who are "helping" us with instructions on how we should do our business have no experience in the field. It seems that most of their ideas solve problems which don't exist, or have no bearing on the problems which do. There is altogether too much emphasis placed on standardizing methods and formalizing procedures which limit our ability to get the job done with a minimum of effort. Flexibility is needed.

Point Systems

A point system used by our sister service on a new fighter some time ago illustrates, in part, why I'm opposed to numerical rating systems. In this case, a total point score of 1000 was used, broken down into four "AREAS", "Operational", "Logistics", "Management" and "Technical." The latter was given 330 points out of the total. The 330 points were broken down into "ITEMS" with one of them, "Air Vehicle", assigned 100 points. In turn, the breakdown continued into four "FACTORS", one of which was

"Aerodynamics", made up of 6 "SUB-FACTORS", the last of which was "Performance". It is apparent that out of the total of 1000 points, only about 5 were used for what we in the Navy consider the most important characteristic of a combat airplane.

Other disadvantages of point systems are well known to those experienced in the art. Almost as much effort is required to establish the point system as to complete an evaluation of the proposals. To complete the scoring system all designs must be given the same detailed treatment, requiring as much effort on the worst as on the best. This is an inefficient utilization of our limited manpower.

Summary

In summary, we believe that the design competition method of selecting a contractor, as we have practiced it in naval aircraft procurement, has demonstrated its worth. We take full advantage of our experienced personnel, we try to be fair with industry, and to date, have had no trouble in justifying our recommended selections. We know of no simpler system that is not objectionable on many other grounds.

We think our system works, and for those who disagree we have the following quotation:

"Your knowledge of the facts is so incomplete that you not only never did, but even more obviously do not now, know what you were or are talking about."

Exhibit A-3. Retype of a paper by G. A. Spangenberg presented at the 33rd Annual Conference of the Society of Allied Weight Engineers, Inc.. 6-8 May 1974. SAWE Paper No. 1020.

AIRCRAFT PROPOSAL EVALUATION METHODS

This is a management rather than technical type of paper. It solves no problem for the weight engineer working on a new proposal but does give him some insight on the process of aircraft evaluation and contractor selection as it has been practiced in Navy design competitions, and as compared to Air Force Source Selections. The record of the Navy is defended and a case made that the design competition method is a fair one and should be continued. The opinions expressed are those of the author, who recognizes himself as a prejudiced observer, and are not necessarily those of the Navy.

In the normal course of events, military aircraft proposals are submitted to a government agency for evaluation and selection of the contractor who will receive a contract. It is essential to all participants that the evaluation and selection process be conducted with integrity and not allowed to disintegrate in a morass of engineering incompetence leading to a decision based on political favoritism. Although there appears to be wide-spread scepticism that any competitions are run fairly with awards based on merit (1), the author knows from first hand experience that nearly all the winning contractors in Navy run, formal and informal, aircraft competitions since 1940, deserved to win. Below are listed the only cases which can be recalled in which the award was made to other than the best proposal as determined at the evaluation board level:

(A) In 1962, Deputy Secretary of Defense Gilpatric overruled the Navy and directed award of the X22 to Bell on the stated grounds of "experience and past performance" (in the VTOL field). So called "industrial statesmanship" actually appeared dominant in the decision, with Douglas and Los Angeles needing work less than Bell and Buffalo. This was the first case in which a service decision was overturned by OSD. (2).

(B) In 1958, the W2F-1 (now E-2) award was given to Grumman on industrial statesmanship grounds after an initial recommendation had been made for Vought. This decision was made within the Bureau of Aeronautics, and at a level which would now be the Source Selection Advisory Council.

(C) In 1940, an award was made to Boeing for the XPBB-1, but only after Vought-Sikorsky was announced as the winner and paid for their design effort.

The record of the Naval Air Systems Command (NavAir) and its predecessor agencies, the Bureau of Naval Weapons and the Bureau of Aeronautics thus have a integrity average of about .980, with only the W2F-1 award really counting against them. The XPBB-1 award was honestly handled, and the X-22 was obviously beyond the control of the Navy. The procedures and methodology used in attaining this record have changed very little over the years, although the appearance has been tailored to conform with Department of Defense Directives and overall Navy Instructions. Every effort has been made to continue the tradition of giving all competitors a fair chance, ensuring that the rules of the game are understood, and avoiding as far as possible unduly restrictive practices in the name of security. If our acquisition system is to succeed, the best proposal must be allowed to win competitions, so that the rewards of production can be achieved by the contractor and the best possible weapon made available for use by the service.

Although occasionally an airplane, such as the A-4, is developed as a result of an unsolicited proposal followed by a sole source negotiation, the great majority of our weapon systems result from some form of competition. In the Navy's case, the process is still called a design competition, as it was in the 1920s, in which qualified bidders are allowed to demonstrate their technical competence by submitting design proposals. After the proposal reaches the government a two step process of evaluation and selection starts. These two steps, while distinct, are interdependent, and should not be separated. Probably the fundamental difference in philosophy between the procedures as practiced in navy aircraft competitions and those followed by the other services is that the navy has not separated them while the others tend to isolate the evaluation process from that of selection.

Although this paper concerns itself primarily with the evaluation and selection portion of a design competition, some comments are necessary on the whole of the acquisition process, which starts in the Navy case with a need developing in the fleet. The need is reduced to a "Requirement" in a closed loop operation between the engineers and operators involving conceptual studies, operational analyses, scheduling and budget studies. After completion of this phase, and with the project firmly in planned budgets, the competition process itself starts with preparation and issuance of a Request for Proposal (RFP) to a selected list of bidders for the development of an aircraft, and sometimes (and preferably) for a follow on production quantity. The process is completed with the signing of a contract. The procedures used are not necessarily applicable to study efforts, to small hardware developments, nor to exercises such as those conducted recently in the name of "prototyping." The rationale for that type of acquisition will be left to those speculative theorists who devised them.

In the Navy system, the RFP is prepared as a joint effort by individuals within the NavAir functional groups and divisions who will later evaluate the proposals, administer the contract, and monitor the development. The RFP includes a type specification for the aircraft which allows wide latitude for design freedom, but spells out the basic performance, strength, and mission requirements. Rules for government or contractor

furnished equipment are given. Lists of acceptable power plants are noted. The intent, basically, is to define the product in enough detail to allow a wide open competition for the airframe portion of a well defined weapon system. For example, design competitions should not be used to select between different concepts such as a high endurance, subsonic, long range missile carrying aircraft versus a supersonic, short ranged, dog fighter. In addition to the aircraft design and contractual requirements, the RFP includes requirements for design data, tests, logistic programs, and management information for the development phase as well as the data requirements for the proposal itself.

The RFP is forwarded to a bidders list normally established in advance by a "letter of interest" to those manufacturers considered fully qualified to develop and produce the aircraft. Manufacturers who are not included on the bidders list are usually permitted to submit proposals if they request the opportunity. Their non-inclusion on the original lists however, serves as a warning that a large scale bid effort may be unwise on that particular development. In recent years, the amount of control exercised by OSD has increased to the point where approval of the RFP by elements of that organization has been required prior to release.

After a period of time, normally three to four months, the bidders deliver their completed proposals, and the evaluation phase of the competition starts. In NavAir, the effort is coordinated by a small division charged with that responsibility for many years. The objective of the evaluation effort, of course, is to develop as consistent a set of facts as possible on the competing proposals so that valid comparisons can be drawn and overall merit determined. The evaluation is conducted in place using the same people who collaborated in developing the RFP, and many of whom had also been involved in the conceptual work preceding the competition. Independent estimates of weight, performance, and cost are prepared, and all other parts of the proposals reviewed. After that review, each division prepares a memorandum summarizing the evaluation for the items under its jurisdiction and including ratings of acceptability for each design and relative rankings. The evaluation task is more difficult than might be surmised from the brief description above. The process must normally be conducted in too short a time with too few people. On an average, the government review period is about half that used by each contractor in his formal preparation of the proposal, while the number of evaluators available is but a fraction of those used by each bidder. This time/manpower constraint is particularly critical in the areas of weight, performance, and cost where the Navy, at least, produces its own estimates and uses them, almost exclusively for selection purposes. The individual evaluator must be experienced in his particular field, must be one whose estimates have proved sound, and whose judgment is respected by his industry counterparts. As an example, the engineer in charge of the weight estimates is expected to develop a full weight statement on each design as it would be delivered for service use, fully comparable with the other competing designs, and also with the operational inventory. The estimator obviously must have his methods well developed prior to the competition, and must have a close working relationship with the specialists in other design areas. Before the estimate is complete, it must reflect the changes and corrections being requested by other divisions, structures, materials, power plant, etc.

The task is difficult; it is not as some imagine, a brief perusal of the submitted report followed by a scoring mark, nor the application of a percentage correction factor based on a bidder's past record. The job of the estimator is aided immeasurably by submittal of sound estimates by each bidder backed up by a clear, but concise, justification. When the government's estimate checks that of the contractor, the justification is obviously not as necessary as when differences do exist. When a bidder submits a low estimate, either in absolute terms or in comparison with the other proposals, his justification is the only hope he has for acceptance of the low figure.

Following completion of the initial evaluation with comments on hand from all divisions, the selection process starts. The methodology is simple, comparisons are made, and the least promising designs eliminated, including any design with a major deficiency. Although the precise definition of such a deficiency has never been made, it is really one which would require major redesign to correct. In general, the preliminary design groups in industry would agree on the type of change which would eliminate a competitor. Examples could be a weight empty estimate which is low by 15%, a wind over the deck required for catapulting of 20 knots when 0 knots was required, or a radius of 375 mile when 500 was required. It would not be the change of a flap angle to correct a single engine rate of climb or take-off distance deficiency, nor the selection of too low a maximum structural design take-off weight, nor the use of non-qualified ejection seat. All of the latter items while requiring correction, would not be regarded as the sole grounds for elimination. In the usual case, the final selection is made after narrowing the field, and re-estimating the remaining designs when each is corrected to the configuration which would be procured. In this step, structural design and equipment differences are resolved as necessary. The winning design is selected by straight comparisons, considering all factors, design, management, logistics, cost, and schedule. The initial selection is made by agreement between those who have been running the competition, the Project Officer, and the Program Manager. Current directives require a formal Source Selection Evaluation Board, Source Selection Advisory Council, and a Source Selection Authority. The latter is normally the Commander, Naval Air Systems Command,, while the Council is composed of his Assistant Commanders who head the functional groups. The Evaluation Board is composed of the involved Division Directors. The decision chain has really not changed from that always used in the Navy aircraft process. As would be expected, the individual evaluators are responsible to their Division Directors, who comprise the Evaluation Board, the Directors are responsible to their Assistant Commanders, who comprise the Councils and who in turn are responsible to the Commander.

During the competitive process, communications between the manufacturer and NavAir are minimized and controlled, but not eliminated. Questions from a contractor are answered directly as promptly as possible, and then the answers made available in writing to all bidders if the question and answer are of general interest. During the evaluation period, requests for clarifying data are again controlled, but transmitted promptly to the bidder. Additional information offered by a bidder after proposal

submission is usually accepted, if the intent is to clarify or amplify the proposal rather than to change it.

Following announcement of the winner, bidders are individually debriefed if they so desire. Normally, the initial debriefing session is limited to an overview of the competition, perhaps two hours in length. The contractor is shown the weight and performance estimates used by the Navy, together with the evaluation comments on his design from all the divisions, and is provided with the rationale for the selection decision. Comparisons with other losing designs are not made. In subsequent sessions, the contractor and Navy engineers get together to review the evaluation in more depth in each area. Although the basic intent of debriefing is to enable the manufacturer to submit a better proposal in the future, by avoiding the repetition of mistakes, it also has a beneficial effect on the objectivity of the evaluation, since each evaluator knows he may have to discuss and justify his comments to his counterpart in industry.

In the mid-fifties, the Air Force changed their contractor selection method from that of a design competition to "Source Selection." Their version of a design competition had been similar to that of the Navy but conducted with greater formality, and security, and with the selection decision made at higher levels, normally by the Secretary of the Air Force. At the time of the change in procedures, the Air Force publicized the move as a means to reduce bidding expenses and to use technical manpower more efficiently. (Some cynics, however, attributed the change to the apparent number of decisions made in the Pentagon which differed from the recommendations emanating from the evaluators at Wright Field. If political decisions were to made, the procedure might just as well be adopted to it). In "Source Selection", as first conceived, only brief management proposals were required to be submitted from the industry. No actual design work was to be done until after selection of the winning contractor(s), when the design would be developed in close cooperation with the Air Force in a funded effort. Although the concept was widely supported and the theory later adopted by OSD, it actually is quite unworkable in the normal case. As might be expected, "Management" proposals from major producers are remarkably similar, and provide little or no data to justify the selection of one contractor over another. There are always several manufacturers available who are fully capable of producing the aircraft, and who are unwilling to concede that any one else is better qualified. Gradually, th Air Force increased its requirements for design data on a specific design until it equaled that formerly required in its design competitions. Despite the renewed emphasis on design, the Air Force continues with the premise that only a source is being selected. Obviously, this gives greater flexibility to the decision maker, but leads to greater justification problems, and tends to obscure the rules of the game for everyone involved.

By 1960, the Air Force procedure had settled down to one which was built around a System Source Selection Board (SSSB) which directed the activities of an Evaluation Group (EG), and which recommended a winner through a chain including their System Command, Logistics Command, "using" Command, the Air Council, Chief of Staff to the Secretary. A point scoring system was used with the Evaluation Group raw scores

being weighted by the SSSB before their use for selection purposes. The point system was used as a guide at the SSSB level, and did not automatically determine the source, although this point was apparently not fully understood by higher authorities. The Army had a similar procedure. OSD started standardization efforts in the early sixties, which eventually culminated in the adoption of a system similar to that outlined in the Air Force regulations. A significant difference, however, was that the evaluation and selection processes should be divorced. The philosophy behind this change was expressed by a former OSD official during the TFX hearings [3] as:

".... it turns out in practice today to be difficult if not impossible to alter a source selection decision on a major procurement action unless you are willing to send the Source Selection Board back to work with new instructions. Otherwise you are placed in the position of making an arbitrary change in the face of a fully objective procedure and determination. That is, in general, infeasible. It is very time consuming, and it exposes the senior decision makers to potentially severe criticism and even outside pressures. It is practically never done.

The process I have described would put the senior, responsible people in the position of making rather than approving or merely presiding over decisions already made. Above all, it would mean that one could consider the relative merit of one selection in comparison with another by noting the effect of slight perturbations in the value assigned to the evaluation criteria. Sometimes a very small percentage change in these alters the outcome of the evaluation completely. These are the circumstances under which the overall judgment of the most senior and responsible officials is not only needed but is indispensable, for otherwise selection almost automatically results from evaluation."

It is clear that those espousing this philosophy had no confidence in the ability of those at lower levels in the Defense Department who had been evaluating and selecting aircraft for years. (However, it is freely admitted that the reverse was also true, viz., that those who had experience in aircraft evaluation and selection had no confidence in those who espoused the above philosophy).

Before commenting on the differences between the Navy and Air Force systems, a more detailed description of the latter as practiced in the TFX and C-5 cases.[4][5][6] As noted before, Army and FAA procedures have been quite similar. The SSSB is composed of one voting member from the "Using" Command, Systems Command and Logistics Command. Other representatives of each of these Commands are also members and attend the SSSB meetings. The SSSB utilizes a small ad hoc committee, normally including experienced personnel, as staff to prepare the SSSB action papers, including staffing of the Evaluation Group, establishment of the point system, and description of the criteria. The members of the Evaluation Group prepare "Standards" for the criteria against which the proposals are scored using a rigid scoring system (10 Excellent, 8 Very Good, ... 2 Poor, 0 Unacceptable). After the evaluations, the Group and team leaders present the evaluation findings and raw scores to the SSSB. After a full

discussion of the evaluation with members of the Evaluation Group, the latter are dismissed. The board then converts the raw scores into the final weighted scores using weights previously agreed upon. The voting members, in executive session, formulate their recommendation for award with a very brief rationale for the decision. As noted previously, the recommendation is forwarded to the Secretary through the decision chain of the Commanders of the involved commands, the Air Council, and the Chief of Staff. Each member or group in the chain can either concur or recommend alternative courses of action. The entire recommendation process is even more closely held than is the evaluation itself. Briefings by the Evaluation Group members are usually given to those in the selection chain prior to the time they make their recommendations. When the Secretary's decision differs from that of the SSSB, a rationale is normally prepared by his staff. (5)(6)

There are obvious similarities, particularly in external appearance, of the systems used in the past by the Naval Air Systems Command, and those used by the other services, but there are also significant differences, some of which are:

1. People — The Air Force and Army use relatively large ad hoc evaluation groups (400 reported for the C-5A, about 100 for the Army's HLH), while the Navy uses its functional organization. The difference really is that the Navy calls on all of its staff on a part time basis, while the others use part of their staff on a full time basis. The Navy's job is also eased by the fact that it has had a small, relatively stable division charged with the responsibility of running aircraft competitions for many years (now on only its third Division Director since the 20s).

2. Location — the Navy aircraft competitions have all been run in place, with each evaluator allowed to work at his own desk, with his own files and equipment. The Air Force normally groups their effort in a separate facility on the base at Dayton, while the Army seems to run to remote locations. In place evaluations are obviously much less expensive, and far easier on the evaluators. The arguments against the practice are interference by routine business, and lack of security. The lack of full time attention cannot be argued factually, but in no other practical way can all of the best people in the organization be brought to bear on the problem. The security argument is specious, as all parts of military procurement agencies routinely handle problems with an equally high degree of confidentiality.

3. Criteria and Instructions — The Navy system permits the process to be carried out with a minimum of instructions to the evaluators (usually a single page memorandum), since all divisions have already been involved in the particular project, all have a normal responsibility for evaluation work, and have done them before. The other services have run from 15-20 pages of "Criteria" and "Instructions" to the evaluators to a 1 inch thick "Handbook" used by the FAA on the SST evaluation.

4. Estimating Quality — The most effective deterrent to competitions becoming "Lying contests" is by the development and use of sound and comparable data on all the proposals during the evaluation. In the services other than the Navy, the ad hoc type of evaluation organization invariably suffers from a shortage of fully qualified personnel to do the most difficult tasks, the independent estimates of weight, performance, cost, and flying qualities. The shortage is related to the basic organizations of the other services which are of the project, rather than functional, type. No Program Manager will willingly release perhaps his only weight specialist to a new evaluation project for a significant period of time. The problem is also compounded by the requirement for estimators to prepare "Standards," fill out rating sheets, and write justifications for those ratings on factors and sub-factors included in the total point rating system. The Navy consistently rates each design against each other, while the Air Force has insisted on rating against a "Standard." Although the difference appears subtle, it assumes more importance when one is advised that even though "A" rates higher than "B" against a "Standard" it does mean necessarily that "A" is superior to "B." In general, more emphasis is placed in Air Force evaluation on th plan to achieve a design, than on the design actually presented.

5. Decision Process - The Navy selection decision starts at the evaluation level, is made by agreement between technical and operational types, who present their recommendations openly in all presentations. As the process reaches higher levels, the presentation is normally restructured to suit the audience. The Air Force gives the same evaluation briefing to all levels with no recommendations included since the presenters are not privy to that information. The recommendation channel is a one way channel without feedback. This can obviously lead to peculiar results when presenters from the Evaluation Board who believe "Contractor N" has been recommended answer questions from a Secretary who has been informed that "Contractor E" has been recommended by the Selection Board.

6. Decision Level — In the Navy system, the Selection Authority has been held at the level where the technical language of the aeronautical profession is understood, and the implications of design deficiencies appreciated. In any system which requires the decision to be made by one who understands neither the language nor the implications, the chances of an unfair decision are greatly increased. The time constraints under which the Secretarial level is forced to operate also tends to preclude full disclosure of all relevant issues and factors.

7. Total Effort - Few statistics are available to compare directly the total effort required in the evaluation and selection process, and those that do appear suspect. The Air Force reported 275,000 man hours expended during the four rounds of the TFX selection, while the Navy reported 4000 man hours on the X-22. The Navy's part in the TFX effort was estimated at 10-12,000 man hours which appears fairly consistent. Although there is no doubt that the NavAir system requires less effort, it is not claimed to be in the ratio indicated above, but is certainly less than one half.

8. "Security" and "Control" - Evaluation efforts in the other services are hampered to a significant degree by restrictions imposed in the name of "security" and "control." There have been cases where evaluators were forced to complete one design before starting on the next, precluding comparative study. In other cases, "Technical" teams have been isolated from "Operational" teams. In many cases, cost proposals are withheld to an unrealistic degree. While restrictions against disclosure of evaluation results are understandable, restrictions against disclosure of evaluation methods are not. Nor can one understand the need for use only of specific notebooks locked up at all times except when in actual use. Prohibitions against contact with the manufacturer except by written communications through a contracting officer have prevented badly needed meeting of the minds, during both proposal preparation and evaluation. It is often quite unfair to not answer a question from a bidder, or not to obtain clarifying information.

9. Page Limited Proposals — The requirement to limit the number of pages in a proposal has frequently been employed by the other services to the detriment of the evaluation process. All too frequently, the page limits are set without regard to the data requirements in the same RFP, which makes the proposer's job impossible. Not as apparent, however, is the fact that the evaluator's job is also made more difficult, both by lack of data and by unreasonably small printing. In many cases, missing data are supplied later in response to inquiries, but time has been lost.

10. Debriefing — Debriefing in the Navy system has provided the government weight and performance estimates to the bidder, while the other services, although not consistent, have sometimes provided only generalized comment. Following the early rounds of the TFX source selection, for example, bidders were advised that deficiencies existed, but the magnitude (and sometimes even the direction) was not defined.

11. Before concluding this paper, some comment should be made on the role of cost quotations in the selection process. During the period when Navy initiated development with a cost reimbursement type contract for an experimental quantity of aircraft, cost quotes had virtually no influence in

selecting a winner. This does not mean that price was not a factor in the weapon systems which were being developed but only that this type of cost quotation, in a competitive environment, had proved unreliable. Comparative cost could be judged more accurately by looking at other characteristics, weight, size and materials. As budget pressures increased, cost considerations become more important, leading the Navy to turn to fixed price type contracting in the early sixties. This eased some budget problems by eliminating the cost overruns experienced with cost reimbursement type developments, and also allowed price to become a significant factor in competitions. To reduce the possibility of "buy-ins" on the initial contract, ceiling price options for follow on quantities then became a standard part of the Navy acquisition process on all relatively conventional developments. This step made the evaluation and selection process more difficult by introducing the possibility of a Quoted Price/Design Merit tradeoff. Small differences in total cost would not change a merit decision, but large differences would require a corresponding margin in capability. No good solution is yet apparent to the problem of fixed price quotations from responsible producers which are well below the government estimates. The procuring agency is subject to criticism if the contractor is not held to his bid, but then is later criticized for accepting a "buy-in" when large losses occur. My personal conviction is that the government must base the award and negotiate the contract on the basis of the bid known to be low, but only when the total estimated loss is within the capability of the contractor to absorb. The Navy's record in holding a manufacturer to his commitments in aircraft competitions has been quite consistent, those who underbid on the fixed price deals lost money. The record of the other services has been less consistent. The Army held the line on the OH-6, one of the most underpriced awards in history on a percentage basis. The Secretary of the Air Force in the TFX decision gave credit to a slightly higher bid on the basis of cost realism, but used a lower price in the C-5 case to justify the award. (6) A repricing formula included in that source selection was apparently intended to limit the loss of any of the potential contractors (regardless of the actual price which might finally be reached), making the use of cost quotations as a primary selection factor of doubtful merit.

12. In my opinion, the record clearly justifies the continued use of design competitions as the preferred method for selecting contractors for new aircraft development. As practiced by the Navy, the rules of the game have been established by consistent usage to give the industry proposal teams a fair chance to win and earn their reward. Although no other system has been shown to offer such uniformly satisfactory results at a minimum level of effort, it is in danger of being destroyed by strict adherence to DOD policies and regulations adopted initially in the name of standardization. The system can also be destroyed by allowing the

technical competence of the procuring activity to fall below the level required to produce accurate estimates of the weight, cost, and performance characteristics of the competing designs. In recent missile competitions, the Navy itself has followed some of the practices which have been criticized in this paper as non-productive.

13. It is also clear to me that the selection decision, and the control of the entire evaluation and selection process, should be made within the organization which is to bear the detail development responsibility. The selection decision itself should be made, in fact, by those who are intimately familiar with both the proposals themselves and the ground rules employed during the entire competition. Those higher in command within the service, or in OSD, are remote from the process and must use facts presented to them in a highly condensed format. When their decision differs from that of those more directly involved, the probable cause is a lack of communication rather than any fundamental difference in judgmental ability.

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3. Senate, Permanent Subcommittee on Investigations, Committee on Government Operations, "TFX Contract Investigation," Part 5, page 1295.
4. Ibid, Part 1.
5. Ibid, Part 2, Page 350.
6. Senate Armed Services Committee, FY 1970, Mil Proc. Auth. R&D, Part 2, Page 2009.

Exhibit A-4. A draft of remarks concerning procurement presented to the Society of Experimental Test Pilots at their Annual Convention in Los Angles, 1974. The panel was supposed to consist of Spangenberg, Senator Cannon, Mr. Packard, and Dr. Currie. All but Mr. Spangenberg cancelled out. The final presentation was taped and printed in SETP report of the convention proceedings.

REMARKS

I'll start by thanking the SETP for giving me the privilege of participating in this program with such a distinguished group of panelists. I particularly want to thank the program committee for their assurances that I need not agree with any of them. As some of this audience knows, I am already on record as disagreeing on the merits of nearly all OSD initiated defense management procedures, and on the merit of all OSD directed multi-service aircraft development programs.

Needless to say, I am talking to you today as a private individual and not as a representative of the Navy.

My biggest hang up is that both OSD and the Congress seem to consider the services to be grossly incompetent, and only interested in spending more and more of someone else's funds. We have been getting lectures on our wasteful procurement methods, our overruns, and on our unwillingness to use products developed by others. From where I have been sitting, I believe most of the criticism is unfounded, and usually misdirected. Our tasks at the working level in naval aviation have been made much more difficult over the last 15 years by the rash of innovative management techniques directed from above which either offer solutions to problems which don't exist, or are not applicable to those which do. As I have indicated, my experience is all in naval aviation. We have made mistakes in the past and undoubtedly will in the future, but we have tried to heed history and in so doing, to avoid repetition of our errors. Overall, I think our record is pretty good, and would have been better if we had the intestinal fortitude to resist more strongly the pressures for innovation in some programs and compromise in others. Some of those pressures have come from within the Navy, as well as outside of it. All of us would like to be judged on our record of accomplishment, and we tend to resent criticism on those items over which we have no control. For example, the sins which may exist in ship building, tank, torpedo, or ABM programs, should not be used to smear those involved in completely separate activities. The Navy may be the Navy, but ship building and aircraft procurement have little in common, utilizing as they do, completely different segments of industry with widely divergent material, design, and production practices. The lack of specificity by those who criticize defense procurement has long been evident.

Since I imagine we would all agree with the proverb that reasonable men will reach the same conclusion if given the same facts, I must assume that those at the top of the OSD hierarchy have been operating on a different set of data than are available at my level.

Let me try in the next few minutes to show you some of our history, review our mistakes, and explore some of the reasons for the differences of opinion between us on the issues of prototyping, fly-before-buy, concurrency, design-to-cost, joint service development, high/low mix, independent T and E, fixed price development contracting with a production commitment, innovative alternative approaches, etc.

Let us look first at the Navy's aircraft acquisition record the last 40 years. The first chart shows the airplanes we have started each year since 1935 - Note we averaged six new starts per year during the 40s, four during the '50s, and only about one since the '60s. Our production delivery record is shown on the next chart — we reached a high of 22,000 airplanes in 1944, and have now reached new lows. In each of the last two years, we have actually had fewer aircraft deliveries than in 1935. Our total deliveries of all types last year was about half a single month's production of the Hellcat at Grumman during World War II. In this sample, we have examples of prototypes, fly-before-buy, and concurrent production programs, together with nearly every conceivable contract type from firm fixed price to cost plus fixed fee. We are also familiar with the results, predictable and otherwise, of the procurements of the Air Force and Army.

Until the time of the build up for World War II, the normal aircraft acquisition method used by the Navy was a true fly-before-buy, competitive prototype method. The last Navy fighter to reach the fleet using this procedure was the Vought F4U Corsair started in 1938. As time became more important, and greater fleet capability was needed to meet the predicted threat, production release became mandatory prior to flight test. The technical community actually opposed the change in procedure at the time, fearing a degradation in quality, but timing and cost advantages prevailed. During World War II, the important programs, with an average degree of risk, were all conducted using major overlaps between development and production. Highly experimental and low pay off programs continued to be conducted on a prototype basis. Contracting changed from almost wholly fixed price to almost wholly cost plus during the early 40s. A comparison of the timing difference between the fly-before-buy F4U and the Navy's most ambitious concurrent program, the F8F, is shown on the next chart (*editor's note: the chart was not in the papers found)*. This highly successful design deployed and was enroute to Japan when the war ended.

The very rapid rate of production build up, which was used in those days led to the potential for large retrofit costs which could not be tolerated in the reduced budgets after the war. Hence, the acquisition process was changed to hold the rate of production low for about a year, with each program tailored to the particular circumstances surrounding it. Contracts for experimental aircraft preceded the production contracts, but the designs were engineered for production from the beginning. Occasionally, fly-before-buy policies surfaced in this era, but were dealt with without disrupting the planned program generally by ordering more experimental, or service test, models. The original Vought F8U Crusader program, started in 1953, became a model for most subsequent Navy procurements, and is shown on this next chart.

Another perturbation in the development of the acquisition process occurred at about the same time in the funding area, when authority was granted to use the scarce R&D funds only for a very small portion of engineering development, e.g., from go-ahead to mock-up, on those designs programmed for production. Predictably, more starts were permitted under this procedure, but shortages in later production funding caused problems. Overruns on the cost plus A3J, W2F, and A-6 programs also contributed to a major budget squeeze, and finally forced cancellation of several projects.

The final major change in our general acquisition strategy then addressed this problem. We found industry was willing to undertake development of our relatively low risk programs on fixed price type contracts with ceiling price options for follow on production quantities. With the maturity of our industry and operating within reasonably well known variables, this was feasible. This method was used on most of the new developments from 1961 on, including the CH-46, A-7, OV-10, F-14 and S-3, solving most of our overrun problems within the government and transferring the problem to the contractor in some cases.

So much for our acquisition process development.

We can now look at our history of new designs since 1950 to see if a pattern of success or failure can be detected. First, let's examine the prototype record. The nine models shown in red are those which we prototyped and for which a production commitment was either deferred or not really contemplated. They included: HCH, HRH, FY, FV, ROE, RON, TT, VF/VTOL, and X-22. None of these designs was continued beyond the prototype stage.

Of the remaining models two were terminated almost immediately after starting; the F6D by OSD in favor of the joint TFX program, and the P6Y by the Navy because of budgetary inadequacies to continue seaplane development. Three more were terminated after some flight testing: the P6M, because of two crashes, some technical problems and very high support cost; the very successful F8U-3 because of Congress's determination to eliminate duplication, and finally the F-111B by Congress eliminating production funding after a long fight.

The remaining models all saw, or will see, service use, one criterion of success. It can be concluded that prototyping is certainly not necessary for those designs for which a technically competent design organization contemplates production. Prototyping saves money over a well planned concurrent program only when the program fails and is terminated. A case for prototyping over a well planned concurrent program can be made only when the program fails technically, and unpredictably. If it fails as predicted, or because of budget inadequacies, even more money is saved by not starting the project at all.

A strong statistical case for concurrency can also be drawn from observing the experience of the major transport producers in developing their wide bodied models

without government support. Time is so expensive in terms of interest on borrowed development capital that prototyping is quite impracticable. The 747 was produced and reached service in about half the time needed for the Army to prototype, test, select, develop and produce their light observation helicopter.

The next item on OSD's list of buzz words that I'd like to address is the so-called high low mix concept. My thoughts on this subject are detailed in an article in the September issue of "Astronautics and Aeronautics", the AIAA publication, so let me just show you what the financial implications seem to be. As a solution to our inadequate budget, OSD is pushing an idea to buy some airplanes capable of meeting the best of the enemy, and to buy some cheaper models which would be programmed to fight only the low end of the threat. Although such a naive assumption is difficult to imagine coming from the department charged with the security of the country, even the claimed cost savings appear highly suspect. As a first order approach, one can assume that development and production cost both vary directly with weight, that the reduced capability design weighs about .7 that of the full capability design (at equal range), and that cutting production rates in half decrease the benefit of learning curves from 80% to 85%. As I run out the numbers, a mix of 400 each of high and low capability designs costs about 40% more than buying all of the better design. The result is shown on the chart.

The next of my selected OSD management targets is the so-called design-to-cost program. As initially conceived, the idea was to fit defense programs of the future into estimated defense budgets of the future. One can hardly disagree with that, but one might wonder what the proponents of the idea thought had been going on during each year's budget preparation. Another logical step, of course, is to ensure that the cost of any new program can be justified using cost/capability/schedule tradeoffs. Beyond these points the program goes divergent with ill stated goals which seem to imply that the design be continuously changed as necessary to remain within a cost budget. There has been talk of making cost a design variable during the entire development cycle, a concept which immediately reaches a new level of speculative theory. In the real world, we must consider cost during the conceptual and definition phases of any new program, but once embarked on the development, changes must be minimized if cost is to be minimized. All of our past experience shows this to be true. One should also realize that any acceptable cost/performance tradeoff change introduced during a program to reduce cost should have been made at the beginning in order to save even more.

My final subject is that of OSD's apparent obsession with joint development programs designed to make one product work for more than one service. In concept, it has merit, using my high/low concept arguments on the desirability of greater numbers, and a single development. However joint programs directed by OSD over objections by the concerned services have failed to produce savings in any case to date, and in most cases, have failed to work at all. The problem is usually one of technical infeasibility of meeting differing requirements with a single design. Both Congress and OSD have apparently directed the Navy to use a version of the YF-16 or YF-17 as a carrier based strike fighter. One would think that the unsatisfactory experience with the TFX and the

Tri-Service Transport, coupled with the satisfactory F-4 and A-7 program would prove conclusively that the land based/carrier based interchange is completely a one way street. In the case now being addressed, the Air Force could operate a Navy carrier designed airplane without requiring significant changes. That airplane, however, should be heavier, less capable, and more expensive than a pure land based airplane and hence less attractive to the Air Force. The transition from an Air Force to a Navy carrier based airplane involves major redesign, and would probably involve a greater, rather than lesser, total expenditure.

The heavy lift helicopter experience in which OSD claimed cost savings by combining Army and Marine requirements into a single development is also related to this subject. Mr. Packard eventually separated the two programs when the true facts were finally established.

Independent T and E is another grossly overdone discipline directed by those at the top. The independence part is presumably due to a belief that test activities under control of a development activity will be biased, leading to a decision to produce unsatisfactory articles for the fleet. Anyone who has ever read a Navy flight test report from NATC, Patuxent River, could certainly testify to the absurdity of that belief. The developing agency usually has to be restrained from terminating the project until the test pilots report informally that the particular design while not acceptable for service use is still an order of magnitude better than anything else now flying.

UNFINISHED

Note by GAS: Actual presentation was oral , using viewgraphs, not read. This written version undoubtedly is much more succinct. SETP's idea of the panel setup was to try to get word to the decision makers of what working level really thought. It didn't work as all the invited (and accepted) panelists dropped out before the meeting.

Exhibit A-5. A retyped paper on Program Analysis and Evaluation that was part of a NAVAIR training program. *Similar pitches were given before retirement, but this was after that and done as "consultant". 1975. GAS*

[Ed Note: Charts are included except where repetitive. Chart 1 is the first chart of the Exhibits – "Naval Aircraft Starts". Chart 8 is the Cumulative Costs chart shown under VF-2, and Chart 9 is the TFX Cost Estimates chart shown under VF-2]

SESSION 14A

PROGRAM ANALYSIS AND EVALUATION

G.A.Spangenberg

Overview – Aircraft Design and Development

Session No. 30A – Summary of Navy Program Requirements

Abstract – Some insight is provided on the history of the Navy's aircraft development process, the reasons for changes as they occurred, and the lessons learned from the successful and unsuccessful programs.

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Subject: Navy Aircraft Programs, History and Lessons Learned

1. Santayana observed that, "those who fail to heed history are doomed to repeat it." The purpose of this presentation is to provide some of our naval aircraft history and give a few of the lessons learned from both successes and failures, so that the mistakes of the past can be avoided in the future.

2. Naval aviation started in 1910 when a civilian pilot, Eugene Ely, took off from the USS Birmingham and landed in Willoughby Spit. The following year, he took off from, and landed successfully on, a platform on the USS Pennsylvania. In that same year, the first appropriation for naval aviation $24,000, was approved by the Congress. When World War I was entered by the USA in 1917, the Navy had a total of 54 airplanes. When it ended a year and a half later, the number of airplanes on hand totaled 2107. Obviously that growth rate could not be sustained in peacetime, but naval aviation continued its progress into the modern era. Chart 1 shows production Navy airplane deliveries for the years of 1935-1970. During World War II a peak of 22000 was reached. Korea produced a slight bulge, but deliveries reached barely 10% of those during WWII. The SEA fracas provided for only a modest increase overall from peacetime practice, with total production purchases running only about 1000 involving costs.

3. A month's worth of production Hellcats of WWII is more than the total planned buy of a new fighter, or a V/STOL. This great reduction in production rate, on the order of 10:1 is a major contributor to our current problems.

4. Chart 2 shows all of the new airplanes started through the same time period of 1935-1970. During the decade of the 40s, on the average, six new airplanes per year were started, only slightly less than the average of the preceding five years.

During the '50s, the average of new starts dropped to about four, while in the '60s, the average was just over one. The outlook continues to be bleak.

5. Charts 3 and 4 show plots of cumulative aircraft deliveries for a number of models versus time from initial go-ahead, and versus time from initial first flight. The following observations can be made:

   a. The F8F-1 was the most rapid of the Navy's combat airplane developments. Started in WWII, it was the light weight fighter (LWF) of its day, designed for the air combat maneuvering arena. It differed from today's LWF concept, however, in providing full armament capability and adequate (barely) fuel. Sacrificed were only the nonessentials. There was no seat adjustment provided. Altitude performance was sacrificed by use of a single stage, two-speed supercharged engine. (A two stage engine under development was planned as a growth step.) To save structural weight, "safety wing tips" were provided, and the overall factor of safety reduced from 1.5 to 1.4. The design was in today's parlance, a minimum risk project, built on the firm background of the F6F series, using a proven engine and propeller, and the best available armament. Production plans called for reaching a 500 per month rate in about two years from go-ahead. When the war ended, a squadron had deployed and was on its way to Japan, and production reached about 200 per month.

   b. The A-1 (started as the BT2D) was the second most rapid development of the era. It was a solid development built on the failure of the SB2D, a two-place airplane with remotely controlled top and bottom aft firing turrets, and with a bomb bay. The airplane was too heavy, overly complex, and few of its innovative features developed on schedule, or performed as predicted. The power plant installation was salvaged and became the base for the very successful, much simpler, single place A-1. At that time, the fly-before-buy concept had arisen again, after the WWII hiatus, so the XBT2D-1 was a prototype on paper, with no formal production release until first flight. Almost as soon as the wheels lifted off, the contractor was given formal coverage for the production effort which had been underway since initiation. Douglas, El Segundo, with this airplane started a series of well designed naval aircraft with emphasis on weight control achieved by design simplicity, good structural load paths, and a strong defense against non-essential requirements.

   c. The F-8, started as the XF8U-1, has served as a model of what a successful airplane development should be. The requirement was sound, the design competition tough, and the development well managed by both the Navy and the contractor. The design followed the quite unsuccessful F7U at Chance Vought, and proved conclusively that selection decisions can safely be made on the merit of a design, and not on the record of the

last development. There were, and are, many who fail to heed history in this regard. The F-8, while labeled as a prototype development by some because of the XF8U-1 designation applied to the first two aircraft was actually a concurrent program, designed from the outset for production, and with a production contract let prior to first flight. This procedure allows a development cycle of about four years from contractual go-ahead to fleet use, or about five years from start of specification preparation for a competition.

d. The Army's OH-6 is noted on these charts to illustrate the length of a development cycle using a full fly-before-buy approach. In that development, the Army purchased five helicopters each from Bell, Hiller, and Hughes, and conducted a fly-off. After a two step procurement competition, Hughes was awarded the production contract. It can be seen that this simple, light weight helicopter required 2-3 years longer to get into the fleet than much more demanding projects.

e. F3H and F4D designs were almost "prototypes" with production release given prior to first flight for designs which incorporated major modifications. Both were started as "interceptors" and both were produced as "general purpose" fighters in the terminology of that day. Both required replacing the unsuccessful J40 engine during development. In this case, the initial requirement was faulty, the engines were not ready to be specified for an airplane development, and the overall results were predicted by some.

6. Chart 5 provides a closer look at the airplanes started since 1950 and categorizes them as to whether they achieved fleet use, one measure, albeit incomplete, of development success. A detailed examination of all these models is well beyond the scope of this presentation, but some lessons learned and overall conclusions can be given:

a. Of the 51 airplanes started, 14 did not reach the fleet. Of these 14, three were terminated almost immediately.

i. The F6D was the "Missileer", a subsonic, long endurance, fleet defense airplane, which carried six "eagle" missiles, the development of which had preceded the airplane by a year or two. The development was stopped by the incoming McNamara administration in favor of the TFX. The airplane would certainly have been a success, but would have required a complementary fighter to handle the jobs requiring airplane speed and agility. The concept won all Fleet Air Defense operational analyses then, and would today. When it became possible to do both fleet defense and the other fighter roles with a single airplane, the concept lost its attractiveness.

ii. The VF/VTOL was a technically feasible design, with little operational capability. The Air Force took over the project, and continued it for about a year before dropping it.

iii. The P6Y was an open ocean ASW seaplane designed to exploit a dunking sonar. The requirement was not firm enough to support the funds required, and it was dropped from the budget immediately after the competition.

b. Of the other 11 projects which failed to reach the fleet:

i. The F-111B failed because of the technical impossibility of meeting the diverse mission requirements of the Air Force and Navy. The failure was predicted.

ii. The F8U-3 was a highly successful fighter started as a single place, single engine competitor to the F-4, cancelled by the Congress to eliminate duplication. It was carried to a "fly-off" stage, which it won in the normal sense. It had better performance and flying qualities and was cheaper. The decision for the F-4 was made because of the growing conviction that 2 men were needed for the all weather fighter job.

iii. The TT-1 was an underpowered primary trainer which verified the predictions that it should not be procured. It was actually started as an afterthought to the well planned T-2 basic trainer project.

iv. The X-22, FY, and FV were all VTOL research projects, although the latter were disguised as "convoy fighters" since pure research projects were not then popular enough to be financed.

v. The ROE and RON were one man, portable helicopters intended to investigate a concept of getting all Marines off the ground. There were few who believed in the practicality of the concept. The RON eventually became the base for the unmanned DASH helicopter.

vi. The P6M was the final attempt of seaplane advocates to continue the type as a prime military weapon. The hydrodynamic development was successful, but two aircraft were lost in accidents, and the overall cost of the program eventually forced abandonment of the concept. The requirement was questionable at best, since at the time, 2 A3Ds could do the military missions from a carrier and would cost less.

vii. The HCH and HRH were related reaction drive helicopter projects. The HRH was a secondary award from the competition which started the HR2S (H-37) and was recognized as a high risk project in order to achieve a 300 kt. Cruise speed for the Marine amphibious mission. The HCH was a crane version of the same design, with a very short range requirement. The power plants were dual T-56 engines driving T-56 compressors to furnish the air for the rotor tip burners. The project was cancelled as development problems, weight and costs all escalated, neither reached flight status.

viii. The remaining 37 airplanes all saw service use, though not always in the precise way intended. For example, the A3J had a short history as a supersonic attack airplane for high altitude nuclear missions, but a long history as the RA-5C for reconnaissance missions. All of the designs started by the Navy, and intended for service use, came close enough to their technical predictions that failure to reach the fleet was for other reasons. It can also be observed that no design characterized as a high risk project which would require prototyping, has achieved a production status.

7. The types of contract used in airplane developments have changed over the years. Prior to WW II, it was normal to procure prototype designs on a fixed price (and underpriced) basis. After a test period, production aircraft contracts would be awarded, again normally on a fixed price basis. With the changing economic conditions of WW II, cost reimbursement types became the accepted means of doing business. This type of contract allows looser specifications, and is easier and quicker to negotiate. Justification from the government viewpoint was normally that contractors would include unduly large contingency allowances in any fixed price arrangement so that the cost plus types would really be less expensive. This reasoning was debatable then and is still questionable. Because of the split in the government's budget process between R&D and Production funds, and with R&D funds tending to be the more restrictive, there was always a tendency to justify projects as "Production". In the early fifties, approval was obtained to fund new airplanes from R&D only through mock-up, or preliminary engineering. This strategy allowed many more starts than would have been possible under full funding rules, but of course, lead eventually to conflicts with other authorities on duplication and an excessive number of production models to be funded. Since the R&D budget failed to expand as rapidly as inflation in the economy did, this later led to very real problems in the '60s when purity in the R&D budget became fashionable again. Any new airplane required orders of magnitude more money than had been allocated previously. For example, the F-4 was built with no R&D funds, and the A3J with about 4 million. The current requirement for this type of airplane would be at least a half billion.

8. It was financial pressure that forced the Navy into fixed price contracting for development in the late '50s and early '60s. In the CPFF and CPIF developments of the A-6, E-2, and RA-5C, the yearly overruns were so sizable that many smaller programs had to be cancelled to fund the airplanes. The government just could not afford such overruns, and so logically undertook to get better cost quotations from its contractors. This led to getting fixed price bids as well as cost plus. Surprisingly, the fixed price bids, in general, were close enough to the others that they were more attractive. Fixed price contracts were then used for the CH-46, CH-53, A-7, and OV-10 contracts, and fixed price incentive (with a ceiling) contracts for the F-14 and S-3. Fixed price contracting is a good deal more demanding for the buyer, as well as the seller. Specifications must be solid not only for the airplane proper, but for all the test work and data required. This requires a discipline not usually appreciated. Because of the lack of flexibility provided in the A-7 FFP contract (when the contractor would not increase the quantity without an increase in unit price) variable lot prices were established in which the contractor provided firm prices for quantities 50% above and below the normal quantity. This is still the preferred method of contracting, in my opinion, but some pitfalls must be avoided:

   a. The period of time, or the number of aircraft, should be limited. The A-7 and CH-46 at about 200 aircraft, and the CH-53 at 100 were reasonable.

   b. The unknowns should be understood well enough to be assured that the contractor can produce a usable product.

   c. Government estimates must be available to give reasonable assurance that any buy-in is within the capability of the contractor to absorb. (For example, the Hughes bid for the 700 -1000 OH-6s was ridiculously low, but he was able to absorb the loss).

   d. Specifications must be firm. (The F-111 FPI contract for the R&D quantity failed to include about half the tasks. The flight test program for the F-111A was completely undefined and unpriced. Eventually, the R&D price doubled, but without loss to the contractor. (*Ed: showing the importance of specifications, this is what happened when they were insufficient*)

   e. Inflation corrections, which are beyond the control of the contractor and the Navy, should be permitted.

9. In the last two years, there has been a resurgence of interest in Prototyping, and the fly-before-buy approach. The interest was generated outside the Navy by some theorists who said that having prototypes available gave more options to the decision maker when force level budget decisions had to be made. Others felt the expenditures worthwhile to keep design teams intact and viable, while

others apparently used the scheme as a way to stall and avoid production expenditures. The GAO has fostered the approach since at least 1959 while RAND has also issued a number of reports favoring the scheme. Few, if any, of the proponents ever price out alternative programs, or offer any proof of the purported advantages. The Navy abandoned the approach because it could not afford the time and dollar costs involved. Today engineers can accurately predict the success or failure of a design. Proof of the ability to fly has not been needed for many years. With a minimum of 2-3 years longer development period, even a noncompetitive prototype program will cost 10-15% more by virtue of inflation alone. When more than one design is prototyped the cost is increased. A Navy study in 1959 showed that a multiple design and prototype approach delayed fleet introduction by 2 ½ years and increased program cost by about 25%, and this without any inflationary penalties. Answers to other proposed benefits are noted below:

a. The OH-6 example noted previously proves that prototyping does not ensure realistic price quotes for production airplanes. Buy-ins are still possible.

b. Cost savings are often cited if contractors are allowed to ignore all MIL specification. An interesting proof to the contrary occurred in the mid 40s when the XF8B-1 and XF15C-1 projects were undertaken. The former was performed without specifications, while the latter was a standard development. Both designs failed to progress beyond the prototype stage, but the non-specification XF8B cost nearly twice the price of the XF15C.

c. The XF8B-1 design also proved the absurdity of giving the contractors a free rein in establishing design requirements. The resulting airplane was a technical success, but operationally unusable, since it was mediocre in each of its possible roles as fighter, bomber, or torpedo plane.

Prototypes and research vehicles have served a useful purpose in the past and can in the future, but they have no place in the acquisition phase of a combat airplane where both time and cost are important.

10. It is abundantly clear that the most important problem facing naval aviation is obtaining enough money to procure a viable force. The magnitude of the problem can be seen by examining charts 6 and 7 which show annual deliveries again in comparison to "flyaway" dollars available in the budget. The dollars have actually decreased, while the purchasing power of the dollar has been cut in half even when using the OSD, Systems Analysis values for variation in purchasing power, inflation, or economic index. (A recent NavAir study shows a significantly worse position for that factor.)

11. The current OSD "solution" to the budget problem is to "design to cost". This is another of many programs with attractive titles, but of no real substance. Cost has long been one of the most important elements in the entire acquisition process. Alternative approaches must be priced in assessing how best to meet requirements. Once a project is defined, specifications prepared, competitions held, and a contractor selected, cost can hardly be treated as a design variable. In the design process, minimum acceptable levels are established for all features of an airplane. In theory then, trade offs are no longer possible to save cost. If lower performance or technical levels were acceptable, they should have been stated in the original type specifications at the beginning of the procurement cycle.

12. In an organization as large and as complex as DOD, a great problem exists in ensuring that the ultimate decision maker has correct facts on which to exercise his judgement. Most, if not all, of the poor decisions of the past can be traced directly to improper, inadequate, or misleading data. At the working level, invariably, the information is complete, but as the problem goes upward through the system there is always a condensation problem, and often a fallback position introduced by compromisers. Too often, "alternatives" are offered only because it is stated that some must be presented. Only a couple of examples need be given:

    a. The TFX original decision to buy a single fighter for the Air Force and Navy was made on the basis that it would save a billion dollars. This was based on data included in a report issued by DDR&E and shown on chart 8, indicating that 1000 DOD compromise TFXs cost a billion dollars less than 500 Navy TFXs plus 500 Air Force TFXs. The individual unit estimates for the three airplanes involved are noted on chart 9. Note that there is an obvious discrepancy between their compromise prices. If the decision had been made to buy the Air Force airplane, as priced by the Air Force, a saving of two billion dollars could have been realized. The decision maker was given incorrect data.

    b. In the HLH decision, Mr. Packard was presented with data, again from DDR&E, in the DCP which indicated a saving of a half billion dollars if the Marines were forced to use the Army's HLH design. Eventually, the decision was reversed when the true facts were presented, showing that the Marines could not operate the proposed design on available ships, and that even if they could, the cost was substantially greater than buying the small CH-53Es for the Marines and the very large HLHs for the Army. Incredibly, the same mistake was repeated with the new DepSecDef and again corrected. The fault in this case lay entirely with OSD staff personnel.

13. In summary, the naval aviation procurement record is markedly better than that of the other services. Most of the tactical airplanes and missiles used in Viet Nam were developed by the Navy. The system has worked well and should be retained and improved. Its essential ingredients have been:

a. Realistic requirements issued by OPNAV, after close coordination with NavAir to ensure technical feasibility.

b. Sound specification system SD-24, MIL-D-8706, MIL-D-8708, etc.

c. Honest design competitions.

d. Competent development monitoring and contract administration by NavAir's functional organization.

END

Exhibit A - 6. A retype of a letter to Russ Light at Boeing concerning the acquisition process.

5 May 1978

Dear Russ,

As I told you on Tuesday, I brought your 5 February letter to Seattle with me to answer in all my spare time. As usual, I had none, so will write this in spells, while awaiting a pick up for dinner, on my way home, and probably after I get there.

I was surprised at the length of your letter, and to some degree, the type of response my letter to Grafton had evoked (or provoked) from you. The bitterness on the military acquisition process was somewhat apparent, to say the least. As you know, I have long sympathized with your feelings on what I believed to be unfair competitions. My gripe against all you good guys is that you didn't raise enough rumpus when you were treated unfairly. There were a few cases when I personally raised more hell than the contractors who were shafted. Did you ever see my pitch on the Navy record? I rate our performance at 98% on the honesty scale over a 30 + year period for airplane competitions run by the Navy and decided by the Navy. I honestly think the winners won in all our competitions except:

1. XPBB-1 - Vought Sikorsky won the competition, but Boeing got the contract. However, it was "honest" since Vought Sikorsky was announced as winner, paid for their design, and their program was negotiated with your outfit. Later, the whole deal was cancelled and the plant (Renton) traded to Air Corps for some B-24s or something. In the long run, Boeing was probably better off with Renton. (Note I start off with the only case I know of where Boeing got the better end of the stick.).

2. E-2 (then W2F) - This competition was won by Vought, and reversed within BuAer by "industrial statesmanship" — Grumman needed production work — a problem not solved by giving them this one. I protested in writing to Chief, BuAer, and was told to withdraw my memo — I refused, but others gathered up all the copies. Vought was aware of the situation, but refused to protest officially. They should have.

3. X-22 — Douglas won the competition, against Bell in follow-up to the "Tri Service Transport" Competition, which we, the Navy ran, but tried unsuccessfully to get killed. Navy got released from participation in the "TST", but ran the ½ scale research program for the twin tanden ducted fan. As I said, Douglas (El Segundo) won, but Navy got overruled by our friends, Brown and Gilpatric. Douglas refused to protest — one of my memos on TFX competition got leaked to Congressional staffers — it included reference to X-22, and a Senate Armed

Services Committee investigation followed. Didn't help the loser, Douglas, but it did clear the atmosphere.

That was the record until the early 70s — I excluded TFX because that was Air Force management and in any event Navy actions were honest. Now to comment on your various exercises of frustration:

(1) VTOL (A). I thoroughly agree that Harrier procurement was ill-advised — I would not have done it. As you know (I guess) procurement was never recommended by the NAVAIR (BuAer, BuWeps) "technical community". Have my doubts that program to date has done much for McDonnell. AV-8B and later mods might. I really think industry should bitch on this type of government procurement but they don't — (afraid to offend the customer) —

(2) On XFV-12A procurement, I could have used a lot more help than I got. Procurement competition was handled by CNM (Tom Davies). — NAVAIR fought hard against "Ground Hugger I", but we lost again.

(3) On the current Navy V/STOL program contractors will all, except McD/D, tell you privately that the Navy is out of its mind, but everyone continues to offer support and bid actively. There is no way, the program, in toto, can be justified.

(4) Boeing ASW — I thought your efforts were worthwhile, and should have been rewarded. Neither the contractors nor the Navy did an adequate job of defending the "requirement", the size of the Pacific Ocean areas certainly made such a defense possible. Eventually, greater capability will be required — Don't give up, completely —

(5) C-5 — From the record (Congressional hearings) Boeing should have protested officially. Wonder what would have happened — Maybe Kelly Johnson would have built a 747.

(6) LWF — Can't sympathize with you on F-16 — Industry should have told DDR&E they were nuts before the "prototype" program got implemented. Boeing should have protested when Northrop got #2 award. Industry should have protested when the technology prototypes turned into a production program. I bitched more than Boeing did.

(7) UTTAS — From what I've heard, Vertol lost the "fly off" to Sikorsky. I wouldn't have done the dual fly off, but would have picked 1 winner from the initial competition.

(8) LAMPS — If Vertol didn't know they couldn't win this one after Sikorsky was selected for UTTAS, they deserved to lose. If they had any good sense, they would have bid an improved H-46.

(9) ATCA — Agree you shouldn't have bid when RFP rules showed you couldn't win.

(10) Can't really figure out how to end this letter — All of us good guys agree we should have honest competitions for worthwhile end items. I'll do what I can toward that end, as I have in the past.

Highest regards —

George

Exhibit A - 7. A retype of a paper. *Note by GAS in 1990: written in July or August of 1977 to assist the old office. Jack Wessel made it an enclosure to a memo he prepared.*

POINT PAPER

Subject: Weapon Acquisition Cycle - Overview

Ref: (a) DDR&E memo dated 10 Jun 1977 to Secs. Mil. Depts.
(b) CNM letter to NAVAIR Mat-09H/LTS dated 5 Jul 1977

Encl: (1) Chart - VF Schedules (F-8, F-4, F80-3, F-14, F18)
(2) Chart - VF Timing - Deliveries vs. elapsed time
(3) Chart - Comparison Schedules - CH-53A and CH-53E

1. Reference (a) informed the services that, as a result of Congressional criticism, the Defense Science Board (DSB) had been asked, as a part of their two week Summer Study, to examine the "Impact on DOD of the Increasing Length of the Acquisition Cycle" and make practical recommendations on how to shorten the cycle without greatly increasing the risk. Reference (b) requested data on a number of aircraft programs which in turn had been requested by the Air/CounterAir Team of the DSB Task Force. This paper will attempt to supplement the detailed information with more generalized observations on past and present naval aircraft acquisition practices.

2. The first point which needs to be considered is probably the degree to which the Congressional criticisms, mentioned in reference (a), are valid as regards the lengthening of the acquisition cycle. The detailed program information being furnished the DSB will demonstrate that the cycle has generally lengthened, although the true extent of the problem may not be readily apparent since no naval aircraft program to date has followed all the policies of DOD Directive 5000.1 and OMB Circular A-109 as they are being implemented. Also to be considered is the fact that direct comparison of aircraft programs may be misleading due to the differing circumstances almost invariably involve in each one. For example, the F-4 program is not representative of a "normal" fighter development of its era due to a premature start for political or industrial mobilization reasons, a reconfiguration, engine changes, and finally a competitive decision period, dictated by Congress, following which the highly successful F8U-3 program was terminated. The F-8 (originally F8U-1) program was more nearly representative of a properly programmed development of the 1950s. It was scheduled in accordance with the Navy's newly evolved Fleet Introduction of Replacement Models (FIRM) plan, which held production at a low rate while

adequate test time was accumulated, insuring against major retrofit changes. The same basic plan has been followed ever since when the Navy was permitted freedom of choice in structuring a development schedule. Enclosure (1) shows graphically the comparative schedules of the Navy fighters, F-8, F-4, F8U-3, F-14, and F-18, with each starting at initiation of full scale development of the configuration. The cycle shown for the F-18 is seen to have the longest period from first flight to a production build-up of any of the models, approximately three years. There is no Navy experience with a program stretched out to this extent, which even then ignores the prototype program which preceded the development, and which has been required in recent years.

3. Enclosure (2) is a plot of various fighter deliveries as a function of time after program go-ahead, which also illustrates the differences in scheduling. In addition to the models noted in enclosure (1), the older F4U-1 and F8F-1 programs are shown. The following points should be noted:

   a. The F4U-1 was the last fighter design to reach the fleet via a fly-before-buy prototype program. The production airplane design was started after flight tests of the experimental model, with deliveries building up at a very rapid rate, despite incorporation of fairly major changes. Wartime needs undoubtedly contributed to this schedule.
   b. The F8F-1 illustrates what could be done with a maximum effort program designed for production from the outset. Build-up was also rapid, but less so than for the production phase of the F4U-1. The two-year shorter time span from initiation to fleet use, as compared to the F4U-1 is obvious. The success of concurrent programs such as this was the reason the fly-before-buy concept was abandoned.
   c. A decade later, the F-8 (then F8U-1) development showed how the concurrent type of program had evolved to slow down the production build-up. Fleet use about 1 ½ years later than for a maximum effort, such as the F8F-1, was a result, but this was still at least two years earlier than possible using a prototype approach followed by a reasonable production schedule.
   d. The F-14 proceeded somewhat less expeditiously than the F-8 primarily due to funding limitations. Minimum option quantities, half of the planned rate, were ordered following the initial test airplane lots.
   e. As mentioned earlier, the F-4 program is not really a representative schedule. It suffered from too early a start relative to its engines and weapons system. Despite the length of the program, it produced a larger number of non-deployable aircraft than any of the other models shown.
   f. The F-18 is seen to have the longest cycle of any of the aircraft, at the 60th delivery, it is a year behind the F-4, two years behind the F-14, and over three years behind the F-8. From a pure airplane viewpoint, it is certainly less of an unknown than was the F-8 in 1953, as both its engine and weapon system developments are relatively less advanced.

4. One of the clearest examples of the difference between previous and current acquisition practices is illustrated in enclosure (3), which compares the schedules of the CH-53A and the CH-53E. The CH-53A represented fully as great a development challenge when it was started in 1963 as did the CH-53E when it was finally approved as a modified fly-before-buy program 8 years later. On a relative basis, the CH-53E acquisition process produces its 36th helicopter some 5 years later than did the CH-53A. Also noted is the four year delay suffered in starting the program by ill conceived attempts at the OSD level to merge the program with its Army counterpart, the HLH. The two types of delay add up to a nine year period, depriving the Marines of a needed capability, and at least doubling the price of the program.

5. The fighter schedule comparisons already drawn ignore the time required for a "competitive alternative concepts" stage as well as the "competitive demonstration and validation" stages. When these are considered realistically, the total impact on the acquisition cycle would seem to be about five to seven years, broken down as follows:

   a. Conceptual stage, formerly on the order of a year from an "Operational Requirement" to an RFP for full scale development, probably on the order of two years from a "Mission need Statement" to the RFP for the competitive validation exercise.
   b. Validation, or prototype stage, formerly not used, would consume about 2-3 years, including decision time.
   c. Actual engineering development cycle extended by approximately 2-3 years to allow for more testing prior to full scale production.

   The cost impact of these acquisition practices is obviously great. To date, prototyping costs have been partially hidden as the contractors have engaged in both "buy-ins" and in cost sharing. Introducing competitiveness into the conceptual phase, previously largely unfunded, also has some financial implication. It would appear that the inflationary cost impact would have to be about 30-40%, while inefficiencies associated with very low rate production plus the competitive prototyping increment would raise the total impact to more than 50% over what were formerly considered reasonable acquisition practices; which produced at least a generation of highly successful aircraft.

6. The reasons for the changes in the methods by which naval aircraft were procured deserves some discussion. Until about 1960, the acquisition process was determined almost entirely by the procuring agency, BuAer/BuWeps, although within the policies established by the Armed Service Procurement Regulations (ASPR). When problems occurred within the developmental process, changes were made to minimize their chances for recurrence. No

compromises were necessary to meet the practices of other parts of the Navy, or those employed by the other services, or other departments of the government. Since 1960 there has been more and more pressure applied to standardize first all military procurement practices and more recently, all federal practices, as well. Simultaneously, layers of authority have been added, and most decisions on major system acquisitions and procurement procedures have been elevated several levels. Management decisions once made routinely at the project level now sometimes reach SECDEF. With more management personnel assigned at all levels, it is perhaps not surprising that more and more changes are made in the acquisition process in the name of improving management control. The need of these imposed controls has seldom been apparent to those engineering and procurement personnel directly involved. Few, if any, of the changes made in the process since 1960 were analyzed for overall cost effectiveness. Prototyping, for example, was reintroduced despite the fact that the services had dropped the concept because of time and cost considerations for all projects considered predictable. At today's state-of-the-art, most designs proposed by the services are in this category. The great emphasis in recent years on the necessity for operational testing prior to a production commitment is another example of a control imposed without proof of cost effectiveness, as is the oft demanded separation of developmental and operational testing. Although the theory of separating development and testing may sound attractive, the necessity for it was never apparent in naval aviation, and probably in no other branch of the service where one's survival could depend on the quality of the product.

7. In naval aviation, at least, the need for all the controls now being exercised over the acquisition process has never been demonstrated. The DSARCs and now (N)SARCs which precede them, are actually duplicative of the very real control exercised in the budget process. That control has always existed, and is today tighter than ever. The obstacles through the departments, OSD, OMB, and at least four Congressional Committees should be more than adequate.

8. If a solution to the problem of a lengthened acquisition cycle is really wanted, it is readily apparent that one only has to return to the procedures and organizations in existence when the cycle was of acceptable length. The naval aircraft produced, while far from perfect, were certainly of an acceptable quality, and were produced in a timely fashion. They could be again, if freedom to do the job properly were delegated in its entirety to the procuring agency.

Exhibit A-8. A retyped memorandum.

30 August 1974

Memorandum for the Record

Subject: Multi-Service Aircraft Procurements

1. The leadership of the DOD is again attempting to bring a multi-service airplane project into being, in the name of economy, by forcing an Air Force design into a Navy mold. To date, the record of the OSD in such attempts has been anything but impressive with the next success being the first. It is clear to those who have lived through the past fiascoes that the current attempt to force a carrier version of the Air Force's light weight fighter on the Navy is also doomed to failure. In every case, the decisions to initiate the unsuccessful projects have been based on data generated within OSD which are at variance with the true facts. The decision makers should not have to contend with this type of problem, yet its incidence is high enough that its presence must be recognized.

2. Information available on the YF-16, YF-17 and their production versions, which will be designed to meet Air Force "ACF" requirements, is inadequate for performing a detail evaluation of weight, performance, schedule and cost such as was done last year on the F-15N. Lacking such information a conclusion on the merits of the proposition could be reached by comparing the current situation with past attempts to achieve economy via the multi-service route, and by analyzing the accuracy of predictions of the various organizations involved. Multi-service usage of aircraft is obviously a different problem than multi-service development. There are many examples of success in the former, and few in the latter. Possibility of success also varies with whether carrier or other shipboard constraints are involved, and the degree to which they penalize the land based model. The past attempts at joint development with shipboard constraints are discussed below:

    a. TFX/F-111 — This project was initiated by SecDef to save one billion dollars by combining an Air Force tactical fighter requirement with a Navy general purpose fighter requirement after cancelling a Navy fleet air defense project (Eagle-Missileer). The Navy and Air Force advised SecDef that no single airplane could meet a combined requirements, but the OSD staff concluded that it could. The saving was converted into a loss of about the same magnitude, the Navy deprived of an F-4 replacement for about a decade, while the Air Force design was also delayed and was less suitable than it might have been. Congress finally had to kill the effort. The culpability can be traced to poor analysis of widely differing designs by OSD staff in the spring of 1961, followed by

gross technical over optimism in August of 1961 by the same staff. After the decision to proceed was made, OSD and Air Force over optimism combined to confuse the decision maker during the source selection and development process. The program was Air Force managed from its inception.

b. Tri-Service Transport (XC-142) — This joint venture was initiated when an ad hoc study group reported to OSD that it was feasible to build a VTOL transport to meet the needs of the Marines, Army, and Air Force. The Navy, although it had disagreed with the conclusion, was assigned management responsibility, and like the Air Force in the TFX case, attempted to meet the directed goal. After a design competition and three service evaluations, the Navy reported to OSD that no single design could approach the combined requirements of the individual services, and recommended dropping the project in favor of smaller individual research programs. The Air Force and Army opted for continuance pursuant to OSD desires. The Navy was allowed to withdraw. Eliminating shipboard size constraints then permitted the project to proceed toward the less impossible goal of satisfying Army and Air Force requirements under Air Force management. Eventually five XC-142s were produced and tested. Since the original payload goal was not achieved by a wide margin, production was not undertaken. The Navy was permitted to fill the original Marine requirement by developing the CH-53 helicopter independently. The Air Force later purchased the design in a rescue configuration in production quantities. Joint development failed, but a joint usage eventually resulted on a different project.

c. HLH/CH-53E — On the advice of OSD staff, the DepSecDef made a decision in 1970 to combine a Marine requirement for a crane type heavy lift helicopter with an Army requirement. Due to specification differences in environmental conditions, the apparent compromise to achieve standardization was between a Marine "18T" capability and Army "23T." In gross weight and real size, however, the difference was at least 1:2. The army design, as first defined, could operate from no Navy ships, and as later compromised, with difficulty from but a single class of vessels then under development. On reclama, the decision to continue the joint development was made subject to review after an industry wide competition. The competition designs were in almost exact agreement with Army/Navy estimates made in 1970, leading to the decision in late 1971 to allow separate developments. Delays in the CH-53E program all at the OSD level, have doubled the cost of that program to the Marines, while the Army is still struggling under an OSD directive to preserve some degree of shipboard compatibility in their HLH design.

3. Joint <u>development</u> on designs with <u>no</u> shipboard constraints included.

a. Light Observation/OV-1 – The project started as a joint development to meet Army/Marine requirements for an observation and spotting airplane to replace OE-1s. Under Navy management, with Army project personnel assisting, the design was a success, but the Marines withdrew from the production program in order to use their funds for a completely different purpose (C-130s). The Army eventually took over cognizance of the program after several years of production. Started as joint development, it ended up as a single service project.

b. COIN/OV-10 – This program was started within OSD by combining a preliminary Marine requirement with a number of others including use as a utility transport in South America. Technical goals were overstated, and cost goals drastically understated. After much negotiation, the project was assigned to the Navy as a joint Army-Navy-Air Force program. Eventually, a usable airplane was developed, although the OSD goals were not approached, and even Navy estimates not realized. The Marines and Air Force have used it in small numbers as a spotting aircraft (FAC) and in a light attack role. There were no shipboard constraints in this case, and the OSD imposed utility requirements penalized all services equally. The OSD production goal of 500 aircraft has not been approached. An airplane designed to meet the Marine mission alone would have been cheaper and equally as useful to the other services for their missions.

4. Joint usage by other services of designs developed initially with shipboard constraints show a total record of success, as might be expected, since no service would buy an unusable design even under heavy pressure from standardization or economy advocates. The successful projects in this category include:

a. A-7 - At the time of the early TFX decision, a companion project, VAX, was under consideration as a multi-service light attack airplane for use by the Navy, Marines, Air Force, and Army. Eventually, the latter two were allowed to withdraw, since the Air Force desired a TFX type of capability for its attack aircraft, and the Army demanded a high speed helicopter. The requirements were so diverse that normal development of the A-7 was permitted as an A-4 replacement by the Navy. The airplane was an outstanding success, meeting its development goals of cost, schedule, and performance. The Marines, however, continued to buy A-4s due to its lower cost and their lesser range/payload requirement. OSD forced the Air Force to complement its F-111 force by purchasing A-7 airplanes, a lower cost alternative. The Air Force required more thrust and developed the TF-41 engine to meet its needs, and collaborated with the Navy in developing the A-7D/E weapons system capability. The design started as a carrier based airplane, and has remained under Navy management. Air

Force models while successfully employed, have never been accepted with enthusiasm by that service due probably to their subsonic performance and lack of a fighter capability as desired by TAC.

b. F-4 - The airplane started and existed for a number of years as a standard Navy/Marine carrier based fighter airplane. The Air Force had developed the F-105 as its contemporary strike fighter, In a standardization/economy move, the Air Force was forced into evaluating the two designs, after which the F-105 production was terminated. The F-4 simply proved to be a better airplane despite its built in shipboard penalties, many of which the Air Force eventually phased out, as they phased in modifications to meet their requirements. Major Air Force modifications initially included a change in the fire control system to improve air/ground capability, an internal gun, controls in the rear cockpit, and larger wheels and tires. The airplane remained under Navy management until after Navy production ceased. Air Force and foreign sales were much greater than those to the Navy/Marines.

c. A-3/B-66 ─ The carrier based A-3 was adapted to use by the Air Force first as a medium bomber and then in an electronic countermeasures role and purchased in reasonably large quantities. Significant changes in the airplane were made including a change from J57 to J71 engines. The Air Force purchase was managed by the Air Force after the Navy had run the entire development and its production program.

d. A-1 ─ The Air Force used large numbers of A-1 airplanes in the ground support role in SEA long after their production as Navy carrier based attack airplanes had ceased. This was simply a case of a service employing the best available product to do a job.

e. H-3, H-53, H-37, H-19, etc. ─ Variants of these helicopters, designed initially for shipboard use have been produced and used successfully by the Air Force and/or Army.

5. The only successful conversion from land to a carrier based design in modern times was a modification of the F-86 to the FJ series. The airplane was purchased initially because of its outstanding fighter record with the Air Force, and its apparent superiority over the then available F9F and F2H series designs. In its finally modified form, it was virtually a new airplane, which became a competitor for the A-4 in the light attack role. The project, while a technical success, would not have passed today's tests of cost effectiveness, as the required modifications made it more costly than the fighters it was supplementing. Nearly every Air Force tactical airplane design in history has been offered to the Navy in a carrier version, but few survived the paper stage, and no other combat

type reached production. Possibly the Harrier should be included in this category, although, as a VTOL, shipboard use required no significant penalty.

6. Joint usage of land based types among the services has been extensive, particularly among non combat types. Most of the trainers, transports, and helicopters developed by one service, or commercially, have been used by others. Something over 50 models fall in this category.

7. From the above, it should be quite obvious that the Navy has taken advantage of development by others when it has made sense to do so. None of the programs forced on the Navy in standardization or economy efforts has met Navy expectations, and none has approached the more optimistic projections of the OSD proponents. It is an unfortunate fact of life that few of those optimists remain in their positions long enough to accept responsibility for their actions.

8. In the current situation, the probability of ultimate success in adapting the Air Force light weight fighter to naval use is even more remote than normal. This is due to the fact that the capability of the present flying models is well below the level now contemplated for the VFAX, which in turn is well below a level representative of a combination of the F-4 and A-7 characteristics. The obvious implication is that the weight growth, and degree of required modification, will be greater than for a more normal case such as modifying the F-15 to a Navy version. Since that degree of change has proved too great in the past to effect cost savings, no hope for YF-16/17 to VFAX should be entertained.

9. While the change from a land based to a carrier based design involves major changes, the reverse is not true, since the Air Force can invariably operate a Navy carrier design as produced. From a practical standpoint, it is really an irreversible process. However, it must be realized that the performance of the carrier based design should always be inferior to the airplane which is designed without the carrier penalties. Whether this edge of advantage can be sacrificed is questionable particularly when one is competing with a minimum capability weapon system against an enemy who already has an easier design problem.

10. Careful, detailed cost and effectiveness studies should be made before either service is forced into the high/low capability morass, or before either service is forced into using the basic design of the other. There is little evidence that the actions being planned can help our defense posture, while the lessons of history indicate strongly that it will suffer further degradation.

/s/
G. A. Spangenberg

Note: This memorandum has been prepared with no great amount of research, and I may have missed a few examples of joint usage, but I believe I've included all joint airplane developments in the last 25 years.

Copy to:
AIR-506
AIR-05
PMA-265
AIR-00
OP-05
CNM
TACAIR

Exhibit A-9. A paper published in the *armed forces JOURNAL international/April 1974*, written by Spangenberg, with the following disclaimer by the magazine: *"GEORGE SPANGENBERG retired recently after distinguished service as Director, Evaluation Division, Naval Air Systems Command. Though still an occasional ad hoc consultant to Navair and other agencies, the views expressed here are his own and do not necessarily reflect positions of Naval Air Systems Command or Department of the Navy.*"

Cheap Fighters - The Impossible Dream

A RECURRING ADVOCACY has raged over the years from outside the Navy for "lightweight" fighters as alternatives to whatever aircraft were then being programmed. This advocacy has generated severe budget justification problems within the service, within the department, and before Congress due to the size, simplicity and cost benefits claimed.

Since World War II, budget considerations have dominated the Navy's aircraft program. There has been a drastic diminution of new starts as well as models in service. The financial problem is fully understood by those attempting to procure adequate numbers of aircraft to meet force level requirements. The corollary need of an adequate capability for each aircraft is also fully understood by those who might be directly involved in any future combat. Few, if any, of those advocating the lightweight, cheap, simple approach have demonstrated an understanding of the problem, particularly as it applies to naval aviation.

The Studies . . .

In the late '60s, staff studies within the Office, Assistant Secretary of Defense for Systems Analysis, offered a program aimed at stopping both the Navy's VFX (F-14) and Air Force FX (F-15) projects. Their suggested solution of a very high performance, minimally equipped airplane, was unsound to the point of absurdity, allowing an effective rebuttal, and eventual discrediting of the VF-XX on technical grounds.

A number of studies have shown that the fighter forces of the Free World would be outnumbered about two to one in any future conflict against Warsaw Pact nations. A "solution" was recommended in 1970 of initiating prototype programs, eliminating military specifications, and allowing greater industry participation in requirement generation, etc. Although no real effort was made to show that this in any way solved the actual problem (long recognized by naval planners), it eventually lead to the initiation of the XF-16 and XF-17 Air Force, and XF-12 Navy, fighter prototypes.

In 1972, another OSD study extrapolated pricing trends and showed that budget limitations would cut planned force levels drastically. A "solution" in the form of a

high/low mix concept was suggested in which a small number of high quality weapons would be complemented by a greater quantity of less capable ones to handle lesser threats. Again, no attempt was made to show the viability of the concept in any specific area for any specific weapon or for any specific service. As a matter of interest, the Navy has been given some credit in the past for optimizing its carrier complements along high/low lines by using high performance fighters together with lower performance attack aircraft, rather than a more costly single design to do both jobs. Similar optimization obviously applies to the mix of vessels in the surface Navy, and to the variety of trucks in the Army, proving that the mix concept is hardly new.

A year ago, OSD directed consideration of what amounts to a high/low mix concept with a decision that the Navy had need for a Phoenix capability in but one half of its fighter force. An OSD prototype plan was also proposed, but deferred when studies proved it to be too expensive. Specific non-Phoenix F-14 alternatives have been under study for some months in comparison with a new lighter weight design. Significant cost savings cannot be expected.

Continuing Pressure

There are reports that continuing pressure exists for a Navy simplistic lightweight fighter of the F-16/F-17 class to complement the F-14. While the concept has little merit, it cannot be rejected on purely technical grounds as was the "VF-XX" since in this instance the weight and performance potentials are not being grossly overstated. The concept must be rejected on operational grounds.

Although the rationale against the concept has been stated before, it bears repetition. During the TFX hearings in 1963, Admiral Anderson, then CNO, stated:

"It is my responsibility to insure that U.S. naval forces are properly equipped to fulfill their missions in time of war. This means that our ships, aircraft, and weapons must be superior to those we may face in combat. Furthermore, it is important that the young men who man our ships, fly our aircraft, or use our weapons are provided the greatest margin of safety consistent with the hazardous tasks they perform . . . . In the military profession, an edge of advantage is of the greatest importance. To those of us in uniform, this factor takes on added significance, first as a deterrent, and second, at the outset of hostilities . . . ."

It has always been our policy to give our pilots some kind of an edge. We would prefer to have better performance, better weapons, greater numbers, better tactics, and better pilots, but we certainly should not rely solely on the latter. Since carrier aviation exists only for offense, it follows that our airplanes must have a greater range than those of the defense. At the same state of the art, we must devote more of our gross weight to fuel, making it impossible to win the performance or maneuverability game when we carry the same weapons in the same size airplane. Our only real option is to incorporate a better

weapons suit, and increase power as practicable to remain competitive, and accept the higher size, weight, and cost.

Sizing Up the Arguments

Other comments bearing on the arguments sometimes presented for the simplistic fighter are:

a. Normally, the defensive unit should be operating in a more favorable command and control environment, intensifying our problem.
b. In the real world, the fixed amount of deck space precludes attainment of the numerical advantages claimed for the cheaper fighters. For example, while 3:1 unit cost differentials have been claimed (ignoring development amortization and carrier outfitting), the deck space differential would be less than half of this. The loss in effectiveness is several times greater against even moderate threats.
c. Again in the real world, it is difficult to envision matching our potential enemies in the numbers game. Since even the advocates of the simplistic fighter would procure some quantity of the more capable machine, the differential in total numbers for a given dollar expenditure is small, or even unfavorable, dependent upon the treatment of sunk costs, etc.
d. The visual identification rules used in SEA cannot be permitted to determine our choice of aircraft. As noted before, we are bound to lose the dogfight game. Only the very naive would stop the development of missiles which operate beyond visual range.
e. Among the arguments presented by some analysts is one that would limit our capability to that required to handle only a portion of the threat, such as 75% or 80%. "Why spend money to handle only 15-20% of the threat," is the manner in which the argument is presented to the uninformed. This is so patently absurd that it should not need discussion. An "edge" of that magnitude would almost certainly assure victory in any competitive arena.
f. A theory is often presented that the chance of winning an engagement varies as the square of the number of contestants on each side. That theory, however, is only valid when all contestants are equal. The latter is obviously not a proper assumption in air combat. For example, an infinite number of "lightweight" fighters could not stop the penetration of a single Foxbat nor prevent the overflight of a supersonic transport.
g. The case for increased numbers of lower cost vehicles can be made easier for the attack mission, particularly against fixed ground targets. Saturation tactics are more effective, and in any case the target remains for later strikes when the first one is unsuccessful.

In summary, there have always been those who advocate cheaper methods of waging war. Such advocates seldom have the responsibility for winning the war, however, and usually do not have to face the consequences of direct participation (any more than I do).

Exhibit A-10. A retype of a GAS article that appeared in the magazine *Astronautics & Aeronautics.*

High-Low Mix — Solution or Problem?

A mixed force of inexpensive "visual attack" and relatively costly fighters and all-weather attack planes would cost more, not less than an equal-number force of the more capable combat aircraft

The high/low-mix concept is the latest innovation proposed within the Office of the Secretary of Defense (OSD) to solve a very real problem which the services have been facing for a number of years: providing adequate numbers of fighters, and other tactical aircraft, in the face of budgets which procure less and less while the threat continues to increase. The idea of using a mix of aircraft to accomplish the total tactical mission is hardly new. In the fighter field, mixes have always existed as several years are normally required to phase out the old models when the new ones are introduced. The Navy, in particular, has used a different type of high/low mix in its carrier operations, by combining relatively costly fighters and all-weather attack airplanes with an inexpensive "visual attack" model to give an optimum complement. But OSD now proposes to buy *simultaneously* a fully capable fighter and one with a markedly lower capability.

The proposed high/low mix concept is being enthusiastically supported within the OSD as a policy, and by some members of Congress as an expediency, to reduce defense expenditures, despite the fact that no proof has been offered that reductions will occur. A service- or industry- initiated proposal of this nature would have been subjected to exhaustive reviews, and some form of justification required. On the other hand, an OSD idea too often gains acceptance without adequate study.

Currently, grossly unfair figures are being used in an attempt to prove that the country cannot afford to replace its F-4 inventory with the F-14 and F-15. The latter two are quoted at prices on the order of $20 million each while "lightweight" fighters are advertised at $3 million. Differences are ignored, or hidden, of one figure being perhaps a program average in current-year dollars with R&D amortization included while the lower figure is an estimated unit production fly-away goal in fixed earlier-year dollars.

The F-14/F-15 models were started only after years of study as to what was needed to counter threats which were, and are, well recognized. Before funds are diverted from their procurement for designs with much less capability, realistic studies should be done to determine the degree of monetary savings, if any, which might be achieved by changing to alternative programs.

It will be recalled that last year's prototype proposal by OSD for an F-14A substitute was shown in Congressional testimony to cost more and to do less. Specific comparisons on these programs, can only be done within the services, but some insight as to the purported advantages can be gained from an examination of a completely hypothetical mix of high- and low-capability fighters in comparison to the single high-capability design. The background of experience on which the examination is based is that of carrier aviation, but it is probable that the general conclusion will apply almost equally to the Air Force case.

Mix High End

The definition of the high end of the mix is quite conventional, and would follow past practice in designing the airplane to be capable of meeting the entire threat spectrum as it is projected by the intelligence community. As part of a carrier strike group, it would have a radius of action commensurate with the attack airplanes with which it operates. Its primary armament would be radar-type missiles for operation in all weather conditions. A crew of two would be carried to cope with the workload anticipated for operation in a high-threat ECM environment and to increase the effectiveness of its long-range missile system. Speed, climb, and maneuverability would be as high as practicable without making the design excessively large and costly. Although in the general size and weight class of the F-4, it would be superior to it in all respects. Against the enemy's very high altitude and high supersonic speed threats, it would rely on its weapon system and long-range missiles. Against F-4-class threats, its missiles would outrange the enemy in a head-on attack, while in close, its speed and maneuverability would permit guns and IR missiles to be used effectively.

Mix Low End

The low end of the mix proves more difficult to define, since the advocates of the concept have yet to be very precise as to which portion of which threat the low-capability fighter is supposed to defeat. Although started by the Air Force as technology demonstrators, the YF-16 and YF-17, by the very fact of their existence, have tended to become one definition of the low end of the mix, and pressures are being exerted to have their development continued into operational vehicles for the Air Force, and possibly for the Navy.

This type of single-place design, optimized for close-in, visual engagements, carries only IR missiles and a gun as offensive armament. In a dogfight it should be a match for the high-end fighter, with an advantage in smaller size, but sometimes with a disadvantage in awareness. Performance in the engagement should be a standoff, if the range requirements are equalized and the same state of the art utilized in design. Equal range is obviously required in the Navy case since the fighters must escort the attack airplanes and provide air superiority over the target. (It is also this fact which allows a purely

defensive fighter to be designed with a smaller fuel fraction, thereby giving better performance at the same size and weight.) Against the F-4, the pilot in the low-end fighter should win the dogfight — if he survives the long-range engagement which may precede it and if the F-4 elects to engage. Likewise, the design should be more than a match for the older defensive fighters, but should not be expected to match a new breed. Against either fighter or bomber threats in the speed and altitude range of an SST, the design is patently not suitable.

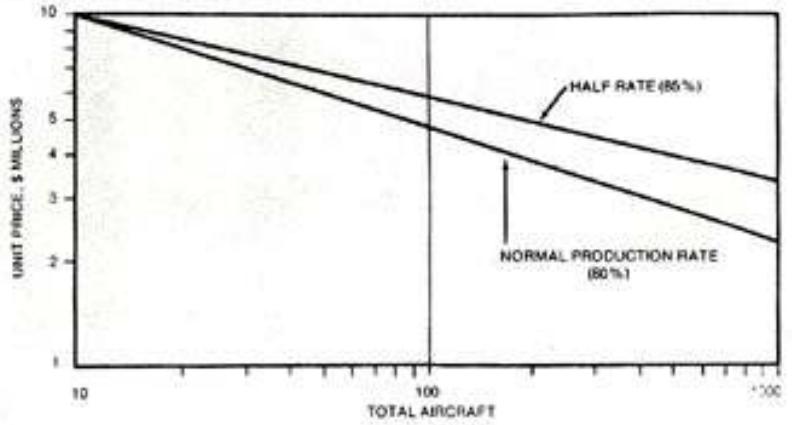
There has been virtually unanimous agreement within the services that, on an airplane-for-airplane basis, only the high-capability fighters should be considered. The only problem arises when the question of cost is introduced, and choices are offered of larger numbers of the low-capability design. Even then, most experts agree that some of the high-capability designs are required.

The relative costs of procuring either (1) all high-capability designs or (2) half high- and half low-capability designs can be estimated to give some insight on the degree of the problem. This will be done using the following first-order assumptions:

1. 800 fighters will be procured: either 800 high-capability design or a mix of 400 of high- and 400 of low-capability design. For convenience, these will be designated the HCF and LCF.
2. Development costs and unit production costs vary directly as gross weight. (Although airframe weight and weight empty are the more common factors used in cost estimating relationships, both are closely proportional to gross weight in similar types of aircraft with equal range.)
3. Both HCF and LCF have the same fuel fraction. This gives equal range and is necessary for a fair comparison.
4. The learning curve, or more precisely, the price-quantity relationship, has an 80% "slope" on a unit production basis for a "normal" production rate. (This is about average for some past procurements, and less favorable than claimed in most new proposals.)
5. The 80% slope changes to 85% when the production rate is halved. (The 5% change correlates well with F-4 experience and is less than indicated by some variable lot option quotations to the Navy.)
6. The LCF is 0.7 the weight of an HCF. (This correlates with a number of parametric studies in which performance was held constant while "military load" was reduced by changing the crew from 2 to 1, and replacing all-weather avionics and missiles with their IR equivalents.)
7. All costs are in constant dollars.

In addition to these terms, it will be assumed for convenience that development of the HCF, including nine aircraft, costs $1 billion; and unit cost of the first production, or tenth total, aircraft runs $10 million. The figures for the LCF run 0.7 of these.

F-1 UNIT PRODUCTION PRICE



F-1 shows unit production price versus quantity in the conventional manner on a log-log plot for the base case of the HCF at its normal production rate and also at half that rate. Although these relationships are normally called *learning curves,* it must be recognized that they include the effect of many other factors, not the least of which is the business base against which fixed charges must be written off. The larger the number of aircraft against which to amortize such costs, the lower the unit price.

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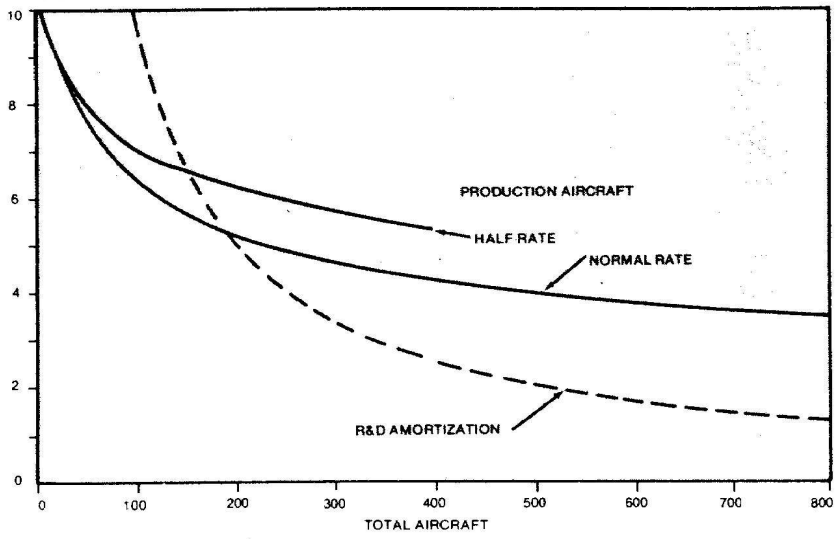
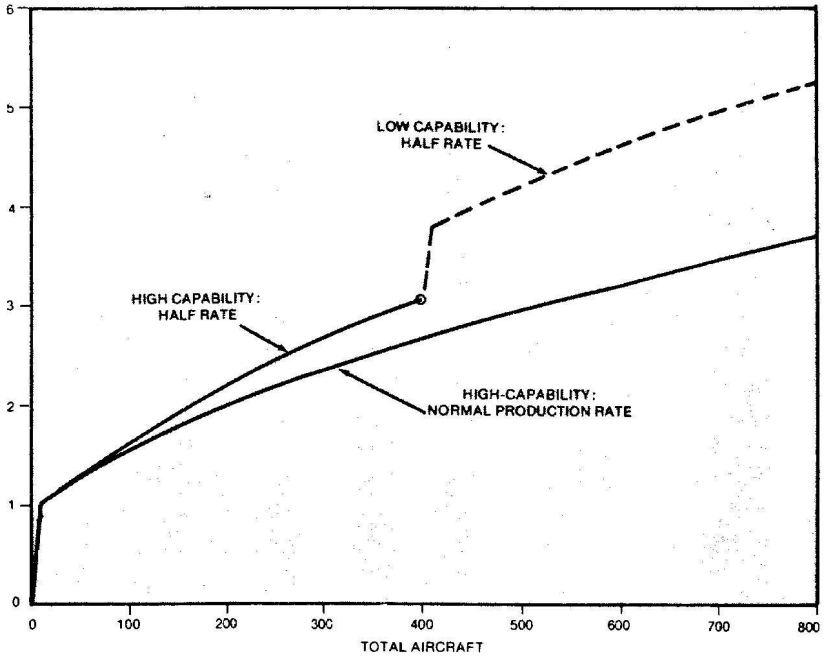
F-2 CUMULATIVE AVERAGE PRICES



F-2 converts the unit prices of F-1 to cumulative average production prices, and shows them for the HCF base case, together with the unit price associated with the amortization of the R&D bill.

F-3 TOTAL PRICE COMPARISON: HIGH VS. HIGH+LOW



F-3 shows the final cost picture. The prices are totaled for buying 800 fully capable fighters at a normal production rate and for buying half that number at half the production rate. To the latter is added the costs involved in developing and producing 400 of the smaller, less-capable fighters also at half the normal rate of production. *The total cost for the 400/400 mix runs about 40% higher than for buying all 800 of the heavier and more capable fighters.* If the complementary fighter had been assumed to be but half the weight of the fully capable machine, there would still be a 25% higher cost involved for the 400/400 mix.

Admittedly, these results reflect approximations, but I believe these are all of the right order of magnitude. In the real world an even stronger case exists for procurement of only the more capable fighter, because development funds for the F-14/F-15 are now largely expended and could logically be ignored in the pricing of future airplanes. It will also be observed that the prices shown have not been identified as "airframe," "flyaway," "program," or "life cycle," since this was hardly necessary for the purpose of this article. The informed reader can readily ratio the results to fit any particular definition, and also to match other assumptions as to initial production and development costs.

It seems clear that those who advocate high/low mixes in the fighter field should provide a rationale to support the concept. At the moment, the net result will be a lower capability at a higher cost — hardly the goal being sought.

Exhibit A-11. An article by GAS published in *Military Science & Technology, Vol 1, No.84, 1981*

In the premiere edition of Military Science & Technology, C. E. (Chuck) Myers Jr. gave to the readership the rationale behind the concept of a Hi l Lo mix of tactical aircraft as seen by those in the Office of the Secretary of Defense (OSD), where he served from late 1973 to 1977. In this article, Spangenberg presents a somewhat different view of both the history and the value of the Hi/Lo mix concept as applied to our tactical aircraft programs—a perspective from what he calls the "working level" within the Navy, "well downstream of those populating the policy level within the OSD. "

Hi:Lo = Cost:Capability

In a world made up of "We's" and "They's," the We's (the good guys) at my level had a great deal of trouble understanding the They's in OSD, who kept us busy with their solutions to either problems which didn't exist or were irrelevant to those which did. Although I sometimes emerged as a spokesman against the various "innovative" management and technical concepts foisted upon us by the OSD "speculative theorists" (Adm. Hyman Rickover's terminology), my position was invariably consistent with that of most (but not all) of my associates, technical and operational, within the Navy. As a civilian, I had somewhat less of a problem in speaking out than my friends in uniform.

The case for the unsophisticated fighter presented by C.E. Myers Jr. in "HI/ LO What??" concerns itself only with a NATO scenario in central Europe in which the U.S. Air Force provides tactical support for ground forces, including the maintenance of air superiority over the battlefield. Apparently, Myers sees no need for a Hi capability, or sophisticated fighters in this engagement; and by discussing only this one requirement, the issue of a Hi/ Lo mix is completely avoided. I will leave to the Air Force the task of restating the justification for their sophisticated F-15s and F-111s to complete successfully missions that cannot be handled by such aircraft as the F-5 and F-16. From press reports, however, it is clear that some operational commanders are reluctant to replace their sophisticated, all-weather F-4 aircraft with the simpler F-16, now equipped with offensive systems designed only for visual conditions.

The history of the OSD Hi/Lo mix concept (my version) goes back to 1972, when the services were given a briefing entitled, *Designing to Cost, or Assessing the Budgetary Realities.* In that OSD sponsored presentation, it was shown that the funding levels necessary to meet the combined requirements of all the services, according to their planning documents, were far greater than the probable defense budgets of the future. One of the "solutions" of the study to that supposed problem was a "Hi/ Lo Force Mix" with the "Hi" force providing "technical superiority with Hi performance" and the "Lo" force providing "numerical adequacy and Lo total costs." No specific programs were identified as candidates for the Hi/ Lo treatment, nor were any cost and effectiveness

estimates of alternative forces provided to justify the concept. Had one of the services proposed such a generalized (and obviously somewhat naive) solution to an OSD posed problem, there would have been an immediate demand to provide the missing specifics. With the concept starting at the policy level, however, the "Hi/ Lo Mix,"in short order, joined the already long list of OSD management buzzwords: *Fly Before Buy, Competitive Prototypes, Value Engineering, Cost Reduction, Independent T&E, Milestone Contracting, Design-to-Cost,* etc. All were well-intended, but badly advised attempts to solve the procurement budget crunch.

In retrospect, it is difficult even now to believe that those conducting the study were surprised to find that the sum of the costs associated with long-range plans bore little resemblance to the projected budget. Imbalances of this nature have certainly always existed in the military (and I would guess in any organization which puts together similar long-range plans). Development and production programs are brought into balance with fiscal reality in two steps, short-range plans and, then, in the annual budget. Almost invariably, the so-called "out years" show much higher quantities and costs than those included within the base years of any plan.

Now, back to history. The OSD study also observed that virtually all defense products were increasing in complexity and cost. These unit increases, coupled with fairly level budget projections, obviously created a "numbers" problem. To the services, of course, this was not exactly news; military planners had been living with the problem since World-War II. In naval aviation, as an example, unit prices tended to double each time it became necessary to replace one of our tactical aircraft due to obsolescence. The price of the F-4 was about twice that of the F-8, as was the price of the A-7 relative to the A-4. In each case, however, the increase in capability, or effectiveness, was even greater which made the procurement justifiable, first to the Navy command, then to all the review authorities in the DoD and Congress. With force levels dictated by the budget since about 1950, it should be obvious that the trade-off between numbers and effectiveness was a well considered problem at all echelons within the services.

Indeed, the novelty of Hi/ Lo mixes as a solution to the acquisition problem has existed for some time. New models enter fleet use gradually over a period of years, creating a Hi/ Lo mix in the operational forces, if not the procurement budget. The phasing out of the Navy's F-4s by F-14s, for example, was originally planned to span about five years after initial fleet introduction. This will actually take at least twice that long due primarily to reducing the production rate from the planned 96 aircraft per year to first one-half, then one-third of that. Obviously, this made the Hi end of the Navy's fighter mix (F-14) cost more, while the Lo end (F- 4) continued to lose capability due to the problems of aging.

Another rather obvious and reasonable mix employed by the Navy was seen every time a carrier was deployed. The aircraft complement included both some relatively Hi and Lo cost aircraft. To find a Hi/ Lo mix to comply with an arbitrary management requirement, a

mix of all-weather fighters with visual attack aircraft (F-4/A-4, F-14/A-7) would have represented a much more viable solution than attempting blind mixes within all types.

It is clear, then, that the problem which OSD was trying to solve was not new to the services, and the basic idea of using mixes of weapons to meet overall goals was well established. Thus, **the real question is whether it is OSD or an individual service which is more competent to select the types of aircraft and weapons needed to meet that service's overall mission requirements.** Experience indicated the latter. The Navy's record of success in aircraft development choices, when allowed to proceed unhindered, is about as high as OSD's record is low.

Further illustrations are found in the implementation of concepts in the fighter aircraft field. By 1970, the USAF had completed their mission analyses, selected their concept, conducted competition, and had contracted with McDonnell Douglas for the development and production of about 750 F15 aircraft to replace part of their F-4 force (F-111s had previously replaced some F-4s). Shortly thereafter, a competitive lightweight fighter (LWF) prototype program was undertaken as part of a broad OSD initiative. Contracts were let for the XF-16 and XF-17 by the Air Force as the winner of the competition, which by now had evolved into the Air Combat Fighter (ACF) program described in Myers' article. It was through this program that the OSD (and Congress) in 1975 authorized 650 F-16 aircraft in addition to the previously approved USAF tactical fighter program.

Meanwhile, the Navy's F-14 program, approved in 1969 as a total Navy and Marine F-4 replacement, came under attack by OSD as too costly. The Navy was ordered in 1971 to find "a lower cost alternative to the F-4", and later, "a lower cost complement to the F-14." A capability level greater than that of the F-4J, the airplane being replaced, was an agreed upon condition of the early studies.

For reasons which have never been clearly explained, the OSD considered that the F-14, with its long-range, multi-shot fire control system and its Phoenix missiles, was too expensive to be procured in the quantities originally justified and planned, and a compromise design somewhere between an F-4 and an F-14 would be adequate for handling moderate threat situations.

The Navy examined improved F-4s, carrier versions of the F-15, stripped F-14s, and new designs. Nothing could be found which came close to meeting the conditions better than an F-4, and less expensive than more F-14s. Even a new LWF, less capable than an F-4, could not compete fiscally in the limited quantities which were being considered. Despite these results, the Navy was told that its F-14 program would be reduced to a one squadron per carrier level, vice two, and the Marine buy was eliminated. Congress and OSD combined to dictate that the other half of the Navy's fighter needs should be met by a carrier version of a lightweight fighter. All these actions by OSD were taken with no proof supporting their concept.

The implementation of the Hi/ Lo concept in the fighter case thus added a lower capability model to the planned inventory of fighters for both the Air Force and the Navy. For the Air Force, as previously mentioned, the model was completely additive, but for the Navy it was a substitution of a less capable design in equal numbers. As might be expected, the acceptance of the concept by the services reflected these facts.
The Air Force, gaining 650 aircraft, did not elect to argue that for the same funds it could have bought higher capability. In the 1975 hearings on the LWF, for example, the Air Force disclosed that they estimated 520 F-15s could be procured and operated for the same life cycle cost as the 650 F-16s. The 20 percent increase in estimated quantity would hardly compensate for the difference in unit effectiveness.

The Navy, on the other hand, fought against the great loss in capability involved in the substitution of ACFs for F-14s, and did manage to delay the imposition of sentencing, as it were, for a year or two. In the last of a series of studies on how best to cope with the OSD decision, the Navy adopted a compromise plan, similar to one which had been worked out a decade earlier when one squadron of F-111Bs was being mandated. Characteristics were established for a design which could serve as both an F-4 and an A-7 replacement. This would increase the total quantity of aircraft sufficiently to make it less of a fiscal disaster, as well as offer some hope that the attack capability of the carrier could be enhanced by the higher performance of the new design.

Meanwhile, reduction in fighter capability could be partially offset by using the normal attack squadrons in a "swing" role as fighters. This 1974 version of VFAX was then compromised still further when OSD and Congress combined to dictate a lower level of capability, more nearly commensurate with the Air Force's ACF.

By 1975, the Navy had consented to the plan, conducted competitions between carrier versions of the F-16 and F-17 (each upgraded to a higher level of capability), and selected the latter as their choice, redesignating it as the F18/A-l8. Cost comparisons showed that the purchase of about 800 F/A-18s was slightly less expensive than purchasing more F-14s while developing and producing a new attack airplane as an A-7 replacement. Not as well publicized at the time were the cost estimates showing that the cost of F-14s and new A-7s was less than that of an equal number of F/A-18s, with an overall capability level substantially higher. The cost history of the lightweight fighter programs, particularly the F-18, demonstrates quite conclusively that the claimed cost savings were, to say the least, illusory.

It appears that in every case, adding a Lo capability design turned out to be more expensive than continuing a Hi capability design already in production. This led in 1974, to an examination of a general case in which the so-called "sunk" costs did not tend to dominate. The case was based on the assumption that 800 all-weather fighters, or 400 all-weather plus 400 day fighters during the same period, would be developed and produced. The results of the exercise, published in Astronautics and Aeronautics, were both surprising and quite convincing. The mix of "Hi's" and "Lo's" cost 40 percent more than all "Hi's," when the higher capability design was 50 percent heavier than the Lo,

and 25 percent more when the Hi was twice as heavy as the Lo. These results were due to the development bill for the second design, and the unit cost increases for both designs when the production rate for each was halved because of split procurement.

Certainly, the Hi/ Lo mix concept seems unable to solve quantity deficiencies in our tactical aircraft inventory. For the Air Force, the costs of buying the lower capability F-16s are about the same as would have been involved in procuring an equal number of F-15s. For the Navy, the F-18 fighters are costing much more than an equal number of F-14s would have cost. Likewise, it is now evident that the A-18s are not only more expensive than an equal number of A-7s, as had been predicted, but are also more expensive than the vastly more capable A-6s.

The chaos and confusion (described by Myers) of the scene over the battlefield is nothing as compared to those elements which have been created in Washington by the advocates of very simple solutions to very complex problems. If simple fighters could win a war, their fiercest advocates would be found within the services. The concept of small size, Hi reliability, Lo maintenance, Lo cost, and all the other attributes of goodness, is indeed, a common goal, but only when the product is capable of performing its primary mission. The simple Lo cost/ Hi reliability club lost favor as a weapon when it was found less lethal than a Hi cost/Hi maintenance bow launching some complex and frequently errant arrows.

We are doing far too little in developing new weapons which will give us some edge of advantage, particularly when we admit we are always going to be outnumbered. Our thunderstorm of weapons had better be of a variety that outranges and outkills those being launched against us. Let's get on with some real solutions to our problems.

Exhibit A - 12. Article by GAS published in *Wings of Gold* (a publication of the Association of Naval Aviation) in 1981.

Aircraft Acquisition – Management Malpractice

With a new administration in place in Washington, supposedly dedicated to the task of improving efficiency of government, the time is obviously propitious for suggesting a major overhaul in the methods now being used to procure our aircraft – the "acquisition process" as it has come to be called.

In the Spring issue of *Wings of Gold*, the subject was forcibly addressed by Admiral Moorer and Vice Admiral Cagle, both of whom called for eliminating the DSARC, and by Vice Admiral Seymour who called for positive change in the entire acquisition process.

The need for significant revision should be apparent to everyone who looks at what has been done in the last 10 to 20 years and compares it with what could have been done. The solution to the problem should be equally apparent. We need only return to the system as it was practiced by the Navy for aircraft procurements in the late 1950s. That system had evolved over a period of years with each procurement tailored to the particular circumstances then existing, while avoiding the mistakes made on previous programs. None of the actions taken from above to reform the system during and subsequent to the McNamara regime was either necessary or desirable. All were designed by relative amateurs and were recognized by the professionals at the time as being either solutions to problems which didn't exist, or which were irrelevant to those that did. Those non-solutions run the gamut from McNamara's "Program Definition Phase" and "Cost Reduction" to the Packard "DSARC", "Prototyping", and "Separate T & E".

As many are aware, I am not considered exactly an unbiased observer in the area of how best to procure aircraft. Since I was convinced that the methods used in the Navy had been demonstrated to be superior to those of the other services, I consistently opposed attempts, usually in the name of standardization, for us to adapt their methodologies, or to reintroduce practices we had previously discarded.

Although we managed to get through the initiation phase of the F-14 and S-3 procurements without complete defeat, gradual compromises have now just about eliminated all vestiges of the system as it was, as everyone now complies instead of circumventing the prescribed rules.

The historians of today have trouble documenting the system actually used internally by the Bureau of Aeronautics (one of the predecessors of the Naval Air Systems Command) prior to the McNamara era. An operative directive covering the procurement of major systems in fact did not exist at that time in the bureau, although on occasions audit officials or management commissions would recommend that such be produced. The Robertson Committee, a Blue Ribbon-type operation, was one example of this. In one of its 1956 reports ("A Program for Reducing the Time Cycle from Concept to Inventory, Manned Aircraft Weapon Systems), it approved of the Navy's procurement record, but directed that an "Instruction" be issued on the acquisition system being used. This was never accomplished since the internal bureaucracy would not agree on the system as it actually existed, and no one wanted to degrade the system to match the charters of those parts of the organization which objected.

An "Instruction" was really unnecessary within the bureau since the basic design competition system was well known to all those actually involved. Up to that point, the Navy had not found it necessary to standardize procurement systems between its bureaus, except on a very broad policy level. Most reasonable people would agree that there was little to be gained by detailed standardization of procurement methods for such diverse products as aircraft, ships, and ammunition procured from quite different industries, by different personnel, in separate bureaus. On the other hand, compromises to achieve a single system could only reduce the efficiency of those several systems, each of which was considered more nearly optimum for its particular field by those using it.

With the absence of any official documentation, let me set down some of the ways in which we conducted the business of developing new aircraft, and the reasons therefore, before control of the procedures was taken from us. Obviously, this is my version of history, and it may be as incomplete and as inaccurate as in the story of the blind men describing an elephant. If there are more competent observers in the readership, perhaps they can contribute to a fuller understanding of the situation, then and now.

In presentations made at the time, the basic steps in the acquisition process were listed briefly as: Establish Requirement; Define Program; Obtain Program Approval; Conduct Design Competition; Contract. Of these, a sound "Operational Requirement" is probably the most important single factor for a successful development. No amount of technical expertise nor management attention can overcome the handicaps introduced by a faulty one.

Subsonic fighters do not grow into supersonic ones. Day fighters do not grow into good all-weather fighters (F3H, F7U). Short ranged designs get shorter, and inadequate payloads shrink during development and operation. On the other hand, overstated requirements kill programs before they start. .

When "Military Requirements" was a part of BuAer (instead of OpNav), the acquisition process started with either "Plans" writing a memorandum to "Engineering" outlining the

characteristics needed in a new design, or "Engineering" writing to "Plans" detailing a new capability judged feasible. Conceptual studies were done both in-house and by industry, and almost always on an unfunded basis. Decisions to start programs were made on a judgmental basis by the Chief, BuAer, after considering – but not necessarily in writing – all the alternatives. By the early 1950s, the discipline of operational analysis had developed to a point that allowed its use internally to help in reaching those decisions, although then and now, the experienced professional, armed with the basic technical and cost characteristics, would usually not need the formal analysis to reach a sound conclusion. The closed loop generation of requirements balancing operational desires with technical and cost feasibility is as necessary today as it was then.

The "Requirements" served as the key for more detailed studies in the Navy and in industry, and were most effective when they spelled out minimum levels of performance to be met and minimum levels of equipment and armament to be carried. A nonspecific, generalized mission type of requirement, such as, "Achieve air superiority over the battlefield in 1990 when operating from a carrier" is virtually useless to any preliminary design organization, although this type of a "Requirement" is frequently advocated in the belief that more creative solutions may emerge. All that really happens is that all the design organizations descend upon the Navy *en masse* trying to determine what is wanted. The process works far better when the professional operators spell out their needs with as much precision as possible, but allowing freedom of acceptable choices in the design process.

In the period of the 1950s, with need and feasibility determined, the program was introduced into the budget cycle. After budget approval, and not before, a type specification was drawn up and a design competition held. The timing for this phase was normally planned as three months to prepare specifications and issue the "Request for Proposal" : (or earlier, and better, an "Invitation to Bid"), three months for industry to prepare its proposals; three months for evaluation; and a final three months for decision, negotiation, and contract award. The entire effort was unfunded. (Industry was allowed "Bid and Proposal" expenses as part of overhead, so the government paid the bill indirectly if the manufacturer had ongoing production contracts.)

The reason for conducting the whole of the conceptual phase of development on an unfunded basis was obviously that this method was by far the simplest, it saved time, money and effort, and sacrificed nothing of value. A cited disadvantage, used in part to change the rules, was that the very small businesses could not compete because of the bid and study expenses involved. Since that type of bidder would not qualify for the later development award, it is not clear what is gained by paying him to compete in the conceptual phase. At least a year is added to the development cycle each time an open, competitive, funded phase is added. There are also some problems, usually unrecognized, in the real world in conducting study type competitions. There is little objective information on which to base a selection, leading to an impossible task in justifying an award to a third party, and particularly to an unsuccessful bidder. The Air

Force's experience with "Source Selection" (note Source, not Design) using only brief management proposals, was apparently unsatisfactory for the same reasons.

The real "benefit" may have been the ability to make politically acceptable decisions, or to practice "industrial statesmanship", in the award of contracts. The Air Force returned to the practice of requiring design data in their "Source Selection" in the early 1960s, although they continued to emphasize "Source".

The design competition method employed by the Navy was planned to permit the selection of the best design from those submitted under ground rules which tried to minimize time and cost for both the Navy and industry. The details of the competition process as practiced by the Navy and how it differed from the other services requires too much space for this article, but a few of the fundamentals may be of interest. Normally the "Systems" were specified, and acceptable engines listed, allowing the aircraft itself to be the primary variable. Remember that the "program" had already been defined and authorized in the budget. The best design was selected on the basis of the Navy's own estimates of performance, cost, flying qualities, logistics, etc. The Chief, BuAer exercised his authority for making all selections and reported his decision to OpNav and Secretarial levels.

If the selected design matched or bettered the characteristics used in making the decision to include the program in the budget, a contract was immediately negotiated and awarded. If the design did not meet the earlier estimates, program rejustification was necessary, although this step in practice was almost never required.

The Navy relied on what was basically an airframe competition for a variety of reasons, among which, of course, was the fact that the system had worked reasonably well over the years. Adequate data were available to evaluate, and then to justify the selection to everyone. The ground rules were well understood by industry who accepted the fact that the bureau had the engineering talent to produce sound comparative data in the evaluation process, thus preventing competitions from becoming lying contests. (We can note a total lack of program failures caused by failure of the Navy's engineers to predict aircraft weight, performance, etc., to an acceptable level of accuracy.)

When major systems, weapons, engine types, etc., are left as variables in a competition, one is forced to rely on more sophisticated analysis techniques, more difficult to define and usually much harder to accept.

Additionally, one runs the risk that a "best system" is in the "worst airplane", or vice versa. Separation of the major variables into separate competitions eliminates that risk. (The S-3 competition was an example of a competition in which the "system" was left as a partial variable, but fortunately, the best system and best airframe were proposed by the same bidder.)

Separation of systems and engine selection from the airplane competition is also logical because of the fact that each requires a longer development period than does the aircraft itself. If the aircraft development cycle is to be reduced to a reasonable length, both engines and major systems have to be funded and developed separately. The "Systems Approach", requiring integrated development and funding was instituted during the McNamara years. Ignored were the lessons taught by programs around the J40, J46 and T40 engine developments and lead-nosed fighters whose fire control systems were late. (These examples were actually separate developments, but with inadequate lead time over the airframes.)

At the present time, the current Navy trainer competition seems to be a good example of how not to structure a program. There are so many variables that a single best selection would seem improbable from the collection of modified and new, foreign and domestic airframes; powered by one or two foreign or domestic engines, and each accompanied by a different ground-based training system and syllabus. Because of budgetary inadequacies, presumably, the development schedule is at least twice as long as it should be. The training system issue at least could have been decided well in advance of the airplane competition.

Leaving the competition process, it might be well to discuss some of the other parts of the development process, as it is now being practiced, which were adopted despite the lessons from the past. Competitive prototyping with fly-and-test-before buy was reintroduced during the Packard era, although discussed before his arrival as DepSecDef, and strongly espoused by the GAO and by some of the think tank theorists. The Navy stopped the practice of the "prototype fly-test-redesign and produce" type of procurement before World War II. Time and cost penalties were too great as compared to concurrent development and production programs when a high probability of success could be predicted. The last Navy fighter to reach the fleet via the old prototype route was the F4U-1 Corsair initiated in 1938. Every service fighter after that was developed in programs which authorized production prior to first flight. We did have a few prototype fighters as well, but none reached production, e.g., XF8B-1, XF5U-1, XF14C-2, and XF15C-1.

As demonstrated over the years, the prototype approach saves money over a concurrent program only when the project fails and is terminated. The professionals in the development game can certainly discriminate between the designs bound to succeed and reach the fleet and those that probably will not. Those that are predicted to fail, or to offer no improvement in capability even if they succeed, should not be started, rather than prototyped (XFV-12).

As part of the Fleet Introduction of Replacement Models (FIRM) plan of the early 1950s, the Navy obtained approval to fund those aircraft developments designed for production and fleet use from the beginning almost wholly with production funds. R & D funding was used only for a "Phase I" effort, usually initial engineering through the mock up, or for about a three-month span of effort. That change in funding rules provided a windfall of R

& D funds which was unwisely exploited to initiate more programs that could be carried to completion. By the end of the decade, that lesson had been absorbed and more realistic, longer ranged fiscal planning implemented. Unfortunately, the McNamara era purists arrived and reinstated full development funding with R & D monies, but without increasing the R & D share of the Navy's aeronautical budget by the orders of magnitude required to compensate for the rules change. In fact, their detailed categorization of R & D funds into separate accounts, and greatly increased scope of testing required to be included, made the R & D budget crunch far worse than it had been a decade earlier. Funding from a single pocket would appear to be a far simpler arrangement, and would facilitate needed trade-off decisions between continuing a design in production or starting a new one.

By the end of the 1950s, the Navy had returned to a fixed price type of contracting for development and production after using cost plus fixed fee (CPFF) contracts during and after WW II. CPFF contracts were much simpler both to negotiate and administer, but their flexibility led to cost overruns, which necessitated cancelling many smaller programs in order to remain solvent. It was found by requesting both firm and cost plus bids that industry was willing to undertake total development and to offer production options on a fixed price or fixed price ceiling basis for a reasonable number of aircraft. This method, with some variations, was used in procuring the first 200 CH-46s, the first 100 CH-53s, and about the first 200 A-7s. The OV-10 contract, which followed, provided for up to 500 aircraft, but the production options for that quantity were never exercised. The fixed price type of contracting solved the cost overrun problem for the government, if not for the contractor. It also greatly increased the credibility of cost quotations, while the increased discipline necessary in defining the program was undoubtedly good for both parties.

At the end of the 1960s, both the F14 and S-3 contracts were let using the same method of contracting with an added feature of providing for a 50 percent variation in production option quantities. The entire system was proved feasible as long as the producer was not forced into accepting too large a cost exposure over too long a period. Lockheed produced all the S-3s within their contract ceiling, but Grumman found it impossible to accept the final production options without going bankrupt. A shorter period of years, as initially recommended by the Navy, would have eliminated that problem while retaining the basic advantages noted earlier. Acquisition instructions in the Packard era directed a return to CPFF development for reasons that I still do not understand, but which apparently were related to our F-14 and the Air Force's C-5 financial problems. Neither of these, however, was caused by fixed price type of R & D contracting.

Among the changes made in the acquisition process in the last 20 years have been the greatly increased emphasis on Program Management, with capital letters. It could be noted that there seems to be a fair degree of correlation between that growth in emphasis with severity of the acquisition problem in terms of lengthened schedules and increased costs. The greater the management, the worse the problem. The former "Project Officer" in the services and "Project Engineer" in the industry has been elevated

by a couple of ranks, designated a "PM" and given "complete authority" for his program. Although the concept has been employed to different degrees within the services, the clearest effect has been the degradation of technical capability in all the agencies involved.

Fixed, or usually reduced, overall personnel ceilings have necessitated that the management growth be achieved at the expense of the functional disciplines, already weakened by previously forced decentralization moves. The PM, with responsibility restricted to only one program, tends to build a self-sufficient staff to overcome a perceived lack of responsiveness from the already reduced size supporting organizations, thereby further compounding the problem. In practice, the PM becomes a salesman for his program, too often ignoring the needs of his service as a whole. Nearly every so-called management improvement, from the "Systems Approach" of the 1950s on, has been introduced in other services or in industry and later adopted within the Navy by outside pressure with no proof of efficacy. From a personal point of view, I believe that every reorganization and every so called management innovation in the last 20 years made the task of starting and producing naval aircraft more difficult.

There are many other nonproductive management techniques which have been adopted since the relatively good, relatively old days. It must be time to get back to basics and get rid of the system which requires the development cycle to be several years longer for the F/A-18 than for the far more capable F-14 (even when one ignores the whole prototype phase of the former); and at least five years longer for the CH-53E than for the original CH-53A (ignoring the four years spent in unnecessary delays in starting the program). We should return to optimizing the naval aircraft acquisition process, rather that accepting compromise in the name of Federal procurement standardization. Perhaps we need a class action, malpractice suit against all those who have fouled up what was once a pretty fair system with a good track record, and which, even then, we knew could have been better.

Exhibit A-13. A Retype of a paper by GAS published by the Association of Naval Aviation, *The Gold Book of Naval Aviation - 1985*

Naval Aviation Planning
A Retrospective View
(and some lessons for 1995)

When I was asked to participate in an effort which would, among other things, attempt to forecast future trends in naval aviation from now until 1995, my immediate reaction was extremely negative; and for a variety of reasons. Long range planning was never a favorite assignment of mine since I had never found any "Long Range Plan" (LRP) to be useful enough to justify the effort required to produce it. This low opinion of LRPs is shared by many.

I remember, for example, as Chief, BuAer, deploring, while ordering, the production of a BuAer Long Range Plan which had been requested (or directed) by higher authority. History has shown that we had better concentrate our efforts on short range plans - with which we have had more than enough trouble.

It also seemed to me that any significant variance between future predictions in the "Gold Book" with those in the current Navy Aviation Plan could not be tolerated. Dissent against programs officially supported by the Navy has not exactly been encouraged by the ANA. The reasoning behind the policy of "no dead hands on the tiller" by retired naval aviators in ANA is understandable. However, in my opinion, I believe that a voice of reasoned dissent, on occasion, might prove useful and serve the needs of naval aviation in the long run.

I had been involved in situations in years past when the official Navy had to go along with directions issued from above under conditions which, to my mind, seemed close to blackmail – as for example, "Support the XYZ or you will lose a carrier in your budget submission", or "Take the ABC or you'll get nothing".

Rather than looking into the future and trying to predict where naval aviation is headed from its base of today, it might be more instructive to consider what today's forces might have been if some of yesterday's plans had been treated differently. Perhaps, in this way, some visibility about 1995 might result. Moreover, a retrospective look might show some of the hazards involved by those now attempting to provide the weapons of the future and also provide some insight as to responsibility for some of our shortfalls. From a personal viewpoint, I would hope that such a review might convince those still fighting the Battle of the Potomac that my generation of the naval air development bureaucracy was not really as incompetent as many of the operators in the fleet believed us to be.

I recall a long conversation several years ago with an officer on his first Washington assignment just after his tour as a carrier skipper. He was appalled at the aircraft development program which not only contained no projects which offered solutions to the operational problems he knew to exist, but did contain some which promised to aggravate the situation. That conversation did not change the development program, but it did alert that officer to the circumstances which had produced it, and gave him some confidence that many of the officers and civilians with whom he was to work for the next couple of years shared his obvious frustration.

This retrospective look at naval aircraft is purely a personal one as I viewed it from my position as a civilian in BuAer, BuWeps and NavAir from 1939 until 1973, involved to a greater or lesser degree in all the aircraft and missile developments during that period. My view of the world may not agree with many of my former superiors and subordinates (remember the fable about the elephant and the blind men?), but I believe it to be reasonably accurate from a factual, if not judgmental, standpoint. My bias in favor of the way we used to develop aircraft in the "good old days" and against today's over-managed, over-studied and incredibly long development cycles is well known. My bias against the need for an OSD is also well known — and probably will be evident before I finish this piece.

With that prelude, let me review some of naval aviation's development and planning past, starting in the 1950s and concentrating on the fighter and attack programs which had a significant effect on the direction of naval aviation.

At the beginning of that decade, our carriers deployed with both "day" and "all weather" fighter squadrons, as well as "light" and "heavy" attack aircraft. The F8U-1, our first supersonic fighter, was begun in 1953 as a day fighter replacement for the F9F and F2H series. The program originated in controversy over differences of opinion as to whether supersonic performance was worth the penalties of size, weight, complexity and cost. That debate, (remarkably similar to another repeated years later between advocates of a "light weight fighter" or a "fully capable fighter") was won initially by the subsonic design backers when the "Invitation to Bid" letter (forerunner of today's RFP) included a *subsonic* speed requirement.

Fortunately for naval aviation, that requirement was changed soon after issuance, and all proposals were submitted for supersonic designs. At the time, the Air Force had already begun its supersonic "Century Series" aircraft, the F100 through F104. If the Navy had deferred accepting the supersonic challenge, it is likely that Navy carriers and carrier aviation would have been judged incapable of competing successfully against a first line threat. The Tailhook Navy might have faded away.

The supersonic controversy was internal to the Navy and the proper decision between the alternative design approaches was finally made. The F8U-1 airplane was initially armed with four 20 mm guns and/or a pack of 60-2 inch air-air-rockets. (Collision course rocketry proved so inaccurate that the rocket option was dropped prior to production.)

When the supersonic design was first put under contract, the Navy estimated the airplane would have a radius of action of 500 nautical miles on internal fuel and would achieve a maximum speed of Mach 1.4. (In fact, the speed estimate was bettered and the "legs" of the airplane proved adequate in the fleet throughout its years of active service).

The next step in fighter development called for a supersonic replacement for the all-weather types. Although this step eventually produced the highly regarded F-4 "Phantom", it started in anything but a well planned manner. At the time, McDonnell Aircraft could see the end of the production run of the F3H "Demon" approaching and offered a series of improved models hoping to continue as the principal supplier of all weather fighters without experiencing the hazards of an industry wide design competition, which would have been held in 1955. The timing of a competition was dictated by the development status of a new generation of engines, including the J75 and J79, suitable for single and twin engine all weather fighter designs, respectively. The contractor was successful in his strategy when he was awarded a letter contract for his model, "F3H-G".

Several months later, when the contract was definitized, the airplane had become the "AH-1". This was a single place, twin J65 engined design armed with 420 mm guns, an "attack" airplane of a type not previously found in any long or short range plans, published or unpublished. A year later, in 1955, a major reconfiguration decision was reached to make the airplane into its well known two place, twin J79 engined arrangement armed with four Sparrows, and with the F4H-1 designation. Early in its development program, the airplane was estimated, by the Navy, to have a maximum speed above Mach 2.0 (limited by the engine design speed, a figure later raised), a radius on internal fuel of 435 nautical miles, and an attack radius with a 2000 lb. store of 750 nautical miles, with partially filled external tanks. With the exception of McDonnell, few would consider this program as ideal from a planning standpoint. At the time, the probability seemed high that a competition would produce an even better design.

By the time of the F-4 reconfiguration, however, a consensus had been reached on the necessity of moving from guns to all weather missiles as primary armament if our fighters were to deal effectively with the expected threat. But no agreement existed on whether a two man crew was necessary for the mission.

With the F-8 day fighter design progressing very well, the contractor, Vought, was requested to submit a proposal for an all weather version of that airplane, utilizing the same basic aerodynamic configuration. This led to the F8U-3 contract in 1956 for a single place, single J75 engined design armed with three Sparrows. The radar and fire control system of the F-4 was used in a single place modification.

Up until that time, our aircraft carriers had always deployed with two fighter types aboard, each powered with a different engine. The necessity for this practice was to prevent leaving the carrier undefended if either the airplane or its engine was grounded.

This rationale was used by the Navy when the Congress in 1957 sought to eliminate either the F4H or F8U-3 production program on grounds of unnecessary duplication.

A year's delay was granted to allow flight testing of the two designs, but in 1958 a choice was forced on the Navy to terminate the F8U-3 despite the fact that the program had been highly successful, and was actually better relative to its F-4 competition than when it began. The F8U-3 was faster, more maneuverable, had better flying qualities, cost 20% less and had more range on internal fuel than did the F-4 with a 600 gal. tank.

The decision to select the McDonnell F-4 was reached primarily on the two vs. one man crew issue. It was generally accepted that a single pilot could do the job *most* of the time, but the two-man crew could do it better *all of the time,* with an advantage that widened with the severity of the threat. Thus, it was stated at the time that the day of the single seat fighter was over in the Navy and that none should be considered in the future. That design decision held for the next fifteen years, until the F-18 program returned to the one pilot, one plane philosophy.

While the competition just discussed was being waged, concern was growing over the ability of the carrier to defend itself against the predicted threats. Conventional deck launched fighters had too little time available to make successful intercepts against supersonic bombers launching air-to-surface missiles. In considering the same type of bomber threat, the Air Force has elected to build a Mach 3.0 interceptor equipped with a single shot fire control system and a moderately long range missile for the Continental Air Defense System. That design never reached production as a fighter but was produced in a reconnaissance version known as the SR-71.

This approach was really not available to the Navy since the aircraft's size and characteristics were well beyond those which our carriers could accommodate. The Navy solution to the problem came out of a large scale (at the time) operational analysis effort called RAFAD, which compared all the alternatives for fleet air defense. The study showed clearly that the most effective, and most cost effective solution against high level threats, was to launch long range missiles from relatively low performance and inexpensive aircraft on Combat Air Patrol (CAP) stations. This type of system was several times more effective than the F-4/Sparrow system.

From these study results came the "Eagle/Missileer" program. The EAGLE, a nominal 100 mile range, two stage missile with command mid-course guidance, together with its fire control system, was started with Bendix in 1958. When its development appeared successful, the "MISSILEER" competition was held and the Douglas F6D put under contract in 1960. The F6D was a two place, side by side, subsonic, 50, 000 lb. airplane powered with two TF30 turbo fan engines. It carried a five foot diameter antenna in its nose and was capable of remaining on a 150 mile CAP station for five hours.

The concept of EAGLE/MISSILEER was then, and may still be, the most cost effective method of providing a point defense against high performance threats. However, there

are some obvious disadvantages to a system of this type, since it really needs a high performance complementary system to handle the "other fighter roles" (OFR), a fact which was not emphasized in the justification process.

It is ironic that the Eagle/Missileer program, one of the more completely planned and I believe, the first to have been justified by quantitative operational analysis (cost effectiveness) was cancelled in its entirety by the incoming administration of Secretary of Defense, Robert McNamara, which made operational analysis its hallmark (at least in its public statements). The original OSD decision to stop the Eagle/Missileer development was made on a superficial basis, predicated on the belief (unsupported by operational analysis) that only one advanced fighter had to be developed to meet the needs of both the Air Force and Navy against the common enemy.

At that time, in early 1961, the U. S. Air Force was about to issue an RFP for procurement of their TFX (Tactical Fighter Experimental) after a few years of studies. By Navy classification, the TFX would have been an "attack" airplane, since its primary mission was the delivery of a nuclear weapon on a Low-Low-High mission profile. The original Air Force requirement document called for an 800 nautical mile mission consisting of a 400 mile subsonic cruise at sea level, followed by a Mach 1.2 supersonic dash for 400 miles, weapon delivery, then climb to altitude and cruise home. In the time period under discussion, the 400 mile dash distance had been reduced to 200 miles "minimum", with the higher figure continued as a goal. Air-to-air requirements were rudimentary ─ guns and Sidewinders ─ presumably intended for self-defense.

It would be hard to imagine less likely candidates for standardization and development as a multi-service fighter than the Navy's air-to-air, straight wing, non-afterburning, subsonic, carrier based, moderate strength F6D and the U.S. Air Force air-to-ground, variable sweep, afterburning, supersonic, land-based, high strength TFX.

Nevertheless, in early 1961, OSD directed the Air Force and Navy to do just that ─ and for good measure, to also perform ground support for the Army.

Since the "Missileer" was completely unsuitable for the Air Force mission, the Navy undertook a study of its own "TFX", a version which might do a reasonable job of fleet air defense, and which also could perform a reasonable strike mission.

Thus, a 50, 000 lb. gross weight limit was established to permit operations from all carriers, CVA-19 and better. The Navy TFX was to be a supersonic, variable sweep design carrying six moderately long range, 1, 000 lb. missiles for the Navy CAP mission with a time on station of better than three hours; and which could perform the Air Force strike mission at about 550 miles ─ including a 100 mile dash at Mach 1.0.

On their part, the Air Force proposed a 63, 000 lb. design to meet their requirements (800 mile radius, Mach. 1.2, dash for 200 miles) which could carry 5,000 lb. of missiles

and remain on station for 4.8 hours for the Navy. The 83 foot length of the airplane was to be accommodated by "suitable carrier modifications".

Neither proposed solution was acceptable to the other service. OSD, nevertheless, ordered the program to continue, with the Air Force assigned development responsibility. After two more months of fruitless negotiations, both services recommended that each be allowed to proceed with its own "TFX", with maximum cooperation and information exchange between the separate programs. OSD responded by ordering the services to issue an RFP for a single design meeting the minimum requirements of each service within a set of specified guidelines.

The task given the services by this order was clearly impossible of achievement. No single airplane could meet the technical requirements which had been outlined.

Thus began the most frustrating, expensive and useless seven years in naval air development history. No realistic planning, short or long range, could be accomplished when the OSD decision makers refused to accept what the Navy regarded as absolute technical fact.

The TFX source selection, conducted under U. S. Air Force rules, ran through four rounds. It ended when OSD reversed the military's recommendations to buy the Boeing design and OSD directed instead that the contract be awarded to General Dynamics. According to Navy estimates, neither of the designs was capable of meeting the combined set of requirements, with the largest shortfall occurring in the ability of the designs to meet the Air Force Low-Low-High mission. The General Dynamics design was rated "acceptable" in meeting Navy carrier requirements (CVA-59 and better), but had no margin for growth. A major concern to the Navy was what would happen when the contractor and Air Force found out what its F-111A radius really was, since only major changes could correct the problem, and these would impact carrier suitability of the Navy's F-111B, making it unacceptable.

The predicted result did happen, and to a far greater degree than anticipated. By mid - 1963, six months after contract award, investigations later showed that empty weight had increased by almost 20%, and drag levels were up considerably.

In early 1965, in a complete reevaluation effort, the Navy found the F-111B unacceptable and recommended the program be suspended until corrective changes could be found. That recommendation was repeated and rejected regularly for the next few years - until 1968 when Congress refused to appropriate further funds for the airplane.

The Navy "B" version of the F-111, if it could have met its contractual guarantees, would have been a satisfactory replacement for the F-4 according to studies conducted both before and after contract award. The airplane carried six Phoenix missiles and the multi-shot AWG-9 fire control systems (both begun with Hughes after the demise of

EAGLE/MISSILEER) and they had a guaranteed CAP station time of 4.0 hours. For the fleet air defense mission, the system with Phoenix missiles was rated as several times better than the F-4. When carrying Sparrows, the paper F-111B airplane was also rated significantly higher in the "Other Fighter Roles" (OFR). However, since the Navy never believed that the guarantees could be met, the study results had little meaning.

When the F-111B's weight and performance characteristics became further degraded during development, features needed for all roles other than Fleet Air Defense (FAD) were gradually eliminated, restricting the F-111B finally to only that mission, and making it necessary to plan on another fighter to do the vital OFR mission.

A full scale carrier complement optimization study was then conducted under the assumption that one squadron of F-111Bs would be assigned to each carrier for FAD. With this constraint, a plan for a multi-purpose VFAX design evolved, with three squadrons of VFAX replacing one fighter and two light attack squadrons.

This 1960s VFAX concept was a two place, twin-engined, variable sweep design which bettered in all respects the characteristics of the F-4 as a fighter and the A-7 as an attack airplane. New technology engines and a new weapon system were required to meet these goals in a design about the size and weight of the F-4. VFAX became part of the Navy's plan for the future, until the F-111B proved itself unusable, eliminating the constraint which had justified it.

The final step in the developments of the F-111B period was what proved to be a real solution to the carrier fighter problem. In essence, this was done by adding Phoenix and AWG-9 to VFAX, thereby completing the circle, nearly returning to where we had been in 1961 with the "Navy TFX". Still another "Fighter Study" was completed showing that VFX, as it was called, was more effective and more cost effective than the F-111B plus F-4, VFAX, or other alternatives. After a competition, VFX became the F-14 Tomcat when a contract was awarded to Grumman in early 1970.

The F-14 was planned as a three model program — F-14A, F-14B and F-14C — the F-14A would be powered with TF30 engines, the F-14B would have new technology engines [then under joint development for the "VFX" (F-14) and "FX" (F15)]; and finally the F-14C with an upgraded avionic system providing an all-weather attack and reconnaissance capability.

The original contract called for six Research and Development airplanes followed by fixed price ceiling options for 463 production aircraft, produced at a nominal rate of eight per month. Each production lot could be varied by ± 50%, giving contractual coverage for quantities from about 230 to 800 airplanes. Replacement of all Navy and Marine F-4s (the intent at the time), required 716 production aircraft, not including attrition. Deliveries of the F-14B with its improved engines were to start with the 68th production airplane.

The F-14's design mission was in the air superiority role carrying four Sparrows on a fighter escort mission. A radius of 565 miles using internal fuel was estimated by the Navy. The FAD mission was treated as an overload, carrying six Phoenix missiles and external fuel. An attack capability carrying a wide variety of conventional stores with a visual delivery accuracy equal to the A-7E was also provided for in the basic design.

As is now well known, the original plans have not been realized despite a very successful technical development. The F-14 production rate was held below the nominal level, the F-14B never reached production, and the F-14C avionic development was cancelled.

Despite initial approval by OSD and the Congress, critics surfaced almost immediately. Cost was the dominant issue, although the advocates of light weight, simple solutions were also in evidence. Most of the real cost problems which developed within a few years could be traced directly to the contract, a tight and complex one, which provided an opportunity for gross misunderstandings, misconceptions and misrepresentations. At the time of the competition, the Navy had estimated that Grumman would exceed its costs on the development portion of the contract, incurring a loss of about $100 million. That magnitude of loss was considered bearable. The fixed price ceiling options for the 463 production airplanes were considered reasonable by the Navy and should have resulted in some profit for the contractor - but only if the airplanes were produced at the eight per month rate (or greater) specified for use in making the estimate.

However, the formula included in the contract for establishing the prices of each lot when produced at a lower rate, seriously underestimated the increased costs involved. The discrepancy was known to the Navy before contract award, and the contractor informed that "he might have a problem" with the variable lot option clause. When Grumman signified acceptance of this clause, without change from his proposal, the issue was closed. (Telling a manufacturer that he should increase his proposed price was not a policy followed by our negotiators.) When OSD and the Congress failed to fund the program at the planned production rate, holding it instead to the minimum production level covered in the contract, Grumman was put into a loss situation which it could not tolerate.

Unfortunately, the facts relating to this dilemma were not widely known. As a result, negotiations were mishandled, particularly at the OSD and Congressional level.

In retrospect, the Navy would have been much better off without the variable lot provision in the contract, which made it easy to cut the quantity in each lot without losing contractual coverage and particularly when the increase in unit price was so low. (Ironically, the variable quantity option had its origins in Navy aircraft development contracts to solve just the opposite problem. During A-7 production, when the Navy sought to increase the quantity of the last lot covered in the original contract, the contractor quoted a higher unit price for the additional aircraft. This made it very difficult to obtain approval of the change in the Congress since a lower unit price would normally

have been expected. In this case, it was obvious to those familiar with all the facts that the contract prices were below actual costs.)

After negotiations between the government and contractor for exercising the Lot IV option in the F-14 contract escalated to the DepSecDef level, that official directed the Navy to seek an alternative to the F-14 and to study a carrier based version of the U. S. Air Force's F-15. At about the same time, the OSD initiated a "Prototype Program", which its advocates claimed would solve nearly all problems associated with government aircraft development and procurement — increasing technical capability, reducing costs and incidentally eliminating cost overrun problems. Light weight fighters were selected by OSD to become a part of the Air Force prototype program, and added more confusion to the overall fighter picture. Studies conducted at the time within the Navy showed that light weight fighters had no place on a carrier and that an F-15 Navy version was unattractive. Such a carrier version carrying Sparrows was 10% more costly and much less capable than the F-14. The Air Force, through whom F-15 data had to be obtained, advised that a Phoenix carrying version was impracticable within the time and resources available.

Despite each study turning out negatively, the OSD continued to press for a lower cost alternative to the F-14 and gradually forced on the Navy their version of a high-low mix concept. Nearly everyone conceded that an F-14/Phoenix capability was necessary to handle severe threats, but that lesser threats could be handled by cheaper aircraft. Although the concept of big trucks for big loads and little trucks for little loads in the transportation industry had merit in some cases, the extension of the concept to fighter squadron mixes on aircraft carriers was not one of them.

Through 1973, the Navy fought off the proposals for light weight fighters, low cost alternatives, and F-15 modifications to keep F-14 procurement on track — although running late — to replace all the F-4s. Every study showed that there was no lower cost alternative available if the alternative was to be better than the airplane it was replacing. In fact, new aircraft with less than F-4 capability were more costly than the F-4 itself. In mid-1973, Congress finally agreed with the Navy, ending a series of schemes originated in OSD and largely directed and managed by the Deputy Secretary of Defense.

In 1974 OSD and Congress renewed their pressure, in the name of economy, to restrict F-14 procurement to about half that called for in the original plan. The Navy responded to the demand for a lower cost alternative by offering an improved performance F-14 stripped of the Phoenix system, but with provisions retained to install it later. As expected, this recommendation was rejected, but an alternate proposal was accepted — to investigate a lighter weight, lower unit cost (note the word "unit"), multi-mission aircraft which could serve to replace some F-4s and eventually also to replace A-7s in the light attack role.

Thus, the VFAX concept was rediscovered, although in a much less capable version than the original. Congress then further complicated the issue by directing that any Navy

lightweight fighter be a version of the one selected by the Air Force from their YF-16 and YF-17 competition. (The Air Force embraced the production of lightweight fighters for their inventory after they were offered the program by OSD as additive to their planned F-15 program, and not as a substitute for a portion of it). The Navy evaluated proposals for carrier versions of the F-16 and F-17, selected the latter, and redesignated it as the F-18. OSD and congressional approval followed, despite the Air Force selection of the F-16. The Navy, in a "TacAir Study" justified the VFAX concept in much the same manner as the 1960s VFAX. Various alternative carrier complements were studied observing a constraint of only one F-14A squadron per carrier, thus avoiding a comparison with what should have been the base case, viz., two F-14 squadrons and two A-7 squadrons.

Of the alternatives reported, a mix of three F-18 squadrons with one F-14 squadron was adjudged the best. An unpublished NavAir analysis conducted at about the same time showed that a mix of F-14s and A-6s, and no A-7s, was the best combination, and the F-14, A-6, and A-7 mix was better than any involving a new VFAX.

In the Congressional hearings of the 1976 defense budget held in late 1975, the F-18 program was strongly supported by the Deputy Secretary of Defense while the Navy — damning with faint praise — justified the design as a *useful* fighter, complementary to the F-14, and *suitable* as an attack airplane with better performance than the A-7 and with *adequate* range and store carrying ability. Life cycle costs over a 15 year period were shown to be slightly lower for "Alternative II" (a mix of 224 F-14s, 202 A-7s, and 800 F-18s) than for "Alternative IA", (a mix of 744 F-14s, 186 A-7s, and 275 VALXs, the latter an undefined new light attack).

The decision to proceed with the F-18 program was a difficult one for most (I believe) of my generation in naval aviation to accept. It appeared to be more a part of an OSD plan for the future rather than that of the Navy, which seemed to accept it on a "better than nothing" basis. To those of us in the loyal opposition, (i.e. "loyal" to the Navy and in "opposition" to most of OSD's aircraft decisions), the design was the first intentional backward step in capability programmed by Naval aviation. The improvements in maintainability, reliability and overall readiness, associated with advances in avionic state of the art, could not offset the performance degradation as a fighter from the 1958 F4H/F8U-3 levels, nor the loss in attack payload/range and store carrying capability from the levels required in the competition to replace the A-4. On the positive side, of course, one might note that the Marine aviation support of the program was easier to accept. F/A-18 replacement of F-4/A-4 squadrons did not entail such a loss in capability.

Let us now turn to the attack field, where the Navy's development record is simpler and appears less affected by outside influences. The A-4, our first jet light attack was started in 1952 after several years of trying to find an adequate replacement for the reciprocating engined A-1s. Turboprop designs, probably in the long range plans of the time, were generally unattractive, but the engine state of the art made it difficult to design a carrier based jet attack airplane with enough capability to warrant development.

"Heinemann's Hot Rod" ─ a name applied much later ─ solved the problem although by compromise on store carrying flexibility. At initiation, the Navy estimated a 400 mile attack radius on internal fuel with a 1000 lb. store. Toward the end of the 1950s, a swept wing version of the airplane, designated A4D-3, was started to improve its capabilities, but budgetary limitations forced cancellation shortly after its start.

The A3J (A-5) program was started in 1956 after a couple of years of unsolicited attack proposals from North American Aviation. Initially the design, then called NAGPAW, was for a low level, twin engine, subsonic attack airplane, which evolved into a supersonic, nuclear weapon carrier with a linear bomb bay, which could be considered as an A-3 replacement.

The program may have been important when it was necessary to show that the Navy had a supersonic nuclear strike capability ─ but its evolution was a closely held negotiation between the contractor and a few Navy planners. The design saw service primarily as the RA-5C in a reconnaissance version for which there had been a long standing military requirement, but for a much longer ranged vehicle. Overall, the planning for this model was pretty much ad hoc.

The next airplane in the attack scene was the long-lived A-6, started in 1957 primarily as a short take off and landing (STOL) airplane for the Marines. OSD approval for the program was held up until the Navy defined a secondary, long range attack mission and included the model in its plans for the future. At initiation, the design close support mission called for an endurance of one hour at sea level at a radius of 300 miles following a short take off (STO) with two-1,000 lb. stores, using partial fuel. For the Navy, the airplane had an estimated radius of 900 nautical miles with two external tanks and a single 2, 000 lb. store, or a radius all at sea level, of 730 miles with four tanks. The short take off requirement of the Marines necessitated excellent low speed performance, while the Navy requirement demanded an efficient cruise arrangement; which combined to give the airplane its margin for growth and an unprecedently long production life (although at a rate so low that it can hardly qualify as "production"). Not even the longest of the long range plans contemplated the A-6s production longevity, which will probably continue until the mission requires ─ or the state of the art permits ─ a supersonic capability for our all weather attack airplanes.

By the end of the decade, the A-4 was reaching its limit in capability. A number of possible replacement designs were studied. These provided data to a formal "Sea Based Strike Study" which served to quantify the need for a greater light attack capability, and to gain the McNamara regime's approval for a "VAX" competition. The VAX was to retrieve the ground support mission dropped from TFX as well as to provide a replacement for the A-4. The competition was limited to modifications of existing airplanes in order to reduce the R&D effort and to permit use of production funds for development.

The winner of the competition, the A-7, was derived from the F-8 although in actuality it was almost a completely new detail design. In rough terms, the A-7 payload/range characteristics were double those of the A-4, while offering a much greater flexibility in store carrying capability. A fixed price development contract with fixed price options for a total of about 200 aircraft was awarded to Vought in 1964 after rejustifying the selection of a contractor to OSD by another operational analysis. At the time of contract award, the Navy estimated the radius of the airplane to be 635 miles, including a 200 mile run-in at sea level on internal fuel while carrying 12 mk 81 bombs; or 815 miles on the standard high-low-high profile with 6 mk 81 stores — also on internal fuel. Airplane development was highly successful with the achievement of fleet introduction within three years of contract award. Furthermore, production continued at a reasonable rate (150 per year or better) for five years before any cut back. When started, only the airframe and engine improvements over the A-4 were programmed, but the weapon system was brought up to the state of the art a few years later (but only after OSD forced the Air Force to join in the development). Once started, the A-7 probably followed its plans more closely than any of the programs I have discussed.

A high performance attack aircraft system study was conducted in the Naval Air Systems Command in 1970. That study presented a series of possible supersonic attack aircraft designs from near term to long term. The near term design was approximately equivalent to an A-7 with some aerodynamic improvements and with an afterburning engine. Payload/range capability of the A-7 was to be held with afterburning thrust used in the combat portion of the radius problem and Sidewinders carried for "self-protection". The project was dropped when the airplane snowballed in weight as the range, speed and strength requirements interacted. Supersonic performance appeared to offer too little advantage in reduced vulnerability to either ground defenses or to enemy fighters to offset the disadvantages of increased weight, cost, and IR signature. I suppose the long standing difference of opinion which has existed between the concept of strike fighters operating alone (Air Force) and pure attack aircraft escorted by fighters (Navy) will probably continue.

One cannot ignore the effect on naval aviation of changes made in the ship side of the Navy. There are a number of examples which come to mind. The decision to eliminate the anti-submarine warfare (CVS) carriers had an obvious effect on the numbers of S-3s needed in the active forces. But there were other effects. If this change had been anticipated, the design constraints imposed by that class of ships would not have been necessary allowing the design of a far more versatile ASW carrier capable aircraft. A COD version of that airplane would have been easier, as would other special purpose types considered and eliminated because of the degree of modification required. The disruption in aircraft planning caused by introduction of concepts such as the "Sea Control Ship", or "V/STOL carriers" is significant, particularly when they seem to appear out of the blue.

So what does this discussion of the last 34 years of carrier based VF and VA programs, and my own experience in the Washington naval aviation bureaucracy offer those

planning for the future? Although Santayana's axiom that "Those who fail to heed history are doomed to repeat it" is widely quoted, it is also widely ignored. We avoid repeating our own mistakes, but find it difficult to persuade others to avoid them. However, a few observations:

1. The record of initial plans being followed by the Navy is poor, while the record of OSD in changing plans for the worse is evident.

2. The aircraft programs controlled by the Navy came close to meeting the Navy's own technical projections. Without exception, all designs increased in weight and all suffered a decrease in range/radius/ endurance. Planners must recognize these facts of life.

3. A companion thought to the above is that the "standard" range/radius/endurance figures generated in Washington bear no fixed relationship to operational capabilities. Some "standard" radius problems give answers which approximate those obtained in realistic fleet usage, but most give decidedly overstated results.

4. Planners immediately after World War II set a goal of 600 miles for its future carrier based strike groups. Realistically, we achieved about half that goal with the F-4/A-4 mix and hoped to reach about 500 miles with the F-14/A-7 mix. With the world's fixed geography and increased threat performance, today's planners should seek no lower goal.

5. Planners must guard against the ever present, grossly optimistic, speculative theorists who offer projects so attractive that they get adopted despite warnings from the Navy's technical community. The XFV-12A is the most striking example in the recent past, but the V/STOL A and B programs are not far behind. As a corollary, planners should insure the competency of their technical community.

6. There was merit in the original plans for the F-14B and F-14C looking toward an avionic system which could handle both all weather VF and VA missions in an airplane with adequate range to do both jobs. The attack mission, raising a realistic radius problem, is the more demanding and still probably prevents attainment of the long time goal of one basic airplane to do all the VF and VA missions.

7. As the threat against the fleet gets more severe, a MISSILEER concept may again become attractive. If so, a multi-mission airplane combining AEW ASW COD, and Tanker with MISSILEER is a realistic possibility.

In conclusion, we all recognize the degree of gamesmanship required in today's political environment to get new programs started and worthwhile ones continued, but the planners must keep in mind that the real goal is to win the next war, when and if it occurs. That challenge is tougher than ever.

Exhibit A-14. This retyped article by GAS was written as a "Letter to the Editor", but the *armed forces JOURNAL international* published it as an article in August 1980.

Why the Country Cannot Afford OSD: A Case in Point — The F-18 Was Not Worth Buying in the First Place

Your F-18 article (July AFJ) seems destined to stir up all kinds of denials — the Navy will defend their program as it always does when challenged from the outside — Dr. Brown will deny that it is a "Second TFX", and even if it is, he didn't start it. (For once he's right). The contractor(s) will assure everyone that all problems are well on the way to solution, all guarantees will be met, all cost increases, if any, are due to inflation, and that, in any event, any publisher daring to print such scurrilous trivia will be cut off from all future advertising.

The most interesting question to be answered is whether the Congress will be able to grasp the problem as a whole and save the Navy from itself and OSD as was done in the case of the F-111B. The F/A-18 is more clearly a Washington invention than even the TFX, which did start out trying to meet Air Force and Navy requirements for a F-4 replacement, even though the combination of characteristics were clearly beyond the state of the art, then and now. The reduction in capability in both fighter and attack roles over current service aircraft which is being achieved by the F/A-18 is not as a result of any fleet demands of which I am aware. There have been no cries from the fighter community to eliminate the second seat, to reduce radar range, to reduce the quantity and capability of the primary armament, to increase the need for drop tanks, to increase approach speed, to decrease aircraft range, to decrease maximum speed, etc. Similarly, there has been no great demand from the light attack community to reduce payload/radius, to reduce store stations, to increase reliance on external fuel nor to increase weight and complexity. There have been requests for more thrust in the A-7, particularly when heavily loaded, a problem not exactly solved by afterburners not planned for use in attack missions.

There will be many asking how and why naval aviation with a pretty fair record of accomplishment, allowed itself to take its first major step backward in capability. A review of testimony in Congressional hearings is revealing:

1. In 1972, The Navy expressed its opposition to Light Weight Fighters (LWF). Admiral Zumwalt supported an all F-14 fighter force by testifying to a 3:1 advantage of the F-13 over the F-4 (or F-15, F-18 or any other Sparrow armed aircraft) and emphasized the necessity of comparing costs of equal effectiveness forces, rather than equal numbers.

2. In 1973, Deputy Defense Secretary Clements pushed his prototype scheme as a solution to the OSD perceived problem of excessive F-14 costs. The Navy resisted internally, I ended up with the opportunity of presenting the working level Navy case to the Cannon Tactical Air Subcommittee upon my retirement, and Congress killed that scheme.

3. In 1974, under an OSD ultimatum to have but one F-14 squadron per carrier, the Navy revived the VFAX concept from the F-111B days. (One F-14 + three VFAX is a better complement than one F-14 +one LWF + two A-7s). Congress and OSD combined to make the plan less viable by specifying commonness with the Air Force LWF, and a reduced level of capability.

4. In 1975, during the Spring hearings, the Navy qualified its endorsement of the LWF by noting the OSD demand for a lower cost complementary fighter to the F-14, but in the Fall hearings, the high-low mix was supported without reservation, despite all logic and previous testimony.

5. In 1977, the Navy dropped the F-18 program from its budget, but OSD put it back. (As noted by AFJ, Brown overruled Woolsey.)

In view of the OSD pressure over the years, I can understand how Navy officials end up testifying in support of the program (the "anything is better than nothing" syndrome.) I'm curious as to whether AFJ asked the F-18 program manager, Capt. John Weaver, whether he favored the basic concept of a high-low mix. After his previous efforts on behalf of the AWG-9 Phoenix level of capability, how could he support the giant step backward? I have to believe he was assigned to the job, and as usual is doing his utmost to get the best possible product under the circumstances, for the Navy. Unfortunately, in the long run, this is probably not in the Navy's best interests. If the original OSD LWF (1973 level) with virtually no capability had been developed it would probably now be dead. Efforts improving poor programs make them harder to kill.

TFX Fiasco

As AFJ has noted, Dr. Brown was associated with the whole TFX fiasco. The record seems to show he really deserves most of the credit for both starting and continuing the Navy version much too long. He signed all the recommendations which McNamara immediately approved. In the F-18 program, however, Brown carried on that which Foster, Clements, Currie, et al started.

In the final analysis, the F-18 is not really an F-111B. Most of the airplane deficiencies now being reported can be corrected, and there is no USAF model to get made worse by each correction. Although weight and performance will get worse, the real case is that the F-18 was not worth buying in the first place. The engineering mistakes and cost growth only reinforce the original conclusion of most of the working Navy that the airplane was not worth buying as a fighter because it was grossly less capable than the

F-14 with life cycle costs projected to be about the same from that point on (1975), and was markedly inferior to the A-7 in payload range, and cost much more. (Admittedly, the design could run from air opposition much faster than an A-7, although this characteristic had not previously been rated high on the priority list for a Navy attack airplane, particularly when it cannot run fast enough. One might also note that the afterburning retreat had better be directed toward a friendly tanker.)

Your chart (p.21) showing the slow production build up to the F-18 is but a part of the problem. The time from go-ahead to first flight was also longer than usual, and if the prototype phase were included, another two-year delay is involved. Current A-109 acquisition procedures are so drawn out that costs must be double what they could be. This is a fertile field for some AFJ investigative reporting to help us get back to the type of scheduling which gave us a fleet squadron in not more than five years from go-ahead.

Overall, I have not changed my opinion that the country cannot really afford the OSD. Between OMB and the Congress, the Services have plenty of supervision and all the coordination they need. Too few of those who are brought into OSD seem to have enough common sense to ferret out the true facts by finding reliable sources of information (The editor of AFJ was an exception.) Too many mistakes of the past have been repeated, and too many compromises accepted.