REPORT OF THE ACQUISITION CYCLE TASK FORCE

DEFENSE SCIENCE BOARD 1977 SUMMER STUDY

15 MARCH 1978

OFFICE OF THE
UNDER SECRETARY OF DEFENSE
FOR RESEARCH AND ENGINEERING
WASHINGTON, D.C. 20301

DISCLAIMER NOTICE

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RESEARCH AND ENGINEERING

26 April 1978

MEMORANDUM FOR THE SECRETARY OF DEFENSE

THROUGH: THE UNDER SECRETARY OF DEFENSE, RESEARCH AND ENGINEERING

SUBJECT: Report of the Defense Science Board Task Force on Acquisition Cycle

The attached report of the Defense Science Board Task Force on the Acquisition Cycle was prepared at the request of the Under Secretary of Defense Research and Engineering and the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). The Task Force was chaired by Dr. Richard D. DeLauer and included members from the Defense Science Board, industry, the Office of the Secretary of Defense, and the Military Services.

I believe the findings and conclusions of the Task Force regarding the underlying causes for the lengthening trend of the Acquisition Cycle are valid. For a concise assessment of the basic reasons for this condition, I would direct your attention to the Section of the report entitled "No Sense of Urgency" which appears on pages 35 through 39. I particularly li'e these pages because they give a rational explanation of the fact that de.ays occur not in the "doing" but in the process of "deciding to do." This explanation rests on an analysis of the perception our society, including DoD, has of the needs of Defense. Secondary to this primary explanation is the continuous lack of funds due essentially to the fact that we start more projects than our available funds permit us to conduct to a satisfactory conclusion. I have some concerns regarding DoD's ability to eliminate this problem. I believe pages 35 through 39 summarize in very clear terms the basic reasons for the lengthening of the acquisition cycle.

The recommendations of the Task Force are listed in pages 2 to 5. They are directed toward three principal areas where improvements in the present process would have beneficial effects on the length and cost of weapon system acquisition:

1. Acquisition management flexibility;
2. Acquisition program stability; and,
3. Defense system affordability.

I recommend this report to your attention, and urge you to direct your staff to comment on the specific and implied recommendations of the study.

This report has been approved by the Defense Science Board, and I will be pleased to provide you with any further assistance you may require with respect to carrying out its suggestions and recommendations. In this regard, I have attached for your signature an implementation letter at Tab A.

Eugene G. Fubini
Chairman
Defense Science Board

Attachment

THE SECRETARY OF DEFENSE
WASHINGTON D. C. 20301

MAY 13 1978

MEMORANDUM FOR Secretaries of the Military Departments
Under Secretary of Defense for Research and Engineering
Assistant Secretary of Defense (C)
Assistant Secretary of Defense (MRA&L)
Assistant Secretary of Defense (PA&E)

SUBJECT: Implementation of Recommendations of the Defense Science Board 1977 Summer Study Task Force on the Acquisition Cycle

I have reviewed the report of the Defense Science Board 1977 Summer Study on the Acquisition Cycle. This study analyzes the increasing length of various phases of the RDT&E and procurement cycle, the causes for schedule and cost growth, and the impact of these on our ability to acquire the weapon systems we need. The report concludes:

- That there has been nearly a three-fold lengthening of the program birth process (the time to reach DSARC II);
- That the acquisition process has gone to unreasonable limits in discouraging concurrency and in overemphasizing advanced development prototypes even when these add more to program cost and acquisition time than they benefit it by reducing risk;
- That there are frequently-disregarded cost advantages, in many cases, of acquiring evolutionary improvements to existing hardware rather than developing entirely new systems.

The DSB Task Force has also suggested that many of their acquisition cycle time and cost reduction recommendations could be effectively implemented if more emphasis was placed in the DSARC meetings on detailed scrutiny of the proposed program plan, schedule, and acquisition strategy to assure that the program is performed in the minimum time required to meet only the approved military mission need.

I recommend this study to your attention, and request that you comment within 30 days on the specific and implied recommendations of the Defense Science Board to improve the acquisition process by reducing the length and cost of the cycle from initial conception to operational deployment.

C W Duncan Jr
DEPUTY

OFFICE OF THE UNDER SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

RESEARCH AND
ENGINEERING

15 March 1978

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Report of the Task Force on the Acquisition Cycle

I am pleased to submit to you the final report of the Defense Science Board Task Force on the Acquisition Cycle. This Report summarizes the findings, conclusions, recommendations, and suggested action items developed by the Task Force during the 1977 DSB Summer Study.

The Task Force found that the full-scale development period (from DSARC II to DSARC III) has not significantly changed over the last 15-20 years despite the increasing complexity of our weapon systems. On the other hand, the "front end" period from initial program conception to DSARC II has increased substantially—from less than two years in the 1950's to an average of nearly five years at present. If this trend is not reversed, the Task Force suspects that an average "birth time" of perhaps six years or more must be anticipated in the years ahead, particularly if the intent and provisions of OMB Circular A-109 are not followed with the proper degree of flexibility which is allowed by this document. It was also concluded that the production and deployment period has increased considerably in recent years as a result of such pressures as operational test and evaluation, reduced concurrency, and production stretchouts necessitated by a lack of the needed procurement funds to complete the program on the original plan and schedule.

The Report discusses the causes and implications of these adverse trends, each of which is important, and suggests positive actions which should be taken to reverse current trends. In the final analysis, the lengthening period between initial consensus on a perceived mission need and full operational deployment is causing the U.S. to lose its technological lead. We typically perceive more needs, and approve more program starts, than can realistically be supported by our annual defense budget. As a consequence, we create a chain reaction by budgeting too little for the individual system acquisition in order to allow more starts to meet our total defense needs. This results in cost overruns, program stretchouts, over-management by OSD and the Congress, introduction of new (and retention of the old) management techniques and program milestones, institutionalizing of procurement practices, and the delivery of obsolescent systems and equipment in insufficient quantities or with inadequate performance and reliability in too many instances.

The Acquisition Cycle Task Force has recommended a number of acquisition policy initiatives which are believed to be sound and consistent with the Administration's objective of a balanced budget by 1981 and an annual increase in the real level of the DoD budget of approximately three per cent per year in the foreseeable future. These include limiting the number of major weapon systems to those we can afford to develop and deploy on the most cost-effective time scale; cancelling programs that are marginal from an operational point of view; precluding the further institutionalizing of the procurement process in such areas as the unwarranted utilization of prototypes and the arbitrary prohibition of a reasonable degree of concurrency where appropriate; demanding that the acquisition strategy for a particular program provide for the level of flexibility and program stability that is suitable; insisting that the upgrading and improvement of an existing system be thoroughly examined before approval of a new system development effort; insuring that the procuring Service is prepared to make the commitment to procure and deploy a system before approval to enter full-scale development is given at DSARC II; requiring that each DSARC decision be a combined programmatic and budgeting review milestone within the limits of DoD statutory authority; and providing for adequate statistical cost margins for the undefined but to-be-expected contingencies and engineering changes which will be incurred in every program.

In considering the adoption and implementation of the recommendations provided in this Report, it is further suggested that DoD contemplate the advisability of taking specific actions such as the following:

- Review all current 6.2 exploratory research programs to determine which should have a MENS developed (as prescribed in Dr. Perry's memorandum of 18 January 1978) and which should be terminated for lack of a definable mission need. The 6.2 money thus freed should be reallocated to true technology base efforts.
- Take actions to assure proper implementation of DoDD 5000.1 (when revised and reissued) in the Military Departments by precluding the issuance of Service Directives which allow:
  1) Proliferation of interpretive documents;
  2) Layering of acquisition management;
  3) Adding time to the acquisition cycle to permit the accomplishment of subordinate reviews and approvals.
- Incorporate OMB Circular A-109 as a referenced attachment to a revised DoDD 5000.1 and make 5000.1 an immediate element of the Defense Acquisition Regulatory System by issuing it as a Defense Procurement Circular.

- In DSARC program reviews, require each Program Manager to demonstrate that his program milestone plan and acquisition strategy will assure the most cost-effective and timely acquisition schedule consistent with acceptable risk.
- Direct that A-109 be accepted as the philosophical underpinning to the acquisition process and eliminate all directed models of the process. Require each Program Manager to present for review at Milestone 0 a strategy for system acquisition which is tailored to that particular program.
- At Milestone 0, insist on convincing proof in the MENS that an existing system will not satisfy the mission need (as stated in Dr. Perry's memorandum of 18 January 1978).
- At Milestone III when the production go-ahead decision is confirmed and rate production is approved, require the Program Manager to demonstrate that adequate funding will be available for the approved rates of production, and reflect this funding in all appropriate PPBS documents immediately (POM, FYDP, etc.).
- As a general rule, insist that whenever a major new or revised acquisition directive is issued, it must be reflected in the DARS within not more than twelve months.
- Transmit this Report to all DoD Components (as appropriate) by a memorandum signed by the Secretary of Defense. A suggested draft of such a memorandum is provided as Attachment I to this memorandum.

In closing, I wish to express my sincere appreciation to all those many people who contributed their time, expertise, and resources to the conduct of this study, both as designated members of the Acquisition Cycle Task Force and in the role of supporting participants in the Summer Study activities. As I indicated in the conclusion of my summary briefing on the final day of the 1977 Summer Study, the best indication of the success of our deliberations will be the absence of a requirement to perform a similar study of the acquisition cycle again in the near future.

Richard D. DeLauer

Richard D. DeLauer, Chairman
Acquisition Cycle Task Force

Attachment

TASK FORCE MEMBERS

*Richard D. DeLauer, TRW Inc. (Chairman)

Robert C. Anderson, TRW Defense & Space Systems Group

Norman R. Augustine, Martin Marietta Aerospace

*Ivan L. Bennett, Jr., M.D., New York University Medical Center

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Captain J. R. Farrell, USN, Office, CNM (MAT-09H)

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*Donald H. Steininger, Xerox Corporation

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EXECUTIVE SUMMARY

The Defense Science Board Summer Study Task Force on the Acquisition Cycle examined a number of major systems acquisition case histories, changes in acquisition policy over the past two decades, and the actual workings of the program advocacy and budgetary processes. The Task Force concluded that, over the past 15-20 years, the acquisition process—from initial program concept to initial operational capability—has increased in length by approximately five years on the average. Most of this increase has been in the "front end" of the process, from the time of initial concept studies to the start of Full Scale Development (i.e., DSARC II), and at the "back end" from the completion of FSD at DSARC III to the achievement of a full operational capability (i.e., the production and deployment phase). The actual development time from DSARC II to DSARC III, or "FSD" phase, was found to have remained essentially the same over the period examined for the various types of major weapon systems studied.

The progression of acquisition policy changes from Total Package Procurement through the DSARC process, Fly Before Buy, full scale prototyping, increased emphasis on operational test and evaluation, and up to the current OMB Circular A-109 policy, has evolved out of the perceived need to correct the deficiencies observed in specific programs by introducing additional management review and decision procedural checkpoints to assure that past mistakes would not be repeated. These procedural changes have become institutionalized and have been applied inflexibly to all programs with the result that the acquisition process has steadily lengthened and the procurement of defense systems has become increasingly costly.

Lack of realism in the estimation of program costs, changes in specified performance requirements, inflation, and other such causes of "cost growth" have caused the aggregate cost of planned production programs to substantially exceed the allocated budgetary resources, resulting in the need to delay the completion of the production phase of programs in order to fit the total available defense budget in each fiscal year. The "bow wave" effect created by too many programs in full scale development at any given time in relation to the available production funds results in an acquisition cycle for the typical defense system which is in excess of the optimum length of time and is more costly than planned or estimated.

The Task Force also concluded that full-scale prototyping often introduces costly and unnecessary program delays; that the policy of "no concurrency" is being applied too rigidly and is inefficient and costly in many cases; and that sequential and separate testing of systems by developers and by the users (instead of the independent evaluation of jointly obtained test data) often adds unnecessary expense and time. It was also concluded that the practice of incremental decision making by requiring the achievement of a consensus between the advocates and the antagonists at each (DSARC) milestone is a cumbersome process that tends to prolong programs so much that—during the acquisition cycle—the threat, the players, and even the concepts of warfare often change, resulting in the necessity to cancel programs and start new ones to meet the threat, with the concommitant waste of limited national resources.

The Task Force was also quite concerned that without very careful attention to the implementation of OMB Circular A-109, this well-intentioned policy could very likely give rise to institutionalized procedures that will significantly increase the length of the "front end" phase of program acquisition rather than shortening it as intended and without achieving the intended degree of program flexibility and stability in acquisition policy.

On the basis of the data studied by the Task Force, it was concluded that a period of six or seven years from initial program concept to IOC is a low risk acquisition time. Depending on the particular nature of a given program, some may occasionally take less time than this, and many will require more time for efficient development.

In order to improve the efficiency of the "front end" of the acquisition cycle (from initial concept formulation to start of FSD), the Task Force identified the following acquisition policy initiatives for consideration:

- Reduce the number of formally prescribed steps in the decision-making process which have been created by the accumulation of checkpoints and gates generated by past acquisition policy changes, which only added but did not remove milestones. (Full implementation of A-109 will involve a maximum of only four key decision points.)

- Use a flexible approach to the application of the required steps by requiring a tailored acquisition strategy for each major system acquisition
- Reconcile and prioritize new major systems acquisitions with existing capabilities and resources through the implementation of the Mission Element Need Statement (MENS) and revitalization of the Decision Coordinating Paper (DCP) process, by returning to its original intent of providing a brief program rationale, a discussion of alternatives, and a resolution of issues*
- Make greater use of the operational experience residing in the user organization to support the identification of mission need and evaluation of alternative system design concepts leading to the DSARC II milestone
- Increase the interaction between the "supporting technology" of the technology base and the "operational experience" of the user.

To improve the efficiency of the acquisition cycle from the start of full scale development through operational deployment, the following policy initiatives are recommended:

- A commitment to full scale development should also be viewed and recognized as a commitment to produce and deploy the system or equipment (provided that the outcome of the development and test phases validate the expected performance)
- FSD should be limited to those programs that are intended to be, and can be afforded to be procured within the total defense budget (on the basis of realistic and credible cost estimates)
- OSD should demand—and approve—a flexible approach to the establishment of an acquisition strategy for each program (as called for in the current issues of DoDD 5000.1/.2, A-109, etc.), particularly with respect to the use of prototypes, operational test and evaluation, program concurrency, fly-before-buy, performance

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*Implementing policy with respect to the MENS and DCP was issued in Dr. Perry's memorandum of 18 January 1978.

requirements, and the provision of contingency resources for unanticipated but unavoidable program difficulties

- Multi-year program commitments should be made to maintain program stability
- An approach to cost estimating and budgeting should be adopted which provides for the unexpected program tasks and needs which occur in every program with statistical regularity.

In order to add to the money which can be made available to fully fund the development and procurement activities of programs on which the DoD currently has real commitments, the Task Force recommends that OSD should:

- Insist that upgrading of existing systems be considered as an alternative for satisfying a new mission requirement, since this may be much less costly than developing entirely new systems
- Eliminate the lower priority programs at Milestone 0 to assure the ability (under conservative assumptions) to fund through procurement and timely deployment those that remain. On the other hand, the range of exploratory development (6.2) efforts that produce the alternatives and support mission analyses should not be reduced, but should, in fact, be increased. Additionally, carry a greater number of competing alternatives into demonstration between Milestone I and II when several are obviously candidates for meeting the same mission need.

I. INTRODUCTION

A. PURPOSE AND OBJECTIVES

The Defense Science Board Task Force on the Acquisition Cycle was convened at the request of Dr. William J. Perry, Director of Defense Research and Engineering and Dr. John P. White, Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) with the assigned purpose of (1) examining the Acquisition Schedule for past and current weapon systems, focusing on the causes and associated costs of the delays in achieving a fully deployed operational capability; and (2) developing recommended changes or policy initiatives to counteract these delays without significantly increasing risks.

The objectives of the Task Force, as defined in the Task Statement, were as follows:

1. Examine the Weapon System Acquisition Schedule to identify those elements which drive acquisition and deployment cycle length.

2. Develop a data base which defines overall acquisition cycle length and cost trends for classes of major weapon systems and more detailed case study data for selected similar—but different time scale—systems. Develop a common thread which applies to all programs and determine how it differs from earlier programs. Include case studies which compare defense versus commercial programs and modifications versus new systems acquisitions.

3. Quantify for selected acquisition programs the cost added by each element of the acquisition and deployment cycle. Highlight the costs associated with delays.

4. Develop recommended changes or policy initiatives toward shortening the acquisition cycle and reducing costs without significantly increasing acquisition risk.

B. PROBLEM

As defined by the Task Force, the basic problem to be studied consisted of two principal parts: First, the existing capability in the hands of the users often does not meet their perceived needs and frequently the cost and schedule goals for its acquisition are not met; and second, the process of weapon systems acquisition appears to be taking longer as time passes, resulting in the delivery on certain occasions of equipment which is obsolescent by the time it reaches the field.

C. APPROACH

In order to develop the required data base prior to convening the entire Task Force at the Defense Science Board Summer Study which was held in San Diego, California at the Naval Ocean Systems Center from August 1-12, 1977, the Task Force Chairman appointed seven team leaders to head up seven different weapon system panels. The objective of these panels was to develop schedule data and other pertinent information on selected weapon systems areas, generally to permit comparison of the Acquisition Cycle of a current system with a system which had been acquired approximately a decade previously. The panels and their team leaders were as follows:

- Air Force Ballistic Missiles - R. C. Anderson, TRW Defense and Space Systems Group
- Tacair/Counter Tacair Systems - N. R. Augustine, Martin Marietta Aerospace
- C^3 Systems - R. R. Everett/N. Waks, MITRE Corp.
- Fleet Ballistic Missiles - R. A. Fuhrman, Lockheed Missiles and Space Company
- Military and Commercial Transport Aircraft - J. H. Goldie, Boeing Aerospace Company
- Air-Launched Missiles - W. W. Maguire (Phoenix)/ J. F. Drake (Maverick), Hughes Aircraft Company
- Navy Ships - N. Sonenshein, Global Marine Development, Inc.

Each of the panels developed comparative data on the acquisition cycle of selected weapon systems in the assigned areas, and presented summary briefings and analyses of the data which had been developed. These briefings were presented to the entire Task Force during the first week of the Summer Study period.

In several cases, the team leaders presented considerable documentation to accompany the panel's briefing. This material has been used extensively by the Task Force in the development of its findings, conclusions, and recommendations as presented in the Summary Briefing delivered by the Task Force Chairman at the conclusion of the Summer Study, and also in the preparation of this Final Report. Due to the very specialized nature of the acquisition process for Navy Ship Systems, the Report of the Ship Acquisition Team, dated August 26, 1977, is included as Appendix C to this report.

In addition to the briefings presented by each Team Leader, the Task Force also received special briefings during the Summer Study period as follows:

- AF Cost Growth Study - Major General Richard C. Henry, Headquarters, USAF
- Condor Missile Program - H. J. Peters, Rockwell International
- Study of the DoD Acquisition Cycle - Robert Perry, The RAND Corp.
- Comments on the Procurement Process - T. V. Jones, Northrop Corp.
- OMB Circular A-109 - Lester Fettig, Administrator, Office of Federal Procurement Policy, OMB
- The B-1 Program - D. D. Myers and B. Hello, Rockwell International.

In preparation for the Summer Study, two meetings were held to review the progress of the various panels and to receive special briefings on particular aspects of the systems acquisition process. A meeting for the West Coast teams was held in Redondo Beach, California on June 29, 1977 at which progress reports were presented by the leaders of the AF ICBM, FBM, and Air-Launched Missile panels.

On July 15, 1977, a final preparatory meeting was held in the Pentagon, during which individual presentations on the Acquisition Cycle were made by representatives of each of the three military services: Major General P. R. Feir, U.S. Army; Major General L. A. Skantze, U.S. Air Force; and Rear Admiral C. P. Ekas, Jr., U.S. Navy. A briefing on the impact of OMB

Circular A-109 on the Acquisition Cycle was presented by Mr. F. H. Dietrich of the Office of Federal Procurement Policy. A briefing on the role of test and evaluation in developing the acquisition schedule was presented by Lt. General W. E. Lotz, Jr., USA (Ret.), Deputy DDR&E/Test & Evaluation. During the July 15 meeting, status reports were also presented by the team leaders of the panels on FBM, Air-Launched Missiles C^3, Tacair/Counter Tacair, and Military and Commercial Transport Aircraft.

In addition to the members of the Task Force itself, the following also participated for shorter periods of time during the Summer Study:

Captain William Abbott, USN - Naval Plant Representative, Lockheed Missiles & Space Company

Mr. Dale Church, ODDR&E

Mr. J. S Gansler, The Analytic Sciences Corporation

Mr. E. D. Greinke, ODDR&E

Major General R. C. Henry, USAF Hq

Mr. A. W. Marshall, OSD/Net Assessment

Mr. R. N. Parker, Principal Deputy DDR&E

Rear Admiral Levering Smith - NMAT Strategic Systems Projects

Mr. Charles W. Snodgrass, Staff Assistant, Defense Subcommittee, House Appropriations Committee

Major General John C. Toomay, DCS/Development Plans, AFSC

D. SYSTEMS EXAMINED

The following major weapon system acquisition cycles were studied by the Task Force during the course of the Summer Study, using the data developed by the various panels:

Air Force Ballistic Missiles: Minuteman I, MX

Tacair/Counter Tacair: P-80, F-86, A-4, F-100, F-4H, A-6, F-111, SR-71, A-7A, A-7B, F-14, F-15, F-5E, A-10, F-16, F-18, Nike-Ajax, Hawk, Improved Hawk, SAM-D, UH-1, AH-1, AAH

C^3 Systems: AN/TPS-44, AN/TPS-63, E-2A, E-3A, 425L, 427M

Transport Aircraft: Boeing 727-100, 727-200, Advanced 727-200, 747, 7N7, AMST (YC-14)

Fleet Ballistic Missiles: Polaris A1, A2, A3, Poseidon C3, Trident I (C4)

Air-Launched Missiles: Maverick, Phoenix

Navy Ships: DDG2, DD963, DDG47, FF1052, FFG7, SSN 637, SSN 688, AOR 1, AOR 7, AO 177, PHM. (Refer to Appendix C for complete report on the acquisition cycles for these classes of ships.)

In addition to the data packages provided by the Task Force panels on the above weapon system acquisition cycles, the briefing on the Air Force Cost Growth Study presented by General Henry also provided acquisition data on the following systems: B-1, E-4, E-3A, F-15, F-16, EF-111, and A-10.

II. THE ACQUISITION PHASE

A. INITIAL CONCEPT TO DSARC II

1. Introduction

This section deals with the first major phase of the acquisition cycle—the birth of a program. Within the definitions of current procedures (as defined in DoDD 5000.1 and OMB Circular A-109) this phase begins at Milestone 0 and ends with the DSARC II decision required for initiation of the full-scale development (FSD) phase. In more generic terms, this program birth phase, or "front end" begins with the official acceptance of a mission need and goes to the point where there is sufficient data to allow confident predictions about cost, performance capability, development risk, and military utility to support a commitment to FSD.

In the past (i.e., pre-A-109), the real starting point of a program was rarely a discrete bureaucratic milestone nor a formally documented mission need, but rather some form of general consensus about how to join an operational need with available or emerging technology that arose spontaneously from the grass roots of the military establishment and the defense industrial base. The exact time when this consensus occurred is difficult to identify and is seldom documented. Nevertheless, it was the general perception of the Task Force that the time required to go from this initial program conception (usually at some point after the particular technology involved had been designated a Program Element in 6.2, Exploratory Development, but before a major program line item identification had been made) to the DSARC II decision has been getting longer in recent decades.

2. Front End Trends

On the basis of an analysis of the chronology of a large number of major weapon system programs, the Task Force believes that this perception is clearly a valid one. Figure 1 depicts, in necessarily generalized form, the average "birth time" of programs (as perceived by a majority—but not all—of the members of the Task Force) during three consecutive periods: prior to 1960, from 1961 to 1970, and from 1971 to the present. This figure suggests a trend from less than two years birth time prior to 1960 to nearly five years in the current decade.

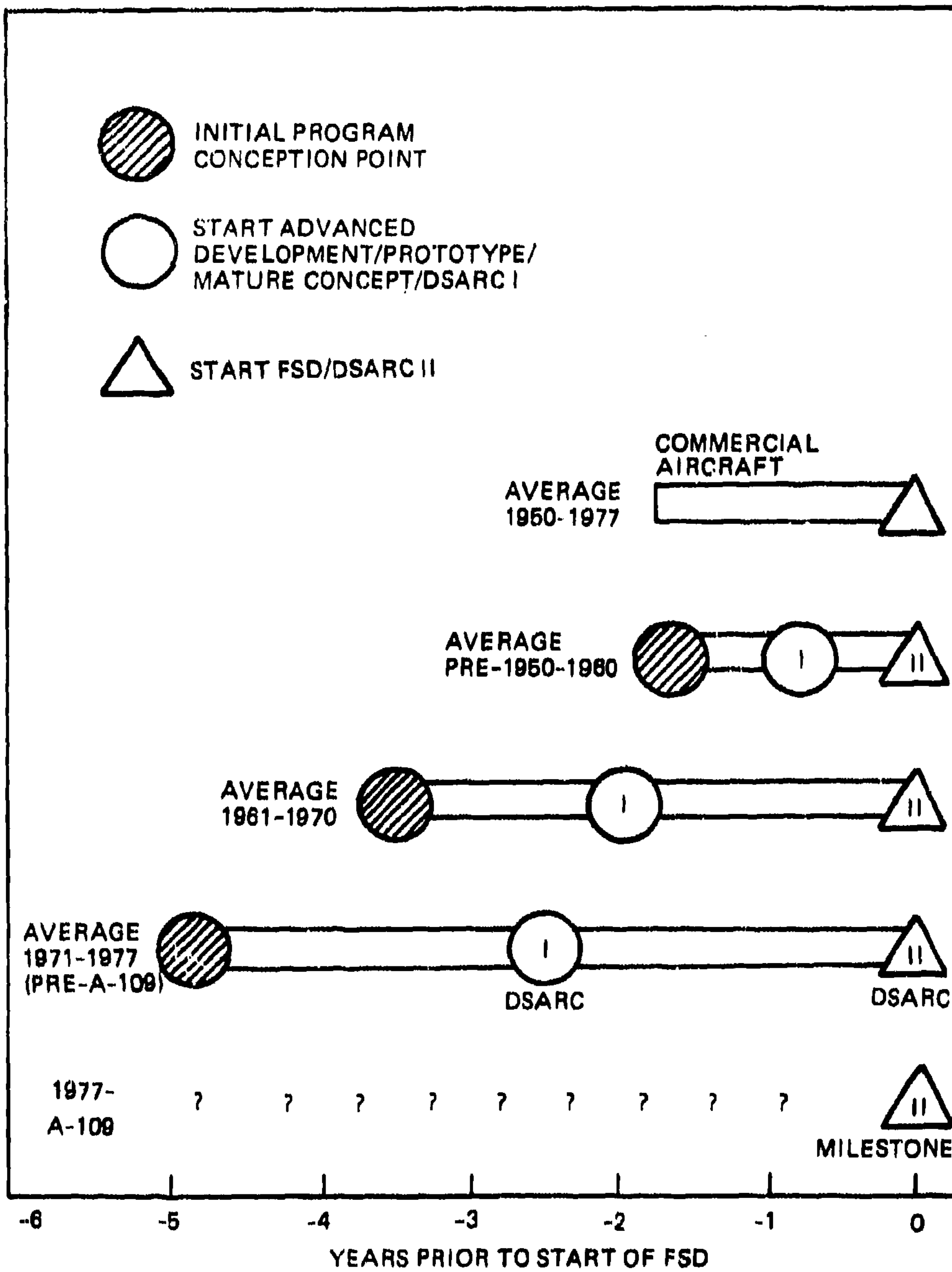

Figure 1. Front End Trends

The chart also indicates the comparable time span for the "front end" of commercial aircraft programs, where the conceptual starting point is defined as the time when a sufficient number of airline customers indicate a firm intention to place orders for a sufficient number of aircraft to cause the offeror to make a corporate commitment to proceed with the design, manufacture, and delivery of the model (which is not the same as the tentative preliminary design studies and requirements analysis effort which may have been underway for as long as ten years prior to the corporate decision to "go").

Finally, Figure 1 suggests the Task Force's general concern that the application of the principles of A-109 will very likely not be as flexible as intended, which could cause the front end to be as long or even longer than past processes. This cannot be determined as yet due to insufficient experience with the use of A-109/5000.1, but concern was expressed by many of the Task Force members that changes in DoD acquisition policy in recent decades have invariably resulted in some lengthening of the cycle, and the application of A-109 is anticipated to show a continuation of the same trend. This is a challenge, at best.

3. Front End Activities

The questions which the Task Force addressed with respect to the front end of the acquisition cycle were:

- Why is the birth-time getting longer?
- What can be done about it?

Before attempting to provide answers to these questions, it is worth reminding ourselves that shortening the time from initial concept to start of FSD should not necessarily be the highest priority objective. It must continue to be recognized that there are many essential but time consuming things that need to be done in the early phases of a major systems development program, and the first priority of those responsible for managing our defense must be to insure that priority needs are met and that all of these are done and done well. Before discussing why it is taking longer to do these things, it may be useful to review what they are. (It should be noted that certain portions of the following were not discussed in detail during the Summer

Study, but were developed or amplified for inclusion in this report as a result of subsequent briefings of the Task Force findings to OSD.)

a. The front end of the acquisition cycle is essentially an information seeking period. It is a period of high technical uncertainty as compared to the more nearly schedulable period of technical activity which follows during FSD and production. Figure 2 depicts the principal events which the Task Force believes must take place before a confident FSD decision can be made. It should be noted that there are two main streams of continuing activity and knowledge-gathering: "Operational Experience" and "Supporting Technology" whose existence, strength, and close interaction are essential to the timely mission area analysis, identification of a mission need, conception of a program and to its rapid and orderly progress through the development cycle.

b. Operational experience resides in the user organizations, such as the armored or artillery forces of the Army, the submarine force of the Navy, or the tactical aircraft elements of the Air Force. This operational experience is accumulated through actual combat, training exercises, identification of deficiencies in current capabilities, field experiments with new hardware and new techniques, simulation methodology, and doctrinal analysis and development. During periods of peacetime, the user's competence and the sophistication of his attitude toward advanced technology and doctrine will be directly related to the amount of time and resources he spends (or is allowed to spend) on operational exercises and experiments with new technology and techniques. His competence and attitude in this regard are crucial determinants of the length of the acquisition cycle. Figure 2 points out that the user must interact with the developer and support the program throughout the entire cycle. First, he must be a contributor to the mission area analyses that identify a mission need. Second, he must assist in the evaluation of alternative system design concepts for satisfying a particular mission need. Once a program has been initiated at Milestone 0, he must support preparation for DSARC's I and II by fleshing out the system concept from a field environment standpoint. Also, through appropriate analyses and experiments, he must determine how competing systems would be used and what their operational value would be. This involvement should become more intense (and more demanding of resources) as the DSARC II decision point approaches. Later in this report, the case will be made that DSARC II should be emphasized as the point of "big decision,"

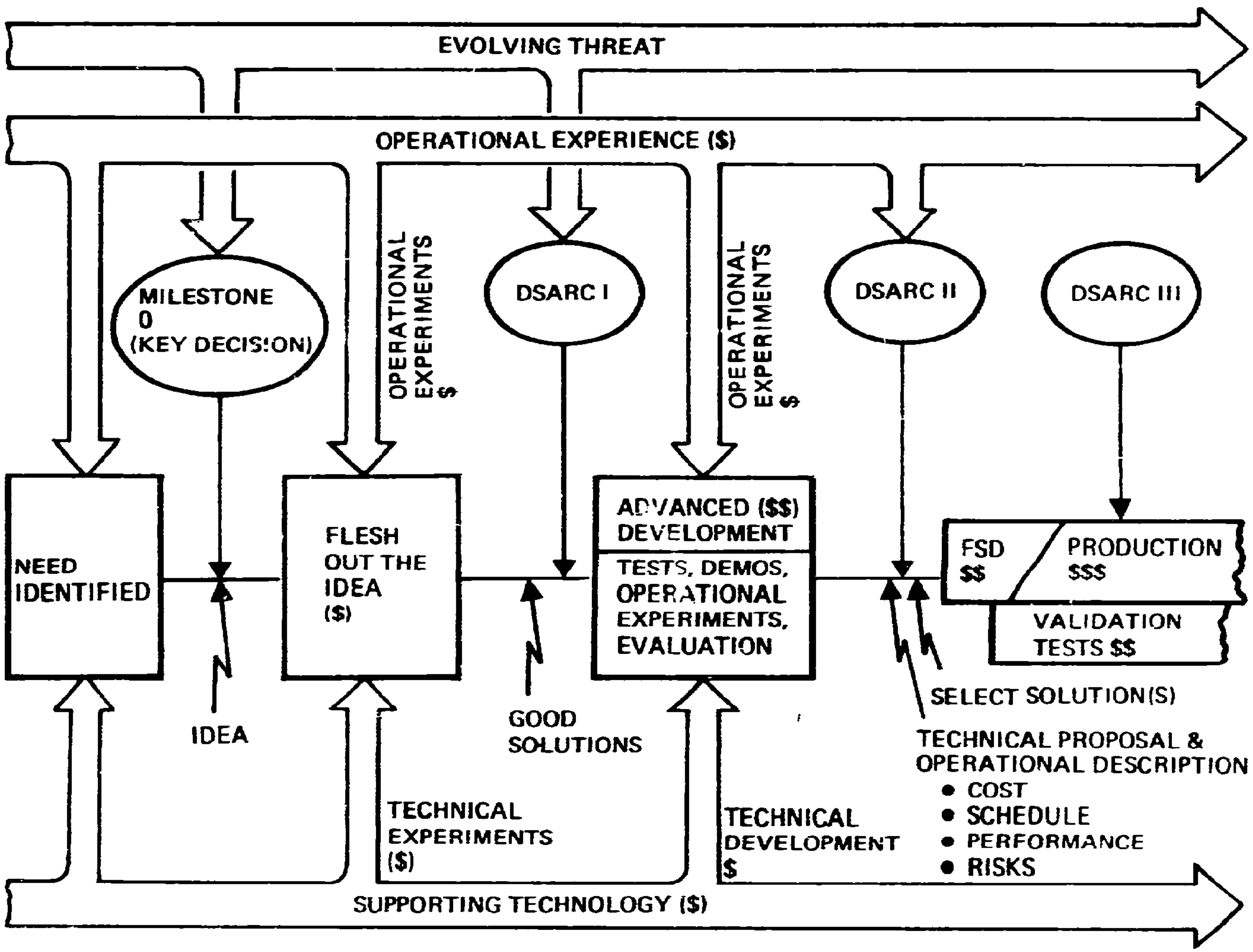

Figure 2. The Anatomy of the Acquisition

when an explicit "commitment" is made to a plan which includes production and operational deployment of the system. Later review milestones therefore should be limited in scope to the monitoring of adherence to the adopted plan, rather than reiteratively reopening questions about the need for the system or what the operational characteristics of the system should be. The Task Force came to the conclusion that these questions either should be "put to bed" at DSARC II or else the request to proceed to FSD should be denied.

It seems clear, then, that the user institution must have a major voice in the DSARC II decision and must have done a lot of homework by that time. After all, this is the element of the defense establishment which must implement the eventual deployment and operational utilization of the system. By DSARC II he must have had access to enough test data and analyses to allow him to buy off on the performance characteristics of the system to be developed and to confirm his willingness to use such a system when it is deployed.

c. <u>The interest in and the resources available for the user institutions to do field environment tests and evaluations have increased substantially over the past decade.</u> However, the Task Force believes that this is an area in which there is still much room for improvement. It is deserving of continued attention and emphasis by the highest levels in OSD. Although the Task Force was not able to do enough work to validate its concerns, it was suspicious that the institutionalizing of a separate OT&E function could have the effect of weakening the role of the real user to the overall detriment of the acquisition process. Further discussion of these concerns is presented in Section III. G. below.

d. <u>The other stream of activity that is so vital to the health of the front end of the acquisition process is that which maintains and improves our technology base.</u> It includes the 6.1, 6.2, and 6.3A programs under the direct control of the DoD, the contractor IR&D programs, and academic and commercial R&D efforts. This activity is highly decentralized and its usefulness to the development of any system depends on how well it has been funded and how wisely laboratory managers around the country have expended their resources. The further along components and techniques are brought in the 6.2 programs, the shorter will be the time required to develop and demonstrate their feasibility for a particular system application. On the other hand, it is important that this process not be over-managed by the DoD or others. It should be recognized that it is very risky to assume that future technology characteristics can be predicted with any degree of accuracy, and accordingly it is very risky to attempt to predict just what 6.2 programs will become important in advance of the adoption of a system idea. OSD can best support this area of technological research by assuring that it is well funded; by seeing that each level of R&D management has sufficient discretionary authority to quickly take advantage of opportunities as they arise; by requiring a close interaction between these managers and users' field environment test activities; and by maintaining personnel career policies that will attract good people to the R&D management field.

e. Vigorous and interactive field environment test and technology support programs are clearly prerequisites to the timely discovery of new system concepts. Even when the idea has been conceptually defined, both field environment tests and technology are still required in order to answer those questions which stand in the way of a confident appraisal of the feasibility, operational utility, and cost of the contemplated system. The Program Manager must accomplish this by fashioning an acquisition strategy tailored to meet the operational and technical peculiarities of his need, alternative concepts, and subsequently selected system concept. He will do this most efficiently if he is experienced, is not constrained by rigid procedures, and is given sufficient discretionary funds to be somewhat free of the budgetary cycle early in the program and to control the direction and emphasis of the 6.2 and 6.3 programs.

B. FULL SCALE DEVELOPMENT PHASE

The Full Scale Development (FSD) phase is that segment of the acquisition cycle extending from the award of an engineering development contract until the end item is authorized for or ready for production. Traditionally, this phase has been referred to as extending from DSARC/Milestone II to DSARC/Milestone III. An essential part of the FSD activity involves the successful phaseover from and to the phases preceding and following FSD, and in particular the phaseover to the production stage. These transitions are not discrete points or milestones; in fact, it is essential that they not be. Therefore, the discussion which follows, while focusing on the FSD phase itself, will also address certain relevant aspects of the phaseover effort. It was noted during the

Task Force discussions of the FSD phase that A-109 includes the clear opportunity to direct initial production by the Milestone II decision, thereby providing the flexibility to accommodate the desired degree of concurrency by designating the quantity of units to be included in the initial production authorization.

The FSD phase can itself be considered in two segments. The first of these is the design and fabrication activity which results in one or more initial copies of the item under development being manufactured for test purposes. The second segment is the test period itself. A common characteristic which was noted in successful programs is that the system tests conducted toward the end of FSD are in the form of "verification" tests which confirm expected and specified results, rather than bring out new performance information.

Figure 3 indicates the length of time which was required to accomplish the first of the above segments (design/first article fabrication) for a sample of typical fixed and rotary wing aircraft programs. It can be seen that the average time to produce the first flying article is approximately two years, and there is no particular trend to suggest that this average time has changed significantly in the past several decades. Also shown in this figure are the corresponding elapsed times for several commercial jet aircraft.

Figure 4 addresses that segment of the FSD phase which just precedes the production phase. This figure indicates the degree of overlap between the initiation of the FSD test phase and the startup of production. It also depicts the way in which the conflicting pressures present during this stage in the acquisition cycle have historically been balanced. On the one hand, fielding a new capability at an early time, minimizing the fixed costs associated with a prolonged R&D period, and preventing a disrupting gap in development/production manpower all argue for an early release to production. On the other hand, the desire to avoid the rapid buildup of an inventory which could require expensive changes if problems are revealed during the test program argues for delaying the release to production.

Figure 4 indicates that during the 1950's and 1960's, production release generally occurred prior to first flight. During the 1970's, there is an increasing trend for release to occur after the first FSD flight—in spite of the fact that many of the aircraft

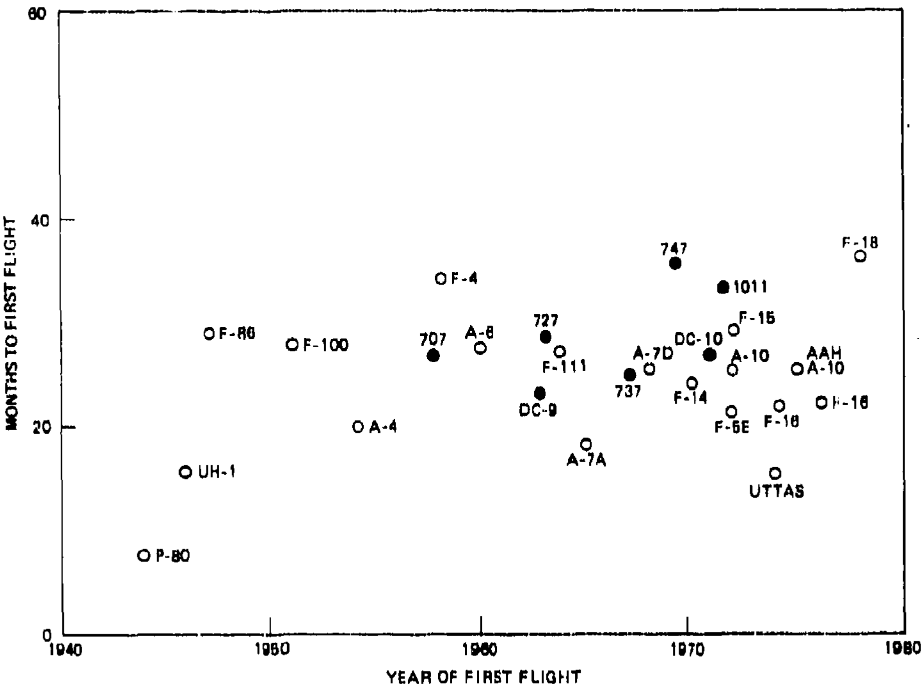

Figure 3. Time from FSD Contract Award to First Flight

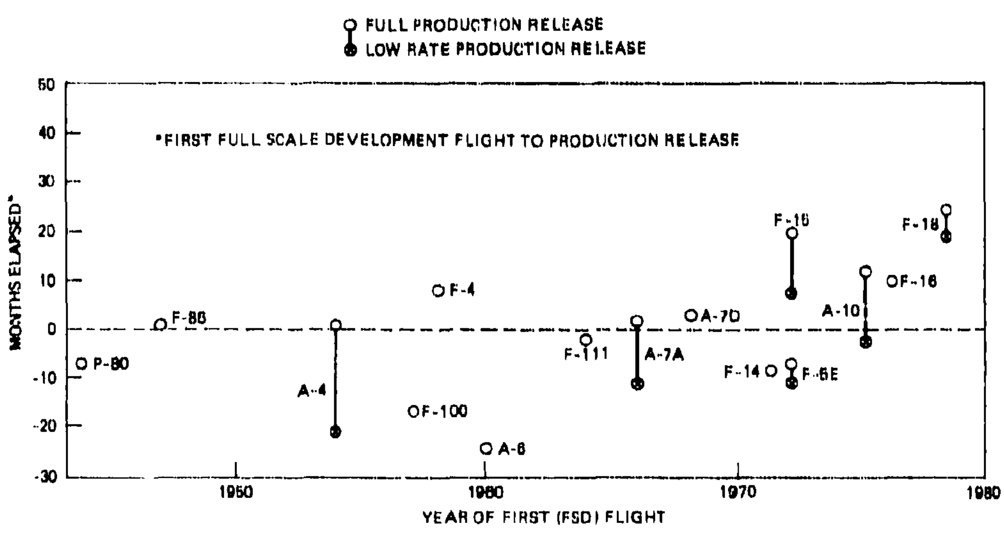

Figure 4. Trends in Development/Production Concurrency

now of interest were previously flown in prototype form. This observed result is, of course, consistent with the stated "fly before buy" policy, but it should be noted that there are two different usages of the term "fly before buy" extant at present. One refers to obtaining flight test data before committing to production, while the other addresses the use of flying prototype(s) before undertaking FSD itself. Both are not needed, as has been amply demonstrated in commercial aircraft practice for many years.

To summarize the schedule data that were collected for the Task Force's study of this phase of the acquisition cycle, there is no persuasive evidence to suggest that there has been a significant lengthening of the time required to execute the Full Scale Development phase itself. There is, however, evidence to suggest that the FSD phase is becoming a smaller segment of the overall acquisition cycle.

C. THE PRODUCTION PHASE

1. Introduction

The evidence examined by the Task Force made it clear that, as discussed in preceding sections, the "front end" of the acquisition cycle, from initial program conception to DSARC/Milestone II has been growing in length during recent decades, while the "middle" of the cycle or full scale development phase from DSARC/Milestone II to III has tended to remain at about the same length of time for comparable system developments. The total length of the acquisition cycle has also shown a trend of increasing in length during the past twenty years or so due to a lengthening in the final, or production phase, of the cycle as well.

Although it seems generally clear that the U.S. defense industrial base is fully capable of achieving production rates and meeting production schedules which are considerably higher in terms of end item delivery per unit time than is typically required, the overall length of the production cycle—from the DSARC/Milestone III production go-ahead decision to the achievement of an initial operational capability has been growing longer and longer. The time to deliver sufficient quantities of the end product to the using forces in the field to achieve the ultimately-planned full operational capability is in many cases a great deal longer still. As this is obviously not the result of capacity of the industrial contractors to produce, the cause must clearly lie in some other diretion.

2. Influencing Factors

Analysis of a number of specific program case histories makes it evident that the basic reason for the lengthening of the production phase is that there are simply more programs ready to enter the production phase at any given time than there are production funds available to fund them.

This is illustrated by Figure 5, which compares the current estimate for procurement funding of seven Air Force systems (B-1, F-15, F-16, A-10, EF-111, E-3A, and E-4) with the original development estimates for the funding of these systems. This figure illustrates that as these systems approach the end of FSD, two things typically occur: the allocation of production funding gets pushed downstream from year to year, and the total cost of procuring the contemplated numbers of systems gets larger. In fact, comparison of the originally planned procurement funding with the available funds in each of the fiscal years in which the procurement was to have taken place makes it clear that there were not enough funds in the budget even according to the original plan. The inadequacy of procurement funding anticipated to become available in future years is even more evident.

Since significantly increased funding can hardly be anticipated during the next several years, the only long-range answer to this dilemma would appear to be to modify our acquisition philosophy. We should enter FSD with only those systems for which sufficient production funding (with realistic cost estimates) can reasonably be expected to become available. To continue to do otherwise will result in the continuing expenditure of large amounts for the development of systems which will never reach the hands of the users.

3. Commercial Aircraft Production Practices

Although the basic thrust of the Task Force was to evaluate the acquisition cycle for military programs, one sub-panel presented considerable data on the analogous cycle for commercial aircraft. Since the acquisition cycle for commercial aircraft has not lengthened significantly during the past two decades, it should be instructive to examine the commercial practice and compare it with the military acquisition process. This comparison provided the Task Force with a number of useful findings and observations on the similarities and differences in the military

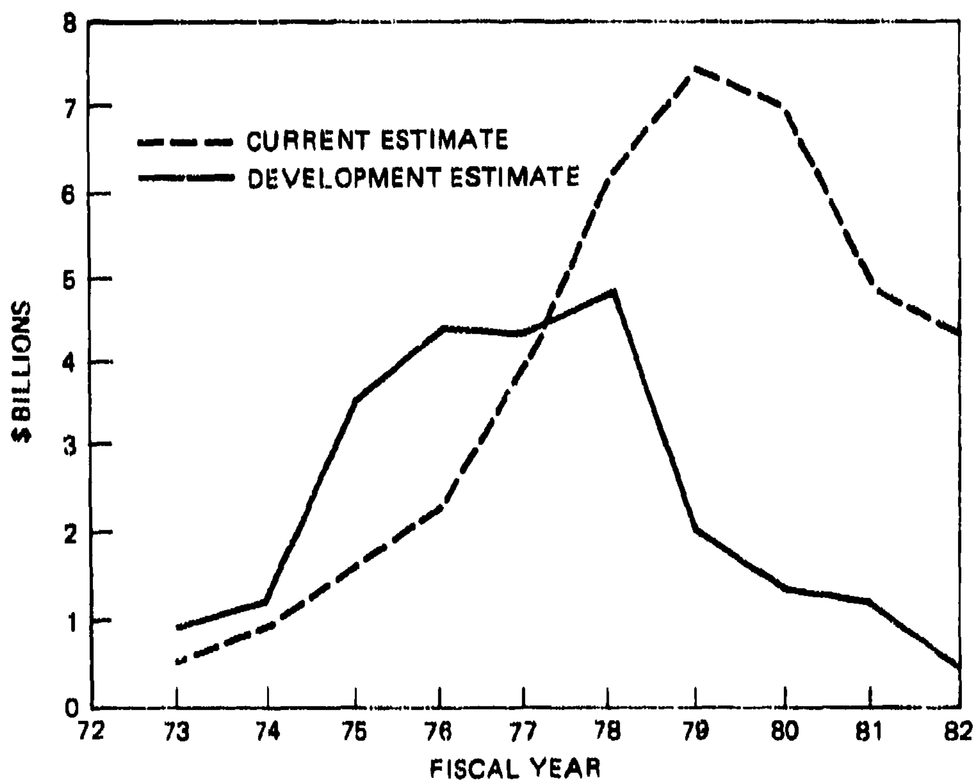

Figure 5. Air Force Procurement Funding (7 Systems)

and commercial acquisition cycles, which can be summarized as follows:

- The sequence of events and the logic of the military weapon and commercial airplane acquisition cycle are very similar
- Although warranting further examination, the number of levels of management review and the time devoted to such reviews appears to be much greater for the military than the commercial
- the commercial programs are designed to take smaller technical steps than the military, hence are lower in technical risk
- The commercial programs overlap final design, production, and flight test heavily
- There are marked pressures for urgency in commercial programs which, if not responded to effectively, may result in the market perishing or preemption of the existing market by competitors.

The comparison of the commercial and military acquisition flows presented in Figure 6 shows the substantial degree of similarity between the military and commercial cycles in a gross fashion, including the types of reviews and decision points. The most dramatic differences of philosophy noted are much greater concurrency in the commercial programs, as suggested by the last three items listed above, which are amplified below.

a. Technical Risk

The military has a long tradition of "pushing the state-of-the-art" because it feels, perhaps justifiably, that relatively small improvements in such performance parameters as speed, range, altitude, etc., can make extreme differences in the outcome of a conflict. There is some evidence that the Soviet Union tends to follow a different philosophy, choosing to buy a greater quantity of slightly inferior weapons. The U.S. military should want individual weapon performance which is clearly superior to that of the Soviet Union. Regardless of the cause, the U.S. military tends to be much more demanding of near perfection in performance of first generation hardware than does that of the Soviet Union.

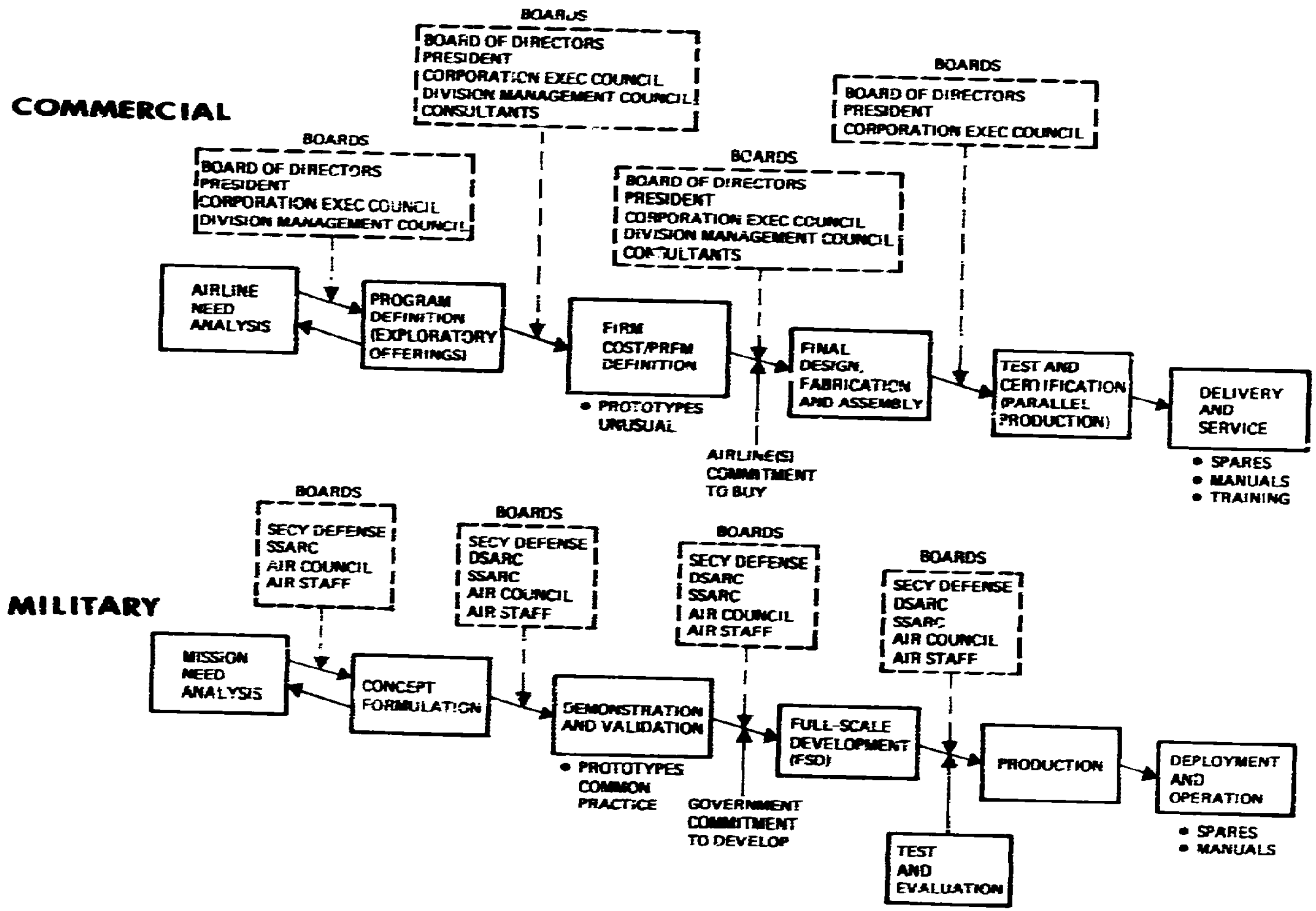

Figure 6. Acquisition Flow Comparison

The commercial airplane manufacturers, the airlines, and the Federal Aviation Agency, on the other hand, tend to converge on proportionally lower risk programs. If the manufacturer reaches too far in a technical sense, he is exposing himself to the probability of very expensive delays in delivery and/or very expensive changes in design calling for out-of-sequence production operations. In some notable cases, errors in the perception of this risk have nearly or actually bankrupted aircraft makers. Further, the manufacturer is committed to several key, specific performance parameters with (in many cases) strict contractual warranties and penalties.

The airline customer tends to seek reasonably low technical risk, as well, although he also tends to play competing manufacturers against each other with respect to performance commitments. From a risk-to-reward ratio, the airline recognizes that the last 3-5% of performance will not benefit his P&L statement nearly as much as a technical failure would hurt it.

In the case of the FAA, the agency has absolutely no direct concern with whether the airplane meets or misses its economic design parameters. It does, however, have final authority on safety and certain other performance characteristics (e.g., noise). Therefore, the FAA is biased strongly <u>against</u> taking significant technical risk, because many technical advances have potential for decreasing safety. For example, the use of graphite-reinforced primary structure, while having excellent effects on weight, is being very carefully evaluated for fire resistance, fatigue, lightning strikes, etc. This is slowing the rate of application of such composites in commercial airplane practice in comparison with that of the military.

b. Commercial Program Overlap

Almost all major acquisition programs have some degree of overlap among development, final design, testing, and production whether in the military or commercial case. It is totally impractical in the real world to finish every step completely before beginning work on the next. At the opposite extreme, to begin all of these steps at the same time would lead to prohibitively expensive programs, missed schedules, and poor end products. Technical risk usually results in the emergence of technical problems which must be corrected through changes in the design and test programs. This should lead to early developmental tests to uncover problems and to fix them before production is far along. A typical commercial airplane program, showing substantial overlap, is depicted in Figure 7.

Unfortunately, there are many crucial tests which cannot be conducted sufficiently early to avoid the necessity to introduce changes after production activities have commenced. The major static and fatigue structural tests require production designs and hardware. Also, many critical performance parameters can only be measured accurately by means of full-scale flight test. Thus, changes <u>will</u> be required late in the production buildup, and they <u>must</u> be anticipated and accommodated quickly and with minimum cost impact. In addition, there will be changes identified during the production phase as a result of production learning. Tolerance problems and interferences will be encountered, but these can be minimized by master dimensioning and numerical control techniques, as well as by engineering mockups and use of an analogy to the Navy's concept of a "lead ship" where an intentional time gap is programmed into the production schedule between the first production article and the succeeding ones. This provides time to incorporate production changes in sequence on all units after the first article. Still later changes are encountered in commercial airplane programs as specialized configurations are introduced for new customers for the same basic aircraft model. Such changes are very expensive, since they reverse the normal trend of the production learning curve. Figure 8 illustrates the effect of such downstream changes on the Boeing 707 program learning curve as a typical example. On the 747 program, approximately 120,000 changes were planned for and incorporated prior to the first test flight, which illustrates the magnitude of the continuous tradeoffs and engineering changes necessary for such a program.

One variable influencing the cost of a given change is the rapidity of production buildup. A commercial airplane program tends to use from three to five production-configured airplanes to conduct a rapid flight test program. These first few aircraft may roll out three or four weeks apart, but right behind them is a production line extending 12-18 months backward and heading toward a rate of from four to twelve deliveries per month by the end of the first year of the production phase.

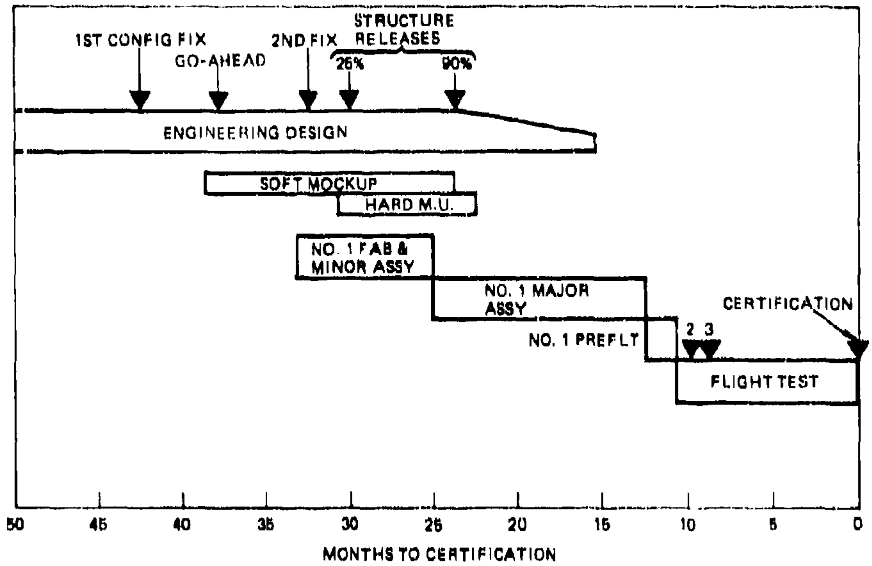

Figure 7. Typical Commercial Airplane Program

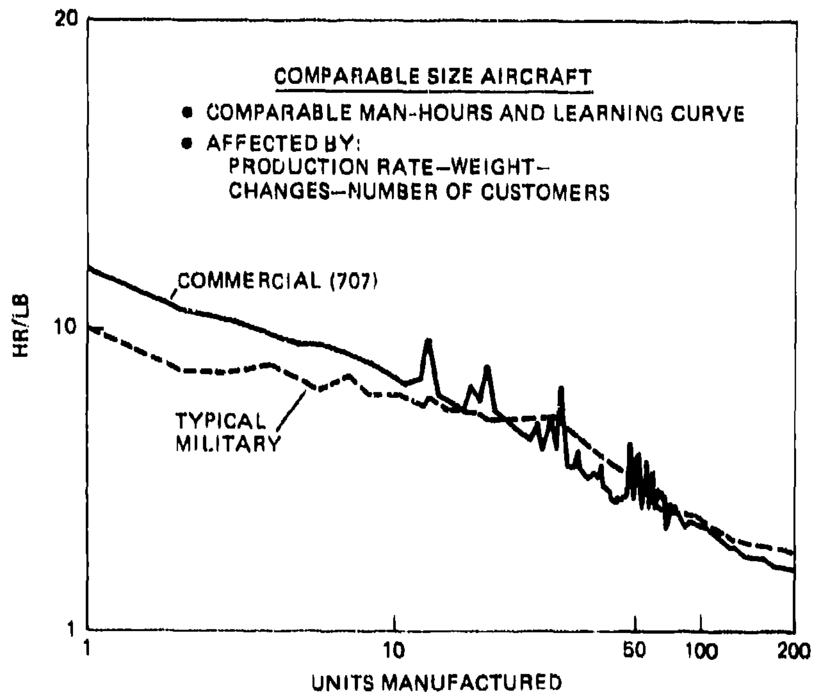

Figure 8. Manufacturing Labor

Summing up all these factors, the empirical curve shown in Figure 9 has been developed by one commercial airplane company to guide its planning for a typical fast-buildup commercial program. Thus, a 25% reduction in engineering changes from the historical norm, by better use of mockups, computer-aided design, rigorous drawing checking, and by phasing development tests earlier, can produce a savings of more than 5% in the fabrication costs of a 200-airplane program. If one assumes these costs to average $20 million per aircraft delivered, the potential saving for this example alone would be about $200 million.

c. Commercial Pressures for Urgency

The observations and statistics cited above were derived for a typical modern-day commercial airplane program with a "reasonable" amount of overlap among the various phases plus a rapid buildup of the production and delivery rate. In the commercial marketplace, there are many forces pushing for that type of urgency. For example, competing airlines want to take delivery of new aircraft at about the same time; the manufacturer who can offer his customer earlier delivery positions as a result of fast production buildup gets a larger percentage of the market. Very low rates of production substantially increase labor costs of airframe construction and assembly. As illustrated in Figure 10, a hypothetical 200,000-pound airframe produced at one unit per month has labor costs about 40 percent higher than the same airframe at two units per month.

To summarize, the production decision is a momentous one, whether for a military or a commercial aircraft program, involving the risk of hundreds of millions—or perhaps billions—of dollars. In the absence of a serious national problem, the military tends to stretch fairly far technically, but also tends to restrict the amount of overlap of development, design, test, and production and to limit the initial production rate. The commercial sector, on the other hand, is driven by pressures from multiple customers and competitors, and tends to compress both aspects but to minimize technical risk. Both approaches appear to be rational.

One message which might be of value is that there are many military systems acquisitions where the degree of technical risk need not be high, or where a reduced-requirement initial configuration, followed by small-step enhancements of performance

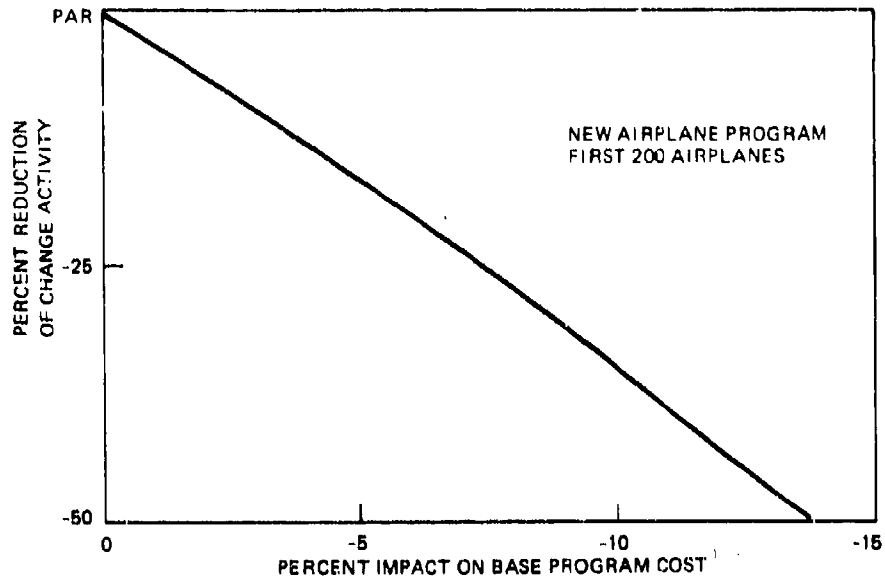

Figure 9. Effect of Change Activity on Cost

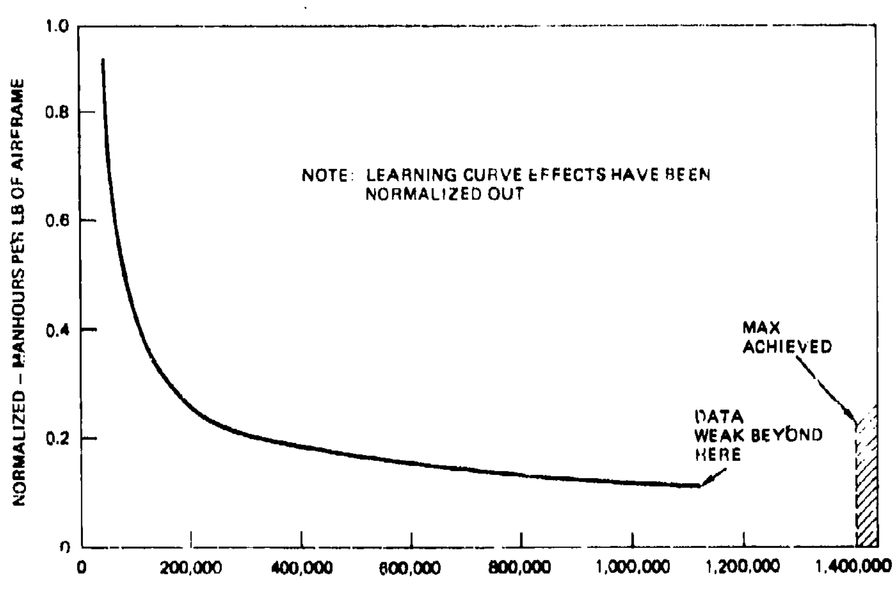

Figure 10. Effect of Production Rate on Commercial Airplane Airframe Cost

in later production units, makes sense. In such cases, the more rapid commercial acquisition cycle would save the military several years (from two to six, typically) as well as resulting in substantial reductions in total acquisition cost.

D. POLICIES AND PROCEDURES

1. OMB Circular A-109

OMB Circular A-109 traces its roots to the publication of the report of the Commission on Government Procurement in December 1972. At that time, consideration of policies and procedures to implement its recommendations began. In January 1974, an interagency task group chaired by the DoD submitted a report to the General Services Administration covering the Commission's recommendations pertaining to major systems. In January 1975 the GSA referred the matter to the newly-created Office of Federal Procurement Policy, which pursued the subject of developing and promulgating a government-wide policy for major systems acquisitions with the highest priority. A draft of A-109 was issued in mid-1975, and the final version was officially issued on April 5, 1976, following public hearings, extensive coordination with government agencies and industry associations, and review by Congress. DoD issued revisions of DoDD 5000.1 and 5000.2 in January 1977 to implement A-109.*

The concept of A-109 is to build a clear decision on the acquisition of a major system on the basis of defining the mission need first. The private sector should be engaged with maximum latitude and flexibility through the instrument of a mission-based RFP. The direct funding of the incremental evolution of competing systems is to be structured to insure competitive continuity and to eliminate time- and cost-consuming gaps in the acquisition cycle. An important objective is to aim for competitive demonstrations of the competing alternative solutions in an operational environment, to the extent that this is economically practical. Finally, A-109 is intended to insure that when a need is approved, a commitment to deploy a capability which will meet that need is implicit in the authorization to proceed. The key provisions and

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* The new Administration issued additional A-109 implementation direction in a memorandum of 18 January 1978 from Dr. Perry which clarified and defined the policy regarding applicability and preparation of MENS.

areas of emphasis of A-109 include a selective decentralization of the decision-making process:

- Within OSD there are four key points for making the acquisition decision
- In the Congress, the emphasis is to be focused on endorsement of the mission need
- A-109 is intended to provide a formal structure for the "front end" of the system acquisition cycle which is specifically mission-oriented, rather than product-oriented.
- A clear decision is required on the mission need as the starting point for the acquisition cycle
- Inter-service needs and resource issues must be addressed at the outset
- The concept of a mission-based RFP embodies a significant degree of flexibility in the specification of system performance requirements.

Competitive continuity through the acquisition cycle is intended to be provided by A-109 through the requirement to provide direct funding at the early phases of the "front end" of the acquisition cycle; through the logical evolution of alternatives and the achievement of incremental task oriented progress; and by extending competitive activities through system demonstration in the operational environment, as appropriate.

In examining the details of A-109, its specific provisions, and the experience gained to date with its application (at the time of the 1977 Summer Study no MENS had been approved), the Task Force expressed concern that improper or overly uncompromising implementation of A-109 could potentially add to the length of the acquisition cycle, especially if the addition of a formalized "front end" or Milestone Zero phase is implemented as an additional "plugged-in" step at the start of the effort. The high level resolve required to create a Mission Element Need Statement in order to start a program by the A-109 process was observed to be significantly different from that needed to start the concept formulation process under previous acquisition policies. The front-end steps prescribed in A-109 would have the mission need identified years earlier than in the prior processes and, <u>if</u> implemented as intended, <u>could decrease</u> the length of the program birth process.

However, the expectation that A-109, because of greater program decision resolve at the start of the program, would reduce the reexaminations and micro-management during subsequent phases was feared to be optimistic and contrary to past experience. For this reason, top OSD attention to implementation is required. It was noted that A-109 is consistent with both the concept of zero-based budgeting and mission budgeting. Also, the evaluation of conceptually different systems (e.g., a gun vs. a missile) in the course of a competitive source selection was observed to be difficult but achievable, and might result in more "shoot-offs" before a final system concept selection is made.

While the Task Force agreed that the conceptual philosophy of A-109 was commendable, concern was expressed that its implementation could be too rigid and inflexible (despite its stated provisions to the contrary), but that it appeared possible that the Congress may be willing to commit for multi-year, inexpensive front end explorations on the basis of a Mission Element Need Statement. Also, advocates of A-109 expect that its application will reduce the probability of downstream program oscillations and redirections and it was the overall (but not unanimous) consensus of the Task Force that A-109 should be implemented as soon as possible.

2. DoD Directive 5000.1

Basic DoD policy for the management of major system acquisitions is contained in DoD Directives 5000.1 and 5000.2. The currently effective versions of these Directives were issued January 18, 1977 to implement the policy promulgated in OMB Circular A-109.

Concern was expressed by the Task Force that these Directives are insufficiently forceful to prevent over-zealous or over-literal application, thereby adding to the length and cost of the acquisition cycle under the A-109 philosophy. It was also noted that the Service versions of 5000.1 are generally even more inflexible still.

The Task Force determined that the current issue of 5000.1 is a mixture of policies, procedures, explanations of positions taken, and cliches. It did not appear to adequately reflect the degree of flexibility in the application of A-109 that is felt to be necessary and desirable. The Task Force believes that a revision of 5000.1

as suggested in Appendix B, would be effective in assuring the intended application of A-109, without resulting in any deterioration in acquisition program management effectiveness or the discipline of the acquisition process. If 5000.1 (and 5000.2) are to express the acquisition policy implicit in the findings, conclusions, and recommendations of the Task Force, it is believed necessary to revise and reissue it in order to reflect the following:

- Introduce the concept of flexibility and timeliness throughout
- Permit concurrency in the acquisition process
- Encourage joint development and operational test and independent evaluation
- Mandate that DSARC decisions are binding on programming and budgeting decisions and actions
- Explicitly state that approval for FSD includes the intent to deploy
- Emphasize upgrade of existing systems as the desirable alternative to new system developments wherever feasible
- Encourage the combining of decision milestones where possible
- Stress "affordability" of system acquisitions
- Discourage "system" prototypes unless they are producible
- Establish DSARC III as the approval point for rate production.

III. FINDINGS AND CONCLUSIONS

A. NO SENSE OF URGENCY

During the Summer Study, the Task Force came to the conclusion that:

- It takes longer to get things done in the DoD (and elsewhere in the U.S.) than it used to
- The increased delays seem to occur in the decision process rather than in the time to do the actual work.

It was determined on the basis of a number of weapon system acquisition program case studies that it doesn't actually take any longer to do something; it just takes longer to obtain the necessary approvals and acquire funding to do it and to get to the deployment stage once the development is finished. These decision delays do not take the form simply of more time for the decision maker to decide; they are manifested by additional complication in the decision process—more levels of review and approval, additional steps in the system definition and development process and therefore more decision points, demands for more analyses, more studies, more justification, more tests, and more evaluation of results.

There is a normal tendency to take this elaboration of the decision process as the cause of the delay and to assume that streamlining the process would reduce the delays. On the other hand, we may thereby be confusing cause and effect: the elaboration of the decision process may be only a Parkinsonian rationalization of the overall delays which actually stem from deeper causes.

In general, the length of time it takes to do something is dependent both on how hard it is to do it and on how badly society wants to have it done. It is not apparently inherently more difficult to do things than it used to be. Although the things we do today are often larger and more complex, we bring better tools and better knowledge to the task. The trouble lies rather in the growing lack of desire of the society to do certain kinds of things, such as to build modern weapon systems or to construct nuclear power plants. There are always certain people who strongly advocate doing almost anything—and others who are as adamantly opposed to doing it.

The change in society's desires in recent years is in part due to the change in the relative numbers of such people, but probably is more importantly a result of the general attitude of the vast majority of the people who are not actively engaged in the struggle but whose sympathies determine the rules under which the struggle takes place. In recent years, society's sympathies have moved away from the doers toward the opposers, thereby increasing their social and legal standing, and their ability to slow down or, in some cases, to stop the activities of the doers altogether. From the point of view of the doers, it is harder and harder to get things done these days—they still want them done as badly as ever. But from the point of view of society, however, it is the desire which has changed, not the difficulty of doing things.

It is fairly clear that the underlying desire of the U.S. society for new weapon systems has been diminishing for many years if we take out the short-term variations due to wars, overt Russian actions, and internal politics. In recent years, there has been a certain level of funding available each year for defense procurement. This level is unlikely to change up or down to any significant extent unless circumstances change quite drastically. The present level of funding allows us to acquire a certain number of things each year, and then the money is all spent and no more is available until the next year.

The time it takes, therefore, to get military equipment into the hands of the forces in the field is dependent almost entirely on when the money becomes available to buy it. It is only loosely dependent, if at all, on when the development program started, on how much gold-plating there is in the decision process, or on who happens to be sitting in the Pentagon. We can change our priorities and buy one thing before another, but the average procurement rate is fixed, so long as we try to buy about the same number of systems.

It is a well known fact that the military R&D budget has held up better than the procurement budget and is, in fact, about one-third of the procurement budget today. There are a great many things in one stage or another of development and, despite occasional talk of developing for the shelf and such ideas, most things that go into full-scale development do seem to be bought eventually, even if only in small quantities. But if there are, say, fifty systems in development at one time and the procurement budget will permit us to buy only five in any given year, simple arithmetic shows us that the average system will stay in development for about ten years.

There is nothing that can be done to alter this without either developing fewer systems or buying more systems each year.

Obviously, the defense establishment has not intentionally pursued a course of action which has led to putting the nation in this position. There are an enormous number of perceived mission needs and a great number of good ideas for meeting them at any time within the DoD. In general, the DoD does not commit substantial funds to development unless there is some reason to expect that procurement funds will be available when the development is complete—in fact, such funds are often set aside in the out-year budgets. Unfortunately, everything always seems to cost more than predicted, so when the development has been completed, the money is frequently—if not usually—no longer available for production of the system or equipment. Other demands have eaten up the money and the price tag on the new system has gone up. Additional money is just not available, so the system cannot be procured and delivered to the field as originally scheduled. Unless the system is cancelled outright (a difficult decision to make considering the magnitude of the investment already made in design, development, and testing), the decision to go into a production buy must be deferred to a subsequent year.

It is of course rare that the circumstances are this clean, and rarer still to face up to them in precisely these terms. The more usual course of action is to determine that the development is not complete (it never is) and that there are still unanswered questions (there always are) and to send the developer back to do some more work. In fact, with only a little thought, it is usually possible to change the requirements for the system and thereby postpone the production decision for quite a while. In a sense, beginning the development process merely places a system in a queue in which it must wait with many other systems until funds become available at last for its procurement. In addition, the queue is far from orderly and much of the effort must go into jockeying for position in hopes of getting funded sooner or to avoid losing out entirely.

If these delays in the acquisition cycle cost us no more than time, they might not be very serious, at least in some instances. An extra year or two to acquire something that we will use to fulfill a mission need for ten or twenty years may not be particularly critical. If we are in a great hurry, we can speed things up by putting the wanted item at the head of the queue, and if we are really in a hurry we can cut out some of the procedural red tape by utilizing what has come to be known as the "Skunk Works" approach. Unfortunately, delays do in fact cost more than time; they also cost money because of the expense of keeping the development effort going. It is very difficult to assess just how expensive this is—it probably varies with each development project—but it is clear that it is substantial. Even worse, costs would not seem to be the most serious result of delay. The most serious problems result from what might be termed the second order effects of the process. Among these effects are:

1. Results are often unsatisfactory. When the system finally appears in the field, it is often obsolescent technically and no longer matches the perceived operational requirement.

2. Desirable system flexibility is sometimes lost. To ask for flexibility during system definition and development is to admit uncertainty, and survival through the approval process appears to demand system optimization to meet a specific need many years in the future. It is then difficult to change the design during the long life of the program to meet the changing perceptions of that future.

3. Systems become over-complicated. Since it takes so long and costs so much, there are great pressures to make the system do "everything." The need to obtain so many approvals tends to make the situation worse since the system becomes the sum of all the minimum demands of each approver. Multi-service programs are particularly bad from this point of view.

4. Too many technical risks are taken. This leads to cost and schedule overruns and to high retrofit and maintenance costs. Once again, since it takes so long to get the system, the designers reach for the latest technology so as to avoid obsolescence insofar as possible. The latest technology is often not ready for inclusion and the resulting problems must be solved at a late stage in the program at great expense.

5. Short-term improvements are dying out. There is a growing belief that it takes at least eight years to do anything; therefore, there is no value in taking small, evolutionary steps to improve the performance of existing operational systems. It also is believed to take longer to develop a big fix than a little one. Therefore, the user must make do with what he has until

1985 or so. In some ways, this is the most troubling of the second-order effects, as it leads to frustration and cynicism in both the user and the developer communities. One hears from operational commanders that there is no point in talking to AFSC (for instance), since they can't or won't do anything this decade, and the only hope for near-term help is to go elsewhere.

c. <u>The problem is getting worse</u>. Senior people who look at these difficulties tend to mistake the symptoms for the problems. The natural human reaction is to assume the troubles arise from inadequate preliminary study and program definition (e.g., the "plan your work—work your plan" syndrome), and they insist on more and earlier review and approval at more frequent intervals. This hurts rather than helps since the difficulty arises not from unwillingness to plan sensibly, but from inability to do so over too long a period of time. Additional early review and approval further lengthens this time and makes the problem progressively worse. We are caught in a vicious circle.

The price we must ultimately pay in unnecessarily expensive, less than satisfactory performing, and difficult-to-support-and-maintain field equipment greatly outweighs the direct added expense of stretched out development.

The proper action should be to improve the efficiency of the development process, probably by reducing the time to develop rather than increasing it as we seem to be doing now. We should face up to things as they are and adjust our attitudes and procedures to spending our effort more wisely over the long haul. Perhaps we should transfer money from the R&D account to the procurement accounts thus buying more things while supporting fewer in development. Perhaps we could teach the decision makers to help define useful development activities if procurement must be put off rather than simply harassing the developer for the overrun condition of the program. Perhaps we should simply stop more things we can't afford rather than letting them drag on. Perhaps we should really mean it when we say we want less expensive systems.

B. FLEXIBILITY

The most prominent single thread that was evident throughout all of the data examined by the Task Force was the necessity for and absence of a high degree of flexibility in every application of the policies and practices for acquisition management. It is perhaps the most significant finding and conclusion of the entire Summer Study that the most fruitful way to make the acquisition cycle more effective is to take steps to insure that the system is applied in a flexible manner. A definite tendency was observed whereby pressures for strict adherence to the letter, as well as the intent, of published policies and directives are not only strong, but increasing over the past several years. The practice tends to be to take a literal or even the most stringent possible interpretation of the policies and procedures rather than to encourage a judicious interpretation of the published requirements in a manner which is appropriate to each individual case.

Thus, the evolution of acquisition policy (before A-109) has been, in effect, a band-aid approach whereby specific acquisition problems lead to the adoption of more and more strict interpretations of policies and practices. The DSARC process, which was intended to loosen up the acquisition system, has been administered in an increasingly inflexible manner, leading to program "gaps" and increased costs due to administrative, not technical, reasons. Prior to the DSARC system, the DCP—Development Concept Paper (more recently known as the Decision Coordinating Paper)—was intended to provide a flexible tool for defining the salient features of a contemplated acquisition program. From the initial goal of a very brief, two- or three-page document, the DCP has grown to the point where it must be measured in pounds, not pages, and it has been turned into a very cumbersome and inflexible serial element in the acquisition process. Further, it no longer fills its original role, of being short enough to be quickly read and understood, or better, written personally by high-ranking personnel.

In addition to the growing inflexibility in the utilization of the acquisition policies, directives, and procedures, there has also been a growing inadequacy in the degree of flexibility employed in several important sub-areas of the acquisition process: contracting, management implementation, and program funding in particular.

1. Contracting Flexibility

Rather than merely follow the currently "fashionable" or most popular practice with respect to the form of contract employed (e.g., total package procurement, CPFF, fixed price incentive, firm fixed price, etc.), the form of contract should be carefully selected in each individual case to best match the needs of that particular program—or of a particular phase of a program. The tendency has clearly been to permit the selection of contract form to become highly institutionalized, and to cause the procurement system to be rigidly adherent to a particular type of contract for all cases, regardless of the appropriateness of that type of contract to the kind of work being procured. The imposition of the "wrong" kind of contract frequently results in increased program costs and loss of time due to the requirement to spend more time attempting to make the contract fit the work than would be the case if a more appropriate form of contract had been chosen. The work is typically made more complicated and difficult than necessary because the presence of an inappropriate form of contract almost always results in the creation of an adversary relationship between the customer and the contractor.

2. Management Implementation

Another manifestation of acquisition program inflexibility is what might be termed the "blessed ROC" syndrome. This is the situation where the initial program requirements and specifications are viewed as sacred and unalterable, even though as the acquisition program progresses, there are almost always opportunities for revising and refining the initial performance criteria in order to achieve reductions in cost or schedule, or even optimization of performance in the final end product. Here particularly in the front end of the program, there is a great need for a flexible environment, so that the design can evolve in the most cost-effective manner, rather than being inflexibly restricted to a single point which was established initially without the benefit of the large amount of research, design, development testing, and performance evaluation which is accomplished during the development phase of the cycle. If, as discussed earlier, the using command is more intimately involved in the development phase, its inputs or changes to the ROC may be invaluable to avoid an obsolescent system. Also, the use of the MENS to explicitly define, review, and approve a specific mission need should be a major step in counteracting this ROC inflexibility.

Similarly, there should be a greater degree of flexibility in the application of established acquisition program review and approval activities such as the DSARC process. The adherence to the formally-prescribed DSARC milestones I-II-III for every acquisition program is clearly counter-productive. It should be noted here that A-109, while clearly defining and describing these individual milestones, does not dictate that they cannot be combined or eliminated to fit the needs of each particular acquisition. The concern of the Task Force is that, based on prior practice, it seems highly likely that the tendency will be to require strict adherence to each of these major decision points "because they are called out in A-109."

In the case of conventional Navy ships with state-of-the-art subsystems, for example, the lead ship could be subject to a single combined DSARC for Milestones 0, I, and II (during which the basic mission need is also approved in the form of a MENS) while the follow ships could be subjected to only a Milestone III review point. In the case of Naval ships with major advanced subsystems, the combat system and the ship could be subjected to a combined Milestone 0 and Milestone I review in which the major emphasis is on the MENS for the combat system, while the entire ship-weapon system combined would be examined together at Milestones II and III. Unconventional ships would be subject to the complete MENS approval and DSARC review process at each of the four milestones as prescribed in A-109. This illustrates the possibility of a spectrum of applicability of the A-109 review/decision milestones which would permit the basic policy to be applied in a flexible manner which best suits the needs of each individual acquisition, rather than inflexibly requiring total adherence to all of the policy provisions regardless of the nature of the system being acquired.

3. Program Funding

Under current acquisition policies and practices, there is insufficient recognition given to the probable impact of program risks (which are always present) in the development of funding estimates and program budgets. There is insufficient flexibility to permit program modifications needed to meet threat uncertainties, or even to solve the technical problems which most assuredly occur in every development effort.

The current reprogramming authority is inadequate to meet the needs of current programs, having been established many years ago when the value of the dollar was greater than at present. The reprogramming limit of $2 million for R&D and $5 million for production simply cannot be responsive to the need for effective management of today's acquisition programs. Although it is expected to be very difficult to accomplish, it appears that what is needed is Congressional authorization of revised limits on reprogramming authority to reflect the current inflated dollar equivalent of the $2 and $5 million limits which were established more than ten years ago.

Similarly, the Secretary of Defense's emergency readiness fund of $100 million should be extended in concept to permit the emergency allocation of funds at the SecDef level to particular acquisition programs where the availability of carefully controlled additional funding would provide the necessary management flexibility to respond efficiently to program emergencies or contingencies which could not have been foreseen at the time the original program funding estimates were established and approved. The present SecDef readiness fund is clearly too constrained in applicability to be usable for this purpose, but adequate funds should be available to OSD for discretionary use in order to respond to particular development problems which cannot be solved without the availability of funding beyond that originally envisioned.

In commercial and non-government industrial development work, the common practice is to maintain an internal reserve for each program on the order of ten percent of the balance-to-go to project completion. Without such reserve, a program manager must replan all or a good part of the remaining work every time a problem hits any element of the job. This would be absurd. This reserve is identifiable and visible to management, and is sometimes allocated at several levels in the project management structure. But it is not reprogrammable for other use and if not used, is returned. This type of a goal should be sought for military programs.

C. MOTIVATION

The Task Force perceived that both institutional and personal values have a substantial influence on the acquisition process. The program data studied and specific case histories examined make it evident that program managers are, probably without exception, highly motivated to achieve the established program schedule. It is also clear that the present acquisition policies and procedures provide certain incentives for timeliness in the achievement of program objectives. Such incentives can range from the anticipation of favorable consideration for subsequent promotion for program management personnel (both military and civil service employees) to direct, profit-related incentive provisions in the contract with industry.

However, despite the fact that such values and motivations are obviously present in the acquisition system, the Task Force also found that such values and motivations are not the same for everyone in the "system." Such differences were found to impede the responsiveness of various parts of the "system" to the need for timely performance and selectivity among different programs. For instance, there are a different set of values and reward systems for military officers, for civil service program management personnel, and for contractor personnel.

Although the functions of program management, procurement, and financial management are all essential to the successful prosecution of the acquisition process, these different functions clearly differ in attractiveness as military career assignments (i.e., some functions, in particular "program manager slots" are perceived by military officers as being of more value in enhancing personal career/promotion objectives than are some of the other acquisition functions). In the case of civil service personnel, there is an attitude that the bureaucrat who is "non-negligent" will be the one who survives and advances, whereas the bold taker of risks or the innovator with procedures and practices will go unrewarded by (or even eaten alive by) the "system" within which he must work.

It was also observed that certain professional bureaucracies and specialists in the "ilities" or "cults" (e.g., producibility, maintainability, value engineering, training, and the like) operate under a professional set of values and objectives which are largely independent of, and not obviously directly supportive of, the goals of program timeliness and achievement of established acquisition schedules. Exploration of competitive design concepts (per A-109) until the most beneficial from a LCC, performance, affordability, and availability standpoint becomes evident will go far toward making reliability, maintainability, etc. an inherent consideration at the "front end" of the acquisition process.

Another element affecting motivation in the acquisition process is the lessened sense of national urgency discussed in a preceding section, as well as the growth of complexity of the "bargaining" process attendant to achievement of a consensus on the best approach to meeting a perceived mission need. These factors create additional problems for acquisition program managers because of the resulting continued questioning of the justification for (or performance adequacy of) all major systems developments through multiple and repetitious program reviews. It is hoped that full implementation by OSD of the MENS approval process, with its overt assignment of priority, worth, and affordability, will reduce if not eliminate this continued requestioning of need within DoD, and hopefully will enable Congress to support (rather than question) system acquisitions once it has concurred in the need as defined in the MENS. If this occurs, then OSD can concentrate on its proper role of program assessment and review at the subsequent Milestone decision points, and the Program Manager can concentrate on his job of technical and contractual management rather than on the time-consuming and demotivating process of program justification and political hand-holding and lobbying. The problem must be cleared up by properly motivating those within the system, beginning at the four-star level and working downward.

D. PROGRAM ADVOCACY

In examining the history and outcome of various major system acquisitions, the Task Force found that there was a common thread relating to the matter of program advocates and advocacy. It was clear that development programs which lacked strong advocacy were much more likely to be cancelled than those which had energetic and dedicated advocates. The Condor program is a typical example of an effort which ultimately was cancelled because the system simply lacked strong advocates for the particular operational capability which it was intended to provide. In a more recent case, the B-1 program, which had clear-cut advocacy for much of its life, eventually lost the most influential of its advocates in the Executive Branch following the change of Administration and was cancelled by Presidential order.

On the other hand, there are numerous examples of programs which appear to be continually in trouble for one reason or another—TOW, SAM-D, F-111, etc.—which are carried on year after year because they have the support of active and vocal advocates, either in the sponsoring Service, in OSD, in the Congress, or elsewhere. Without passing judgement on the specific programs mentioned, it seemed clear to the Task Force that, without advocacy, the chances of a program proceeding through its complete acquisition cycle into production and deployment are significantly diminished, while with strong advocates, certain programs may be continued in existence long after they should have been terminated for technical problems, inadequate capability, cost or schedule overruns, or similar reasons.

Thus, program advocacy may be either good or bad in terms of system acquisition. It is often a necessary ingredient if a program is to be continued through to completion, and a lack of advocates can spell serious danger to even a "good" program. In other cases, strong advocacy may result in the continuation of programs which would otherwise be terminated. Such advocacy covers the entire range of possibilities: it may be political, it may be mission-related, it may be extremely parochial, it is often misdirected and misused, and it is frequently needed.

The government procurement system is filled with 7-8 levels of management (above a program), all of whom (2-3 times a year) feel obliged to requestion the program's continued existence. Without a really strong advocate, these drops wear away armor. If the MENS concept of A-109 is fully implemented as intended, the SecDef in effect becomes the advocate for the need, and the Program Manager can concentrate on his job of advocating the optimum solution.

E. CONCURRENCY

One of the major conclusions of the Task Force was that a commitment to enter full-scale development should be recognized and accepted as a clear reaffirmation of intent to produce and deploy the developed article, barring truly unforeseen events. This decision, at Milestone II, is second in importance only to Milestone 0, the approval of the Mission Need (with intent to produce and deploy). In view of continuing budget limitations, rapid advances in military weapons technology, and the past history of the practice, pursuit of "R&D for the shelf" appears to the Task Force to be of no merit in terms of providing the forces in the field with the systems and equipment needed to fulfill their assigned missions. Based on this premise, a certain amount of program concurrency can contribute to the shortening of the acquisition process, with attendant savings in total acquisition cost and an increased return on investment in terms of the availability of modern tools in the hands of the using commands for a longer period of time before obsolescence. The amount or degree of such concurrency should be based on the extent of technical risk and/or national urgency in each particular acquisition program.

There seems to be no general and accepted definition of concurrency. The Task Force, therefore, has defined it as "The conduct of the steps leading to production for inventory before the end of the full-scale development time span." These steps can vary from rather low-cost actions such as manufacturing planning or tool and factory test equipment design, to more significant cost actions such as ordering long lead time items and the start of certain fabrication activities (this actually is not very expensive; the big costs are in subassembly and final assembly).

Concurrency is the normal way of doing business in developing and producing commercial products. As discussed earlier in this report, commercial aircraft programs, once committed to development, move forward with a high degree of program overlap or concurrency. Computer systems, automobiles, and many other commercial products are developed and produced on a concurrent basis. Since this is the case, the question is raised as to why acquisitions should be done differently (and with added time) when DoD pays for the development.

Because of the extreme degree of urgency which characterized the early ballistic missile acquisition programs, concurrency was accepted and exploited effectively as one means to meet critical operational availability dates (in addition to backup programs for high-risk subsystems, reprogramming flexibility and management control of certain funding reserves, and extensive overlap in air- and ground-based systems development). As noted elsewhere in this report, the commitment to production was in some instances made before the first developmental flight test was conducted. (The first development test has been used as a milestone when relating to start of production.) In the early and middle 1960's, some concurrency was an accepted practice (Total Package Procurement was certainly the ultimate of that practice). The OSD Systems Analysis organization took the strong position that Engineering Development could not commence unless they had approved a force structure change to accommodate the developed item. The effect of this position was to identify the procurement and operations budget requirements early in the development process.

As programs such as the C-5A, F-111, Main Battle Tank-70, and Cheyenne ran into trouble, a body of opinion began to develop which claimed that part of the problem was caused by starting production activities before the development effort was completed. This argument became quite convincing after several major programs were cancelled subsequent to substantial expenditures having been made in preparing for production (e.g., Cheyenne, MBT-70, F-111B). Deputy Secretary of Defense Packard was a most articulate spokesman for the "slow down" school of thought. Writing in the Fall 1971 issue of the Defense Industry Bulletin, Secretary Packard said: "As I reviewed program after program in the spring of 1969, almost all were in trouble from a common fault—production. They had been started before engineering development was finished. I am sure you all know about this problem."

In July 1970, the Blue Ribbon Defense Panel had recommended, among other things, the following:

- More use of competitive prototypes and less reliance on paper studies
- Selected lengthening of production schedules, keeping the system in production over a greater period of time so that incremental improvements could be introduced
- A general rule against concurrent development and production efforts, with the production decision deferred until successful demonstration of developmental prototypes.

These recommendations grew out of a report, "Staff Report on Major Weapons Systems Acquisition Process," included as Appendix E to the report of the Blue Ribbon Panel. There is no discussion or rationale for the recommendation of "non-concurrency"—simply the unadorned "general rule."

In May of 1970 (before the Blue Ribbon Panel report had been released) Secretary Packard issued his now-famous memorandum which significantly changed the course of the defense systems acquisition process. The matter of concurrency was addressed both directly and indirectly in this memorandum as follows:

"The program schedule (structure) is another very key consideration. It must make sense. It must allow time for accomplishing important task objectives without unnecessary overlapping or concurrency. The ideal schedule is sequential with enough slack time for resolution of those problems which inevitably arise in any development program.

"Consideration must be given in development to all matters necessary in a full operating system. This will include such things as maintenance, logistic support, training, etc. However, where these matters are dependent on the final production design, as much of this work as possible should be delayed until the production stage. [Emphasis included in original document.]

"The most important consideration before moving into full-scale production on a new weapon system is to have assurance that the engineering design is completed, that all major problems have been resolved, and this has been demonstrated to the extent practical by actual performance testing.

"The start up of production must be scheduled to minimize financial commitments until it has been demonstrated that all major development problems have been resolved. In most cases production engineering has been satisfactorily accomplished. It may also be necessary to develop and demonstrate new production processes, methods, and procedures. Thus, some limited expenditure on production may have to overlap development."

It is clear that the underlying theme was to discourage concurrency. The burden of proof was on the program manager, if he wanted an overlap. Since it was probably easier to not fight the bureaucratic battle for concurrency, programs began to stretch out.

One of the arguments which has been advanced against concurrency is that the quality of the delivered product is questionable as the degree of concurrency becomes significant. No clear correlation between concurrency and poor quality of the end product could be discerned from the data examined by the Task Force. On the contrary, the argument can be made that some of the most highly concurrent programs were also the most successful in terms of meeting schedule and cost goals as well as established system performance objectives (e.g., F-5E, Polaris, Minuteman, Boeing 727).

In addition to the "poor quality" argument, the other major contention is that the money expended in making preparations for production is wasted if the program is cancelled. An often-cited example is the Condor program, where approximately one-quarter of the $300 million expended before the program was cancelled was procurement funds. In the case of Condor, however, the information presented to the Task Force (by the contractor's Program Manager) made it clear that the final decision to cancel the program was made on grounds other than lack of success because of concurrency, and in addition the convoluted nature of the program's history makes it very difficult to determine for just what category the funding was actually spent in many cases.

However, when considering all programs, the total amount which has been "wasted" is obviously a very small percentage of the total procurement budget, and it appears to have been more than offset by the following:

- Concurrency provides a smooth transition from development to production. The developing agency's technical people are available to correct problems arising during early production, operational testing, and introduction to service usage. The engineering force can properly evaluate the impact of changes on the original design. Further, the development article/production article similarity is protected by continuity of the manufacturing process.
- Concurrency minimizes the acquisition time span. It has a psychological advantage of forcing a planned "end of development." Design freeze points and change control must be established. The shorter span avoids line gap and restart time losses and requalification of process-intensive hardware.
- Finally, properly done, concurrency drives the total system to be ready—training, logistics, support services, etc. T ere is nothing quite like an approaching IOC date to get everyone moving and working together.

On the basis of the data and information available to the Task Force, including discussions with knowledgeable and experienced people, the following conclusions are offered with respect to concurrency:

- Concurrency is the normal way of doing business in the commercial business world
- There is no convincing evidence that concurrency necessarily adversely affects program outcome in terms of cost, performance, or field utility
- The transition from development to production is smoothed significantly by the right degree of concurrency
- The acquisition time span from FSD to IOC can be minimized if concurrency is properly employed
- Program tradeoff flexibility must be available to support successful development progress in a concurrent program
- Assuming the intent to deploy clearly exists at the start of FSD, concurrency is highly desirable
- The degree of concurrency should reflect the extent of risk
- Low-rate initial production is desirable with operational suitability testing preceding the high-rate production go-ahead.

F. PROTOTYPES

Webster defines a prototype as "an original model on which something is patterned." The use of prototypes in engineering practice is probably as old as engineering itself—a breadboard in an electronic research laboratory is a form of model on which the production end item is eventually patterned. The breadboard can be refined in form and function to a brassboard and the brassboard to a product-engineered prototype of the production article. Such prototypes can be extensively tested for various categories of function and performance in laboratory environments, in flight environments, and in field (operational use) environments. An engineering prototype can be employed as a precursor to the production phase—a pre-production model of the final article whose purpose is to verify the adequacy of the engineering concept on production tooling. The prototype concept can be used in the field to test and confirm the support and logistics subsystems. There is general agreement that these concepts are sound and useful—under the proper circumstances. The issues with respect to prototyping are as follows:

1. When is a prototype in order?

When a new system presses the technological state-of-the-art or when there are several attractive solutions, a prototype can often be employed to great advantage. For example, in 1977 a simple search radar requirement can be satisfied by an obvious solution; therefore, the use of prototypes would add almost no useful information. In 1964, the Phoenix missile program ran into computer problems, the solutions to which were not readily or clearly obvious. Two alternate prototype computers were procured and evaluated. Both computers performed satisfactorily in the intended application, and a final selection of one was made on the basis of potential for satisfying anticipated future growth requirements. The prototype test program in this case was continued only as long as information pertinent to the making of a final selection was being generated.

2. How much of the system should be prototyped?

The answer to this question must be as much, or as little, as dictated by the circumstances of the particular program. If only a simple subsystem is a high technical risk element, then only that subsystem should be prototyped and evaluated. If system integration represents the principal area of program risk, then a prototype of the entire system makes sense. The AMST program was examined by the Task Force as one type of program where a particular kind of prototyping effort was employed. Here, the entire system concept represented a significant advancement of the state-of-the-art. Each of the required functional characteristics had a solid base of supporting technology: powered lift, turbofan power, high-lift wing design, high energy absorption landing gear, fly-by-wire controls, etc. The challenge of the AMST program, and the basic area of high risk, was the integration of all these elements into a viable, cost-effective solution to a particular military requirement. Therefore, the development and evaluation of an all-up flying system prototype represented the most direct approach to demonstrating the selected system solutions.

3. <u>How many prototypes are required</u>?

Again, there is no pat answer to this question. As many prototypes should be produced as makes sense to meet program objectives. If only one solution is available, then a single prototype should be sufficient. If there are two or three possible solutions from which a single "best solution" must be chosen, then two or three prototypes may be in order. However, when one or all solutions are obvious, then the use of prototypes merely for the sake of competition can be wasteful.

4. <u>Who pays for the prototypes</u>?

Here, the point to be made is that there is no such thing as a free lunch. Small investments of a contractor's own funds for simple prototypes are one thing, but for DoD to request or expect contractors to make very large (i.e., multi-million dollar) investments of their own resources for all-up, complex system prototypes is short sighted and poor practice indeed. Such practices force "teaming of teams" and ultimately result in the elimination of competition altogether.

The widespread or mandatory use of full-scale system prototypes for all programs up to the production prototype level is frequently wasteful of critical national resources—dollars and manpower as well as time. There are examples in recent programs (e.g., A-10/A-9, F-16/F-17) where little benefit can be found in the use of prototypes in terms of shortening the development cycle, reducing overruns, reducing overall cost, or minimizing risk. In fact, if not properly managed and controlled, the process is often counter-productive in the long run because of the adverse effects on industry willingness and ability to engage in such costly competitions. The basic problem is that the present competitive environment and the practice of inadequately funding prototype programs have become so incompatible that few of even the largest defense contractors can afford more than one or two losses of "company funded prototype competitions" before bowing out of any future such competitions. The magnitude of required company expenditures for even a single large prototype competition can severely reduce the company's capability to carry on a broad IR&D program appropriate to his product lines as well as reducing his capital resources for investment in improved productivity.

On the other hand, competitive prototyping at less than the system level, utilizing breadboard, brassboard, and simulation techniques in conjunction with a modified contract definition phase (i.e., CDP as practiced in the late 1960's plus product design and detailed program/cost planning) can often reduce cost and schedule leading to an FSD decision by a significant degree. (This process is provided for in the demonstration phase following the Milestone I decision as provided for in 5000.1/A-109.) When combined with extensive contract and specification negotiations, substantial advantages may often be realized. Typically, the time to reach the FSD decision can be reduced by one and one-half to two years or so at perhaps only 20-25% of the cost of a full system prototype competition. Further, the contractor and the government are both far more likely to understand the true nature of the development job which must be accomplished, as well as the realistic costs and risks of achieving the established program objectives. The success of the venture will, in any case, depend largely on the establishment of full and open communications between customer and supplier, in a competitive but non-adversary environment.

5. How much change from prototype to production?

One of the virtues of prototypes is that they make it respectable again to take a large technical jump with concommitant technical risk. When successful, the translation to production should be of modest risk. However, a cost-effective flying prototype to prove a new engine cycle may cheat substantially on supporting structural fatigue life, load factor, and corrosion resistance assessment without jeopardizing the true purpose of the tests. Thus, we encounter the dilemma of a "demonstration" or an "X-Model" vs. a prototype. Again, flexibility and judgement must be used. If the prototype is close to the final production design, even to its subsystems, repeating the development process merely to fill in a procedural square is nonsense.

To summarize, the Task Force concluded that prototyping can be a sound and useful practice in major systems acquisitions provided that the candidates for the use of prototypes are carefully selected, that only those things are prototyped which really need verification, and that prototypes are not considered to be some form of "free lunch" for the procuring agency. Where a known solution via existing technology would satisfy an established military need, but a higher risk technical alternative offers significant potential increase in operational capability or reduced life cycle costs, evaluation of competitive system alternatives by means of prototype(s) can often be justified. Where lateral exploitation of an existing system is no longer a cost effective means of delaying obsolescence, competitive prototyping at the level required to support a rational FSD decision (e.g., breadboard, brassboard, static or captive test, flight test, etc.) to establish the necessary degree of confidence in a new development approach is often useful.

G. OPERATIONAL TEST AND EVALUATION

1. Flexible Testing Philosophy

The Task Force agreed that a flexible testing philosophy is a prerequisite to achieving improvements in the acquisition process. Significant amounts of both time and money can be saved by conducting combined development tests and operational tests whenever feasible. Closer relationships and interactions must be promoted among such agencies as DT&E, OT&E, and the user organization. It appeared to the Task Force that the Services have been using a reasonable approach to operational test activities thus far, but there is concern that the independent test agencies will gradually gain increased influence and demand duplicate test activities.

In order to prevent unnecessary duplication of testing, which is both costly and time-consuming, it is important for OSD to clarify its intentions and philosophy now. The Task Force believes that what is really desired—and desirable—is joint testing, but independent evaluation.

The Task Force concluded that it is important for all participants in the acquisition process: the industrial contractors, the procuring agency, the user organization, and the test and evaluation agencies to participate throughout the entire acquisition cycle on an appropriately time-phased basis. Feedback should be provided to the developer of the system as an output from operational-relevant testing which is performed as early in the program as is feasible.

Finally, the OT&E policy should provide for flexibility and adaptability in the testing process as appropriate in order to permit testing requirements to be tailored in such a way as to reduce development risk in recognition of the fact that the test requirements will vary from system to system as a function of the nature of the end product being developed.

2. OT&E and the Role of the User

The nominal acquisition process begins with a user requirement which, after suitable validation and approval, is given to a developing command to satisfy. The user then reappears only after the full-scale development phase has been completed, to participate in the operational test and evaluation work. In other words, the user states what he wants, the item is developed, and then the user gets a chance to participate in the assessment of whether or not what he is getting is what he wanted. This scheme may be effective in the case of inexpensive items of equipment that can be delivered in a very short time. In the case of most modern, complex weapon systems, however, it is highly questionable that it will ever work effectively, because of the very large cost involved in developing the system and the long time span required to deliver the operational end item. In general, there is no one in authority at the using command at the time the requirement for a military system is written who is still there when the development of that system is complete.

In actual practice, it is normal for the using command to participate in various ways during the development of the system, often through liaison with the SPO. It is also typical that the user's requirements will change to some extent as time passes. Nonetheless, the user is essentially disconnected from the actual development process for a period on the order of about ten years (for the typical modern weapon system development). The recent interpolation of OT&E between FSD and the production decision is an attempt to deal with this problem. The inventors of OT&E are saying, in effect, "The development process some way or other comes up with products that the user doesn't like. We can save a lot of money if we can find out which they are and then not put them into production." This approach is clearly wrong, since the objective of the entire business is to get needed capabilities into the hands of the fighting forces in a timely manner, in order to give them the tools to respond to the threat at any given time. The present OT&E philosophy seems to encourage deciding at this late point in the acquisition cycle that we are better off with nothing than with the wrong thing. To accept the waste of what may have been a very large expenditure of development money if only production money can be saved appears to the Task Force to be a dismal approach to defense systems acquisition, at best.

Operational environment testing conducted only after completion of FSD probably will not work very well anyway, because an unsatisfactory test report presents the DoD with a set of equally unpalatable alternatives: either cancel the program which wastes the investment already made and denies the product to the field; order a major rework which is enormously expensive after FSD has been completed; or bite the bullet and go ahead with production anyway. The pressure to do the last is enormous even after having made the substantial investment in time and money required for operational testing. Supporters of OT&E react by attempting to make OT&E even more independent, such as by attaching it to Systems Analysis, or, for all anyone knows, perhaps by deciding it should be under the GAO.

OT&E supporters are swimming upstream. The idea behind the whole thing should not be to put a stop to the acquisition process, but to assist in getting needed equipment into the field. The way to get better equipment is to do better development, not to do more critical after-the-fact evaluation of the development that has been done. The challenge is to get equipment out of FSD that the user needs, understands, and can use. The way to do that is to involve him throughout the development process. Field environment test and evaluation should be a continuing activity, the purpose of which is to assure that the net result of FSD is an end product that is, in fact, what is wanted. It is too late to start to do OT&E after FSD.

The Task Force is convinced that there is a great need for many more development experiments and tests in realistic field environments, with participation by both users and developers. Such tests can surface the user's real needs and identify the real inadequacies of existing equipment, and suggest the ways in which these needs can be met and these inadequacies overcome. The participation of the developers in this process can lead to more realistic testing since the developers can provide simulated and breadboard equipment and can bring to bear much greater technical resources than can the users. The developers will also gain a much better understanding of the real operational problems and requirements, and will be encouraged to seek and provide the immediate and near-term fixes that are badly needed but seem so difficult to obtain.

Such realistic test environments would be the appropriate places to perform development experiments using breadboard, brassboard, and prototype equipment as they become available, thus engaging the users and existing user equipment as part of the tests. Properly done, such tests could be the basis for the continuing test and evaluation process described above. They can also establish a baseline of existing capability against which the value of the new development work can be measured. The continuing involvement of the users has the following advantages:

a. The user and developer can together seek the best balance between tactical changes and equipment modifications or new developments in correcting difficulties. After all, procedures and equipment are two faces of the same coin and should develop together. New tactics suggest modified equipment; new equipment suggest new tactics; both can be used to satisfy new needs or overcome difficulties.

b. The agreement between user and developer about what to do, which should result from their joint participation in exercises and tests, could greatly shorten the time required to get a decision to proceed on major steps in the acquisition cycle.

c. The user can begin preparing to receive major new capabilities while they are still in the development phase because he will be closely involved with the early testing. It is often overlooked that the user's acceptance of a new capability is an integration process in itself. He must understand what he is getting, what it can do, modify his procedures, sometimes his organization, often acquiring new people, and train his people. The sooner he can begin this process, the sooner a true "operational capability" will be achieved.

d. Joint activities by the user and developer in a Test Bed environment can lead to prompt and satisfactory completion of the formal OT&E phase without costly delays in major programs.

The above observations refer primarily to those development activities which arise from the definition of specific needs by the user organizations. There are also many development activities which arise from perceived technology and the identification of cost saving opportunities. There is also a need for user participation in these kinds of developments, although it may begin somewhat later in the acquisition cycle. After all, no matter how an idea came into existence, the ultimate operational capability will only be of maximum value when the intended user fully understands and accepts it.

In summary, the needs of the user will be most readily served if the concept and role of OT&E are modified so that the system is evaluated for operational suitability by testing it once to procedures agreeable to both the developer and to the OT&E organization, followed by independent evaluation of the results.

H. EARLY DEPLOYMENT

The Task Force concluded that there is considerable evidence to support the claim that early deployment is frequently a useful and valuable practice, particularly in those cases where less than the ultimate system performance is acceptable in the initially-deployed units. Several examples support this finding: Minuteman I, where the first wing did not meet the range specification; Polaris A1 which also did not possess the full specified range; and the 425L system, which represented a significant reduction in operational capability over that originally envisioned in the initial performance requirements. Each of these systems served a very useful operational function, and provided a valuable operational capability and experience until subsequently replaced by an upgraded version with greater performance than the initially-deployed system.

Early deployment also permits a shortened acquisition time for the initial operational capability, which also has considerable value in terms of dollars spent:

- A shorter acquisition cycle avoids costly and usually unnecessary gold-plating
- It means a shorter period of time during which the overhead costs associated with the acquisition of the system must be carried
- It means a shorter time for costs to increase due to the effects of inflation
- It permits the realization of more efficient production rates in most instances.

Early deployment and a shorter acquisition time also enhance the ability of the Services to match or achieve superiority over a changing threat. The shorter acquisition time which permits earlier deployment also puts the end product in the hands of the user for a longer period of time before it is no longer adequate to meet the threat—a longer useful life before obsolescence which results in a greater "return on investment" when the cost of acquisition is amortized over a longer operational lifetime.

I. THE EXTERNAL ENVIRONMENT

1. Probability of Program Cancellation

The Task Force concluded that there is a definite indication that, due to the influence of external forces and influences, the longer a program stays in full scale development, the greater are its chances of being cancelled prior to completion. Primarily as a result of changes in personnel and viewpoints within DoD, in the Congress, in the Executive Branch external to DoD, and in the public sector, there is frequently a shift in the perception of priorities, attitudes, and appreciation of the external threat which caused the program to be approved for development in the first place. Such changes often result in major redirection of the program, with attendant increases in overall cost and significant delays in the schedule for completion of the acquisition cycle.

The probability of a program being cancelled during each year of its acquisition cycle is illustrated in Figure 11, which depicts the growing probability of cancellation for each year in the life of a program. Such programs are often cancelled only after they have been subjected to a series of costly and time-consuming redirections, and many are subsequently re-initiated at some later time under a new name. The B-1 program, as a typical current example, was continued for a period of approximately fifteen years, with a total expenditure on the order of $4 billion before it was finally brought to a virtual halt by Executive Order in mid-1977. If a requirement for an advanced manned penetrating strategic bomber is adopted at some time more than perhaps two or three years in the future, it is likely that very little of the time and money expended on the B-1 will be salvageable for applicability to the new program.

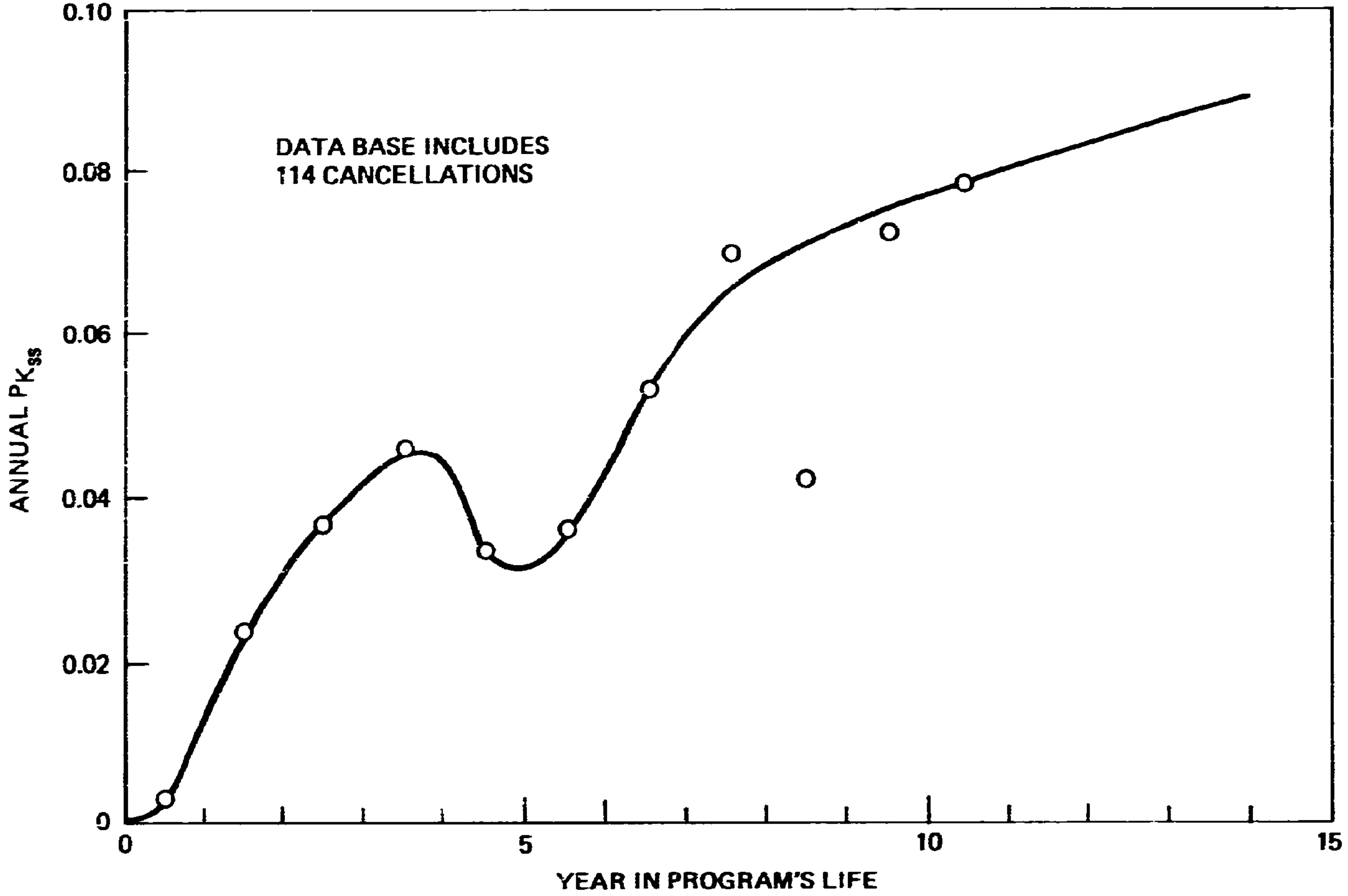

Figure 11. Program Survivial Function (Probability of Program Cancellation)

One conclusion that was drawn from this examination of the effect of external influences on the probability of program cancellation is that the likelihood of a program ever being completed decreases as it passes through more than one "administration" which, for lesser systems may be the tenure of the military SPO, and for major, national systems such as the B-1, may be the tenure of a political administration, i.e., of the top federal elected officials in the Executive Branch. Thus, there is clearly significant potential advantage, in terms of shortening the acquisition cycle within which a particular mission need is to be satisfied, as well as in terms of conserving considerable national resources which must be expended to satisfy that need, in completing approved programs as quickly as is consistent with the practicalities of the scientific and engineering risks associated with meeting the need.

2. Congressional Influences

Another significant external factor is the Congress which, in recent years particularly, has become a much more diffuse institution with less identifiable leadership. The quasi-monolithic committee leadership structure of the past, which was in general totally supportive of the perception of national security held by, for instance, the Defense Science Board, no longer exists in the Congress. Nearly half of the Majority members of Congress, for example, have been elected within the past two years, and they represent a diversity of views regarding national priorities and the threat to our national security.

Thus, there is no "magic formula" for solving the problems of the DoD in its relations with the Congress. In addition to the new diversity of viewpoints represented in the membership of the House and Senate, as illustrated in Figure 12, the identifiable leadership of the key military committees responsible for military programs is no longer pre-eminent in military affairs as was the case in the past.

Another important influence in the Congress is the exponentially growing Congressional staff, which has exhibited an increasing interest in, and capacity for detailed involvement in the management of military programs. The recent growth in the involvement of staff members in the review of the defense budget is illustrated in Figure 13. A significant portion of the "blame" for this increasing Congressional "micro-management" can

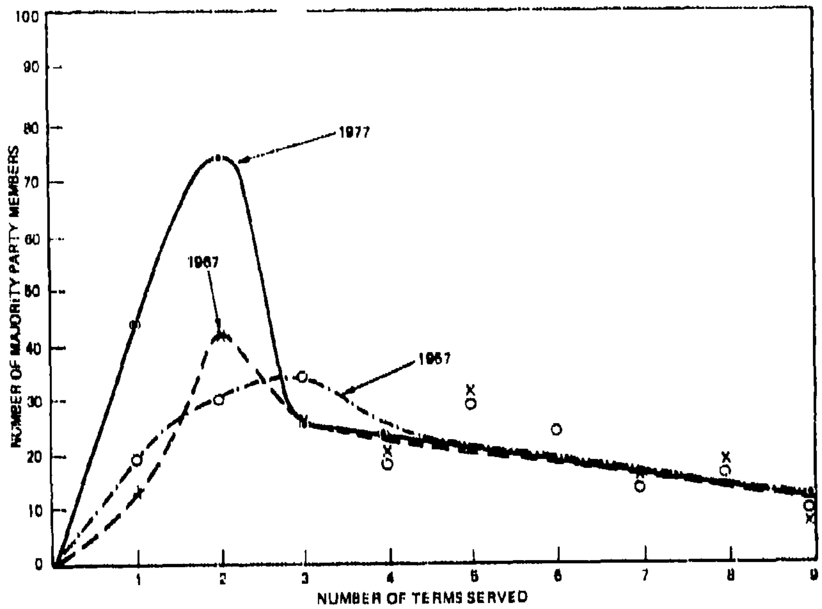

Figure 12. Distribution of Members of the Majority Party, House of Representatives, by Terms Served

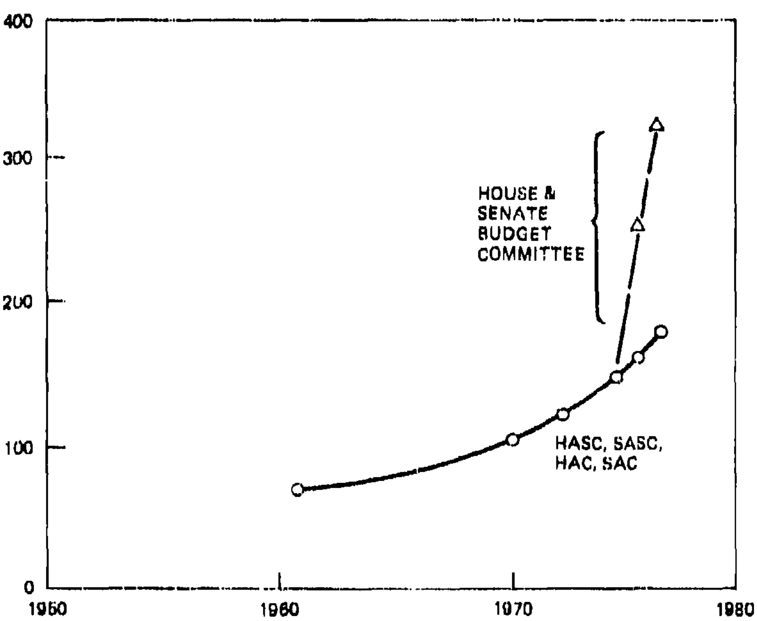

Figure 13. Staff of Committees Involved in Review of the Defense Budget

probably be laid to the fact that the DoD has exhibited a chronic inability or unwillingness to adequately forecast program, cost, schedule, and performance information and projections to the Congress. Because of this repeated lack of accuracy in the data provided, many members of Congress tend to lose interest in defense affairs, and others seize upon these inadequacies as an excuse to attack particular defense programs on a variety of grounds. For example, analysis of the average unit cost of tactical aircraft acquisition since pre-World War I times indicates a well-defined trend whereby costs increase by about four times per decade. Despite this well-documented and statistically-predictable trend, the DoD has continued to underestimate the total cost of new systems, and also typically understates the cost to complete as programs proceed through development into procurement. Data from 38 major programs indicates that a cost correction factor of 1.8 must be applied to the prediction of total R&D plus procurement cost at the time development is initiated. This correction factor gradually decreases as the development phase proceeds, but does not approach unity until the program is well into the production phase, typically.

Another aspect of this lack of forecasting accuracy is the fact that the data indicate a distinct tendency to underestimate the time-to-go to major milestones in the acquisition cycle. Analysis shows the relationship between "estimated time-to-go" and the actual time required to achieve the same milestone is typically optimistic by a factor of about 1.3, on the average.

Still another reason for the lack of credibility of the DoD with many members of Congress is the apparent inability (presumably not intentional) to provide accurate predictions of system performance and operational reliability. A typical example is the trend of reliability estimating for the A-7D aircraft depicted in Figure 14. From an estimate made in 1968 of over three combat sorties per day per aircraft, made at the start of the test and evaluation period before the production go-ahead, the actual operational data in 1973 indicate a true reliability of less than one sortie/per day/aircraft was achieved.

3. <u>Comparison with Soviet and U.S. Commercial Practices</u>

There are also some lessons about how to contend with the external environment to be learned from both the U.S. commercial world and the Soviet military acquisition management systems.

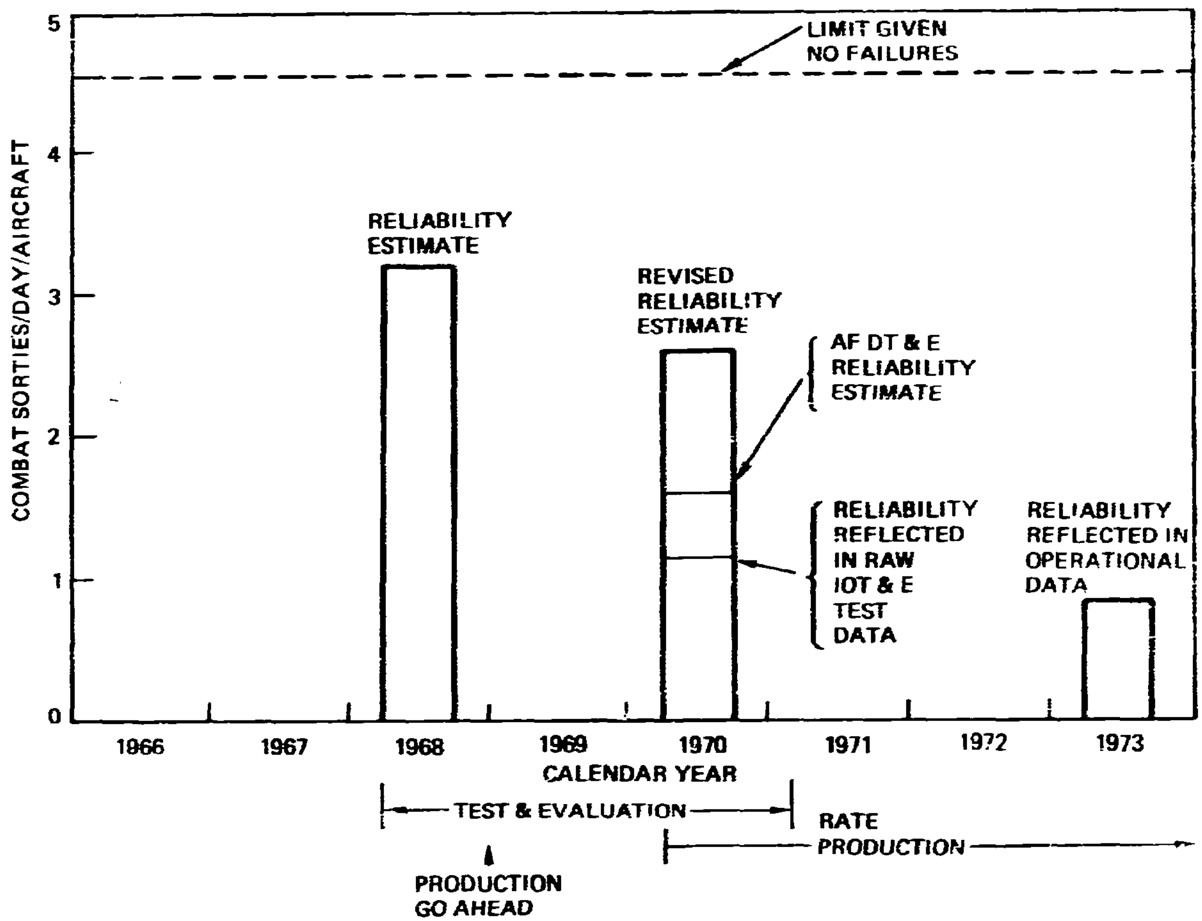

Figure 14. Capability Assessments for the A-7D

Both the U. S. commercial aircraft industry and the Soviet management system make deployment decisions one time—and then typically carry them through. Both modify and upgrade their existing systems quite frequently and with significant cost effectiveness. The 727 program is a typical commercial aircraft case in point, as is the basic Soviet tank engine history, which has evolved from a design concept first introduced in the 1930's. The program management teams in both instances tend to be extremely stable, without the rapid and periodic complete turnover of key management personnel typical of the DoD. The Soviet system development time, from the start of initial prototyping to IOC, is typically about seven years. For U.S. commercial aircraft manufacturers, the typical time from program go-ahead (in which the decision to "deploy" is explicit) to initial deliveries of production aircraft to the airline customers is about four and one-half years. A final comparative factor is that the Soviet defense budget over the past twenty years has not exhibited any oscillatory trends, as has the U.S. defense budget during the same period.

4. External Management Review

The Task Force determined that the DSARC, OMB, and PPBS processes are reasonable with respect to the provision of external review and control over acquisition program budgeting and management. As was illustrated in Figure 6 above, the DSARC process has a close analog in the commercial world. But these systems do have weaknesses that contribute to delays in the acquisition cycle:

a. Industry makes the production/deployment decision only once, while in defense systems acquisition the debate continues at least once during every budget cycle.

b. The DSARC, with halts for testing, produces gaps in the cycle which have serious industrial implications.

c. The DSARC/budget procedures are not connected; thus the decision to proceed does not necessarily mean the funds are available. For example, DoDD 5000.1 states that DSARC decisions are not budget commitments, while DoDD 5000.2 states that if PPBS and program plan provisions are different, the acquisition executive should be informed. This is necessary, but insufficient to resolve such conflicts when they arise, with the result that the program manager is unable to hold to the previously-decided-upon plan, alternate paths are made available to the "losers" to renew their attack, the program can be stretched out, and the desire to avoid hard priority choices often results in across-the-board cuts in many programs.

d. Program guidance can seldom, if ever, be fully complied with given the funds which are made available.

e. While the objectives of OMB Circular A-109 are sound and commendable, it is probably unrealistic to assume that the Congress will ever give a formal, early commitment to any program proposed to satisfy an approved mission need, and hold to it, with the likely result that the program will merely be exposed to an additional two years of attack.

f. The current OMB guidelines which are based on an assumption that the inflation rate will be 4% annually beyond two years into the future are obviously unrealistic and impractical; they are not even consistent with the other elements of the Administration.

5. <u>Diversion of SPO Resources</u>

The job of the SPO is rapidly becoming impossible because of the demands made upon him by the external environment. Something on the order of 80% of his time must now be spent on "marketing" activities rather than on program management. He is given inadequate authority to make and implement the decisions and management actions necessary to fulfill his assignment, and he is faced with external influences which create turbulence in his management of the program rather than with the clearly-defined responsibility and authority which he needs to do his job.

6. <u>Environmental Influences</u>

Finally, the implications of current environmental concerns in the external world—both governmental and public—can serve as a very powerful lever for the disruption of major defense acquisition programs. Recent typical examples are the delay in construction of the Trident SLBM base, siting and installation of the Sanguine/Seafarer ULF communications system, and construction of prototype trench installations for test and evaluation of MX basing concepts. The requirements for environmental impact studies affect not only such advanced defense systems acquisitions as these; they also exert a powerful delaying influence on such routine DoD activities as the opening and closure of defense installations anywhere in the country. These environmental issues are a recent external influence which can have a significant effect on the length of the acquisition cycle.

J. INCREASING REALISM IN COST ESTIMATION

Certain portions of the material discussed in this section were developed subsequent to the Task Force deliberations at the 1977 Summer Study, and are presented here in response to requests for such supplementary material voiced during subsequent briefings and reviews of the preliminary findings and conclusions of the Task Force in OSD.

1. Recent Trends in Program Cost Control

A number of individual studies of program costs have been evaluated, both with regard to FSD costs and total program costs. Although there are large variations in the relevant data, two conclusions seem to emerge, as indicated in Figure 15. First, the trend in controlling costs seems to be an improving one, going from a typical 200% growth exclusive of inflation in the 1960's to perhaps 50% in recent years. This still leaves considerable room for improvement, obviously. Second, few if any programs ever seem to have been completed in an underrun condition (as defined in SAR terminology). In fact, none was found in this study.

Six principal problems have been identified in connection with cost control during the full-scale development phase and the transitions into and out of that phase. These will be discussed in order of probable importance, together with suggested corrective steps which should be considered.

Problem 1 - No Allowance for Additional Tasks

Development programs, typically lasting about eight years, are planned with no allowance for funds to undertake any tasks other than those specifically identifiable (and contractually defined) at the outset. This ultimately requires a degree of prescience not often found in Program Managers or others. It was the perception of the Task Force that cost overruns in recent years are due relatively infrequently to classical "poor management" but very frequently occur as a result of imprecise initial cost estimating—both on the part of the contractor and the government.

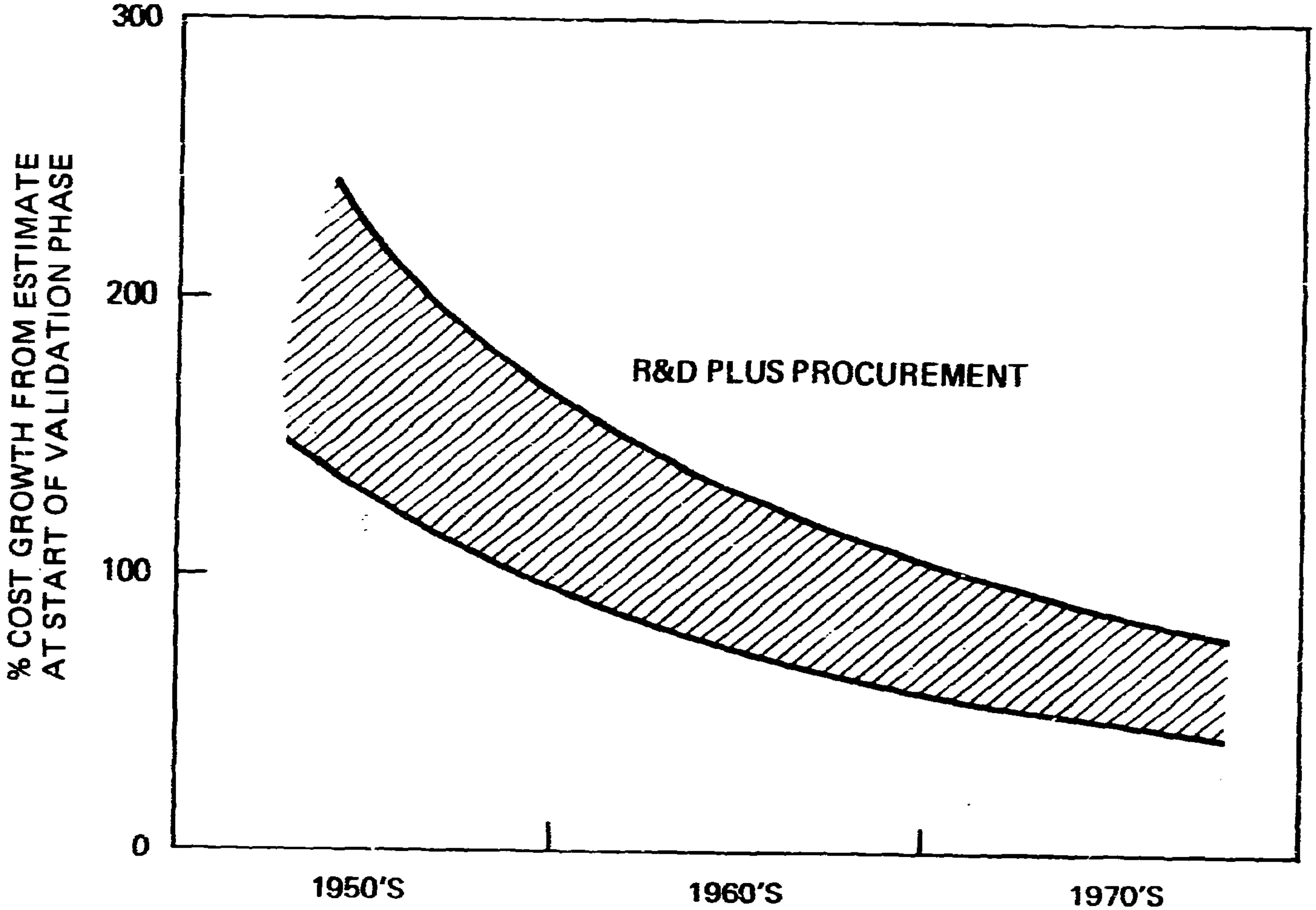

Figure 15. Trends in Program Cost Control (In Constant Dollars)

A principal underlying difference in the commercial endeavors by defense firms which distinguishes these efforts from their defense undertakings is that the commercial endeavors invariably begin with an allowance in probable cost for unforeseen, but statistically near-certain, problems to arise. The decision to proceed with a project is made with an understanding that unforeseen problems leading to additional costs are going to be encountered, so when they do occur the management has the resources and flexibility to work around the attendant problems. In contrast, these same firms, with the same facilities and managers, historically overrun DoD contracts—which offer no latitude to accommodate the unexpected, even though, ironically, the DoD endeavors generally involve greater technical risk than do the commercial ones.

Another factor which may account for the overrunning of military developments versus not overrunning commercial developments involves the cost optimism practiced by companies to fit prior government budgets and to win cost-competitive procurements. The government practice of awarding a contract to the lowest bidder (in most cases) forces understating of expected costs during competitions. Historical records show that program actuals come very close to company "grass roots estimates" but are over bid prices by substantial percentages.

If changes are introduced to attempt to remedy this situation, it can be anticipated that several objections would be raised:

- The higher expected cost indicated at a program's outset will make it necessary to eliminate other programs from the Service's plan and will make it more difficult to obtain Congressional approval.
  Comment: This is certainly true, but little purpose is to be served by approving a MENS if the resulting program will ultimately be cancelled due to an overall lack of funds. In fact, the present practice merely absorbs funds which might otherwise have been spent meeting other needs.

- Congress will not approve a "slush-fund reserve" and the dollars thus requested are likely to be lost.
  Comment: This also is true if it is indeed a "slush fund" but if what is requested is rather a level of program support based on a more realistic assessment of cost than has in the past been provided to the

Congress (judging by historical SAR overrun data), then it appears there is some likelihood of the needed Congressional support being forthcoming.

- The provision of an allowance for statistically probable but initially unidentifiable problems will lead to a self-fulfilling prophecy and the higher level of funds will inevitably be spent.
  Comment: This concern points up the necessity to hold the additional funds at a level above the developing organization, to be released only when fully justified; or to be made available for reprogramming when appropriate; or to be returned to the Congress when unneeded.

Problem 2 - Management Effort to Rejustify the Program

An intensive examination of the need to initiate a new program is an essential ingredient of management under limited resource conditions. This same scrutiny is generally afforded proposed new commercial programs pursued by industry, but here the parallel to DoD programs appears to end. In commercial practice, once the Board of Directors has made a commitment to a new project (a "Milestone 0" decision) it behooves all concerned to adopt a "help get the job done" mode as rapidly as possible. In government practice, on the other hand, opponents frequently continue to impede the progress of the program throughout its existence. This is not to suggest that programs should not be reexamined when significant new data become available; it is, however, to say that in the absence of such significant new evidence the obligation of all involved should be to support the management of the program in executing the approved plan. One element of this support would be to find ways of providing assurance that DSARC decisions are not undermined by funding reductions made as a result of the recurring budget process.

The data assembled by the Task Force provided an interesting insight into the relationships between the length of a program and the probability that the program may be cancelled at any point during its typical 8-10 year development cycle. Figure 11 summarized the data on a large sample of programs (114) and illustrates the relatively high probability that a given undertaking will be cancelled before producing a combat-useful product, particularly if the FSD phase extends beyond about five years in length. The dip in the annual probability of cancellation which occurs at about three and one-half years after start of FSD reflects the initial obtaining of test data, which usually suggest that "we may really have something useful here." As the test/development effort continues on past about five years, problems of a technical, schedule, and financial nature tend to crop up, leading to growing disenchantment with the project and in increasing probability that it will be cancelled prior to completion of FSD.

Problem 3 - Source Selection Practices

The source selection process too often rewards optimism on the part of contractors rather than realism, thereby increasing the likelihood of schedule slips and cost overruns. As indicated in Figure 16, for any given development program there is a fairly broad range of possible cost outcomes, each with an attendant probability of being achieved. The actual cost proposal submitted by a contractor in any given case can vary widely depending upon the confidence level that the contractor deems appropriate to assign to the undertaking. At present, it appears to be a widespread perception in industry that the government is awarding cost-reimbursable contracts to bidders who select a very low level of confidence in making their quotes. This practice, while saving fee, further increases the likelihood of substantial overruns and provides a questionable discriminator in selecting among contractors for work to be funded under cost-type contracts.

The Task Force has identified the following as possible ways in which the source selection process might be strengthened:

- Make the contracting function responsible to the program manager in a line fashion
- Base cost-type contract awards on the government's assessment of probable cost rather than on the contractor's claims—and considerably strengthen the government's in-house capability to distinguish between the two
- Include "past performance" as a more important factor in the management assessment of a contractor's proposal
- Maintain competition among multiple sources as far as economically feasible into the exploratory and demonstration phase of major programs

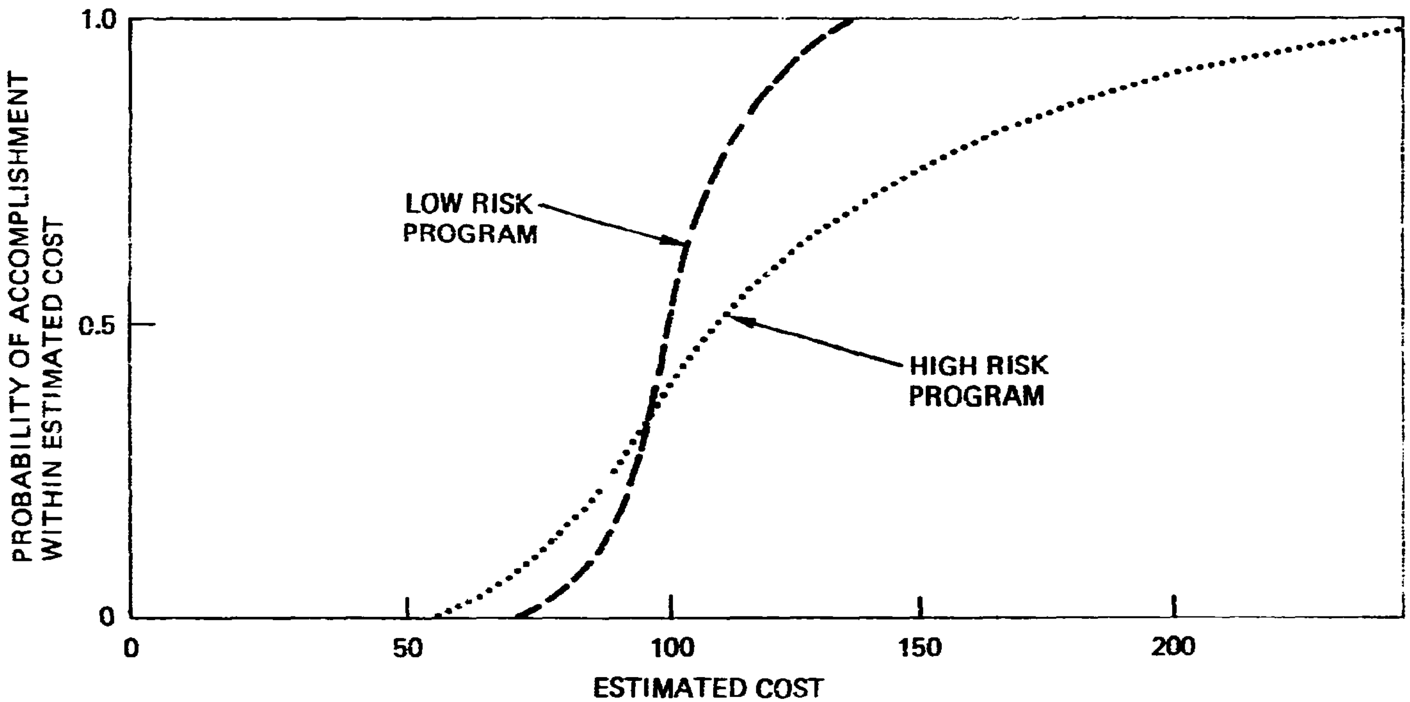

Figure 16. Range of Possible Cost Outcomes for Development Programs

- Eliminate all-up cost as selection criterion in cost-type competitions (including Best and Final auctions).

Problem 4 - Rigorous Transition from FSD to Production

It is observed that a rigorous heel-to-toe phasing of the transition from FSD to production has generally led to disruptive gaps in manpower utilization in past major programs. The policy of obtaining convincing test data before entering high-rate production is strongly endorsed, but such policy should not mandate that no production can commence before all testing has been completed in its entirety.

The Task Force believes that a policy of intensive testing should continue to be followed, but also suggests that the initiation of production (initial low-rate or final high-rate) should be keyed to the actual state of knowledge available at any given point in the test effort, rather than to an arbitrary criterion such as "three months after availability of data for the final test point."

Problem 5 - Testing is Costly—and Ineffective

As currently practiced, testing is expensive and highly time consuming, yet operationally unreliable items are still passed with a fairly high frequency. The solution to operational unreliability —probably the greatest "performance" shortcoming of systems deployed in recent years—requires more conservative design practice as well as more exhaustive reliability testing. However, at the present time, testing is already one of the major time consumers in the development process. This is particularly true of multi-phased programs structured in such a way that separate and duplicative periods of testing are called for following the development phase, and following the low-rate production phase; each as a precursor to entering the subsequent phase of the program.

The achievement of satisfactory test results should be recognized as being a pivotal factor in validating the initial decision to move into production upon completion of FSD—but once satisfactory results have been achieved, repetitive test cycles should not be imposed as a condition for moving into production rate buildups. In particular, the acceptability of test results should be viewed as a pivotal condition for moving through the DSARC III milestone but subsequent test activity (e.g., OT III) should be consid[illegible] be primarily in the nature of confirmatory tests rather than a vehicle for reopening already-settled questions of design adequacy, system or mission need, and other such basic issues relating to the program. To implement this concept, the following measures are suggested for consideration:

- Place greater emphasis on component tests and on assuring component and system reliability
- Conduct full-system test programs at a more intensive pace, making greater use of overtime and automated data collection and analysis
- After a brief period of contractor checkout testing (which is an integral and important part of the design process), conduct a single set of development tests —with multiple planners and users of the data if appropriate. Do not repeat the collection of individual test points solely because a new user of the data is involved.

Problem 6 - Lack of Reprogramming Flexibility

The DoD generally possesses inadequate budgetary flexibility to manage dynamic endeavors such as major system developments with sufficient effectiveness. The adoption of a risk-recognizing cost estimating approach would assist in providing much-needed latitude to manage. Further appropriate latitude could be obtained from external means by obtaining an increase in the Congressionally imposed reprogramming threshholds. At the present time the development program manager must commit to execute a task for a relatively precise amount of funds some two or three years before the task itself is to be undertaken. Because of the established budget cycle, the critical tasks (from a fund availability standpoint) tend to be the ones which take place at the end of the fiscal year. This is a result of the lead times involved in converting the program manager's fund request into the annual appropriation of funds by the Congress.

Thus, with only $2 million of reprogramming authority available to DoD, and even that precluded for the 30-40% of the programs designated as Congressional Special Interest, adequate capability to work around problems of either a technical or a fiscal-year timing nature is not available to the DoD Program Manager. One consequence of this is the frequent need to break contracts and renegotiate new conditions, often to the detriment of the program, the government, and the national interest.

The present reprogramming threshold of $2 million was established by the Congress in 1962, and would, in constant purchasing power, probably represent $4-5 million today. Reprogramming authority at this higher level does not appear to the Task Force unwarranted or excessive. Even though the Congress may disapprove of a DoD request for a higher threshold, the Task Force considers it necessary to highlight this factor as a significant limitation on sound program cost control and overall defense program management.

Further, additional budgetary flexibility is needed to permit the immediate followup of a Milestone 0 program start decision with studies necessary to support the needed Concept Formulation (CF). When a MENS is approved, action in the form of resolving the issues and defining a program within a year (or two) is obviously necessary. However, a major program decision is usually accompanied by a budget change which is not effective for at least a year and could not result in completed studies for at least two years (they wouldn't even start for at least one year). Such additional budgetary flexibility could be accomplished either through reprogramming (if sufficient authority is available) or through the continuous existence of a CF line item in the budget with reprogramming authority. There could be a two-year limitation for funding any particular program out of the CF line item (which should give enough time to get the program in the regular budget). If necessary, Congress could be notified when a new program is placed in the CF line item, and thus the A-109 concept of getting Congress into the act at the beginning would be further satisfied.

2. Impacts of Inflation

During the past five to seven years there has been a significant turbulence in program cost control and resultant schedule changes due to inflation. This is believed to have been an important contribution to pre-conceived cost growth and program stretchouts triggered by the long lead times involved in the government budgetary processes. The GAO has stated that there is no government agency that has a good handle on the impact of inflation, with which the Task Force wholeheartedly agrees. It is believed that a forcing function for better stability in defense system acquisition programs would be operative if our programs were measured and managed by constant year dollars or base year dollars (as is done by several European countries). Many of these countries develop a defense program budget for a particular weapon system in base year dollars with adjustments made for inflation by their treasury department. The DoD might take a leaf from that and do the same since working in then-year dollars and the constant cost growth that derives therefrom continually forces the question of affordability as cost growth continues.

3. The TRACE Approach to Increasing Realism in Cost Estimation

TRACE (Total Risk Assessing Cost Estimation) is an Army estimating technique which has been used with considerable success to determine on a probabilistic basis the additional costs which must be expected to be incurred in a particular program in order to solve unexpected problems. The particular approach to determining the exact values to be used in obtaining a TRACE estimate can be derived from a variety of methods, but the key point is that the final estimate results in about a 50:50 likelihood (on a dollar basis) of either an overrun or underrun. When applied to a group of programs, the probability of the total cost for the group ending up as estimated is greatly enhanced (even though overruns and underruns may still occur in individual programs within the group).

Perhaps the most damaging long-term factor in undermining public and Congressional confidence in the management abilities of the DoD ironically concerns only about 20% of the DoD's activities. This factor is the cost growth observed over a number of years in R&D and procurement of major systems.

Engineering development expenses can be viewed in two categories:

- Expenses that can be foreseen and planned for
- Expenses that arise in overcoming unexpected problems.

Only good management can resolve the first category, but the last category represents a not insignificant portion of the costs incurred in RDT&E activities which, by definition, involve performing something that has never been done before (sometimes operating near the edge of the state-of-the-art). The problem is exacerbated by the fact that competitive pressures drive contractors to almost unbounded optimism in submitting cost estimates for cost-reimbursable contracts, and there is not a functioning check and balance within the responsible Services in that they, too, are anxious to see new programs approved. In fact, the entire system borders on instability in that even the government's contract negotiators are to a considerable degree motivated to try and drive down the costs shown in contractors' proposals and in the contracts which are negotiated with the winners. As a result, the challenge faced is not one of improving cost estimates by a few percent—the problem is to overcome gross underestimates which have been commonplace for several decades.

The degree to which this problem pervades major RDT&E programs is suggested by the fact that it is virtually impossible to name a program that has been performed in its entirety within the budget originally allocated for its accomplishment.

But even with these above-mentioned pressures, it is doubtful that "conventional" cost estimates can ever produce accurate results. "Conventional" cost estimates are defined herein as those based on listing all tasks known to be required and then assessing the cost of each of those tasks. As noted earlier, there is probably no manager alive who is able to project all the problems which should be expected during the typical eight years of the average major system program's lifetime.

The need thus clearly exists to make provision for the unforeseen—but statistically highly predictable—difficulties which invariably arise in major developmental projects. The costs associated with solving unforeseen problems are in fact statistically determinable in the aggregate. The fact that various studies show that the average program growth (from all causes) just a decade ago was about 100%, and that, as has been noted, virtually no programs were completed with an underrun, suggests the extent of the need for improved cost estimation (as well, perhaps, as better execution). The Army TRACE technique appears to be worthy of serious consideration as an approach with considerable potential for alleviating a substantial part of this problem.

Whether the technique is called TRACE or Management Reserve or Reserve for Engineering Changes, the important point to bear in mind is that this is not "contingency" money that is simply budgeted "in case something happens." It is a necessary management resource that should be provided because it is well known, and experience amply demonstrates, that something will happen and it must be fixed quickly if the program is to remain on schedule and within the "planned for" costs.

The size of such a reserve for any particular program is a matter that should be decided primarily on historically derived "rules of thumb" flavored with informed experience and good judgment. Rather than base such a reserve determination on analytic methods that defend a dollar amount that purports to reduce program risk by some derived number of percentage points, recent experience suggests that the reserve is more realistic if based on studies of completed programs which calculate the expenses that would have been incurred if the unexpected problems that arose had been fixed immediately.

If such a reserve is applied, experience suggests that most of it should be held at a staff level above the Program Manager as a budgetary line item to be allocated for "Engineering Changes" upon adequate justification by the Program Manager. Since such a justification process will require some period of time—perhaps as much as several months if adequately strict management control is to be maintained—it is extremely useful to allocate perhaps one or two percent of the reserve to the Program Manager directly, for his use as quickly as he determines there is a problem and can decide what needs to be done to keep the program moving toward its goals. This smaller reserve will frequently tide the Program Manager over until additional funds are released to him from higher management.

The budgeting of a reserve above the planned expense of the program assists in keeping the program on schedule as it allows the Program Manager to react quickly to problems with additional development effort or design work-arounds. This quick response capability is possible only if funds are available, at a level (or levels) which allow rapid justification and approval, which cannot be realized unless the money has been budgeted to the program previously.

A reserve is also desirable since the integrity of the entire weapon system acquisition structure rests on the "attitude" of DoD's Program Managers. It is absurd to think that we can maintain a workable acquisition system while we routinely ask Program Managers to do what we, and they, know in advance cannot be done. That is in fact what we ask them to do when we do not budget any kind of a reserve for the program.

As has been mentioned previously, DoD cannot expect to deal with changing priorities and program tradeoffs unless the out-year plans reflect realistic program costs. Also, DoD's credibility with the Congress can only be reestablished by demonstrating a capability and a will to estimate program costs accurately.

Concern is expressed by some that reserves held at lower management levels will be unwisely or frivolously spent, while others are concerned that if Program Managers know there is a reserve available, they will become too relaxed about holding down costs and getting the most for their money. The only reasonable response to such concerns would appear to be that if Program Managers and the lower level commanders are not competent and conscientious, then our acquisition process will never be improved. Therefore, we must assume that they are capable and put our confidence in them to be able to manage a budgetary reserve in a responsible manner. By doing so, a management environment will also be created which fosters esprit de corps, and will make it more likely that these managers will be conscientious.

It appears more probable that it is at the higher levels of the Military Departments and in OSD that there ought to be concern about the breakdown of the discipline needed to sustain such a policy, which is, in essence, simply one of honest, conservative planning and budgeting. For it is at these higher levels that political pressures converge and push toward squeezing as many programs as possible into a limited defense budget. These are the levels that put pressures on the Program Managers and the defense contractors to do the same with less money, and to commit to more than they know they will be able to deliver. These are the levels that must be rigorously policed and disciplined if such a policy is to work.

In summary, it is the conclusion of the Task Force that:

- Independent cost estimates should be made by DoD of every industry proposal to be sure that all of the costs for all of the things which can be planned on are not underestimated
- Some amount, typically on the order of 5-10%, should be added to these identifiable costs and placed in a line item allocated for "Engineering Changes" (or something similar. A historical study,

using a technique such as that employed for the Army TRACE system for example, should be done to determine just what this percentage should really be

- A small portion of this reserve (typically on the order of about 1% of the total reserve) should be assigned to the Program Manager for use at his discretion <u>without prior approval</u>
- The remainder of the reserve should be held at the Command or Service level for release only upon proper justification by the Program Manager
- The managers and staff at the OSD and Service levels should be rigorously policed to insure that they <u>insist</u> on the submission (and advocacy up through the chain of command) of realistic cost and schedule (and performance) estimates by lower level commands and Program Managers.

Unless and until adequate recognition is given by DoD to the need to budget for future expenses associated with the requirement to overcome unforeseen problems in its weapons acquisition programs, cost overruns will continue to be a way of life. The integrity of the materiel acquisition system will continue to be undermined if the Congress and DoD Program Managers are routinely asked to do that which all know in advance cannot, on the basis of historical precedent, be done.

IV. RECOMMENDED ACQUISITION POLICY INITIATIVES

A. REDUCE THE NUMBER OF PROGRAMS

The number of major weapon system development programs should be reduced so that those which are continued are the ones which the DoD intends to—and can afford to—put into production and deploy. An important aspect of this is to include in initial program cost estimates adequate margins for the undefined (but statistically likely to occur) contingencies which are to be expected in nearly every complex, advanced, technical development program. Most important, a worth and priority must be assigned to the Mission Need when the MENS is approved at Milestone 0. Comprehensive analyses of feasible and effective ways to provide for program contingencies and management reserves were presented in the (1974) Materiel Acquisition Review Committee reports issued by the Army (AMARC) and Navy (NMARC). These studies addressed the issue of cost realism and accurate cost estimating at great length, and concluded that the DoD does in fact possess an effective capability within the Service Comptroller organizations, Cost Analysis Improvement Group, etc. If the full resources of the DoD's cost estimating and cost analysis organizations were used so as to insure realistic program cost estimates, progress could be made toward limiting the number of programs approved at any time to those for which sufficient funds are budgeted and can be expected to be made available to (1) complete the FSD as planned, and (2) produce and deploy the system on the most cost-effective time scale. Major surgery will be necessary if these objectives are to be achieved at any reasonable time in the future, but unless a start is made now, the present "bow-wave" of programs completing FSD and waiting for the allocation of sufficient funds to produce and procure the end item which has been developed will simply continue to get worse and worse. This bow wave not only causes an increase in the length of the acquisition cycle for the systems affected, but also results in increased acquisition costs due to the added inflation and the costs of constant reprogramming. It also results in the delivery to the using forces of equipment which is either obsolescent by the time it is deployed or which has a relatively brief lifetime before it becomes inadequate to meet the threat.

It is a fact that the current 6.2 programs include many systems concept studies in addition to true exploratory development efforts. Those 6.2 programs should be critically reviewed to determine which should have a MENS developed and which should be terminated due to lack of a definable Mission Need. Such systems concept study activity should only be undertaken upon approval of the MENS and should be focused on a validated need, thereby establishing priorities and freeing those 6.2 funds currently used for such studies for allocation to true technology base efforts.

The Task Force found that in recent years a bow-wave of approximately 1/3 of the budget apparently exists at all times. While a certain amount may be desirable, since it offers a choice of options to be pursued in any given fiscal year, most of the bow wave is undesirable, because it leads to destructive competition, Service rivalry for the available funds, and encourages the prolonged continuation of obsolescent programs on the basis that "we've already got so much invested that we can't afford to cancel the production even though it will have to be delayed until the out years." The magnitude of the bow-wave problem is typically hidden at least partially by optimistic cost and time estimates from both the procuring organization and the contractors involved, still it is obvious that it not only exists, but that it has been getting worse in recent years. There is some indication that the bow wave has been tolerated because of a philosophy that the larger it is, the more likely Congress will be to supplement the DoD budget, but what actually tends to happen is that the Congress is unimpressed by the bow-wave threat, and if DoD fails to make the cuts necessary to bring the expenditures into line with the available funds, the Congress will do so. When the Congress makes program cuts, reprogramming must occur, usually resulting in program stretchouts and schedule slippages, and always additional costs.

The alternative, which is recommended strongly by the Task Force, is for DoD to alter its policy so that it funds fully only that number of the most critically-needed programs so that the resources required will be within the Congressional budget limitations. These programs should be viewed as the "affordable" and "sacred" ones; the less important or less urgently required programs, no matter how desirable they may appear to their advocates, should be identified as being of less than first priority, and incremental funding should be requested of the Congress. If budgetary supplements are provided, then the programs may be pursued, but if they are denied, the programs not funded should be cancelled.

This is a painful change in policy, but the alternative has proved painful also. Perhaps, relations between the DoD (and its elements) with the Congress (and its elements) would become less painful, as well.

B. DEMAND AND APPROVE A FLEXIBLE APPROACH

The Task Force concluded that there is nothing basically wrong with the present DoD (5000.1/5000.2) approach to system acquisition, when viewed in the context of an environment in which lead-time is not considered a serious problem by our national security leaders in terms of perceived or potential threats. That is, the present approach is considered to be generally satisfactory, broadly speaking, for fielding replacement capability with an acceptable operational life, exploiting new technical opportunities in a timely enough way, and satisfying new military concepts in a reasonable time frame. Also, the present approach to system acquisition appears able to readily accommodate—on an exception basis—urgent needs (provided too many do not arise at any one time). Thus, the recommendations presented here are offered as non-revolutionary initiatives to improve the current process and preclude misimplementation of A-109. Hopefully, they will thereby either help to reduce or stabilize the dollar and lead-time cost of gaining increments of new military capability, or provide us with more capability for the dollars and time being expended. The latter may well be the only thing we can achieve as a practical matter, given the fact that acquisition lead-time is paced principally by the availability of procurement funds.

Non-revolutionary improvements of this type involve management goals such as:

- Increasing motivation to improve the efficiency and timeliness of the process (in government as well as in industry) by overt rewards for good performance
- Improving communications among the many participants in a normal acquisition effort
- Clarifying the roles and responsibilities of these participants, particularly during the early and transition periods in the cycle
- Increasing management flexibility at all levels and stages of the process—especially during the "front" and "back" ends of the acquisition cycle where

lead-time is definitely increasing in contrast to the relatively stable development phase.

While the specific recommendations which follow are believed to contribute to a degree to all four of these management goals, they are focused primarily on the last one—increasing management flexibility—because such flexibility is believed to be the over-riding need of the moment.

1. OMB Circular A-109

The Task Force recommends that DoD view A-109 as being essentially a philosophy of major system acquisition which encourages a continuous active competition of results which is carried on for as long as is useful (i.e., as long as the benefits of competition continue to be realized) and affordable (i.e., the costs of the competition are not out of line with the scope and expected military benefits of the program). A-109 should not be viewed as a rigid, step-by-step procedural directive, or as a single acquisition strategy which must be mandatorily applied in each and every case. An educational effort (and audit of results) throughout DoD will be necessary in order to assure that this flexible approach is not aborted in practice.

A suggested direction in which a revision of OMB Circular A-109 might go to enhance accomplishment of this objective is presented in Appendix A to this report.

In applying the A-109 concept, special attention must be given tothe Mission Element Need Statement and its reconciliation with existing and planned capabilities, priorities, and resources. As a particular example, OSD must take steps to assure that the Military Departments understand that the type of effort traditionally described as "Requirements Analysis" must be reoriented as necessary to provide a "Mission Analysis" function within each Service. This function, which need not continue into selection from among promising alternatives as in the past, will provide the Service with a capability to develop the MENS for submittal to OSD with currently available resources.

2. DoD Directive 5000.1

Given A-109 as a philosophical underpinning to the acquisition process, DoD should eliminate all directed models of this process (beyond the basic decision points and acquisition phases) —whether general or for application to a particular class of material. Instead, a requirement for program proponents to overtly devise, for review at the beginning of each program, a strategy for system acquisition which is tailored to that particular program should be directed. This strategy should be regularly revised as the program proceeds and the validity of the strategy is tested. DoD should assist program managers to devise such flexible strategies by developing a data bank of possible strategies, sample criteria for applying them, both by functional type of systems (e.g., C^3 or ASW systems), and by program characteristics (e.g., relative importance of lead-time and degree of acceptable risk). DoD should also maintain a history of the results of having applied the different possible strategies in various cases. The program acquisition strategy should be as important as other acquisition documentation.

The principal purpose of such a dynamic strategy concept would be to assure that program goals, and the manner in which these goals are to be achieved, are stated in an explicit and yet flexible enough way so that all participants in a program—the various levels in the DoD as well as the contractors—can know exactly what they are as they evolve over time.

A suggested approach to revising DoD Directive 5000.1 to permit such tailored acquisition strategies and a more flexible approach to the entire system acquisition process is presented in Appendix B to this report.

3. Return to First Principles

In important technical management areas, DoD can and should give its program managers more flexibility in tailoring acquisition strategies by encouraging them to go back and review the full intent and breadth of what have come to be simplistic one-word designators for basic principals.

Two outstanding examples of such designators which currently are inhibiting flexibility are "concurrency" and "prototype." The former is presently viewed as a "bad" thing and the latter a "good" thing. Both evaluations are incorrect. Concurrency is simply the planned and systematic overlapping of certain activities relating to development, test, and/or production. The degree of such overlap should be the issue, not the mere fact that it exists.

In actual practice, there must always be some degree of concurrency; the desirable goal is to maximize the overlap without incurring unacceptable cost or schedule penalties as a consequence. The "goodness" or "badness" of concurrency, therefore, should be viewed as a function of the appropriateness of the degree to which it is carried out in the case of a particular system acquisition.

The question which should be asked in tailoring a specific acquisition strategy is the extent to which concurrency will benefit that particular program in relation to the added cost of gaining the schedule reduction which can be realized. This, in turn, is a function of the relative importance of lead time to the program in comparison to cost. If the program is extremely urgent, it may well be worth spending extra money and manpower in order to save lead time, i.e., we can "buy" time when it is necessary. Conversely, if achievement of a given military capability at the least cost is the program goal, then the acquisition strategy for that program may be to "sell" time, i.e., trade time for dollars. The point is that the amount of concurrency which is desirable is a function of the needs of a particular program, and should not be dictated by an inflexible policy. DoD should determine the degree of concurrency to be included in a particular program at DSARC II (the key decision point for commitment to FSD and to initial production, per 5000.1). By varying the initial production quantity, the degree of concurrency is thereby tailored to the particular program objectives.

A similar situation exists in the case of prototyping. Providing a prototype of a military capability is not the goal. The goal is to carry exploratory and advanced development to the point, and only to that point, necessary to validate a concept and assess its risks sufficiently to permit the appropriate decision makers to determine if the program is ready for full-scale developments. While such validation may be facilitated by, or in some cases may require, the use of a complete system prototype demonstration, it may also require only a small-scale demonstration of only a critical subsystem or sub-element of the total system. Again, it is a matter of degree, not of decree.

4. Assure that a New System is Required

As part of the new Milestone 0 (MENS) decision effort called for by A-109 (or its equivalent at lower system levels), the DoD should take steps to assure that the need being approved requires a new system. All new program proposals should be required to include an evaluation of the alternative methods of satisfying the need through upgrade or product improvement of an existing system. Acquisition data indicate that new generation systems are characterized by an average cost growth rate of about 4.5 times per decade, compared to the cost of the initial system, while improvements to existing systems exhibit an average cost growth rate of about two times that of the initial system per decade.

There is often considerable opportunity to shorten the acquisition time in the case of product improvements also, compared to the time required for an entirely new system acquisition. A product improvement of a system already in the inventory or in production should always be considered as the first alternative to meeting a new mission need.

5. Base Competitive Selections on Achievement

DoD should avoid the possible lead time losses of the multiple competitions suggested by A-109 by not making the selections for continuing contractor roles in a program solely on the basis of either prototype demonstrations, paper promises, or on the results of efforts for fixed periods which are evaluated after that period. Rather, DoD should consider, as an option, making its contractor evaluations as much as possible while the work is proceeding, and should base them almost entirely on the contractor's record of accomplishment. The running evaluations of alternative solutions should focus on the goals of: (a) eliminating efforts which are going nowhere, (b) identifying, in the case of similar approaches, those instances in which the results being achieved by one competitor are clearly superior to those of others, and (c) identifying those alternative approaches which are sufficiently promising as to warrant continued funding. The latter also should be cut off promptly when it becomes evident that the promise will not or cannot be fulfilled. To evaluate contractors in this way, the government must, of course, be sure that it is a technically competent buyer in the particular case. Otherwise, it will not be able to handle the burden-of-proof involved in this "sudden death" approach to source selection. If a trial of this method proves useful, then the experiment could be expanded.

6. <u>Encourage Informal Competition</u>

As an essential prerequisite to its program flexibility, DoD should recognize that a major contributor to the efficiency of the continuous, but formal, competition of results called for by A-109 can be the work done by potential competitors on their own initiative well <u>before</u> the formal competition starts. This so-called "industry competition" is encouraged and enhanced by the relative flexibility of the expenditure of IR&D funds, by the early dissemination of DoD planning and requirements data, and by the allowance of profit margins on contract work that permits industry investment in R&D facilities.

7. <u>Contract for Complete Development Programs</u>

To prevent the lead-time funding gaps that can appear during a development effort as a result of the lead-time involved in making the major decisions at the milestones called for by A-109 and the DSARC process, development programs should be authorized and funds appropriated on a total program basis, with incremental contract authorizations to each industry competitor. Such an approach will additionally encourage advanced program planning which is focused to a greater extent on program efficiency, since an environment of continuity will be created.

Such an approach by OSD to contracting with industry would simply be a complement to its "contract" with a particular component of DoD which is responsible for management of the program, under the DCP "threshold" concept.

Such contracts could still be funded on an installment or phased basis, in which actual fund releases and "go-aheads" for succeeding phases (preferably in the form of ratification rather than rejustification and re-examination of the entire program) are conditioned on the results of prior phase performance.

To accomplish this objective, DoD must take steps to achieve a closer meshing of the budget and program cycles. The mission budgeting system must be linked to the program decision milestone points, such as by establishing the development budget requirements at the time the Milestone 0 decision is made, inserting the development/production budget requirements at DSARC II, etc. Similarly, DSARC I should be viewed as a program check point where future program budget requirements are identified for insertion into the budget cycle at the appropriate lead times, and not as a milestone where the basic need for the program must be reevaluated and rejustified.

8. Deploy What is Developed

The total program approach to development contracting proposed above could be extended to the initial phase of the production effort as well, if the decision is made that the system will be deployed at the same time that the full scale development is initiated. The Task Force recommends that DoD accept the concept that the Milestone II decision to enter full scale development (or to construct the lead ship in a class of Navy vessels) is also a reaffirmation of the Milestone 0 intention to proceed through the production and deployment phases of the cycle (assuming the system works as expected). As recommended earlier, the approval of the MENS at Milestone 0 should be made only for those systems which are affordable. If this is the case, the funding available for the "selected" programs should be adequate to support confident, full, and optimally scheduled development and production, and timely deployment of the operational system.

Programs for which sufficient funds cannot be budgeted should either be retained in pre-FSD R&D, or cancelled. This recommendation is not intended to limit or restrict a wide range of exploratory technology base efforts; in fact, the Task Force recommends that such defense R&D be on an even broader base than at present. But since we obviously cannot afford to produce and deploy everything we now have in FSD, and probably never will be able to, the exploration of alternative solutions to an approved Mission Need as called for by A-109 should be made more explicit and much more disciplined than it is at the present time.

9. Choose the Contract Type Carefully

It is of major importance in defense contracting to distinguish between the kinds of incentives which are offered by cost-type and fixed-price-type contracts. In the case of early, exploratory development effort, a good deal of iteration is required between buyer and seller. Such iteration is encouraged by the informal atmosphere of the cost-type contract, rather than by the arms-length relationship which does and should prevail in a fixed-price-type contract. Also, considerable development effort involves the seller acting as an "agent" or fellow-advocate of the buyer, rather than an independent and objective supplier of an end product. In such a case, a cost-type contract permits a legal relationship where the iteration can be continued until the buyer has been able to settle adequately on what he wants in relation to what he can have, for what price in cost, and at what price in lead time. Finally, the cost-type relationship is necessary during development in order to assure an attitude of shared direct responsibility for results on the part of the buyer, instead of the relatively hands-off or even adversary attitude he must be constrained to until the results have been delivered, as is the case under a fixed-price type effort.

10. Adjust Reprogramming Thresholds

As one means of gaining some of the management flexibility needed to acquire systems on a more efficient basis, DoD should attempt to negotiate higher reprogramming thresholds with the Congress. As a minimum, the statutory thresholds should be adjusted to reflect the inflation which has taken place since they were last enacted many years ago. In fact, the level aimed at in such negotiations should preferably reflect today's inter-program needs, not simply an adjustment for the past and anticipated change in the value of the dollar. Examples of such inter-program needs are:

- Getting started on the technology and system experiments needed for some promising new system concept that DoD has already decided must be proposed in the next budget request
- Buying good ideas from the losers of competitions
- Technically exploring the ramifications of new military concepts
- Providing extra financial support to programs achieving better than planned, or unexpectedly desirable results.

Such negotiations with the Congress will not be easy. The budget cycle is so long that large queues of desired changes to any given budget always build up. This causes a flood of programming actions to be recommended once the defense budget has been approved by the Congress. Unfortunately, Congress appears to believe that there are too many of these reprogramming actions, and that many of them thwart their intent and their understandings in approving the budget (e.g., the shift of funds to lower priority programs). In other words, Congress feels that the budget system is being abused by DoD. Negotiating new and higher thresholds will thus require a restoration of DoD's credibility with the Congress.

Also, in reviewing the impact of A-109 on reprogramming actions, it seems clear that when a program decision is made by approving a MENS, it will be desirable to have confidence that some action in the form of resolving the issues and defining the program will take place within a year (or two). Yet, a program decision is usually accompanied by a budget change which is not effective for at least a year and could not result in completed studies for at least two years (since they could not even start for at least one year). Budgetary flexibility in the form of additional reprogramming authority should be authorized by the Congress to permit DoD to immediately follow a program start decision with the studies necessary to support the needed concept formulation efforts.

11. Use the DSARC to Assess Program Progress

The more flexible acquisition approach, as well as acquisition cycle time and cost, could be effectively monitored by DoD if the DSARC meetings were devoted more specifically to review of the proposed acquisition strategy, program plan, and schedule for the system under consideration. The DSARC reviews should assure that the program is proceeding in such a way as to be completed in the minimum time while satisfying only those military requirements which were approved in the MENS.

12. Provide for Management Reserves

DoD should make every effort to reach some agreement with the Congress whereby it would have the capability to save lead time and/or dollars in the achievement of a given overall level of military capability through the availability of certain funds clearly ear-marked as management reserves. Such reserves should be openly provided for, even within given overall levels of the approved DoD budgets, by the elimination of less-needed programs if necessary. Such funds should be allocated for control and disbursement to a management level not more than two levels above the program manager. In particular, management reserves should be provided for:

- OSD or DoD component headquarters levels, where budget allocations or post-Congressional hearings apportionments are made:
  - To prevent forcing managers to either budget or apportion on the unlikely basis of all programs being successful on the first test, or conversely, to budget or apportion too high on all programs because of the likely negative results in some;
  - To allow unanticipated savings in some program predictions to offset unexpected losses in others; and
  - To permit program managers to make last minute funding adjustments resulting from apportionment decisions.
- System command levels:
  - To permit such commands to meet their "contracts" with higher levels and the Congress on the basis of true estimates of program costs, and thus help prevent overruns.
  - For small scale, but full developments of needed fixes and promising incremental improvements to existing capabilities, or to resolve specific field problems—under acquisition procedures that recognize that only a couple of years may be required for the effort. Such small-scale efforts now require as much justification, and as much decision time, as major systems acquisitions, and are thus discouraged from being pursued in place of major "new system" efforts.

The management reserves that would be earmarked for such purposes are not "slush funds" but can and should be prejustified on a statistical basis (dollar amount probable but specific use undetermined as yet) and/or on a case-by-case basis (the use forecastable with some certainty, but the dollar cost not fully determinable) for things that are very likely to happen in any program. The old concept that such reserves will automatically be used up by programs in a "self-fulfilling prophecy" has not proved true in the rare usage by the military nor by the prevalent usage in commercial programs.

C. IMPROVE AND SHORTEN THE FRONT END OF THE CYCLE

The Task Force recommends that the formal steps involved in the definition and approval of an acquisition program be reduced wherever appropriate to the needs of the individual program, either by complete elimination of certain steps or by their combination with other milestones. Past policy changes have tended to add, but not remove or replace, such decision points, resulting in undue lengthening of the program initiation and definition phase of the cycle.

In defining the program, critical consideration should be given to the possibility and desirability of completely eliminating certain parts of the "standard" acquisition cycle, such as by waiving the requirement to carry out a complete advanced development effort—or even a full scale development phase—where a successful prototype demonstration has already taken place. Also, steps should be taken to increase the involvement of the potential user of the system during the initial phase of the program (as well as throughout the acquisition cycle). Greater interaction is necessary between the operational experience of the user community and the technical research and development resources of the supporting technology base.

The advocacy and adversary processes should be resolved so as to achieve a reasonable consensus early in the program by revitalizing the DCP process for those programs for which the full MENS process is not required.* The DCP should be returned to its original intent of providing a program rationale, presenting a discussion of the alternative solutions available to meet the mission need and considered in arriving at the system concept, and of limiting the process to major programs only. The DCP should be used as the internal DoD working document to respond to the requirement of A-109 to affirm the mission need and to explore and select from among the viable alternative solutions to meet that need. If properly employed, the DCP (when the MENS is not required) could also serve as the means for affirming the dedication of the acquisition executive to the sense of purpose which leads to efficient and orderly systems acquisition at a cost which is compatible with defense budget limitations and on a time scale which permits the highest possible return on investment for the deployed system.

* As defined in Dr. Perry's memorandum of 18 January 1978, Subject: "Mission Element Need Statement."

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

R PROPOSED REVISIONS TO
CIRCULAR NO. A-109

April 5, 1976

TO THE HEADS OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS

SUBJECT: Major System Acquisitions

1. Purpose. This Circular establishes policies, to be followed by executive branch agencies in the acquisition of major systems.

2. Background. The acquisition of major systems by the Federal Government constitutes one of the most crucial and expensive activities performed to meet national needs. Its impact is critical on technology, on the Nation's economic and fiscal policies, and on the accomplishment of Government agency missions in such fields as defense, space, energy and transportation. For a number of years, there has been deep concern over the effectiveness of the management of major system acquisitions. This Circular establishes approaches, decision milestones, and program phases which are considered appropriate for development and acquisition of major systems. However, it is recognized that flexibility is necessary in the acquisition process to accommodate varying national emergency and unique program situations. In such cases, the basis for deviations from the practices described herein will be reflected in the program acquisition strategy and made visible throughout the planning and decision process. R

3. Responsibility. Each agency head has the responsibility to ensure that the intent of the provisions of this Circular are followed. This Circular provides administrative guidance to heads of agencies and does not establish and shall not be construed to create any substantive or procedural basis for any person to challenge any agency action or inaction on the basis that such action was not in accordance with this Circular. R

4. Coverage. This Circular covers and applies to:

a. Management of the acquisition of major systems, including: ° Analysis of agency missions ° Determination of mission needs ° Setting of program objectives ° Determination of system requirements ° System program planning ° Budgeting ° Funding ° Research ° Engineering ° Development ° Testing and evaluation ° Contracting ° Production ° Program and management control ° Introduction of the system into use or otherwise successful achievement of program objectives.

b. All programs for the acquisition of major systems even though:

(1) The system is one-of-a-kind.

(2) The agency's involvement in the system is limited to the development of demonstration hardware for optional use by the private sector rather than for the agency's own use.

5. Definitions. As used in this Circular:

a. Executive agency (hereinafter referred to as agency) means an executive department, and an independent establishment within the meaning of sections 101 and 104(1), respectively, of Title 5, United States Code.

b. Agency component means a major organizational subdivision of an agency. For example: The Army, Navy, Air Force, and Defense Supply Agency are agency components of the Department of Defense. The Federal Aviation Administration, Urban Mass Transportation Administration, and the Federal Highway Administration are agency components of the Department of Transportation.

c. Agency missions means those responsibilities for meeting national needs assigned to a specific agency.

d. Mission need means a required capability within an agency's overall purpose, including cost and schedule considerations.

e. Program objectives means the capability, cost and schedule goals being sought by the system acquisition program in response to a mission need.

f. Program means an organized set of activities directed toward a common purpose, objective, or goal undertaken or proposed by an agency in order to carry out responsibilities assigned to it.

g. System design concept means an idea expressed in terms of general performance, capabilities, and characteristics of hardware and software oriented either to operate or to be operated as an integrated whole in meeting a mission need.

h. Major system means that combination of elements that will function together to produce the capabilities required to fulfill a mission need. The elements may include, for example, hardware, equipment, software, construction, or other improvements or real property. Major system acquisition programs are those programs that (1) are directed at and critical to fulfilling an agency mission, (2) entail the allocation of relatively large resources, and (3) warrant special management attention. Additional criteria and relative dollar thresholds for the determination of agency programs to be considered major systems under the purview of this Circular, may be established at the discretion of the agency head.

i. System acquisition process means the sequence of acquisition activities starting from the agency's reconciliation of its mission needs, with its capabilities, priorities and resources, and extending through the introduction of a system into operational use or the otherwise successful achievement of program objectives.

j. Life cycle cost means the sum total of the direct, indirect, recurring, nonrecurring, and other related costs incurred, or estimated to be incurred, in the design, development, production, operation, maintenance and support of a major system over its anticipated useful life span.

6. General policy. The policies of this Circular are designed to assure the effectiveness and efficiency of the process of acquiring major systems. They are based on the general policy that Federal agencies, when acquiring major systems, will:

a. Express needs and program objectives in mission terms and not equipment terms to encourage innovation and competition in creating, exploring, and developing alternative system design concepts.

b. Place emphasis in the initial activities of the system acquisition process on examination of improvements to existing systems to satisfy mission needs, and allow competitive exploration and comparison of alternative new system design concepts.

c. Communicate with Congress early in the system acquisition process by relating major system acquisition programs to agency mission needs. This communication should follow the requirements of Office of Management and Budget (OMB) Circular No. A-10 concerning information related to budget estimates and related materials.

d. Establish clear lines of authority, responsibility, and accountability for management of major system acquisition programs. Utilize appropriate managerial levels in decisionmaking, and obtain agency head approval at key decision points in the evolution of each acquisition program.

e. Designate a focal point responsible for integrating and unifying the system acquisition management process and monitoring policy implementation.

f. Rely on private industry in accordance with the policy established by OMB Circular No. A-76.

7. Major system acquisition management objectives. Each agency acquiring major systems should:

a. Ensure that each major system: Fulfills a mission need. Operates effectively in its intended environment. Demonstrates a level of performance and reliability that justifies the allocation of the Nation's limited resources for its acquisition and ownership.

b. Depend on, whenever economically beneficial, competition between similar or differing system design concepts throughout the entire acquisition process.

c. Ensure adequate risk assessment and appropriate trade-off among investment costs, ownership costs, schedules, and performance characteristics. R

d. Provide strong checks and balances by ensuring sul system and system test and evaluation, as appropriate for the risks in the program. Plan and conduct only such tests as are necessary to verify system feasibility and performance. Such tests will be conducted jointly but may be evaluated independently by the developer and the user. R

e. Accomplish system acquisition planning, built on analysis of agency missions, which implies appropriate resource allocation resulting from clear articulation of agency mission needs.

f. Tailor a flexible acquisition strategy for each specific program, as soon as the agency decides to solicit alternative system design concepts, that could lead to the acquisition of a new major system and refine the strategy as the program proceeds through the acquisition process. Encompass test and evaluation criteria and business management considerations in the strategy. The strategy could typically include: ° Use of the contracting process as an important tool in the acquisition program ° Scheduling of essential elements of the acquisition process recognizing that the evenutal cost and utility of the system acquired will be influenced by either too aggressive or too slow a schedule ° Demonstration, test, and evaluation criteria ° Content of solicitations for proposals ° Decisions on whom to solicit ° Methods for obtaining and sustaining competition ° Guidelines for the evaluation and acceptance or rejection of proposals ° Goals for design-to-cost ° Methods for projecting life cycle costs ° Use of data rights ° Use of warranties ° Methods for analyzing and evaluating contractor and Government risks ° Need for developing contractor incentives ° Selection of the type of contract best suited for each stage in the acquisition process ° Administration of contracts. (R)

g. Maintain a capability to: ° Predict, review, assess, negotiate and monitor costs for system development, engineering, design, demonstration, test, production, operation and support (i.e., life cycle costs). Make provision for risk margins in all cost, schedule, and performance estimates to allow for resolution of unforeseen risks. ° Assess acquisition cost, schedule and performance experience against predictions, and provide such assessments for consideration by the agency head at key decision points ° Make new assessments where cost, schedule, or performance variances occur beyond the pre-planned tolerances. ° Estimate life cycle costs during system design concept evaluation and selection, full-scale development, facility conversion, and production, to ensure appropriate trade-offs among investment costs, ownership costs, schedules, and performance ° Use independent cost estimates, where feasible, for comparison purposes, and weigh them more heavily than contractor or agency estimates where the condition of competition or advocacy make that appropriate. (R)

8. Management structure.

a. The head of each agency that acquires major systems will designate an acquisition executive to integrate and unify the management process for the agency's major system acquisitions and to monitor implementation of the policies and practices set forth in this Circular.

b. Each agency that acquires--or is responsible for activities leading to the acquisition of--major systems will establish clear lines of authority, responsibility, and accountability for management of its major system acquisition programs.

c. Each agency should preclude management layering and placing nonessential reporting procedures and paperwork requirements on program managers and contractors.

d. A program manager will be designated for each of the agency's major system acquisition programs. This designation should be made when a decision is made to fulfill a mission need by pursuing either alternative system design concepts or a major change to an existing system. It is essential that the program manager have an understanding of user needs and constraints, familiarity with development principles, and requisite management skills and experience. Ideally, management skills and experience would include: ° Research and development ° Operations ° Engineering ° Construction ° Testing ° Contracting ° Prototyping and fabrication of complex systems ° Production ° Business ° Budgeting ° Finance. With satisfactory performance, the tenure of the program manager should be long enough to provide continuity and personal accountability. (R)

e. Upon designation, the program manager should be given budget guidance and a written charter of his authority, responsibility, and accountability for accomplishing approved program objectives.

f. Agency technical management and Government laboratories should be considered for participation in agency mission analysis, evaluation of alternative system design concepts, and support of all development, test, and evaluation efforts.

g. Agencies are encouraged to work with each other to foster technology transfer, prevent unwarranted duplication of technological efforts, reduce system costs, promote standardization, and help create and maintain a competitive environment for an acquisition.

9. Key decisions. Technical and program decisions normally will be made at the level of the agency component or operating activity. Normally, each system acquisition program will require the following first four key decisions, authority for which should be retained by the agency head. The fifth decision is retained by the agency head in case of unforeseen events and program perturbations: (R)

a. Identification and definition of a specific mission need to be fulfilled, the relative priority assigned within the agency, the range of competitive system concepts to be explored, the general constraints within which a solution is sought, and the general magnitude of resources that may be invested. R

b. Selection of a chosen design concept to be developed, or competitive system design concepts to be demonstrated and tested. R

c. Commitment of a system program to (1) full-scale development only, or (2) to full-scale development, production, and deployment. R

d. Commitment of a system program to production/deployment. R

e. Immediately delay or stop any program determined to be in trouble due to unforeseen events or where pre-determined tolerances for cost, schedule, or performance estimates have been exceeded. R

10. Determination of mission needs.

a. Determination of mission need should be based on an analysis of an agency's mission reconciled with overall capabilities, priorities and resources. When analysis of an agency's mission shows that a need for a new major system exists, such a need should not be defined in equipment terms, but should be defined in terms of the mission, purpose, capability, agency components involved, schedule and cost objectives, and operating constraints. A mission need may result from a deficiency in existing agency capabilities or the decision to establish new capabilities in response to a technologically feasible opportunity. Mission needs are independent of any particular system or technological solution.

b. Where an agency has more than one component involved, the agency will assign the roles and responsibilities of each component at the time of the first key decision. The agency may permit two or more agency components to sponsor competitive system design concepts in order to foster innovation and competition.

c. Agencies should, as required to satisfy mission responsibilities, contribute to the technology base, effectively utilizing both the private sector and Government laboratories and in-house technical centers, by conducting, supporting, or sponsoring: ° Research ° System design concept studies ° Proof of concept work ° Exploratory subsystem development ° Tests and evaluations. Applied technology efforts oriented to system developments should be performed in response to approved mission needs.

11. Alternative systems.

a. Alternative system design concepts will be explored within the context of the agency's mission need and program objectives--with emphasis on generating innovation and conceptual competition from industry. Benefits to be derived should be optimized by competitive exploration of alternative system design concepts, and trade-offs of capability, schedule, and cost. Care should be exercised during the initial steps of the acquisition process to include the exploration and comparison of the full potential of improvements to existing systems as well as new system design concepts to satisfy mission needs. However, mission needs or program objectives should not conform to known systems or products that might foreclose consideration of alternatives.

b. Alternative system design concepts will be solicited from a broad base of qualified firms. In order to achieve the most preferred system solution, emphasis will be placed on innovation and competition. To this end, participation of smaller and newer businesses should be encouraged. Concepts will be primarily solicited from private industry; and when beneficial to the Government, foreign technology, and equipment may be considered.

c. Federal laboratories, federally funded research and development centers, educational institutions, and other not-for-profit organizations may also be considered as sources for competitive system design concepts. Ideas, concepts, or technology, developed by Government laboratories or at Government expense, may be made available to private industry through the procurement process or through other established procedures. Industry proposals may be made on the basis of these ideas, concepts, and technology or on the basis of feasible alternatives which the proposer considers superior.

d. Research and development efforts should emphasize early competitive exploration of alternatives, as relatively inexpensive insurance against premature or preordained choice of a system that may prove to be either more costly or less effective.

e. Requests for alternative system design concept proposals will explain the mission need, schedule, cost, capability objectives, and operating constraints. Each offeror will be free to propose his own technical approach, main design features, subsystems, and alternatives to schedule, cost, and capability goals. In the conceptual and less than full-scale development stages, contractors should not be restricted by detailed Government specifications and standards.

f. Selections from competing system design concept proposals will be based on a review by a team of experts, preferably from inside and outside the responsible component development organization. Such a review will consider: (1) Proposed system functional and performance capabilities to meet mission needs and program objectives, including resources required and benefits to be derived by trade-offs, where feasible, among technical performance, acquisition costs, ownership costs, time to develop and procure; and (2) The relevant accomplishment record of competitors.

g. During the uncertain period of identifying and exploring alternative system design concepts, contracts covering relatively short time periods at planned dollar levels will be used. Timely technical reviews of alternative system design concepts will be made to effect the orderly elimination of those least attractive.

h. Contractors should be provided with operational test conditions, mission performance criteria, and life cycle cost factors that will be used by the agency in the evaluation and selection of the system(s) for full-scale development and production. Contractors should be given the flexibility to offer testing, system performance, and cost options (backed by adequate substantiating trade study results) for full-scale development which offer the potential of reduced overall program cost and/or accelerated system deployment. (R)

i. The participating contractors should be provided with relevant operational and support experience through the program manager, as necessary, in developing performance and other requirements for each alternative system design concept as tests and trade-offs are made.

j. Development of subsystems that are intended to be included in a major system acquisition program will be restricted to less than fully designed hardware (full-scale development) until the subsystem is identified as a part of a system candidate for full-scale development. Exceptions may be authorized by the agency head if the subsystems are long lead time items that fulfill a recognized generic need or if they have a high potential for common use among several existing or future systems.

12. Demonstrations.

a. Advancement to a competitive test/demonstration phase may be approved only when the agency's mission need and program objectives are reaffirmed and it can be shown that a competitive test/demonstration phase is required before concept selection can be made. (R)

b. Where the need for a competitive test/demonstration phase has been substantiated, the agency head will authorize the phase to proceed. Major system acquisition programs will be structured and resources planned to demonstrate and evaluate competing alternative system design concepts that have been selected. (R)

c. Development of a single system design concept that has not been competitively selected should be considered only if justified by factors such as urgency of need, or by the physical and financial impracticality of demonstrating alternatives. Proceeding with the development of a noncompetitive (single concept) system may be authorized by the agency head. Strong agency program management and technical direction should be used for systems that have been neither competitively selected nor demonstrated.

13. Full-scale development and production.

a. Full-scale development, production, and deployment may be approved when the agency's mission need and program objectives are reaffirmed and results verify that the chosen system design concept is sound. (R)

b. Production and deployment may proceed following full-scale engineering development in those cases where development test and analysis results verify a system design which will satisfy the need in an operational environment. In those cases, a production schedule will be established with the initial production rate lower than the expected peak rate, and formal operational test and evaluation may take place concurrently with initial production. (R)

c. Selection of a system(s) and contractor(s) for full-scale development and production is to be made on the basis of (1) system performance measured against current mission need and program objectives, (2) an evaluation of estimated acquisition and ownership costs, and (3) such factors as contractor(s) demonstrated management, financial, and technical capabilities to meet program objectives.

d. The program manager will monitor system tests and contractor progress in fulfilling system performance, cost, and schedule commitments. Significant actual or forecast variances will be brought to the attention of the appropriate management authority for corrective action.

14. Budgeting and financing. Beginning with FY 1979 all agencies will, as part of the budget process, present budgets in terms of agency missions in consonance with Section 201(i) of the Budget and Accounting Act, 1921, as added by Section 601 of the Congressional Budget Act of 1974, and in accordance with OMB Circular A-11. In so doing, the agencies are desired to separately identify research and development funding for: (1) The general technology base in support of the agency's overall missions, (2) The specific development efforts in support of alternative system design concepts to accomplish each mission need, and (3) Full-scale developments. Each agency should ensure that research and development is not undesirably duplicated across its missions.

15. Information to Congress.

a. Procedures for this purpose will be developed in conjunction with the Office of Management and Budget and the various committees of Congress having oversight responsibility for agency activities. Beginning with FY 1979 budget each agency will inform Congress in the normal budget process about agency missions, capabilities, deficiencies, and needs and objectives related to acquisition programs, in consonance with Section 601(i) of the Congressional Budget Act of 1974.

b. Disclosure of the basis for an agency decision to proceed with a single system design concept without competitive selection and demonstration will be made to the congressional authorization and appropriation committees.

16. Implementation. All agencies will work closely with the Office of Management and Budget in resolving all implementation problems.

17. Submissions to Office of Management and Budget. Agencies will submit the following to OMB:

a. Policy directives, regulations, and guidelines as they are issued.

b. Within six months after the date of this Circular, a time-phased action plan for meeting the requirements of this Circular.

c. Periodically, the agency approved exceptions permitted under the provisions of this Circular.

This information will be used by the OMB, in identifying major system acquisition trends and in monitoring implementations of this policy.

18. Inquiries. All questions or inquiries should be submitted to the OMB, Administrator for Federal Procurement Policy. Telephone number, area code, 202-395-4677.

HUGH E. WITT
ADMINISTRATOR FOR
FEDERAL PROCUREMENT POLICY

Approved:

JAMES T. LYNN
DIRECTOR

(DRAFT REVISION)

DEPARTMENT OF DEFENSE DIRECTIVE

SUBJECT: MANAGEMENT OF MAJOR SYSTEMS ACQUISITION

Refs: (a) DoD Directive 5000.1, "Major Systems Acquisition," January 18, 1977 (hereby cancelled)

(b) OMB Circular A-109, "Major Systems Acquisitions," April 5, 1976

(c), etc.

I. REISSUANCE AND PURPOSE

This Directive reissues reference (a) to implement reference (b) and revises DoD policy for the management of major system acquisitions. Reference (a) is hereby cancelled.

II. APPLICABILITY AND SCOPE

A. The provisions of this Directive apply to the Office of the Secretary of Defense and the Organization of the Joint Chiefs of Staff and to the Military Departments and the Defense Agencies (hereinafter referred to as "DoD Components"). As used herein, the term "Services" refers to the Army, the Navy and the Air Force.

B. The principles of this Directive apply to programs designated by the Secretary of Defense as major system acquisition programs. The designation shall be determined on the recommendations of the DoD Component Head and OSD Officials. System programs involving an anticipated cost of $75 million in research, development, test and evaluation (RDT&E) funds or $300 million in procurement funds shall be considered for designation as major system acquisitions.

III. DEFINITIONS

A definition of terms as used in this Directive is shown in Enclosure 1.

IV. POLICY

A. The system acquisition policies stated are directed to the achievement of the timely acquisition and deployment of Defense systems.

B. Management of the acquisition process shall maintain flexibility of approach. The strategy and execution for each program will be tailored to the particular circumstances of technical and economic risk, degree of concurrency, economic production buys and form of contracting appropriate for that program.

C. Responsibility for the management of system acquisition programs shall be decentralized to the DoD Components except for the decisions retained by the Secretary of Defense.

D. DoD Components are responsible for a continuing analysis of mission areas to identify mission deficiencies and needs and to define, develop, produce and deploy systems to satisfy those needs. Mission needs shall be stated in terms of the operational task to be accomplished and not in terms of performance or characteristics of systems to accomplish the mission.

E. The Secretary of Defense shall make the decisions to initiate, increase, decrease, redirect or terminate program commitments. DoD Component Heads are accountable to the Secretary of Defense to execute approved system acquisition programs in accordance with the Secretary's decisions and to keep the Secretary informed on the current status. The four key milestones identified with program activity are as follows:

1. Milestone 0 - Mission Need Approval

a. When a mission need is determined to be essential and has been reconciled with other DoD capabilities, resources and priorities, the Secretary of Defense or his delegate will approve the mission need and direct one or more of the DoD Components to a systematic and progressive exploration of alternative system concepts to satisfy the approved need.

2. Milestone I - Validation

   a. Approval of one or more selected alternatives for validation.

   b. The Secretary of Defense will reaffirm the mission need and approve one or more selected alternatives for competitive validation.

3. Milestone II - Full-Scale Engineering Development

   a. Approval of system selected for full-scale development.

   b. The Secretary of Defense will reaffirm the mission need, and approve the selection of a system for full-scale engineering development.

   c. Approval shall be given only to those systems that are intended to be produced and deployed.

4. Milestone III - Production and Deployment

   a. Affirmation of previous Milestone II decision, and approval of rate production.

F. The Defense Acquisition Executive, reference ( ), is the focal point in OSD for system acquisition matters.

G. Mission needs shall be satisfied through the use of existing or commercial hardware and software wherever feasible. Upgrading of existing systems shall be given first consideration to meet new mission needs. When a new development or modification is essential, the mission needs of other DoD Components and NATO shall be considered including the requirement for NATO standardization and interoperability.

H. The DoD technology base shall be maintained by the DoD Components and performed by industry, universities and government in-house organizations with the major emphasis on industry and universities.

I. The decision for full-scale development is made with the intent to produce and deploy.

J. Contracting methods that retain program flexibility will be used.

K. For low risk systems, decision milestones shall be combined to save time and money.

L. Full-scale development shall be initiated only if, after development, programmed production and deployment can be afforded within the total forecast defense budget.

M. Concurrency of development and early production will be permitted. The degree of concurrency will depend on extent of technical risks, and national urgency of the program.

N. The systems acquisition process and the OSD budgeting and programming system shall be carried out in a manner to support the DSARC decisions.

O. Competitive prototypes for systems will be exceptions to normal practice. When approved, full-scale prototypes must be producible.

P. A flexible testing policy will be utilized. Development and operational testing shall be combined where possible. Independent evaluation of jointly obtained test results will be normal practice.

V. EFFECTIVE DATE AND IMPLEMENTATION

A. This Directive is effective immediately. Two copies of implementing regulations shall be forwarded to the Defense Acquisition Executive within 120 days.

B. DoD Directives 5000.2 and 5000.3 have been prepared in support of this Directive.

DEFINITIONS

A. Decision Coordinating Paper (DCP) The principal document to address essential system issues for use in support of the Secretary of Defense decision-making process at Milestone 0.

B. Etc. per DoDD 5000.1 as of 1/18/77.

APPENDIX C

C-1

DEFENSE SCIENCE BOARD SUMMER STUDY, 1977

REPORT OF THE

SHIP ACQUISITION TEAM

OF THE

ACQUISITION CYCLE TASK FORCE

August 26, 1977

C-2

GLOBAL MARINE DEVELOPMENT INC.

KOLL CENTER NEWPORT
4100 MACARTHUR BOULEVARD
NEWPORT BEACH, CALIFORNIA 92660

TELEPHONE: 714-752-5030
TELEX: 69-2316
CABLE: GLOMARCO
REPLY TO:
P.O. BOX 3010
NEWPORT BEACH, CA 92663

30 August 1977

Dr. Richard DeLauer
Executive Vice President
TRW Systems, Inc. (E2-11000)
One Space Park
Redondo Beach, California 97208

Dear Dr. DeLauer:

In your capacity as Chairman of the Weapon Systems Acquisition Schedule Task Force of the 1977 Defense Science Board Summer Study, you requested a separate report from the Ship Acquisition Team. Enclosed for your information are three copies of this report.

Copies are also being furnished to the members and staff assistants of the Ship Acquisition Team.

We were most fortunate to have the services of such talented and experienced individuals for this important undertaking, and I am taking this opportunity to express formally to them my appreciation for their contributions.

Finally, we were truly honored to work under your splendid chairmanship.

With warm regards, I am;

Sincerely yours,

N. Sonenshein

N. Sonenshein
Rear Admiral, USN (Ret.)
Chairman, Ship Acquisition Team

NS:ch
Enclosures
cc: Mr. John V. Banks
Mr. Archibald J. Dunn
John R. Farrell, Capt., USN
Richard E. Henning, Rear Adm., USN (Ret.)
George G. Halvorson, Rear Adm., USN (Ret.)
Stuart C. Jones, Capt. USN (Ret.)
Mr. Robert Link

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SECTION 1 - ABSTRACT

Ship acquisition for the U.S. Navy is a major DOD program entailing an annual appropriation in FY77 of some $6B and projected to about $8B for FY82 (in constant dollars) for procuring an average of 31 ships annually. This represents about 20% of the total procurement budget. The ships to be acquired cover a wide variety of types ranging from small tugs through nuclear powered aircraft carriers. The combatants are generally multipurpose platforms fitted with a wide variety of sub-systems for navigation, propulsion, command, control, communications and weapon delivery for offense and defense.

Acquisition cycles for multi-ship programs of combatants typically extend over 10 years with delivery of lead ships on the order of 75-80 months. Such lengthy cycles face the prospects of long lead times for Fleet introduction of new capabilities, technological obsolescence of ships and their sub-systems at the tail end of programs, and increased costs in an economic environment that is characterized by an underlying inflation.

Analysis of representative acquisition cycles for programs initiated in the 1970's that are still underway, and of programs initiated in the 1960's show that:

a. Acquisition cycles are longer than planned by 25-40%.

b. Pre-contract award periods, starting at concept definition, are 50-100% longer compared to earlier programs.

c. A distinct trend is developing toward longer post award or building periods, which average 18 months longer than planned over a wide variety of ship programs.

Acquisition cycles can be stabilized, or at least inhibited from growing longer by:

- Improving program stability through sustained management commitment, stronger MARAD/Navy coordination in industry loading, authorization by Congress of a 5-year Shipbuilding and Conversion Program (SCN)* based on firm force structure decisions, and provision for continuity in RDT&E (6.3 and 6.4) funding for conceptual and contract design, and
- Exercising flexibility in tailoring acquisition strategy based on ship type, status of sub-system development and industry posture. This can be approached through early coordination of sub-system R&D with platform design constraints, controlled concurrency, selection of appropriate procurement approaches for each case, adaptation of MARAD

*It is of interest to note that, subsequent to preparation of this report, VADM James H. Doyle, Jr , USN, Chief of Naval Operations (Surface Warfare) made a strong case for a firm five-year shipbuilding program during testimony before the National Security Task Force of the House Budget Committee on 4 Oct. 1977.

and USCG field contract administration practices for non-combatant ships, and adjusting the number and type of DSARC reviews to suit the needs of particular cases.

Most of the foregoing recommendations can be implemented within the framework of existing DOD acquisition policies; in fact, precedents exist in most cases. The recommendation for adoption by Congress of five-year authorizations for shipbuilding programs contemplates a major departure.

There is serious concern over the implications of OMB Circular A-109 as applied to shipbuilding programs whose basic aim is to replace aged and obsolescent ships with new ones needed to sustain and improve upon the Navy's capability to fulfill long-standing mission requirements. There should be no need to debate the need for these new ships, or their basic characteristics as weapons platforms. The Mission Element Need decision (Point "0") of A-109 should, if anything, relate only to weapons these ships will carry and the need for new types of weapons to meet projected mission requirements. On the other hand, advanced ship concepts that would embark on new tactical or strategic concepts would merit such treatment.

SECTION 2 - THE ACQUISITION PROCESS AS APPLIED TO SHIPS

While the basic tenets of the DOD acquisition process pertain as well to naval ship procurement as they do to aircraft, missiles or other military systems, application of the process should recognize a number of distinctions that are to varying degrees peculiar to ships.

Ships require many years to design and build after a decision is made to proceed with a particular design, after which they are produced in relatively small numbers. The process of defining the ship to be built requires 2-4 years and is heavily influenced by the design requirements of the combat systems to be included. Once built, naval ships typically enjoy a useful operational life of 30 years or more, during which they may be upgraded from time to time with improved combat systems or other new capabilities reflecting technological advances occurring throughout their lives. Ship design must provide the capability for such growth.

The platform characteristics of most new ships (i.e., hull form, propulsion, speed, range, seaworthiness, habitability, etc.) are generally based on state-of-the-art technology, representing a gradual evolution from one class of ships to the next. On the other hand, combat system technology evolves more rapidly and new ship programs seek to introduce the most advanced technology that is possible, with due consideration to its degree of maturity and projected operational use. Thus, the early decisions to be made in the ship acquisition process focus strongly upon the combat suite, which in turn influences the size of the ship, its design and constuuction details, and its acquisition cost.

A fundamental issue that must usually be resolved in planning a new ship program concerns the mission of the ship and where it will fit in the overall force structure. The Navy's basic missions (sea control, force projection and naval presence) remain relatively unchanged with time and, as ships grow older, new ships are required to take their place. A continuing reexamination of the force structure is required, however, in order to optimize the Navy's capabilities within existing budgetary constraints. Decisions must be reached relative to the countervailing requirements for expensive ships of maximum capability vis-a-vis quantitative requirements for less expensive and less capable ships needed to meet the nation's world-wide sea control commitments. Occasionally, new ship concepts are introduced in this process in the expectation of creating new capabilities heretofore unexploited. These new concepts might be based on state-of-the-art technology (e.g., sea control ship) or new technology (e.g., hydrofoils or surface effect ships). Such new initiatives are relatively rare, however, and are not the driving considerations affecting force structure. Nevertheless, for any operational ship, a force structure decision must be reached as a basis for initiating the acquisition process. This is not necessarily the case for other types of systems where extended research and development, and even prototyping, may be necessary before a force structure decision can be made. For ships, the military requirement and the force structure issues should be resolved ahead of and perhaps outside of the acquisition process which can then address itself to the strategy for meeting the requirement.

The above considerations question the necessity for the four-step decision process contemplated by OMB Circular A-109 and suggest that, except for advanced types of ships, only Decision Points II (full scale development, or lead ship) and III (production) are appropriate to the ship acquisition process.

SECTION 3 - TEAM COMPOSITION AND STUDY METHODOLOGY

The Ship Acquisition Team of the Acquisition Cycle Task Force consisted of the following members and staff assistants:

Members

John V. Banks	Former President, National Steel & Shipbuilding Corp., San Diego, California
Archibald J. Dunn	Vice President, Ingalls Shipbuilding Division, Litton Systems, Inc., Pascagoula, Mississippi
George G. Halvorson RADM, USN (Ret.)	Manager, Test and Evaluation, Rohr Marine, Inc., Chula Vista, California
Richard E. Henning RADM, USN (Ret.)	Director of Operations, Marine Division, Bird-Johnson, Inc., Walpole, Massachusetts
Stuart C. Jones	General Manager, Los Angeles Division, Todd Shipyards Corp., San Pedro, California
Nathan Sonenshein RADM, USN (Ret.)	Assistant to the President, Global Marine Development, Inc., Newport Beach, California

Staff Assistants

John R. Farrell CAPT, USN	Director of Planning and Performance Evaluation, Naval Material Command (MAT09H), Navy Department, Washington, D.C.
Robert H. Link	Office of Special Assistant for Shipbuilding (00X), Naval Sea Systems Command, Navy Department, Washington, D.C.

The study methodology adopted by the team consisted of briefings, a review of prior studies, and an analysis of selected ship acquisitions. Briefings were received by representatives from the following organizations:

a. Newport News Shipbuilding and Drydock Company
b. U.S. Coast Guard
c. Maritime Administration (MARAD)
d. Shipbuilders Council of America
e. Naval Sea Systems Command

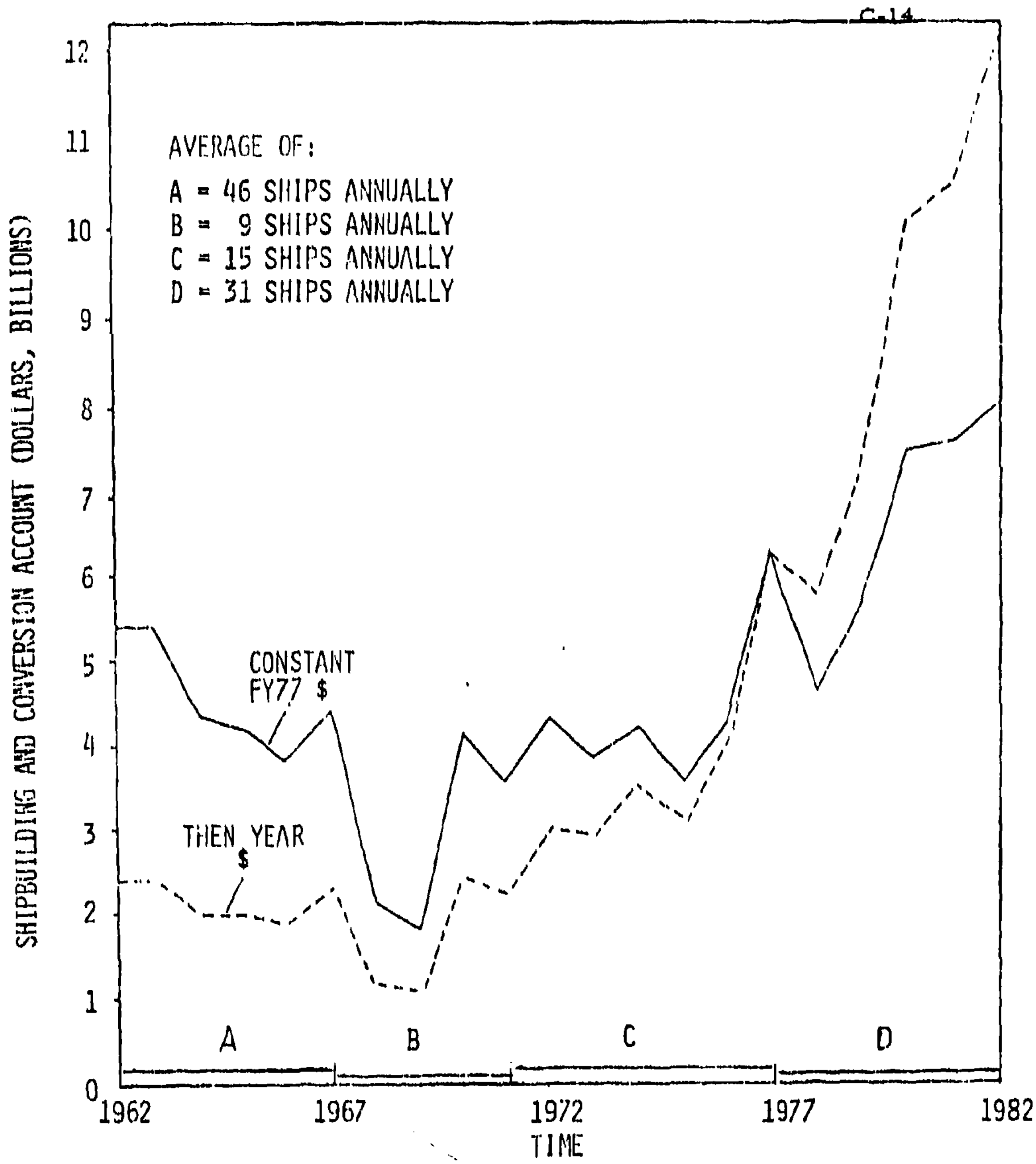
This was followed by a review of prior studies such as the SCN Pricing and Cost Control Study ('69), NSSM54 ('69), the Commission on American Shipbuilding ('73), NMARC (1974), Acquisition Advisory Group ('74), and International Maritime Associates ('77). DOD and OMB acquisition directives were also studied. This was followed by an analysis of five cases that involved Destroyers, Frigates, Submarines, Oilers, and the Patrol Hydrofoil.

SECTION 4 - NAVY SHIPBUILDING PROGRAMS AND INDUSTRY PROFILE

The Navy Shipbuilding Program is broadly outlined in Figure 1 for the period 1962 to 1982. Currently funded at about $6B and projected through 1982 at about $8B, in constant FY77 dollars, it provides for about 31 ships per year. Ship types that are included vary through the entire ship spectrum of size, propulsion systems, sensors, communications and armament, and include submarines as well as surface ships.

The scope and diversity of the program impacts all sectors of the U.S. private shipbuilding industry. This industrial complex may be considered as having three groups: the builders of small ships such as mine sweepers and patrol ships, the medium sized building yards for non-combatants such as replenishment ships and frigates or destroyers that are conventionally powered, and a small number of large shipyards that have integrated design and construction capabilities and are qualified to build nuclear powered ships.

U.S. private shipyards capable of major new construction, i.e., having facilities for producing ships having a length of at least 475 feet and a beam of 68 feet, currently number 27 and have an employment level of about 125,500. This excludes eight publically-owned navy yards, which employ about 67,000 people, and which are



SHIPBUILDING AND CONVERSION APPROXIMATION FUNDING LEVELS, 1962-1982

FIGURE 1

dedicated to repair and modernization of Fleet units. Considering all private shipyards, which number 188 and employ about 165,000 together with the eight navy yards, the total shipbuilding and repair industry of the United States numbers about 230,000. Only the USSR has a comparably sized industrial base for these purposes. Figures 2 through 7 characterize the 27 U.S. major shipyards as to capability, dollar value of work done for principal accounts, numbers of ships delivered, manning and profitability. It will be observed that:

- The industry is labor intensive, producing a limited number of large complex products.
- Naval ship construction is now being accomplished by nine shipyards.
- The value of work done for naval ships is about 45% of the total, and ships constructed with MARAD Construction Differential Subsidies comprise some 25%. Thus, these two accounts are the principal customers of the U.S. shipbuilding industry.
- The Navy and MARAD programs are each cyclic in their historic patterns.
- Total workload for the major shipyards, projected to peak in 1978 at an employment level of 140,000, is expected to drop shortly thereafter to about 100,000 in 1983. This sharp decline is forecast despite the growing

SHIPYARD CAPABILITY

	EMPLOYMENT Jan. 1977	EMPLOYMENT OPTIMUM	NAVAL SHIPS - COMBATANT	NAVAL SHIPS - AUXILIARIES	TANKERS - LNG	TANKERS - VLCC/ULCC	TANKERS - OTHER	CARGO	OFFSHORE EXPLORATION	REPAIR
EAST COAST										
BATH IRON WORKS	3400	4000	⊗				×	⊗		⊗
GD/Quincy	4600	5000	×	×	⊗		×	×		×
GD/ELECTRIC BOAT	28,300	28,500	⊗							⊗
SEATRAIN SHIPBUILDING	1700	4000				⊗				×
SUN SHIPBUILDING	4300	6000			⊗	×	×	⊗		⊗
BETHLEHEM - SPARROWS PT.	2300	4000		⊗		⊗	×	⊗		×
MARYLAND SHIPBUILDING	1000	2000					×	×		⊗
NEWPORT NEWS SHIPBLDG.	24,100	25,000	⊗	×	⊗	⊗	×	×		⊗
TAMPA DRYDOCK	300	800					×	×		⊗
GULF COAST										
ALABAMA DRYDOCK	1200	3500					×	×	×	⊗
INGALLS SHIPBUILDING	25,100	18,000	⊗	×	×	×	×	×	×	⊗
AVONDALE SHIPYARD	7000	7200	×	⊗	⊗	×	⊗	×	×	⊗
LEVINGSTON SHIPBLDG.	2000	4000					⊗	×	⊗	⊗
BETHLEHEM - BEAUMONT	700	1800					×		⊗	⊗
GALVESTON SHIPBLDG.	300	400					⊗			×
MARATHON - LETOURNEAU	800	1200					×		⊗	⊗

SHIPBUILDERS COUNCIL OF AMERICA, JULY 1977

× - Capability

⊗ - Current Activity

FIGURE 2.

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SHIPYARD CAPABILITY

	EMPLOYMENT Jan. 1977	EMPLOYMENT OPTIMUM	NAVAL SHIPS - COMBATANT	NAVAL SHIPS - AUXILIARIES	TANKERS - LNG	TANKERS - VLCC/ULCC	TANKERS - OTHER	CARGO	OFFSHORE EXPLORATION	REPAIR
WEST COAST										
LOCKHEED SHIPBLDG.	2900	2500	×	⊗				×		⊗
TODD - SEATTLE	900	3000	⊗				×	×		⊗
FMC	1500	1300					⊗			
BETHLEHEM - SAN FRAN.	700	900								⊗
TRIPLE "A"	1000	2000					×	×		⊗
TODD - LOS ANGELES	1800	4500	⊗				×			⊗
NATIONAL STEEL	6300	7000		⊗			⊗	×		⊗
GREAT LAKES										
FRASER SHIPYARDS	300	500						×		⊗
BAY SHIPBUILDING	1300	1400						×		⊗
AMERICAN SHIPBLDG.	1600	1400						×		⊗

× - Capability

⊗ - Current Activity

SHIPBUILDERS COUNCIL OF AMERICA, JULY 1977

FIGURE 3.

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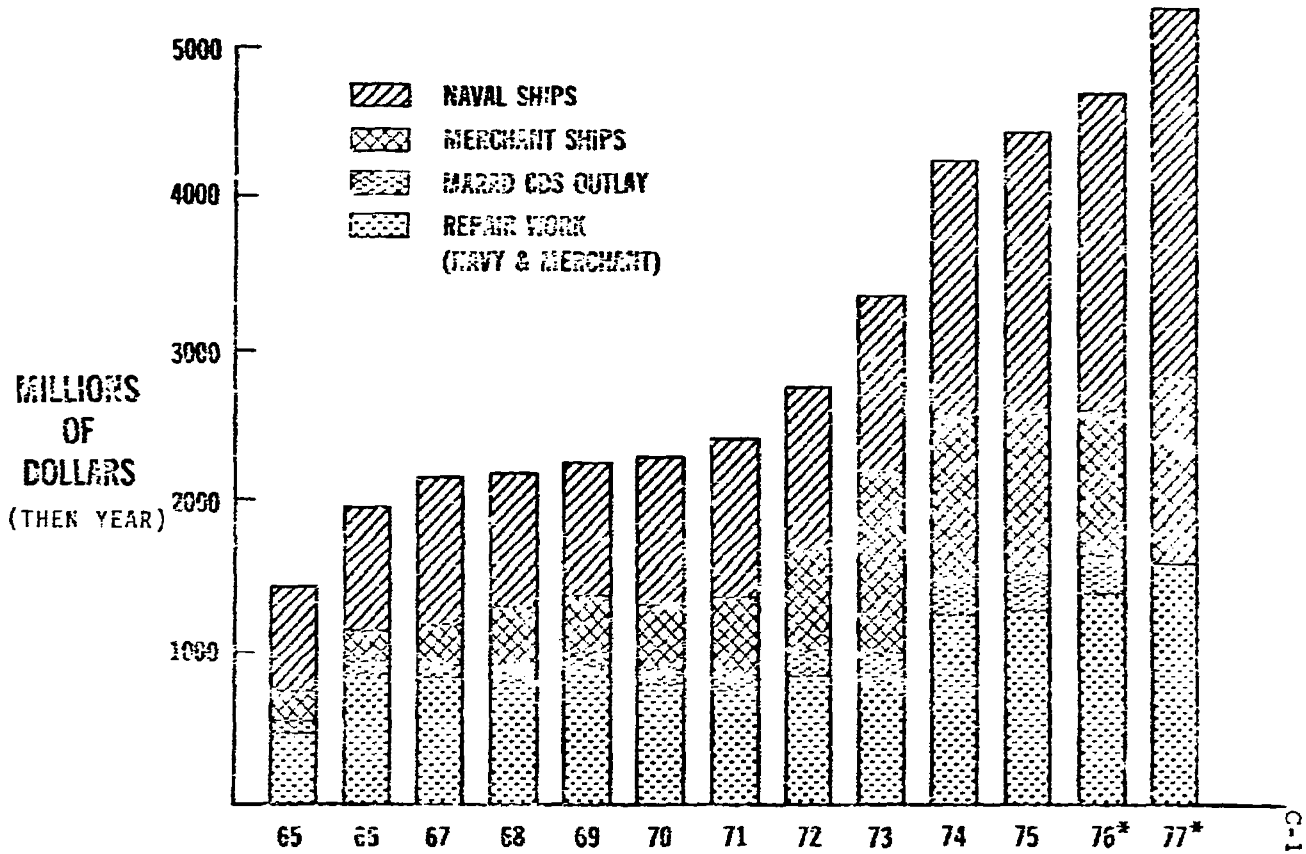
C-18

TOTAL SHIPBUILDING INDUSTRY

VALUE OF WORK DONE



SHIPBUILDERS COUNCIL OF AMERICA, JULY 1977

*Estimated

FIGURE 4.

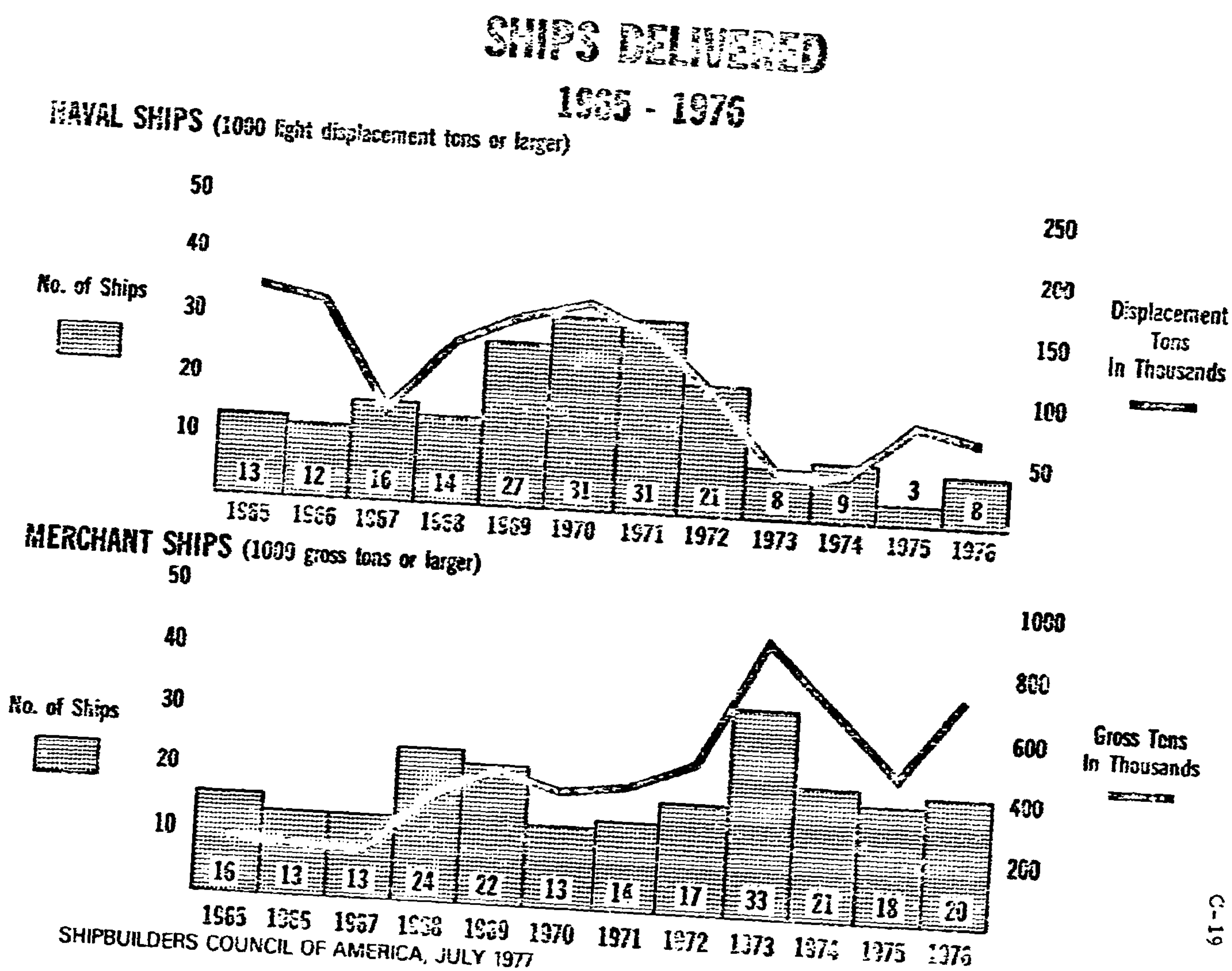
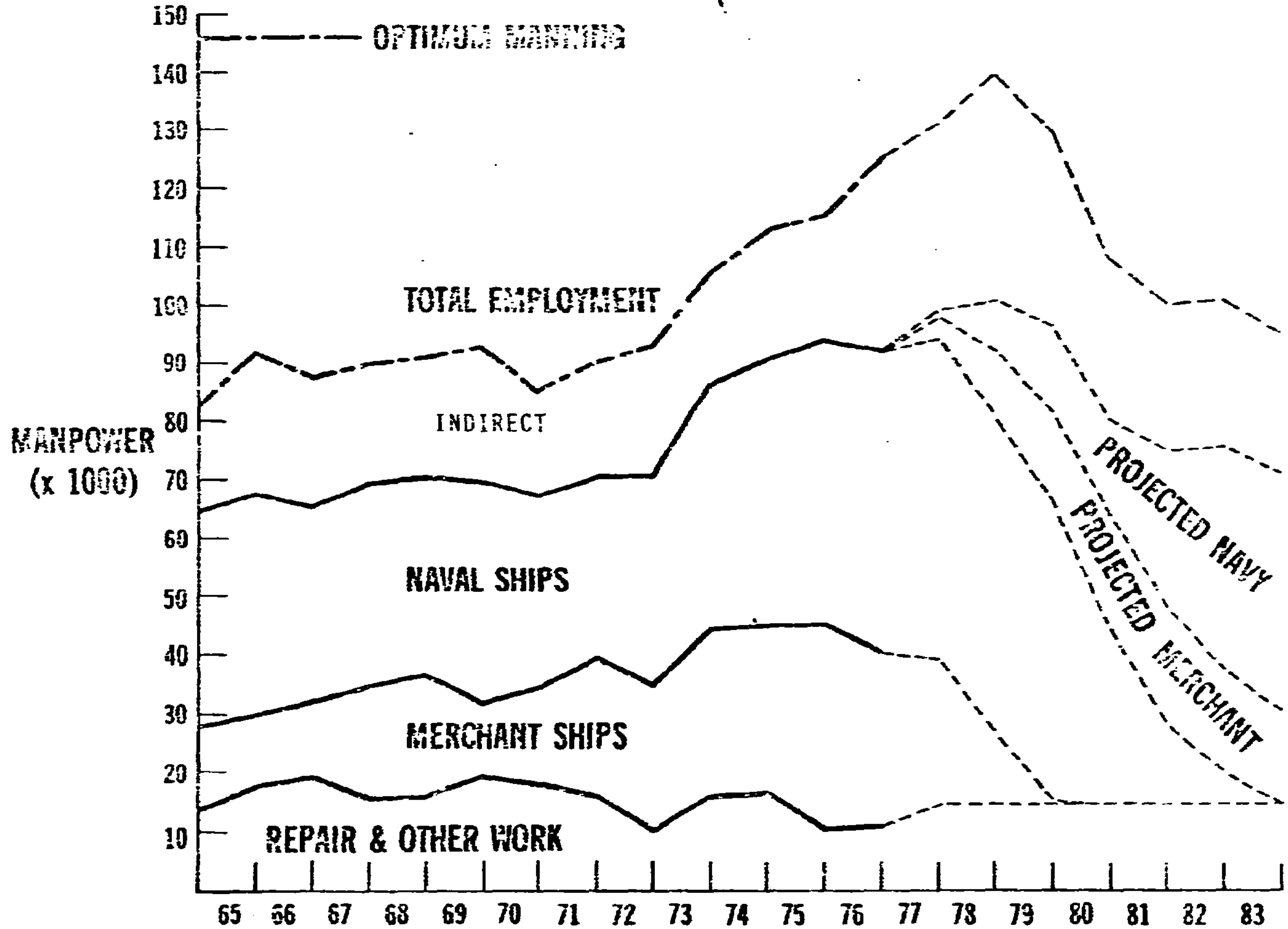

SHIPS DELIVERED
1965 - 1976
NAVAL SHIPS (1000 light displacement tons or larger)
No. of Ships
50
40
30
20
10
13
12
16
14
27
31
31
21
8
9
3
8
1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976
250
200
150
100
50
Displacement Tons In Thousands
MERCHANT SHIPS (1000 gross tons or larger)
No. of Ships
50
40
30
20
10
16
13
13
24
22
13
14
17
33
21
18
20
1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976
1000
800
600
400
200
Gross Tons In Thousands
SHIPBUILDERS COUNCIL OF AMERICA, JULY 1977

FIGURE 5.

C-19

SHIPYARD WORKLOAD (27 MAJOR YARDS)



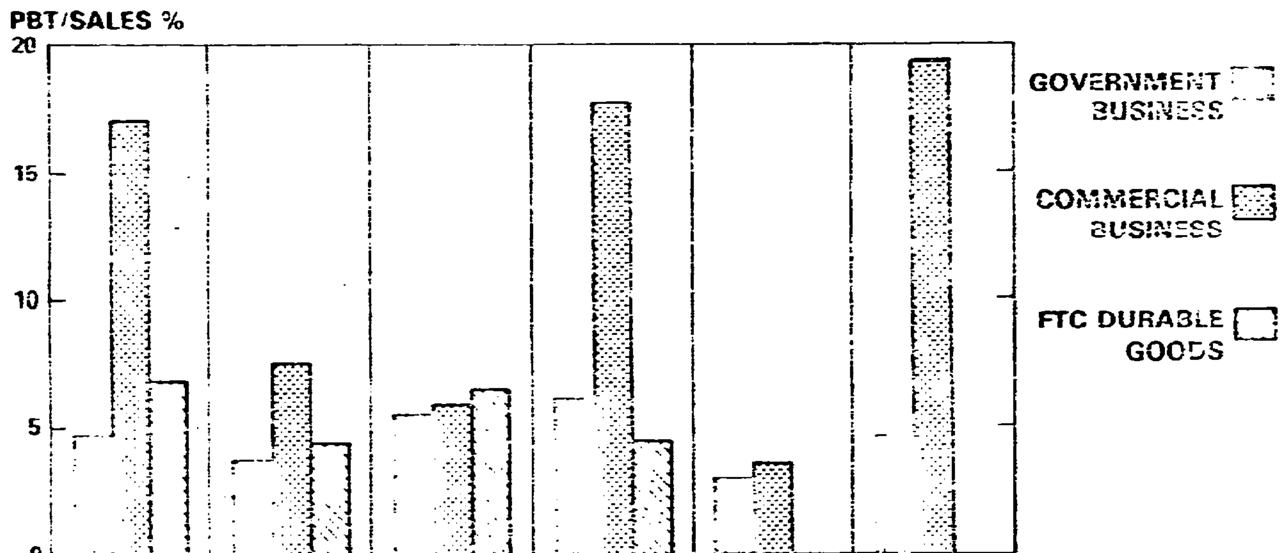
SHIPBUILDERS COUNCIL OF AMERICA, JULY 1977

FIGURE 6.

PROFITABILITY — RETURN ON SALES

PROFIT BEFORE TAXES/SALES

5 YEAR AVERAGE BY PRODUCT GROUP



TOTAL	AIRCRAFT	ELECTRONICS	MISSILES	SHIPS	OTHER
4.7	3.7	5.4	6.1	* 2.9 (.6)	4.5
17.1	7.5	5.8	17.7	3.5	19.3
5.7	4.2	6.3	4.2	—	—

Profit '76 Study

* 2.9 - INCLUDES FULL AMOUNT OF CLAIMS OUTSTANDING

(0.6) ASSUMES SETTLEMENT OF CLAIMS AT HISTORIC VALUE

FIGURE 7.

Navy program. Its root cause is a lack of orders for commercial vessels that started with the 1973 oil embargo and resultant glut of tankers on the world market, and reflects the effects of the subsequent recession.

- Profitability, as depicted in Figure 7, is lower than that achieved by the aircraft, electronics, missile and other defense industries.

It should be noted additionally that the shipbuilding industry experiences a surprisingly high level of labor turnover (sum of accessions plus separations divided by average employment) of about 15% per month vs. a general industrial average of about 7-1/2%. This is generally attributed to the lack of attractiveness of shipbuilding work as compared to cleaner and more comfortable environments found in other industries. Higher wages in the cyclic construction industry for the same crafts also tend to encourage a high degree of mobility among shipyard-construction industry workers.

In addition to instability of markets and high labor turnover, shipbuilding costs and schedules are being heavily impacted by rising wages, material costs and material lead times, thus:

	1967	1976
Wages-Average Weekly	$140	$234
Material Index (BLS)	100.0	193.6
Lead Times for Castings & Forgings	9 Weeks	33 Weeks

In recent years, the Navy and MARAD, as the major governmental agencies concerned with the health of ship technology and the shipbuilding industry, have been cooperating in several ventures to enhance the maritime portion of the U.S. industrial base. The need for stronger coordination in formulating Navy and MARAD shipbuilding programs in order to stabilize shipyard workload has been recognized for decades, but the results, as shown in Figure 5 have not been satisfactory. Good meshing -- where it has happened -- has occurred more by chance than through good planning; for example, the 1972 "fit" followed from passage of the Merchant Marine Act of 1970, which gave a strong impetus to commercial projects at a time when the Navy program bottomed.

Finally, it is clear from Figure 6 that the long term strength of the shipyard industrial base is in jeopardy starting in FY79, and that concerted efforts by MARAD and Navy are needed to provide for efficient production of the Navy's growing programs. The sharp drop foreseen after 1979 may well result in a reluctance to build up forces and facilities for the 1978-79 peak; inevitably slippages in ship deliveries and increased costs will impact programs whose success depends on full manning in the 1978-79 period.

SECTION 5 - CASE STUDIES

Five acquisition cases were investigated to determine trends in the length of the acquisition cycle in shipbuilding. SAR data were the primary source of information, but were supplemented by NAVSEA program narratives. Program background for each case studied is presented followed by a graphical presentation illustrating the times involved in the acquisition cycle. Contract award dates are used as the datum for such plots.

a. DDG2/DD963/DDG47

(1) DDG2 Class

The DDG2 was conceived in 1955 as a Tartar missile version of the FORREST SHERMAN (DD931) class. The mission was general purpose to provide for both offensive and defensive operations against enemy aircraft, ships, and submarines. It also included shore bombardment.

Characteristics are: length 429', displacement 4500 tons F.L., and speed 30+ knots. Propulsion was twin screw 1200 psi steam geared turbines, with 70,000 SHP. Weapons included one Tartar launcher, one Asroc launcher, two 5"-54 guns, and two triple MK32 ASW torpedo tubes. Major sensors were the SPS/29 air search radar, SPS 39/3D radar, and the SQS/23 sonar.

The acquisition included no preliminary design. There was a conventional Navy contract drawing and specification package, and an IFB and multi-yard award for each annual increment. The lead ship was part of the first annual increment. There was concurrent development of the weapon systems, principally with respect to Tartar and the SPS-39 radar.

Slippages occured. The award slipped three months due to weight and space growth in developmental items plus special arrangement requirements which necessitated new ship design efforts.

First delivery slipped four months due to delay in availability of design details of developmental items. This was the fastest of programs examined as to delivery. However, the lead ship was not fleetworthy until approximately two years after delivery due to the immaturity of the Tartar system.

(2) DD-963 Class

This program was initiated in 1966 as a large program of new general purpose destroyers with initial emphasis on ASW but with provisions to allow future modernization or conversation to AAW role. The mission was multiple purpose: to protect attack carrier forces against the surface/ submarine threat; to escort amphibious assault/ preassault forces; and, to provide shore bombardment in support of amphibious assault or land warfare forces.

The ships have the following characteristics: length 563 ft., displacement 7865 tons F.L., and speed 30+ knots. The propulsion system is twin screw, with four gas turbines, controllable pitch propellers and a total of 80,000 SHP. Weapons include one ASROC group, two triple MK32 ASW torpedo tubes, one NATO sea sparrow, two 5"-54 LW guns, two Harpoon Quads (space and weight), and a Lamps I helo group, and two CIWS (space and weight). Major sensors include the AN/SQS-53A sonar, SQS-35 sonar (weight and space), SPS-40B air search radar, SPS-55 surface search radar, and a short stop EW suit. An NTDS Command and Decision System is also provided.

Program objectives were to procure a large number (30) adequate for the mission with minimum life cycle cost and maximum flexibility for the contractor. Moreover, the contractor was to assume full responsibility for performance, cost, and schedule under a total package procurement. The acquisition strategy involved selection based on competititve CF/CD. Detail design and production went to one contractor for all ships under a multi-year contract, which was an FPI type with successive targets.

Slippages occured. The contract award slipped 13 months because of a decision to develop two fully definitized and negotiated contracts, and because of additional scope refinement to both contracts to meet budget limits. The first ship delivery slipped 19 months. Causes for this are presently under discussion. Fleet-worthiness of seven units delivered is reported as excellent.

(3) DDG-47

Conceived in 1975, this will be AEGIS version of the DD-963 class, with emphasis on AAW. Ship characteristics will be basically the same as the DD-963 and the combat suite will have several advancements in addition to AEGIS, thus:

	DD 963	DDG 47
Surface/Air Surveillance System	AN/SPS-55 (Surface) AN/SPS-40B (Air)	AN/SPS-55 (with ADT) AN/SPY-1A AN/SPS-49 (with ADT)

	DD 963	DDG-47
Missile Fire Control System	MK 115 Sea Sparrow (BPDSMS)	AEGIS Weapon System
Command & Decision Systems	NTDS	Command & Decision System MK 1-Mod 1
Gun Fire Control System	MK 86 Mod 3	Mark 86 Mod ( ) (AN/SPQ-9 only)
EW Suite	Short Stop (WT & space)	AN/SLQ-32
ASW	LAMPS I	LAMPS II (WT & space)
	AN/SQS-53A MK 116 AN/SQS-35 (WT & space) Nixie	AN/SQS-53A MK 116 Mod ( ) AN/SQR-19 AWS (Wt & space) Nixie
Navigation System	MK 19 Gyros	ADSG Type II Gyro System AN/SRN-5 (SATNAV) AN/SRN-7 (OMEGA)
AAW/SDW	1 - NATO Sea Sparrow (MK 57 MODO)	2 - GMLS (MK 26, Mod 1) 2 - Phalanx (MK 15 Mod 0)
	2 - Harpoon Quads (Space & Wt)	2- Harpoon Quads
	2 - 5"/54 Guns (MK 45)	2 - 5"/54 Guns (MK 45)
	2 - CIWS (space & Wt)	
ASW	ASROC MK 15	ASROC (in MK 26 GMLS)
	2 - Triple Tube (MK 32, Mod 14)	2. Triple Torpedo Tubes (MK 32, Mod 14)
	2 - LAMPS I Helo	2. LAMPS III Helo

Acquisition strategy includes technical characterization and contract design review from three participants. The RFP response offers will be for detail design and construction of the lead ship.

Slippages in the program have occurred due to Congressional action to move it from the FY-77 to the FY-78 appropriation. This has caused a delay in the program of eight months.

Figure 8 depicts in graphic form the schedular aspects of the three destroyer programs, each shown with a common datum - contract award.

(4) Destroyer Program Conclusions

The DDG-2 was the shortest, equivalent to 67 months (if one adds 12 months for a normal preliminary design period) but needed 24 months post delivery to correct TARTAR deficiencies. For the DD-963, the CF/CD and production phases took 102 months; but, deliveries of seven (of thirty) highly fleetworthy ships have been achieved to date. The DDG-47 program is in its pre-award state and conclusions would be premature.

SAR HISTORICAL INFORMATION

DDG 2, DD 963 & DDG 47

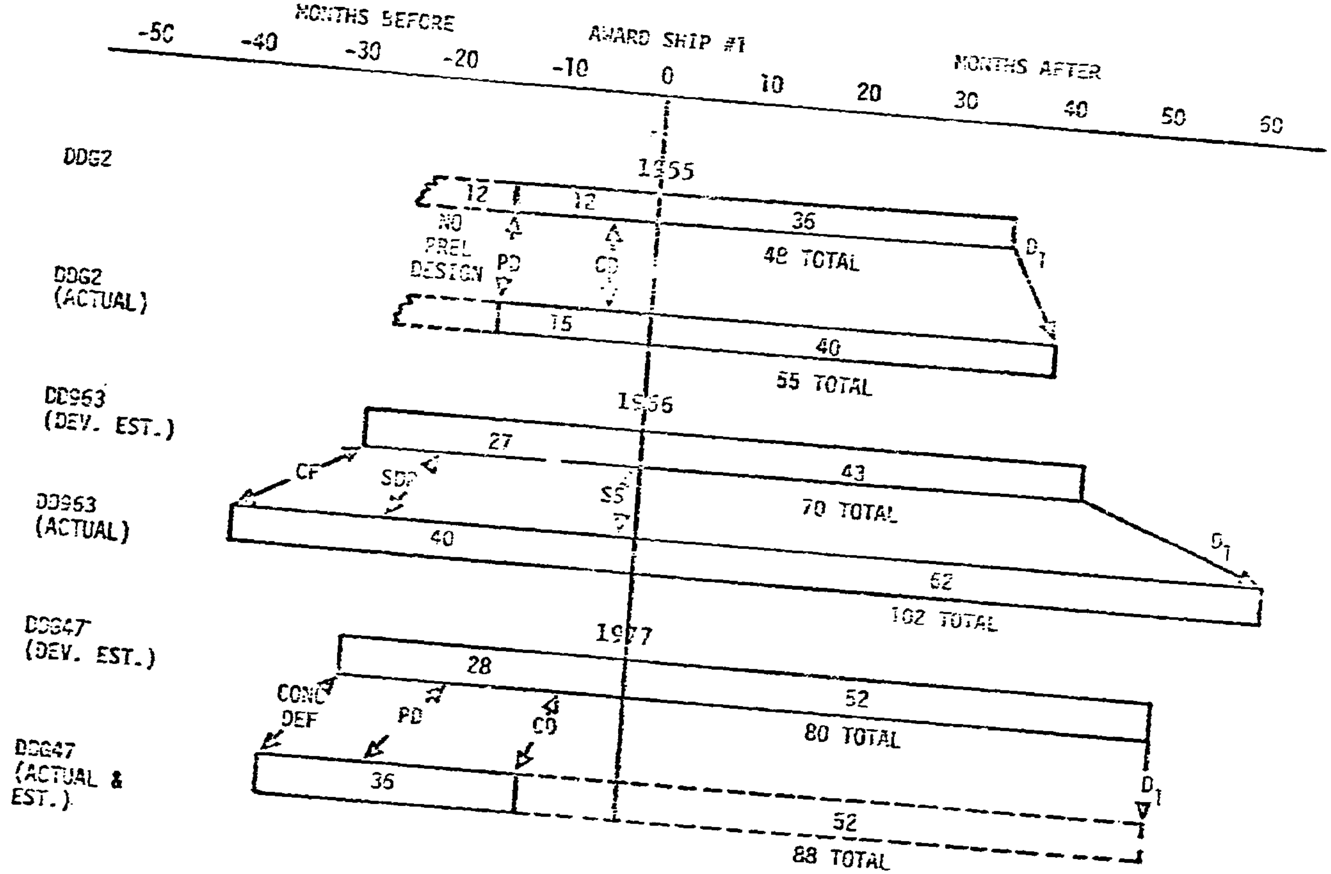


FIGURE 8.

b. FF1052/FFG7

(1) FF1052 Class

The FF1052 is a KNOX class Destroyer Escort with a primary mission of ASW. Twenty-six ships were built in four shipyards on an IFB basis. The operational and technical characteristics are LOA 438 ft., beam 46 ft. 9 in., draft 25 ft. and displacement 4100 tons. The propulsion system is steam turbine with a total of 35,000 SHP. The complement consists of 17 officers and 228 enlisted, and speed is in excess of 25 kts. The weapon system includes an ASROC launcher, two MK32 torpedo tubes, two MK25 torpedo tubes and one 5" dual purpose gun. The ship design was evolutional, not developmental. The original concept formulation, design, and IFB planning were delayed by a change in sonar selection and a decision to change from pressure-fired to conventional boilers. These delays extended into the building period and resulted in additional delays in the program.

The acquisition plan was standard for the era. Delays were caused by decisions made to change the sonar and the boiler design, production problems related to other GFE/GFI matters and shock hardening requirements. Total program cost growth information was not available for analysis. Price to contractors grew from about $11.3M/ship at award to $17.2M after claims settlement.

(2) FFG-7

This is the OLIVER HAZARD PERRY class of Guided Missile Frigates. Their primary mission is to counter submarines employing either torpedos or anti-shipping missiles. This was the first class of ships to be acquired on the "Design-to-Cost" philosophy. The acquisition strategy employed involved the use of in-house ship system design with the assistance of two selected shipbuilders, "A" (Bath) and "B" (Todd). Contractor "A" was awarded the lead ship. A delayed competitive award of follow-ships was made to two other shipyards. The program was initially for the procurement of 50 ships, but it is now variously estimated that somewhere between 50 and 74 ships will be procured for Navy and FMS programs.

The operational/technical characteristics of the FFG-7 are: LOA 445 ft., beam 45 ft., draft 24.5 ft., and displacement 3600 tons. The propulsion system is gas turbine (two LM2500) geared to a controllable reversible pitch propeller with a total of 40,000 SHP. Accommodations are provided for 17 officers and 168 enlisted men. Ship speed is in excess of 25 kts., and there are facilities for operating helicopters. The weapon system consists of HARPOON, 76 mm gun, MK92 GFCS, SQS56 sonar, and two MK32 torpedo tubes.

The FFG-7 was, as previously noted, procured to an entirely new plan emphasizing "design-to-cost" together with shipbuilder involvement early in the design phase. Energetic efforts were made to reduce production and life-cycle costs. Emphasis was placed on increasing standardization, reliability, and maintainability. The FFG-7 total program cost has grown (in constant 1973 dollars) from $52.3M/ship to $C0.8M/ship. This cost growth can largely be attributed to a combination of characteristics and engineering changes and a greater-than-estimated price to the shipbuilders. Figure 9 portrays the schedular aspects of the procurement.

(3) <u>Frigate Program Conclusions</u>

The FF1052 was conventionally procured in 75 months. Stretchouts were primarily due to design changes in the sonar and boiler installation, as well as

SAR HISTORICAL INFORMATION
FF1052 -- FFG7

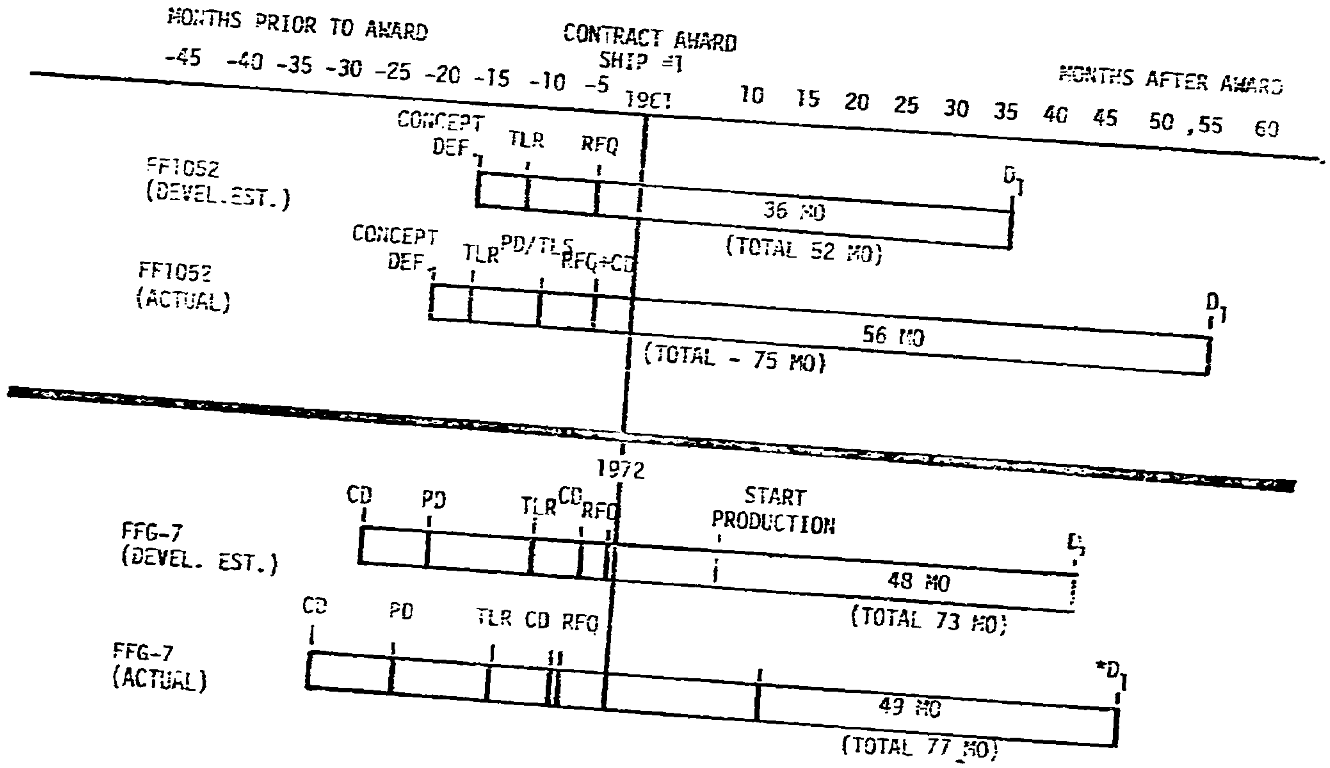


FIGURE 9.

other production problems. The FFG-7 lead ship is projected to deliver in 77 months; the program having been well paced and well accepted. Overall times have been about the same for both classes, but delays have been differently distributed. Installations in FFG-7 have been more developmental, involving the use of land-based test sites and more operational evaluations. Since the lead ship is estimated to deliver in November, 1977, further judgements cannot be made at this time. However, the prognosis is now favorable. The principal risk reducing feature of this program is a planned two-year gap between corresponding events in the lead and follow ships permitting the use of validated (as built) lead ship working drawings for the follow ships.

c. <u>SSN 637/SSN 688</u>

(1) <u>SSN637</u>

This is a nuclear attack submarine class of 37 ships. SSN 637, 638, and 639 were originally awarded as follow ships of the SSN 594 class in November, 1961. In December, 1961 the Bureau of Ships was directed to develop a step improvement in operating reliability and logistic simplication. This resulted in the approval of revised characteristics (TLR) in October,

1962. As a result, these ships were redesignated as a new class called SSN 637 (STURGEON). The mission of these ships is to locate and destroy ships, particularly other submarines. They are designed to perform radio, radar, and sonar reconnaissance intercept missions. Visual reconnaissance and coordinated ASW with other units also form part of their mission. The design provided for significant reduction in self and radiated noise to improve ASW. There was a major impact on ship design and construction which resulted from the Subsafe Program that was invoked subsequent to the loss of SSN 593 (THRESHER) in April, 1963. Ships of this class are equipped with S5W Reactors. Speed is in excess of 20 kts. The FY67-69 ships were lengthened to accommodate an acoustic information gathering system (AIGS). Cost growth on the SSN 637 over the original development estimate ($2,515.8M) is $391.9M for a final estimate of $2,907.7M. The three largest elements of cost growth were class and Subsafe changes ($94.7M), added cost of Navy Yard construction ($96.6M), and economic changes ($98.0M).

(2) SSN 688

This is a nuclear attack submarine class of 40 ships (planned) of which 28 are under contract. Development of CHARLIE/VICTOR (C/V) submarine classes in mid-1960's caused U.S. Navy studies of high speed attack submarines to counter the C/V threat. These studies resulted in characteristics (TLR) for SSN 688 class which were approved in November, 1968. The mission of the SSN 688 class is to destroy ships, primarily enemy submarines. Primary roles are ASW barrier, vectored search, broad ocean search, ASW escort, trailing and intelligence surveillance. The design provided low levels of self and radiated noise and significantly increased speed by including an S6G Reactor. Sonar capability was increased initially with an AN/BQS-13 DNA and subsequently by an AN/BQQ-5. Armament advances were the MK 48 torpedo capability and acoustic counter measure launchers. Cost growth in the SSN 688 Class over the original development estimate ($5,747.5M) is $4,800.3M for a current estimate of $10,547.8M. The two largest elements of cost growth are quantity change from 32 to 40 ships ($2,289.2M) and escalation ($2,282.5M). Schedular aspects are shown in Figure 10.

(3) Submarine Program Conclusions

Both classes reflected a minimal period from concept definition to contract award. Both classes

SAR HISTORICAL INFORMATION

SSN 637 & SSN 688

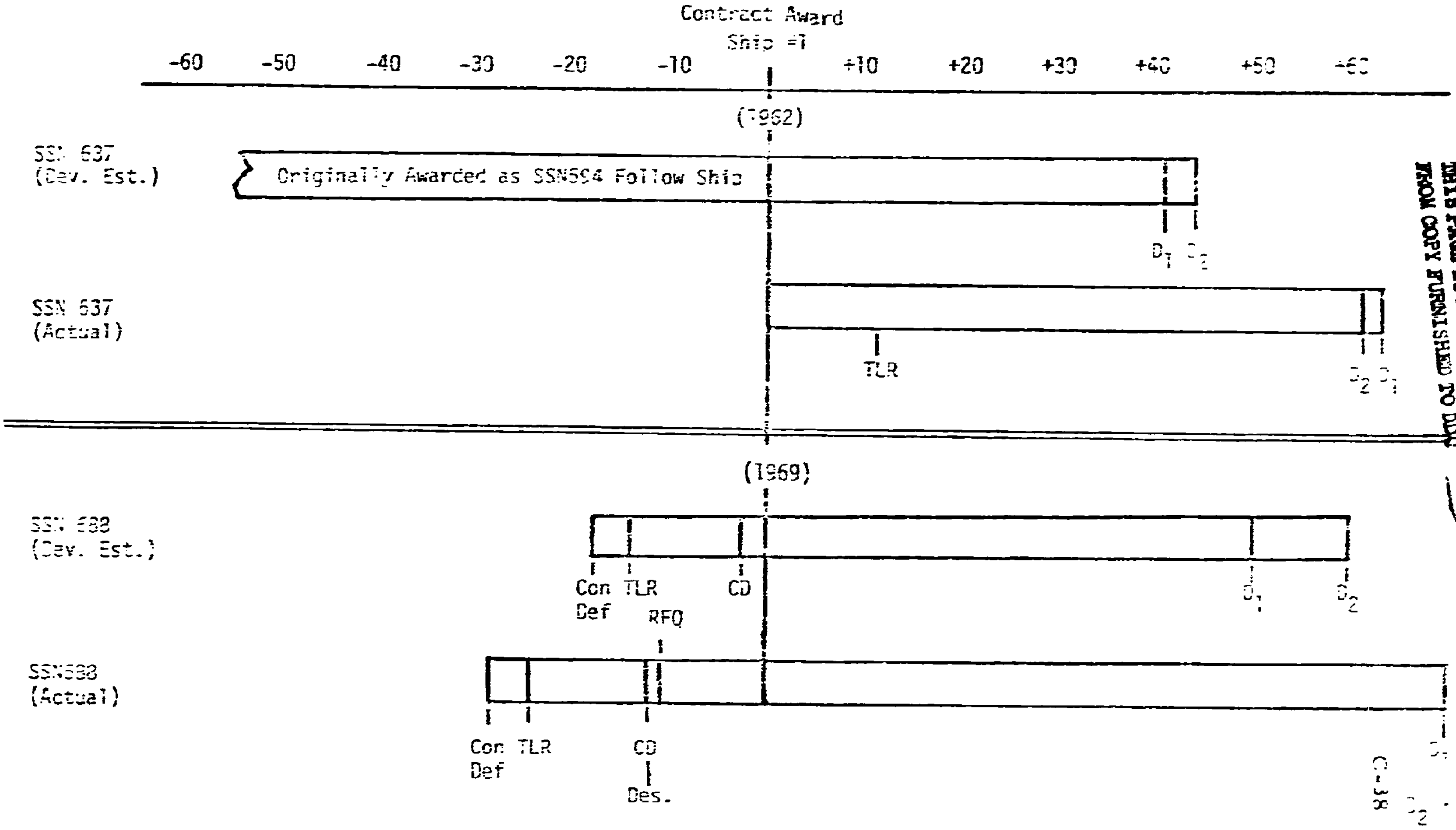


FIGURE 10.

experienced major detail design changes/problems which severely impacted production schedules. Average delivery delays across the SSN 637 class were 13.4 months and are projected to be 19 months across the SSN 688 class. While design changes/problems were the prime cause of program delays, vendor equipment/information availability, and shipyard production manpower problems were also significant contributing factors. More complete design definition prior to construction award would have significantly improved both the schedule and cost performance of construction contractors, and shortened the total time from concept definition to initial ship delivery.

d. AOR 1/AOR 7/AO 177

(1) AOR 1

This oiler was designed to provide petroleum products, selected ammunition, provisions, repair parts, consummable stores and fleet freight to operating forces by underway replenishment and by helicopter operations. The ships are 658 feet long by 96 feet in beam. The total complement of personnel is 457. The propulsion system is twin screw steam turbine capable of producing a speed of

20 knots. AOR-1 was procured to "commercial standards", although the substance of many MIL SPECS/STDS was incorporated in the specifications. The construction contract for two ships was let in June, 1965, to General Dynamics, Quincy. Subsequent contracts were let to the same contractor for AOR-3, 4, 5, and 6. All follow-ships were essentially the same.

(2) AOR 7

This ship is essentially like the AOR 1-6, except that the capability for the NATO SEA-SPARROW was added post delivery. The construction contract was let in December, 1972, to National Steel and Shipbuilding Company, San Diego, California.

(3) AO 177

This ship is a fleet oiler which provides rapid bulk transport of petroleum products to combat support ships such as the AOE and AOR while underway. The ship is 592 feet long by 88 feet in beam. The total complement of personnel is 200. The propulsion system is single screw steam turbine capable of producing a sustained speed of 20 knots, and the cargo capacity is 120,000 Bbls. This is a new design with a planned procurement of 17 ships through FY 82.

The construction contract for two ships plus an optional third (since exercised) was let in August, 1976, to Avondale Shipbuilding Company.

(4) Figure 11 shows the acquisition schedules for the three programs.

(5) Auxiliary Program Conclusions

Slippages which occurred prior to contract award for AOR 1 and 7 are of comparable time span from TLR to contract award. An exception to this was the extended bidding period for AOR 7 to accommodate suppliers. Further, there was a delay in award of this contract to reprogram funds from \$56.5M to \$68.0M. The increase in pre-contract award time span for the AO 177 over both the AOR-7 and AOR-1 was driven by Congressional action delaying the lead ship to FY 76.

Post-award delays in the AOR 1 were attributable to contractor overload in developing working drawings for several new ships simultaneously plus problems with the FAST underway replenishment system developed by a supplier and later deleted. AOR 7 post award delays were attributable to supplier failures, MIL SPEC rigidity, and uncoordinated specifications and plans. Cost differentials are shown in Figure 12. Cost growth in both the AOR 7 and AO 177

AOR/AO SAR HISTORICAL INFORMATION

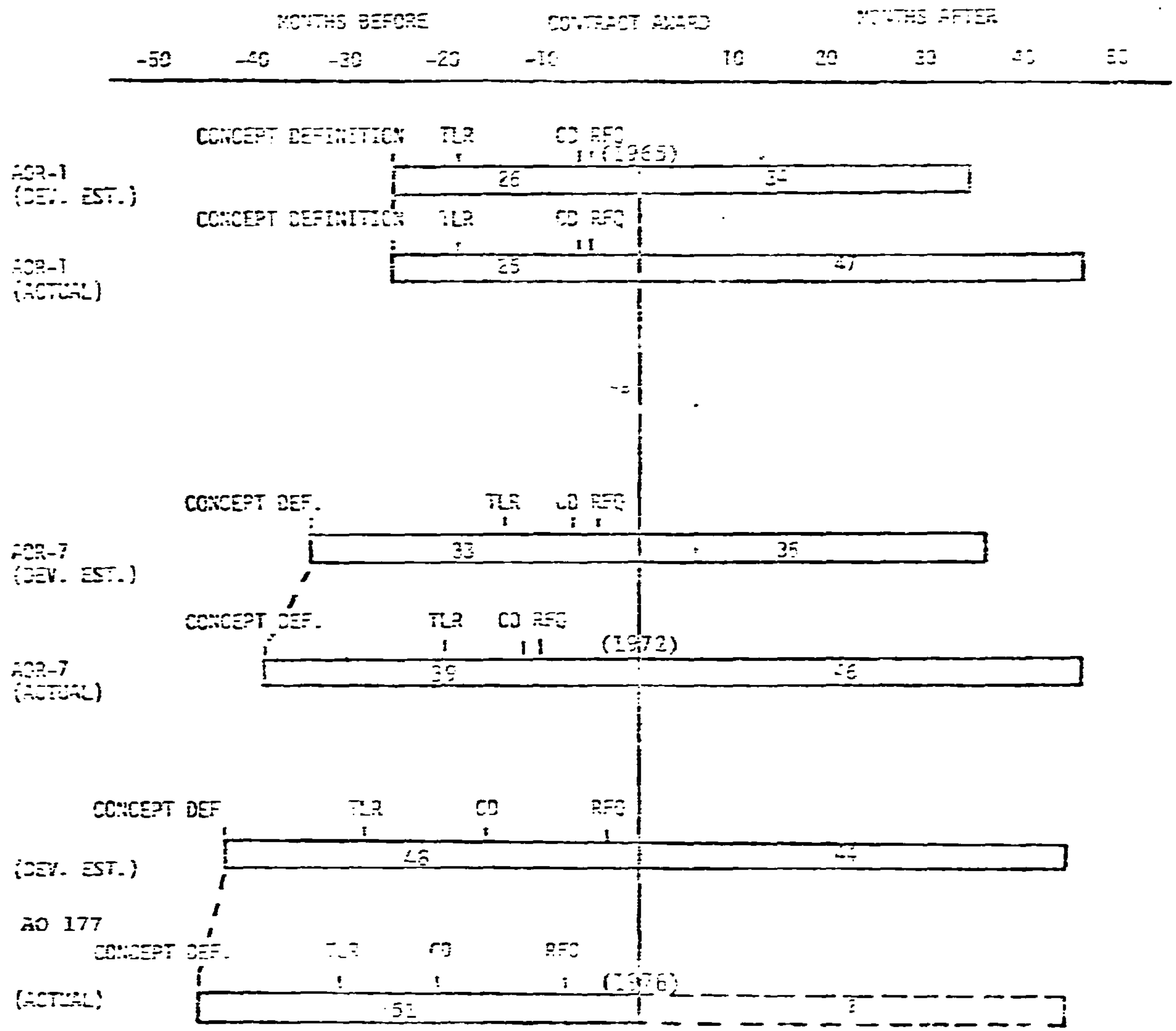


FIGURE II.

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COST DIFFERENTIALS ($M)

	AGR-1	AGR-7	AC
PLANNING ESTIMATE	45.3	68.5	71.0
ESTIMATE UPDATE	----	65.5	31.3
DOD APPROVED (BUDGET)	45.3	56.5	136.0
AFTER BID RECEIPT	39.7	68.0	136.0
END COST (ACTUAL)	42.1	86.3	?

FIGURE 12.

resulted from rapidly increasing escalation factors, overruns in basic construction (AOR 7), compounded by Congressional delay of one year in funding (AO 177).

From the data analysed it is clear that in the acquisition of replacement auxiliaries they need be subjected to only a single combined DSARC 0, I, II, and III. This could preferably be done with an NSARC. Greater emphasis should be given to allowing the use of commercial components in vessels of this type. In addition, it is clear that the quality of the bid packages - contract, plans and specifications - could and should be improved.

c. PHM

(1) This is a joint US/German/Italian program under NATO auspices. The program has shared development costs and is based on an established mission. The intention was to have two US "lead-ships" to be followed by a coordinated multi-year procurement. The plan as envisioned in 1973 is shown in the table below:

	FY72/73	FY74	FY75	FY76	FY77
US	2	-0-	10	10	8
FRG	-0-	-0-	5	5	-0-
GOI	-0-	-0-	-0-	2	2

The design was based on demonstrated US hydrofoil technology, and the system used US/FRG/GOI components. Metrication was applied. The prime contractor is Boeing. The characteristics are LOA, 44.7M with a displacement of 245 MT. Speed is in excess of 40 knots. The weapon system includes HARPOON, the 76 mm gun, and the WM28/MK94 GFCS. The complement consists of 4 officers and 17 enlisted men. Estimated unit production costs are shown in the table below:

	For 20 Ships	For 5 Ships
1973 Plan	$18.1M	N/A
Estimate	30.1M	$64.9M

Figure 13 gives the acquisition schedule.

(2) Conclusion

Basic hydrofoil technology was again shown to be sound. Prosaic design problems were encountered in the propulsor and gear box which caused reliability problems. Difficulties were also encountered in hull and foil fabrication. As a result, there was a two-year delay in IOT&E and in DSARC III. There was good political support until April, 1977 when the new Administration cancelled the program based

PATROL HYDROFOIL -- PHM

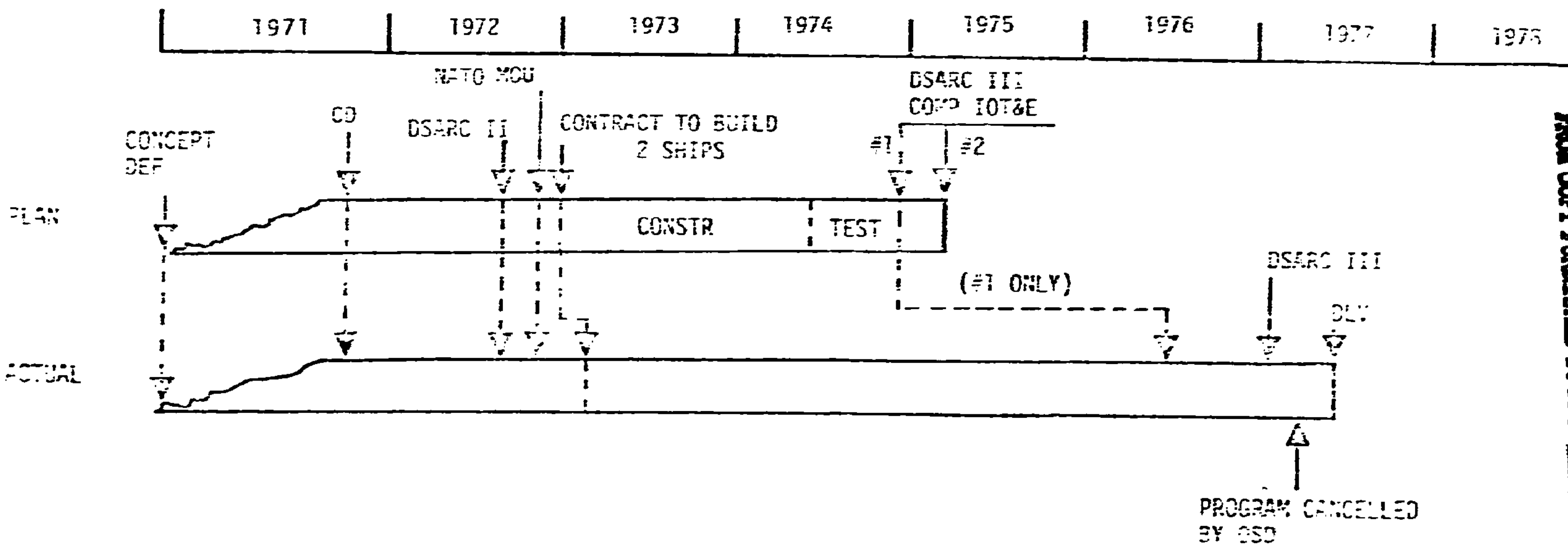

FIGURE 13.

on a "lack of mission." If the program were to be reinstated, the benefits of co-production as originally envisioned would not be recoverable. Although funded in R&D, the Navy assumed that the technology was "in hand." However, Boeing had a lack of experience in fabrication. Also, there had been inadequate development tests of the propulsor and the Navy was slow to provide added technical support.

In summary, the ship was a developmental prototype that experienced technical problems during construction and test. Full DSARC treatment was appropriate.

SECTION 6 - PROGRAM STABILITY

Significant improvements to the ship acquisition cycle could be achieved through measures that would enhance the overall stability of the shipbuilding program. There is a need to:

- Reduce false starts.
- Better utilize limited resources for ship design.
- Plan shipyard workloads.
- Increase management commitment to approved programs.

To achieve these ends there must be increased emphasis on long range planning, and greater support to programs once they are begun. Considering the extensive planning effort and management interest that already characterize the shipbuilding program, further emphasis may be difficult to achieve. Nevertheless, the following discussion may be constructive.

a. FYDP

Figure 14 provides a useful summary of the survival rate of ship programs in successive annual updates of the Five-Year Defense Plan. It is seen that all categories of ships have slipped, some more than others. It should be noted here that Figure 14 is based upon the President's annual budget submission and that it does not reflect the further annual curtailments invariably made by the Congress. Neither do the figures reveal where programs have been

VARIATION IN DOD FIVE YEAR SHIPBUILDING PROGRAMS BASED ON ANNUAL PRESIDENT'S BUDGET SUBMISSION, 1/71-1/77

SOURCE: DERIVED BY IDA FROM HISTORICAL DATA ABOUT FIVE YEAR SHIPBUILDING PROGRAMS

	FISCAL YEAR											
	71	72	73	74	75	76	77	78	79	80	81	82
MAJOR SURFACE COMBATANTS (NON-NUCLEAR)												
JAN 71 FYDP (72-76)	6	7	7	7	2	7						
JAN 72 FYDP (73-77)		7	8	7	7	11	10					
JAN 73 FYDP (74-78)			8	7	7	11	10	3				
JAN 74 FYDP (75-79)				7	14	11	10	11	11			
JAN 75 FYDP (76-80)					10	13	12	10	15	10		
JAN 76 FYDP (77-81)						6	9	8	11	11	11	
JAN 77 FYDP (78-82)							3	10	12	15	17	16
OTHER SURFACE SHIPS												
JAN 71 FYDP (72-76)	2											
JAN 72 FYDP (73-77)		0	2	9	13	7	7					
JAN 73 FYDP (74-78)			0		7	13	14	2				
JAN 74 FYDP (75-79)				0	7	10	14	2				
JAN 75 FYDP (76-80)					4	2	9	8				
JAN 76 FYDP (77-81)						0			1	4	7	
JAN 77 FYDP (78-82)							0		2	6	8	9
AUXILIARY/UNREP												
JAN 71 FYDP (72-76)	2	6	1		5	9						
JAN 72 FYDP (73-77)		3		8	9	8						
JAN 73 FYDP (74-78)			2		4	9	7	7				
JAN 74 FYDP (75-79)				0	3	9	9	9	4			
JAN 75 FYDP (76-80)					2	[illegible]	2	8	5	3		
JAN 76 FYDP (77-81)						[illegible]	2	6	3	5	5	
JAN 77 FYDP (78-82)							3	9	12	12	8	3

FIGURE 14.

VARIATION IN DOD FIVE YEAR SHIPBUILDING PROGRAM BASED ON ANNUAL PRESIDENT'S BUDGET SUBMISSION, 1/71 - 1/77

SOURCE: DERIVED BY IDA FROM HISTORICAL DATA ABOUT FIVE YEAR SHIPBUILDING PROGRAMS

	FISCAL YEAR											
	71	72	73	74	75	76	77	78	79	80	81	82
SSN												
JAN 71 FYDP (72-76)	4	5	5	5	5	6						
JAN 72 FYDP (73-77)		5	6	5	5	6	5					
JAN 73 FYDP (74-78)			6	5	5	5	5	5				
JAN 74 FYDP (75-79)				5	3	2	3	2	3			
JAN 75 FYDP (76-80)					3	2	3	2	3	2		
JAN 76 FYDP (77-81)						2	3	2	2	2	2	
JAN 77 FYDP (78-82)							3	1	2	2	2	2
SSBN												
JAN 71 FYDP (72-76)						1						
JAN 72 FYDP (73-77)				1	3	3	3					
JAN 73 FYDP (74-78)				1	3	3	3					
JAN 74 FYDP (75-79)				1	2	2	2	1				
JAN 75 FYDP (76-80)					2	1	2	1	2	1		
JAN 76 FYDP (77-81)						1	1	2	1	2	1	
JAN 77 FYDP (78-82)							1	2	1	2	1	2
MAJOR SURFACE COMBATANTS (NUCLEAR)												
JAN 71 FYDP (72-76)	1	1	1	1	1							
JAN 72 FYDP (73-77)		1	1	1								
JAN 73 FYDP (74-78)			1	1								
JAN 74 FYDP (75-79)				1	1	1			1			
JAN 75 FYDP (76-80)					1	1	1	1	2	2		
JAN 76 FYDP (77-81)						[illegible]		1			1	
JAN 77 FYDP (78-82)							0					

FIGURE 14 (contd).

stopped altogether or merely reduced or stretched out; however, the impact of this instability on the front end planning effort as well as on shipyard workloads should be obvious.

b. FUNDING FOR SHIP DESIGN

In earlier years the Navy was allotted a relatively small R&D budget for conceptual studies and preliminary design effort for new ships. Most of the ship design effort was funded by the SCN appropriation, including the design stage known as contract design.

In recent years Congress has been increasingly insistent that all ship design, up to the point of contract award for the lead ship, be funded in the RDT&E appropriation. Two program elements were established:

Ship Preliminary Design . . . . PE 6.3
Ship Contract Design . . . . PE 6.4

While some flexibility is possible within each of these program elements, the transition from preliminary design to contract design connotes DDR&E (or even DSARC) approval and release of funds to the Navy. This artificial division of the ship design process is equated roughly to the "advanced development" and "full scale development" stages applied to other weapon system acquisition programs -- an inappropriate restriction in the case of ship design.

There is basically no objection to use of RDT&E funds for ship design; however, allotted funds are seldom sufficient for the effort needed to support several ship projects simultaneously albiet at various stages of design maturity. Unfortunately, ship projects that are not already in the SCN force structure have difficulty obtaining the RDT&E funds needed to get started.

These problems with early funding would be exacerbated by the requirements in OMR Circular A-109 that appear to prevent a new ship program from entering the force structure until it is recognized in the DSARC process.

c. NAVY/MARAD COORDINATION

Stability in the shipbuilding industry, as a whole, should be a consideration in scheduling new ship programs. One means for improving industry stability would be to coordinate plans more closely with the Maritime Administration in a mutual effort to schedule and distribute work so as to reduce the cyclic nature of the industry. The need for such close coupling by the two major customers of the shipbuilding industry has been recognized for many years, and was discussed earlier in Section 4.

Over the past year initiatives within the Maritime Administration and the Naval Sea System Command manifest a recognition of closer coupling and positive improvement toward that end. This is encouraging.

d. MANAGEMENT COMMITMENT

"Management commitment" is an abstract but nevertheless very important ingredient for a successful acquisition program. Strong advocacy is required on the part of the military services as well as in OSD. It would be worthwhile, for instance, for the services to disseminate information on the objectives and status of new programs, aiming this information at the rank and file in the operating forces in order to gain their comment and support.

More pragmatically, however, the strong advocacy must come from top management. The need to give greater than budget year stability to the FYDP is also apparent. This can be achieved by more careful long range planning, and by recognition of the political/economic realities forecast for the out years as well as for the present. A major goal should be Congressional recognition of the force structure planning represented by the FYDP and to seek Congressional approval as a valid planning document, by an act of authorization. Obviously, such an action would be subject to annual review and update by the Congress. Nevertheless, the very fact that the 5-year DOD plan is thus made a Congressional plan would lend significant stability to its program.* Current Congressional interest in a 2-year plan is noted with satisfaction; success in its passage should be the signal to press for a larger authorization.

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*Refer to VADM Doyle's testimony of 4 October 1977 before the National Security Task Force of the House Budget Committee, in which he stated: "One of the more important actions that the Congress could accomplish in order to assist the Navy in its efforts to insure that new ships are built in the most efficient way would be to formally authorize a five year shipbuilding program."

SECTION 7 - ISSUES AFFECTING SHIP ACQUISITION PROCESS

Given the early establishment of the military need for a new class of ship and its introduction into the planned force structure, a number of issues must be dealt with in planning the acquisition program. These include:

- Interaction of ship design with subsystem development programs
- Test and evaluation requirements
- Procurement approach and type of contract
- Contract administration and inspection requirements

The management approach to these issues must be flexible, taking into account the particular requirements of each acquisition program.

a. INTERACTION OF SHIP DESIGN WITH SUBSYSTEM DEVELOPMENT

Conventionally designed ships fall generally into three categories in terms of the impact of subsystem technology on their design characteristics: (1) auxiliary type ships with minimal armament and state-of-the-art systems (e.g., AOR/AO); (2) conventional combatant platforms with contemporary armament (e.g., FFG-7); and (3) ships whose purpose is to field a major new development in propulsion, command and control or armament (e.g., AEGIS).

The first category, auxiliaries, generally are designed with proven technology, and concurrency between ship construction and subsystem development is minimal if any.

The second category typifies the majority of new combatant ships including submarines. These ships generally incorporate the most modern armament and other subsystems that are available. Proven subsystems are used wherever these are perceived to meet the ship's mission requirements and/or cost constraints; however, there is the understandable tendency to include features that are nearing the end of their development cycle and which are viewed as "high-confidence" systems programmed to complete development and operational testing during the construction period of the lead ship.

A reasonable approach, used in the FFG-7 and the SSN688 programs, is to employ shipboard or land-based test platforms to complete the development and initial operational testing of these systems concurrently with the design and construction of the lead ship of the new class. These subsystem test programs then become part of the ship acquisition program and are subject to the DSARC review process along with the ship. This controlled concurrency is a means for expediting the ship acquisition process while minimizing the risk that the subsystems may not be operationally suitable when deployed. A concomitant requirement of this approach is to ensure that suitable backup subsystems exist and that the ship design can accommodate them. The alternative is to complete the ship without the new subsystem, with provisions for retrofitting after delivery. The DD963 class is an example of both approaches, where the ship platform was carefully designed with provisions to install additional systems at a later date, and land-based testing was used for the combat and propulsion systems.

Acquisition decisions in the second category center on selection of the combat suite or other subsystems to go with the new ship platform. These decisions are made in the context of an established need for the new ship and concern themselves with ensuring that the best possible trade-offs are made regarding cost, schedule and capabilities of the ship's installed systems. Accordingly, one major decision point is needed to review results of the ship design program and to ensure that the acquisition plan is compatible with the program objectives. If substantial concurrent subsystems testing is planned during lead ship construction, a second DSARC review may be desirable to review program progress prior to start of follow ship construction.

From the point of view of acquisition strategy, the third category of ships is the one involving major new developments whose design interacts with the design of the ship platform to such a degree that neither the ship nor the subsystems can be developed independently of the other. Typically, new combat system developments take many years to reach a degree of maturity that warrants production for operational use. Early planning is needed to ensure that the weapon system and the proposed ship will be compatible and that, together, they are consistent with the force structure requirement. Thus, ship design considerations must be allowed to influence the weapon system development from the outset, with continuing coordination throughout the weapon development phases.

Figure 15 illustrates the relationship that should be established between weapon system development and ship design. Ship concept studies and preliminary design effort should run in parallel with the weapon system concept formulation and validation effort, with close coordination between the two. The major program decision point, DSARC II, should address both the weapon system

MODULATION OF COMBAT SYSTEM R&D FOR SHIP PLATFORMS

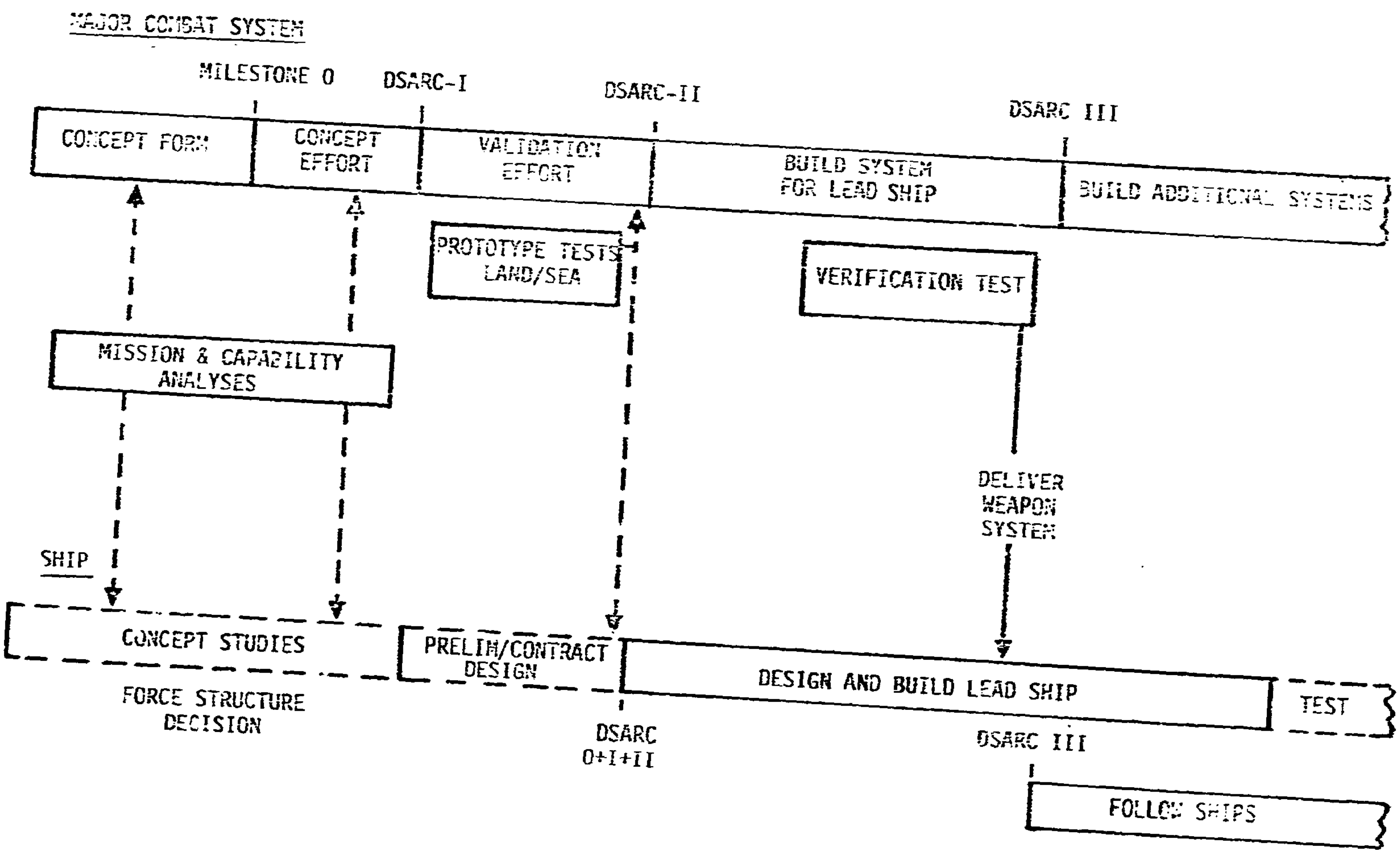

FIGURE 15.

and the ship, but the timing of this decision point must be geared to the readiness of the weapon system for at least limited operational deployment in the lead ship. This would normally be possible if the advanced development effort on the weapon system has included adequate prototype demonstrations through land-based or sea based tests. On this basis, the first operational weapon system could be considered a "lead system", comparable to the lead ship with a class to follow. The weapon program could then include verification tests concurrent with lead ship construction, in a manner similar to the approach described in Category 2 above. Similarly, the DSARC III decision point would be timed to occur when the weapon system verification and ship integration tests are completed, and the decision would apply to follow-on construction of both the ship and the weapon system.

b. TEST AND EVALUATION OF SHIPS

DOD INST 5000.3 sets forth policy on test and evaluation requirements during the acquisition process. The policy basically prescribes a progressive program of testing to support development and to ensure that the new system is operationally suitable for deployment before being committed to production.

DOD INST 5000.3 recognizes the long time required to build ships and that, for ships based on conventional technology, it is not necessary to conduct operational testing of the lead ship of a class prior to initiating follow-on construction. As discussed earlier, separate test programs can be established, where necessary to provide an initial verification of new subsystems concurrent with procurement of equipment for the lead ship. However, the policy also requires that a full operational evaluation be made as soon as possible after the lead ship is delivered.

For new ship concepts (e.g., hydrofoils and surface effect ships) with major innovations in the platform and propulsion technology, DOD INST 5000.3 requires an initial operational evaluation of a prototype or lead ship prior to follow-on construction programs. Decisions for follow-on programs are to be based on the operational suitability and military value demonstrated by these tests.

The principles of DOD INST 5000.3 have been applied in the FFG7 and PHM programs and are intended for future ship acquisition programs. For the FFG7, a combination of land-based and ship board tests were performed on the radars, sonar, missile fire control system and the gas turbine main propulsion systems. These tests were a part of the lead ship program. On completion of these initial tests, follow-on procurement was authorized to support the follow-ship program. An operational appraisal of the lead ship is planned soon after its delivery.

The PHM1 has completed a successful operational evaluation embracing all aspects of its design, including both the ship platform and its combat systems. Significant deficiencies were disclosed by these tests and subsequently corrected, resulting in a substantial delay in satisfying T&E requirements for follow-on construction. Follow-on ships, if authorized, will benefit greatly from this experience.

In the main, present policies on T&E for ships appear to be working well and are endorsed.

c. PROCUREMENT APPROACH AND TYPE OF CONTRACT

The approach to naval ship procurement has varied over the past fifteen years, reflecting the procurement environment that pertained for various classes of ships.

Figure 16 illustrates the principal types of contracts that have been used. Conventional competitive bids

PROCUREMENT APPROACHES FOR NAVAL SHIPS

1962 — 1967 — 1972 — 1977

COMPETITIVE BIDS (FIRM FIXED PRICE)
LIMITED NAVAL SHIPYARD CONSTRUCTION
LST, DE's, AKA's, LSD's, AS'S

TPP(CF/CD)
LHA, DD-963

COMPETITIVE NEGOTIATED PROCUREMENTS (FIXED PRICE INCENTIVE)
688's, TRIDENT, AD's, AO's

CPIF LEAD SHIP (CPFF DESIGN)
FFG's

FIGURE 16.

(firm fixed price) were used in the early to middle Sixties, where procurements were primarily for auxiliary ships or relatively non-complex surface combatants. The total package concept was used for two major procurements (DD963 and LHA). Submarine programs and certain auxiliary procurements in the early Seventies employed competitively bid, negotiated fixed price-incentive type contracts. As noted by the case studies in Section 5 of this report, many of these programs experienced problems ranging from program stretch-out, to excessive cost growth and, in some cases, Congressional criticism of the manner of awarding and administering contracts. While each of these approaches may still be applicable in certain cases, the process has continued to evolve.

The FFG7 procurement was initiated in 1972 for a planned procurement of 50 ships. It was recognized that use of a single shipyard for this large procurement would result in a very lengthy programs; thus, the procurement plan was structured for three shipyards. A lead shipbuilder was selected competitively to assist the Navy in-house design effort and to build the lead ship. A second shipbuilder was also selected to participate in the design process so as to be better prepared to undertake a portion of the follow-on construction, and to be alternate lead ship builder in the event of unsuccessful negotiation with the first one for lead ship construction.

A cost-type contract was utilized for detailed design and construction of the lead ship in order to provide increased visibility into cost factors and added flexibility in effecting design changes. Fixed price incentive contracts have been awarded to both the lead ship contractor and to two other shipyards for follow-on-ship construction, with the lead yard being responsible for design, configuration control and procurement documentation for vendor furnished equipment.

As noted in Section 5, an important additional feature of the FFG7 procurement was the deliberately planned two-year gap between starting construction of the lead ship and follow-on-ships. This planned delay has permitted the lead ship contractor to overcome early construction problems and to validate major drawings and documentation to be used for the follow-on-ships. It is expected that this will preclude major slippages in the follow-on-ship program.

Figure 17 provides a convenient summary of the FFG 7 procurement approach as compared with earlier approaches. While it may be too early to judge, the FFG 7 approach appears to be a workable solution to many of the problems that have characterized multi-ship procurements in the past, and is being applied to upcoming programs such as DDG 47, LSD 41, and CGN 42.

d. CONTRACT ADMINISTRATION

In examining case histories, production problems account for much of the increase in the length of the acquisition cycle. Some of these problems are traceable in part to contract administration:

(1) Delayed placement of CFE purchase orders under FPI contracts due to ASPR "pass down" clauses and complexity of consent packages requiring government approval.

(2) GFE/GFI delays and inadequacies.

(3) Large number of change orders, typically:

- CVAN - 2500 changes
- CGN - 2000 changes
- SSN - 1000 changes

(4) Rigidity in use of MIL SPECS/STDS, and the application of system engineering "illities".

(5) Rigidity in on-site contract administration.

SHIP PROCUREMENT STRATEGIES

	MAJOR ALTERNATIVES	SHIP SYSTEM DESIGN (CONTRACT DESIGN) NAVY DIRECTED DESIGN	NAVY MONITORED DESIGN	DEVELOPMENT PHASE	PRODUCTION PHASE
I.	CONVENTIONAL PROCUREMENT	IN HOUSE OR BY DESIGN AGENT SELECTED AFTER COMPETITION OR ALLOCATION		NONE	LEAD YARD + FOLLOW YARD CONTRACTS AWARDED SIMULTANEOUSLY AFTER COMPETITION
II.	COMPETITIVE CF/CS (LHA, DD963)		BY SHIPBUILDER TEAMS SELECTED AFTER COMPETITION	NONE	1 SHIPYARD SELECTED AFTER COMPETITION FOR LEAD AND FOLLOW SHIPS
III.	SHIP DESIGN & LEAD SHIP BY SELECTED BUILDER (SSN688)	BY SHIPBUILDER SELECTED AFTER COMPETITION OR ALLOCATION		LEAD SHIP BUILT BY DESIGN YARD	FOLLOW SHIPS AWARDED AFTER COMPETITION
IV.	IN-HOUSE SHIP DESIGN WITH COMPETITIVELY SELECTED BLDR. ASSIST. (FFG-7)	IN-HOUSE WITH SHIPBUILDER ASSISTANCE		LEAD SHIP BUILT BY DESIGN YARD	FOLLOW SHIPS AWARDED AFTER COMPETITION

FIGURE 17

In light of the above, some comparisons were made with USCG and commercial practices. It was found, as might be expected from at least a cursory survey, that MARAD and the USCG programs are characterized by very small field organizations that are staffed by highly competent professionals, and that the number of change orders per ship is almost minisculo (typically twelve for a MARAD ship) compared to Navy programs. The hasty conclusion cannot be drawn from these observations that the Navy SupShips organization and operations should be restructured along MARAD/USCG lines. However, there are enough naval auxiliaries being regularly acquired that special consideration should be given to drastically simplifying their contracts and contract administration. Among other things, the realistic application of so-called "commercial practice" based on American Bureau of Shipping and USCG specifications for non-military equipment and material should be expanded to reduce material lead times and costs without increase in risk. Finally, greater delegation of authority, similar to that exercised by MARAD and USCG field representatives, could be beneficial.

e. DSARC REVIEW AND DECISION

The foregoing sections have discussed some of the issues that are generally considered in structuring an acquisition plan for naval ships. It is now of interest to summarize the study results in terms of how the DSARC review process applies.

As noted in Section 2 of this report, the first essential step in a ship acquisition program is to establish the program in the force structure. For ships, this has normally been done in the past through the POM/FYDP process which is the primary vehicle for reflecting integrated requirements established by the Joint Chiefs of Staff and the military services. It is not clear how this first step can be achieved for ships through the DSARC process as visualized by OMB Circular A-109 without introducing unacceptable delays in the program formulation stage. Nevertheless, by whichever route the program is initiated, the force requirement should be supported by both the FYDP and the DSARC so that the necessary RDT&E funding may be released for the conceptual studies, design and planning effort that must be accomplished prior to initiating a lead ship program.

A DSARC-I review may well be appropriate in certain programs near the end of the preliminary design phase, mainly as a review of progress and to clarify technical issues regarding the design of the ship, systems integration and plans for concurrent testing. If a DSARC-I review is scheduled, however, it should not be used as a vehicle for interrupting funding or the transition from preliminary to contract design.

The primary program review should be the DSARC-II, aimed at authorizing the detail design and construction of the lead ship. This review should cover all of the major issues, including the design of the ship and the plans for acquisition of the entire class. If necessary, the need for the new ship class can be re-affirmed at this point and the results of on-going mission analyses and tests can be introduced to ensure that the proposed program will satisfy the requirements.

In some respects, the DSARC-III appears to be a superfluous requirement for ship acquisition programs. Normally, the first or lead ship would not be undertaken unless the intent was to carry on with follow-on ships. The DSARC-III is not the vehicle to re-determine how many ships are to be built. Policies are clear that follow-on ships will incorporate only those subsystems and equipment which have been themselves approved through the DSARC process for production and service use.

For complex programs, however, a DSARC-III may be appropriate to review results of subsystem test programs that have occurred since the DSARC-II, or to consider in greater depth the procurement and management plans for the follow-on ship program.

From the above considerations, the applicability of DSARC reviews may be summarized as illustrated in Figure 18:

(1) Non-combatants. Combine DSARC's O, I, II, and III, into a single DSARC. An NSARC would be preferable for such cases.

(2) Conventional Combatants with State of the Art Sub-Systems. Combine DSARC's O, I, and II into a single decision point aimed at authorizing the lead ship and manufacture of the systems to be installed in the lead ship. Additionally, this DSARC should review plans for on-going testing and clearly define the milestones to be met before follow-on ships or their subsystems can be ordered. If necessary, a DSARC-III could be held to reaffirm that the necessary milestones have been met.

(3) Ships with Major Advanced Subsystems. The approach for these ships can be essentially the same as for the previous category, with the added requirement

DSARC APPLICABILITY

	DECISION POINTS			
	0	I	II	III
NON-COMBATANTS • LEAD & FOLLOW SHIPS	SINGLE DSARC (OR NSARC)			
CONVENTIONAL SHIPS WITH STATE-OF-THE-ART SUBSYSTEMS • LEAD SHIP	SINGLE DSARC			
• FOLLOW SHIPS				X
SHIPS WITH MAJOR ADVANCED SUBSYSTEM • COMBAT SYSTEM	X	X	X	X
• SHIP	↑	↑	X	X
UNCONVENTIONAL SHIPS	X	X	X	X

FIGURE 18

that earlier DSARC's on the weapon system must include considerations of the entire ship-weapon system.

(4) Unconventional Ships. Should follow the full DSARC structure as is applied to any other major new development.

SECTION 8 - SUMMARY AND RECOMMENDATIONS

Based on the foregoing discussions, which place primary emphasis on considerations that affect the length of ship acquisition cycles and measures that might be taken to shorten or avoid additional growth, it is concluded that program stability and flexibility in tailoring acquisition strategy are the principal means to those ends.

Program stability should be improved by:

a. Seeking authorization by Congress of a 5-year SCN Program based on firm force structure decisions. *

b. Sustained management commitment to programs established through the POM/FYDP process.

c. Stronger MARAD/NAVY coordination in industry loading, and

d. Provision for continuity in RDT&E (6.3 and 6.4) funding for conceptual, preliminary and contract design.

Flexibility should be exercised in tailoring acquisition strategy based on ship type and maturity, status of sub-system development and industry posture by:

a. Early coordination of sub-system R&D with platform constraints.

b. Controlled concurrency of sub-system development and ship production.

*As strongly endorsed in recent CNO (SW) testimony before the House Budget Committee, 4 October 1977.

c. Selection of applicable procurement approach.

d. Adaptation of MARAD and USCG contract administration practices for non-combatant ships, and

e. Limiting the number and timing of DSARC reviews for each case according to practical need.

It is the judgement of the Ship Acquisition Team that implementation of the foregoing recommendations will inhibit further growth in the lengths of ship acquisition cycles, and offer the prospect of a significant reduction.