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NAVAL AVIONICS FACILITY

INDIANAPOLIS, INDIANA 46218

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PREFACE

This report summarizes the results of a brief study performed by Naval Avionics Facility, Indianapolis, personnel to determine the impact of advanced technologies on traditional concepts of Navy acquisition management.

Prepared By: Steven L. Hart
STEVEN L. HART, Manager
Advanced Microelectronic
Engineering Staff 908

Terry R. Ising
TERRY R. ISING, Head
Microwave Systems
Engineering Branch 942

ABSTRACT

This report examines current and anticipated acquisition management policies/practices, as they will be applied to advancing technologies, and attempts to forecast those shortfalls which require attention by those personnel involved in the Naval Air Systems Command material acquisition cycle.

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I. INTRODUCTION

Navy acquisition concepts, policies, and practices have continually evolved and been improved since those original rudimentary precepts were formed with the establishment of the First Continental Navy in 1775. The four fundamental elements of acquisition management have traditionally been development, acquisition, deployment, and logistic support of those Naval materials which are deemed mission essential. Now, as then, the potential adversary is committed to a powerful, ocean-controlling, offensive naval force. Unlike his earlier counterparts, today's Naval acquisition manager must be increasingly creative, by reason of the modern dynamics of world-wide, multi-faceted threat scenarios, reduced reaction and retaliatory times, and accelerated rates of technological change. Successful acquisition of future systems will require increasingly efficient utilization of those assets which can be mobilized to offer definite force superiorities, e.g., advanced microelectronic technologies. Unfortunately, optimum Navy and general Department of Defense (DoD) implementation of such technologies has not yet been satisfactorily achieved, due in many cases to the competitive volatility of the United States marketplace.

This treatise examines current and anticipated acquisition management policies/practices, as they will be applied to advancing technologies, and attempts to forecast those shortfalls which may require Naval Air Systems Command Acquisition Management (AIR-05) attention, by means of refinements or changes, in order to successfully cope with the increased implementation of weapons platforms utilizing advanced technologies.

The NAVAIR acquisition manager of the 1980's will play, even to a greater extent than today, one of the key roles in the U.S. defense chain, because his decisions will determine whether the various squadrons are operationally ready and can be efficiently supported. His decisions will determine if the Fleet receives the platforms it requires in a timely and cost-effective fashion; whether these platforms can be supported across their operational life cycles; and whether their numbers can be increased and sustained if periods of national mobilization are required. His chief adversary will be time. The computer-oriented U.S. society will force technological obsolescence to occur so rapidly that incorrectly formulated acquisition decisions can create obsoleted and unsupportable subsystems, even before they reach initial operational capability (IOC). Technology obsolescence may reduce acquisition windows to months vice years, such that properly planned procurements must be of paramount importance.

Historical definitions of acquisition managers have been centered about those individuals responsible for development, production, and initial support of procured hardware items. Acquisition management, as currently outlined by SECNAVINST 5000.1, System Acquisition in the Department of the Navy, is primarily involved with acquisitions which are associated with government furnished equipments (GFE) to be supplied as systems, subsystems, or components to major acquisition programs, or to projects which are under laboratory development.

In April 1976, the Office of Management and Budget (OMB) released Circular No. A-109, entitled "Major System Acquisitions," to become effective in FY 79. This Circular provides the following definition for the system acquisition process: "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." Under this new scope, the acquisition manager, working in conjunction with the program manager, will become involved earlier in the program cycle with many of those management aspects that have traditionally been resolved at a later time. This accelerated acquisition management involvement should be compatible with the necessary strategies that must be developed in order to satisfactorily deal with new and volatile technologies. Technological acceleration may require changes in the very scope of acquisition management, which may encompass "cradle-to-grave" system considerations, possibly as early as the advanced or engineering development phases in areas such as GFE/CFE (contractor furnished equipments) decisions, qualification methodologies, configuration management, specifications, standards, and others.

Traditionally, the Naval Air Systems Command has managed three fundamental commodities: airframes, propulsion systems, and avionics systems plus related support equipments. This triad of commodity families will not change in the foreseeable future, but their definition, integration, and support concepts will undergo major modifications - changes brought on by the new directives of Circular No. A-109 and subsequent DoD/SECNAV Directives and changes created by rapid technological evolution. New airframes, e.g., advanced tactical remotely piloted vehicles (RPV), vertical/short take-off and landing (V/STOL) vehicles, and advanced missiles, will be very dependent upon increased, efficient utilization of new advanced technologies to achieve the reduced weights and life cycle costs that are demanded, while improving their collective availability (A), reliability (R), and maintainability (M).

Examination of these three families reveals several interesting aspects. First, there are relatively few aircraft manufacturers (aircraft, in this context, includes missile systems) and these few are spread across production of fixed and variable wing forms of attack, fighter, tanker, helicopter, and other conventional forms of aircraft, and missile and RPV types of airframes. The numbers of potential new military aircraft contractors appear to be few, if any, because of extremely high start-up and sustaining costs. In recent years, new aircraft design concepts have been somewhat volatile, with numerous new and innovative models emanating from this numerically small airframe base. However, the numbers of different Navy aircraft that have actually achieved full production stages have been few, primarily because modern economic constraints cannot support the high costs for numerous, large scale aircraft development/qualification programs. Even with encouragement from OMB Circular No. A-109, it is forecast that parallel engineering/production programs will not often be economically feasible; hence, it is predicted that acquisition management of airframes in the next decade will not differ greatly from that of recent years.

Second, the numbers of prime engine manufacturers are limited to a very few domestic sources (some may, however, be cross-licensed with foreign producers). Engine technology per se has a history of slow but thorough development and qualification before engines are permitted to achieve production status. Akin to the airframe market, military engine markets are highly concentrated and react positively to DoD requirements. It is not anticipated that drastic acquisition changes will be needed to comply with propulsion system procurements.

Finally, the electronics industry, producer of avionics equipments, is undergoing a period of unprecedented technological growth. Even though DoD heavily financed the early development, engineering, and production of equipments utilizing these technologies, it now commands a very small percentage of the market share, and can no longer apply the vast economic leverage that was once enjoyed. Recent technological breakthroughs, such as low cost large scale integrated (LSI) circuits, have created widespread high volume commercial market applications that were undreamed of just a short 5 years ago. Examples of these high volume, high profit commercial applications are watches, calculators, appliance controls, automotive controls, citizens band radios, point-of-sale terminals, etc.

In addition to obvious low cost advantages, these advanced technologies are providing consumers with highly reliable, easily maintainable equipments, goals NAVAIR has long sought but seldom realized in avionics subsystems. A recently released (1976) electronics industry market survey conducted by the Western Electronics Manufacturers Association noted that the profitability of electronic suppliers dealing primarily with military customers is one-half that of firms dealing with consumer markets, 5.5% versus 10.7%. Therefore, the future NAVAIR acquisition manager must not only be creative in realizing operational performance goals achieved within imposed economic constraints, but must be increasingly creative to "incentivize" contractors in meeting their requirements in a low-profit structured marketplace.

Development, application, and intelligent monitoring of a selected number of these advanced technologies will result in significant improvements in avionics equipment operational capabilities, sizes and weights, reliabilities, maintainabilities, testabilities, life cycle costs, standardization, and future alteration costs. In addition to careful selection and, if necessary, development of mission-unique technologies, the Naval Air Systems Command must develop and then utilize new acquisition concepts and elements regarding specification, procurement methodology, qualification testing methodology, preproduction and sample testing methodology, configuration management concepts, overhaul/repair concepts, and technological monitoring and tracking methodology.

Changes in the future course of NAVAIR acquisition management circa 1980-1990 will be driven by at least two primary factors. The first is time, or lack of it. Advanced technologies, especially the electronic technologies, will continue their accelerated growth and with this growth will come obsolescence. The acquisition manager cannot control the industrial economies associated with this growth, so he must learn to plan and grow with technologies rather than oppose or ignore them. He must plan his acquisitions, knowing their risks, by defining strategies that accommodate their shortfalls. Second, the recently announced OMB Circular No. A-109 of 5 April 1976 and subsequent DoD Directives 5000.1 of 18 January 1977, Major Systems Acquisitions, and 5000.2 of 18 January 1977, Major Systems Acquisition Process, will alter in some aspects the role of future acquisition managers. The following sections first address the issues of advanced technology and the resultant effects they have on the acquisition manager, and then examine the acquisition process and how it is becoming impacted by technological factors.

II. EXAMINATION OF ACCELERATED TECHNOLOGY EFFECTS ON ACQUISITION MANAGEMENT

A. Airframes and Propulsion

Earlier, it was projected that traditional acquisition management techniques will continue to apply in the general sense for airframes and propulsion systems. There will be exceptions, however, as new innovations are conceived, proven, and then adopted into production forms. When these occur, new and more modern forms of management must be developed.

The primary aircraft development programs of the 1980's will be the advanced, lightweight RPVs; Type A subsonic V/STOLs; possible VAMX (A-6 replacement); and several forms of advanced missiles, Since these platforms are all to be lightweight, versatile, and low cost, they will demand high levels of innovative advanced technology implementation. As an example, to insure that the V/STOL weight reductions are realized, integrated avionics equipment racking approaches could be employed throughout the aircraft. This concept would place more than one avionics system in a common rack or container by using printed wiring boards or ceramic plug-in pages for the various sustems, e.g., communications, IFF, LORAN, OMEGA, countermeasures, and stores management. This type of mechanization would significantly reduce avionics weights resulting from individual system cabinets, racks, supports and trusses, power supplies, cables, connectors, etc. In current airframes, volume is typically "allowed" for avionics equipments. Additional AIR-05 airframe acquisition management involvement early in the airframe development stages could positively impact the definitions of airframe/avionics/modular packaging interfaces, and thereby insure that all aspects of airframe-avionics interfaces were examined and evaluated for potential V/STOL weight savings. Other forms of technology driven aspects that involve airframe manufacturers will be advanced modes of thermal management (e.g., airframe/avionics equipment heat sink interface, quality and quantity of coolant air), composite materials (EMI, EMP, electrical discharge, shielding, grounding effects), fly-by-wire control systems, and others. High performance systems, such as airborne electronic warfare (AEW) radars that will employ conformal wrap-around airframe antennae, will require much earlier attention (potentially as early as exploratory development) by the acquisition manager to insure that all platform (airframe as well as avionics subsystems) requirements can be satisfied.

Engines and propulsion systems are generally furnished as GFE, and even though these will not require new forms of management, engine designers are turning to advanced electronic technologies for engine monitoring and control functions. Special high temperature silicon and hybrid packaging technologies will be explored to achieve improved operational performance in these very difficult environments. The acquisition manager and his team must stay abreast of the developments and develop their acquisition strategies accordingly.

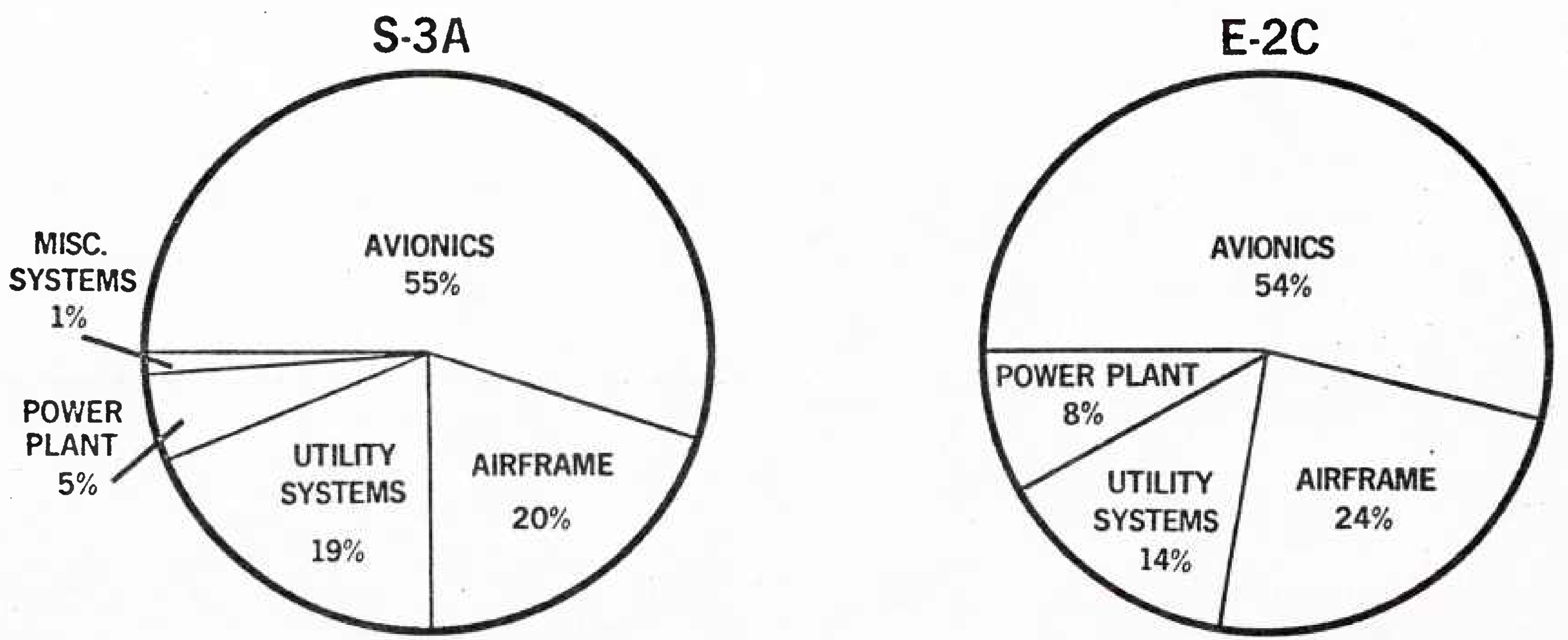
B. Avionics Subsystems

The third and final family of NAVAIR commodities, avionics systems and related support equipments, accounts for expenditures of approximately one-third of the annual NAVAIR material acquisition budget. Unlike airframe and engine counterparts, many of the technologies which directly support avionics subsystems are <u>not</u> militarily driven, and thereby encounter potential suppliers who are not always responsive to Navy/DoD requirements. Compounding this growing dilemma is the fact that only a small fraction of the electronic marketplace is DoD-consumed. Unfortunately, even this small share is decreasing annually, with a 1980 projection of DoD electronic markets accounting for less than 1% of the entire electronic marketplace. Thus, unless revisions to present forms of, or new dynamic concepts toward, acquisition management of electronic technologies are quickly brought on-line, the proper application and logistics support of these new and vital technologies in <u>current</u> as well as future systems will become increasingly remote.

Paradoxically, much of the electronic technology which DoD spawned and/or supported during its early development in the 1950's and 1960's is today providing high volume commercial applications with the very advantages that NAVAIR has long sought: lower costs, reduced size and weight, increased system availability through improved reliability and maintainability, and improved testability, Primary examples of these advanced applications are custom LSI, surface acoustic wave (SAW) devices, hybrid microcircuits, microprocessors and memories, fiber optics, and to a large extent, display technology.

The most dramatic examples of these occurrences are associated with the large scale integrated circuits, those silicon chips that contain thousands or tens of thousands of transistors in an area approximately 1/30th of a square inch. DoD and NASA LSI funding began in the middle 1960's and remained a predominant factor until the three chip, miniature hand-held calculator was introduced in the early 1970's. From that time on, DoD lost the favorable position it had earlier enjoyed with the semiconductor industry, as high volume commercial markets absorbed almost all highly qualified design personnel and most fabrication, test, and packaging resources. Current commercial applications include calculators, carbueretion and emission controllers, anti-skid controllers, digital watches, radios, point-of-sale terminals, home entertainment, and almost all forms of computers and memories. These products all display the positive attributes of reliability and speed and reduced cost, power, and weight; which the Naval Air Systems Command continuously seeks for upgrading and improving the Fleet's operational readiness posture. Figure 1 demonstrates the current failure scenarios of two modern Navy platforms, the S3-A and the E2-C. Avionics equipments are the primary failure contributors for each aircraft. Properly applied technology can improve this avionics subsystem reliability outlook, as demonstrated by reliable and maintainable commercial products, but it will not occur of its own volition.

AIRCRAFT SYSTEM FAILURE SCENARIO



PERCENTAGES ARE FAILURE CONTRIBUTIONS OF EACH SYSTEM CATEGORY TO TOTAL AIRCRAFT FAILURES.

BASED ON MAINTENANCE ACTIONS CONFIRMED AS FAILURES AT O&I LEVELS PER 3M DATA COLLECTED APRIL-SEPTEMBER 1976.

FIGURE 1.

In order to efficiently gain the advantages offered by new technologies in both current and future avionics subsystems, NAVAIR must first examine the present acquisition directives, policies, standards, and practices that were configured for the administration of either large weapons systems, or subsystems that were mechanized with mechanical and/or discrete forms of electrical elements. AIR-05 must then revise current or formulate new acquisition policies which are compatible with modern technologies and their volatile marketplaces. NAVAIR must also examine what current technologies are implemented in what equipments, and their resultant deficiencies; what future technologies must be developed to support specific mission-unique objectives, and most important, how will subsystems mechanized in these technologies by acquired and then supported throughout their operational lives. Critical deliberations such as CFE versus GFE, contractor warranties, government depot versus contractor depot, NATO standardization, and others will also enter into the consideration.

Technology time compression and associated obsolescence will require close NAVAIR-05/03 interface to evaluate future electronics needs, perform life cycle cost trade-offs, analyze multi-platform utilization probabilities, make GFE/CFE recommendations, identify modularization/standardization candidates, develop acquisition strategies, and identify associated technological risks. AIR-05 will find it imperative to work with AIR-04 in very early stages of program development in making specific logistics decisions. Figure 2 depicts the potentially frightening time compression impact that new technologies can place on logistic support scenarios. As each technology accelerates, its competitive life is shortened. This will force new AIR-05/04 tactics concerning platform and subsystem readiness issues, availability of spares, future production requirements, and potential mobilization needs. Tasks that will evolve will center upon specification development, procurement analysis and planning, market availability analysis, life cycle support developments tailored to specific hardware/firmware/software issues, qualification testing methodology, and

EFFECTS OF TECHNOLOGY ON AVIONICS EQUIPMENT LIFE CYCLES

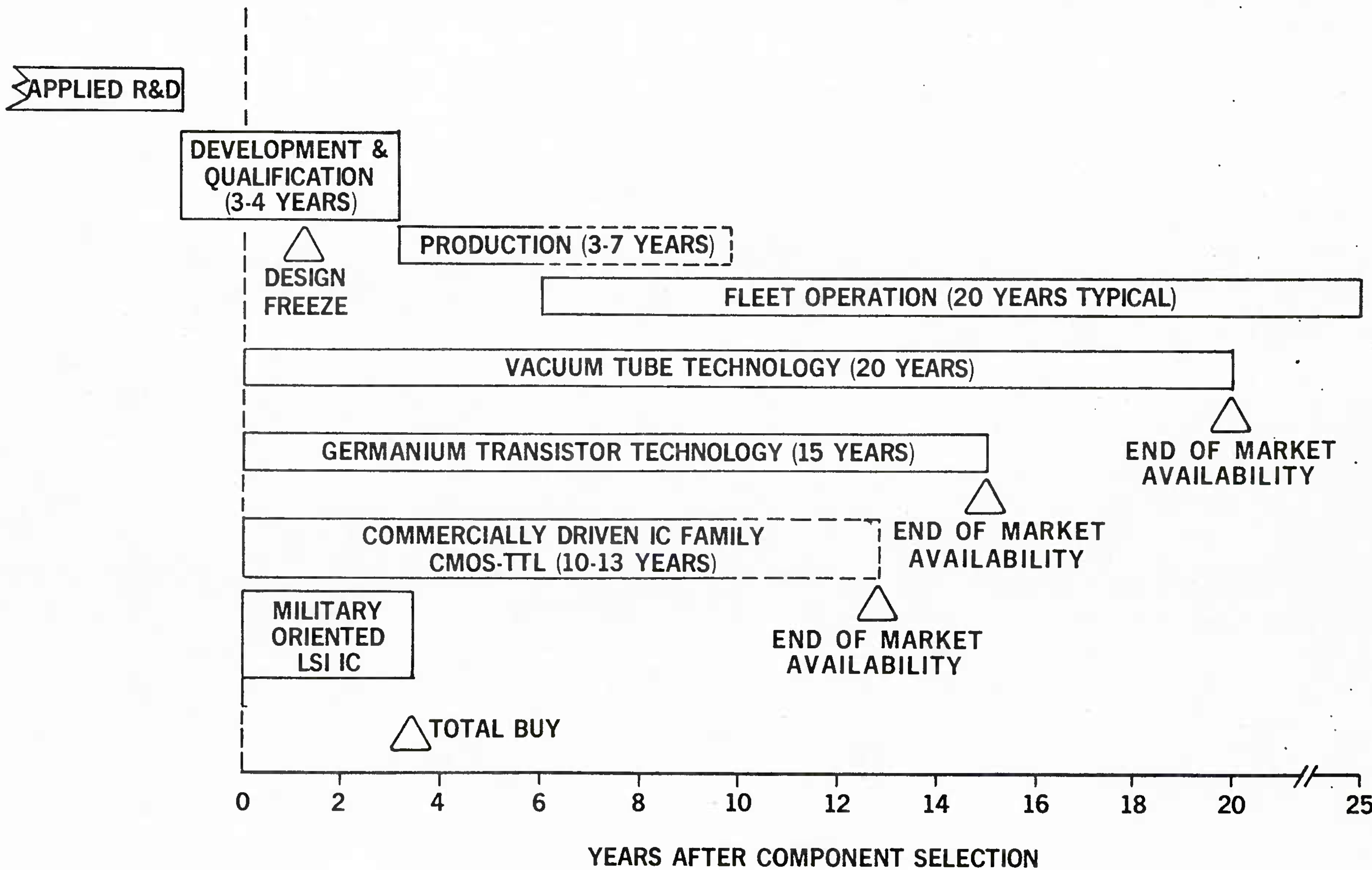


FIGURE 2.

configuration management concepts. Immediate acquisition management attention must be brought to these tasks, as they are real time problems presently confronting the Fleet.

During the course of a recent NAFI microelectronic study and investigation, serious conditions with respect to present-day and future microcircuit usage became increasingly apparent. One of the most significant problems is the extremely high certainty that many of the microcircuits with which many of NAVAIR's primary electronic systems are constructed have become, or soon will become, unavailable for purchase. The net result of this will be a critical shortage of components for support of additional systems, repair parts, and mobilization needs. The very real benefits potentially afforded to advanced aircraft equipments may be totally negated by traditional AIR-04/05 field logistic plans, unless proper advanced microcircuit technology management practices are first developed and then correctly implemented. Very fundamental changes must be undertaken in basic development, acquisition, deployment, and logistic support policies prior to initial acquisition, if a long term, manageable logistic support posture is to be realized. If such a plan is not developed and adopted, long term NAVAIR avionics logistic support will be utterly chaotic.

The Navy is being told more and more frequently by contractors that they are unable to supply the required repair parts, modules, and assemblies because they are now unable to buy one or more of the microcircuit parts required. In many cases, there are no direct substitutes, the space and power constraints eliminate the possibility of utilizing a discrete element replacement, and the costs of redesign and/or requalification are prohibitive. In these cases, a number of relatively unattractive options exist. These are:

- Development, test, and qualification of a replacement microcircuit from the original or an alternate supplier, or

- Development, test, and qualification of an alternate circuit mechanization which utilizes available microcircuitry, or

- The replacement of this system with a new system, causing the abandonment of a useful system due to the lack of one or more vital, but unobtainable, parts.

In many of the current cases, any solution to this type of problem results in the unavailability of repair parts, new production, and/or mobilization hardware for many months until the problems can be solved. The solution is accompanied by an unplanned expenditure of funds to pay for analysis, redesign, requalification, and production of replacement hardware and spares, technical manual changes, etc. The situation will become increasingly complex and proportionally more expensive with 1985-1990 avionics due to the anticipated increase in equipment complexity and packaging density.

To further complicate today's dilemma, NAVAIR's current electronic systems are filled with microcircuit products, produced by myriad suppliers with various manufacturing technologies, and present configuration control processes do not allow AIR-04 to identify "which" technologies (Rockwell PMOS/metal gate process, RCA CMOS/silicon gate double-guarded process, etc.) are employed "where" (e.g., A7, A6, P3) to do "what" (e.g., A7 navigation system, A6 central computer, HARM guidance system). As a result, the Navy will typically not be aware of a potentially serious, long procurement delay. Nor will the Navy be aware of the need for significant levels of R&D qualification and production funding until a few weeks or months after the needed parts are ordered, and the supplier becomes aware that he cannot purchase the necessary high technology parts for support of his production.

The following NAVAIR-05 actions must be taken on a priority basis to gain control of this very serious situation:

- New systems being developed for the Fleet must be procured in such a manner as to yield effective configuration, qualification, and logistic support control and support for the high technology portions of the system.

- Concepts and methods must be developed to reduce the severe time and cost penalties for qualification of primary advanced technology product elements. Methods must be developed to allow the use of pre-qualified elements in the initial R&D modules so that initial tests for feasibility, followed by ADM and EDM hardware, can utilize the final high technology product and eliminate or reduce the present problems relating to time/cost which preclude the utilization of these promising circuitry elements.

- Military specifications and requirements such as AR-5, AR-10, AR-30, and others must be reviewed periodically and updated to include effective coverage with respect to advanced technology structured systems.

The end effect of the NAVAIR management configuration, qualification, and logistic support control actions should be a computer-assisted technology guidance and configuration monitoring capability, giving NAVAIR the ability to identify which technology/manufacturing process/manufacturer combinations are being used in which portions of what Fleet electronic systems in which aircraft, missile, etc. With this information coupled with a real-time dialogue with the manufacturers involved, it will be a straightforward problem to:

- Identify technologies and/or specific manufacturing processes that are planned for abandonment with sufficient lead time to allow an orderly choice of operation including:

  - The utilization of an alternate part, or

  - A lifetime buy of the needed circuit component/ module, or

  - The purchase of an X-year supply and the initiation of the development of a replacement component under an alternate technology;

- Identify applications of this technology (i.e., Module 35A3 in the V/STOL Navigation System, Module 76A521 in the Communication System, etc.);

- Notify NAVAIR/ASO/CFA points that specific parts will no longer be available after a certain date and make recommendations regarding viable options.

In this manner, advanced technology circuit elements can be employed in vital Fleet hardware, but their use can be controlled to insure the ability to support these systems logistically for their anticipated service lives.

In summing up the discussion of this section, the 1980-1990 acquisition manager must be realistic in his judgments and assessments of technologies. He will be faced with technological obsolescence at unprecedented rates. He must learn to work within these futuristic time compressions and adapt his acquisition policies accordingly. This will require very close AIR-03/04/05 planning and cooperation. To quote Mr. David Shore, Division Vice President, Government Systems Division, RCA, "We can live with "Future Shock" in military electronics if we recognize it is here, if we plan how best to enjoy the fruits of technical progress while minimizing its dislocations, and if we depart from the current policy of stretching out production over a long number of years."

III. EXAMINATION OF ACQUISITION MANAGEMENT CONCEPTS

A. General

Recently announced changes in regard to Federal acquisition management policies introduced by OMB Circular No. A-109, and subsequent DoD Directives 5000.1 and 5000.2 (SECNAVINST 5000.1 and 5000.2 revisions have not yet been released), will affect the procedures through which AIR-05 acquires major weapons systems in the future. As outlined by Circular No. A-109, increased emphasis will be placed on marriage of mission needs, capabilities, priorities, and resources; from initial development through the introduction of the system into Fleet operations. Certain A-109 influences are already visible, such as the creation of PMA-269, the V/STOL Program Office, and supporting AIR-05/03 management and technical teams. Acquisition management strategies and V/STOL-supported exploratory (6.2) development projects are currently being set in motion. Contemporaneous acquisitions are being managed under the directives outlined in SECNAVINST 5000.1, "System Acquisition in the Department of the Navy," of 14 May 1976. Examination of known and anticipated deficiencies in the present approach can be beneficial in defining future acquisition management policies and roles. Current phases of the acquisition management process include program initiation, consisting of conceptual (research and exploratory development) and validation (advanced development) stages; full-scale development (engineering and prototype) stages; and production/deployment (pilot or limited production), followed by unlimited production and deployment. These various phases are graphically depicted in Figure 3.

The program management considerations outlined by SECNAVINST 5000.1 are, and will continue to be, directly affected by new technologies. These considerations are planning, programming, and budgeting systems; cost parameters, estimates, reporting, and review; integrated logistics support; test and evaluation; advanced procurement planning; proposal generation, evaluation, and source selection; review of contract work statements and related

Phases of Program Cycle DODDIR 5000.1 SECNAV 5000.1	Program Initiation			Full-Scale Development		Production/Deployment	
Program Phases DODDIR 4100.35	Conceptual		Validation	Full-Scale Development		Production/Deployment Fleet Support Sustaining Engineering	
RDT&E Program Structure OPNAVINST 3900.8 NAVAIR/ORDINST 4200.12				Engineering Development		Production (AIR/SEA) Deployment	
	Research	Exploratory Development	Advanced Development	Engineering Phase	Prototype Phase	Pilot or Limited Production	Unlimited/ Deployment Production
SECNAV/SECDEF Program Milestones DODDIR 5000.1	Program Decision DCP (Development Concept Paper)			Ratification Decision DSARC		Production Decision DSARC (Defense Systems Acquisition Review Council)	
Funding Category OPNAVINST 3900.8	6.1	6.2	6.3	6.4		6.6	

FIGURE 3. MAJOR DEFENSE SYSTEM ACQUISITION CYCLE

technical data; management information and program control requirements; contract administration/management; project/contract management change control; and contract cost performance measurement. A general program representation, including these considerations, is presented for reference in Figure 4.

The following discussions explore each of the acquisition manager's primary program considerations, and explore those elements which will require additional AIR-05 involvement in the 1970's and 1980's in order to meet the challenges confronting the Naval Air Systems Command in the form of new technology and subsequent technological obsolescence.

B. Planning, Programming, and Budgeting System (PPBS)

The objective of planning, programming, and budgeting is to assess the national objectives, convert them into the requirements of a program, relate resources to these objectives, and finally match available funds to the specific costs of a program. Simply stated, it is an attempt to make the best use of scarce resources to meet national security objectives. Acquisition management encompasses this process of planning, programming, and budgeting. It will be demonstrated in the following acquisition management program considerations that advanced technology will have a tremendous impact upon the planning, programming, and budgeting of future weapon system developments.

The Naval Air Systems Command goal will continue to be the establishment of totally integrated weapons systems' development and support programs, based upon directed projects oriented toward defined mission requirements. Satisfying these objectives will require increased acquisition management planning and new policies that continually assess mission requirements vs. technology progress vs. in-process technology programs to assure life cycle cost-effective utilization of advanced technologies. The acquisition manager must always be in a planning position to:

Conduct of Program: PROGRAM INITIATION — FULL-SCALE DEVELOPMENT — PRODUCTION/DEPLOYMENT

Mode of Operation:

Project Management (Major Systems) → (Authority by Charter; comprehensive responsibility, resource control and allocation)

Acquisition Management (Non-major Systems and Equipment) → (Responsibility extends from development to production and initial hardware support)

Program Considerations: (Life cycle planning, management, and execution utilizing prescribed DOD/Navy acquisition management techniques and procedures)

- PPBS (Planning, Programming, and Budgeting System)
- Cost Parameters, Estimates, Reporting, and Review (Life Cycle Costing)
- ILS (Integrated Logistic Support)
- Test and Evaluation
- Advance Procurement Planning
- Proposal Preparation, Evaluation, and Source Selection
- Review of Contract Work Statements and Related Technical Data
- Management Information and Program Control Requirements
- Contract Administration/Management
- Project/Contract Management Change Control
- Contract Cost Performance Measurement
- Deployment

FIGURE 4. NAVY ACQUISITION MANAGEMENT (OVERVIEW OF PHASES AND PROGRAM CONSIDERATIONS), SECNAV Instruction 5000.1

- Predict "too little/too late" shortfalls.
- Recommend corrective technology programs.
- Assure implementation of goal-oriented technology programs.
- Provide for adoption of acquisition practices and logistics support concepts compatible with technology advances.

The AIR-05 acquisition manager must work closely with AIR-03 during research and development (R&D) cycles and stress the following themes:

- R&D must consider reductions in cost-of-ownership.
- Mission requirements vs. technology progress vs. in-process R&D programs must be periodically reviewed for adequacy.
- Efficient liaison with industry must be maintained to assure proper direction (and non-redundancy) of in-house programs, and afford the opportunity to influence industry R&D (IR&D) programs.

Long-term management planning should also address the following technology-related acquisition cycle issues:

- Assuring continued emphasis on reducing life cycle costs.
- Adopting acquisition policies that encourage use of advanced technologies.
- Structuring manufacturing technology (MT) programs having high returns on investment.

- Pursuing logistic policy changes where mandated by advanced technology.
- Implications of CFE/GFE decisions.
- Encouraging standardization whenever practical.
- Insuring that incentives are adequate for proper industry participation.

As technology developments accelerate, technological obsolescence will become an even greater problem than it is today. Devices/components/materials may be available only for short periods of time unless sufficient economic incentives are provided (primarily from the commercial sector) to assure production longevity. The acquisition manager must be in a position to decide which technologies should be used and how they should be supported, so that adequate planning and budgeting can be performed. This will result in the need for accelerated AIR-05 and AIR-04 involvement.

Future acquisition planning must place increased emphasis on life cycle cost trade-offs. If the advantages of high reliability and low maintenance, available through utilization of advanced technologies, are to be achieved, then greater development and procurement costs will be incurred earlier in the acquisition cycle. This is contrary to present "low initial procurement - high logistic support" cost methodologies. Research, development, and engineering (AIR-03 and AIR-05) requirements, as well as logistic support (AIR-04) requirements, must be used to determine which advanced technologies should be used, and how they must be properly supported once selected for use in an equipment. The system designer can no longer be permitted to make hardware design decisions based solely on design considerations. The successful acquisition manager must plan, program, and budget, based on life cycle considerations, beginning in the program initiation phase; and require designers to justify design approaches/

changes in terms of life cycle techniques. These considerations are also valid for development, deployment, management, and operational support of system software.

This initial planning by the acquisition manager will result in requests for the budgeting of funds at earlier stages of acquisition. Because of the use of advanced technology, life cycle cost studies may mandate revision/change of traditional budgeting cycles. Earlier funding will be required to support higher design costs for equipments that use advanced technology, to purchase one-time lifetime support quantities, or to purchase and store unique tooling. These potential changes will alter present budget concepts. An acquisition manager will have to utilize life cycle cost studies to make convincing budgetary presentations justifying the "up-front" costs of advanced technology in order to achieve the low-cost pay-offs realizable during equipment life.

C. Cost Parameters, Estimates, Reporting, and Review

SECNAVINST 5000.1 cites the requirement to establish cost parameters that reflect the total cost of acquisition and ownership. Life cycle costing (LCC) is the acquisition process for estimating operation, maintenance, and other cost parameters, in addition to initial design/development costs. The objectives of LCC are to:

- Develop cost data for evaluating development, engineering, acquisition, and logistic trade-offs.
- Provide data for estimating total program costs.
- Seek lowest total cost of ownership during initial acquisition process.

If future systems are to realize the performance and cost benefits truly offered by high degrees of advanced technological implementation, NAVAIR must very carefully evaluate contractor proposals based upon LCC rather than the initial design, development, and initial production cost evaluations that are typically performed today. These LCC considerations should be applied during the program initiation phase and continued throughout all acquisition phases. Advanced electronic technologies can offer the opportunity for reduced life cycle costs because:

- Utilization of high volume, high reliability advanced technology devices will reduce avionics acquisition and support costs.

- Reduced weight, size, and power requirements afforded by highly integrated avionics will diminish airframe, fuel, air conditioning, and power system acquisition and maintenance costs.

- Advanced digital architectural concepts, e.g., built-in test, will significantly reduce support costs while increasing system availability.

These potential benefits will never be realized if typical system procurements are based on front-end acquisition costs alone. It has been demonstrated that low volume engineering development and prototype development contracts are generally won by contractors employing simply architectured system designs that can offer less than desirable costs of ownership if follow-on production quantities are great. The benefits of technology, as well as the potential logistics support problems created by accelerated obsolescence, can only be considered within the framework of LCC and must be evaluated prior to development.

Historically, acquisition managers and contractors/designers have quickly seen the physical advantages offered by advanced technologies, higher packing densities, reduced weight, higher speeds, lower power dissipation, etc., during the development phase of acquisition. Procurement costs during these early stages are easily established from contractor proposals or government cost estimates. Hidden, however, is the reality that every technology becomes obsolete, and with obsolescence comes lack of spares, system unavailability, redesign costs, high requalification costs, etc. Therefore, careful acquisition strategy and close scrutiny of LCC elements are critical. Some of the LCC elements that must be considered early in the acquisition process when decisions are made concerning the use of the latest technology are:

- Cost of replacement spares - High costs to replace obsoleted spare parts could be avoided if sensible procurements of lifetime quantities of devices were made prior to the time the devices became obsoleted by production of more advanced components, or some other sensible option were developed prior to part unavailability.

- Cost of equipment maintenance - What will be the cost savings in maintenance dollars of using smaller, more reliable devices? Due to the projected higher density and reduced cost per function of future solid state devices, the device cost may be so low that modularized units can become throw-away items during the remove-and-replace maintenance actions on deployed equipment. If modular units are not throw-aways, and unless circuit architectures are developed with built-in test (BIT) or built-in test equipment (BITE) primary requirements, maintenance at base or depot repair facilities may be significantly more complex as to increase depot maintenance costs. These concepts must be examined and evaluated during the life cycle cost trade-offs.

- Cost of supply management - Costs are incurred each time a new supply part/software program is introduced into the supply system and additional costs are incurred in maintaining inventory throughout the system life. As designers take advantage of newer, improved technology mechanizations (that may be considered the "latest" only for a few months/years), commonality of components/software between deployed systems will drastically decrease. More new supply parts will have to be added to the supply system with a potential increase in overall supply costs. Miscalculation of anticipated repair parts requirements during final procurement for lifetime repair parts will result in high costs for custom design or redesign of replacement parts.

- Cost of new facilities - Facilities include any new support facilities and equipment necessary to the maintenance of a deployed equipment. Again, the variety of new devices and the degree of sophistication of these devices may require new specialized equipment at support facilities at all levels of maintenance. Requirements for storage facilities for the devices and maintenance of unique tooling, such as LSI masks, must be entered into the life cycle cost equation.

- Training costs - Personnel training costs may be affected by the increasingly complex devices that will be utilized in the 1985 time frame. The "modular throw-away" maintenance policy will be increasingly popular and possible with the low cost multi-function devices available in the future. This policy may reduce the technical level of personnel needed at Fleet level activities, but will increase the technical competence needed at higher level maintenance facilities (e.g., depot) to support and repair high technology mechanized systems.

These LCC elements are a few of the considerations the acquisition manager will have to include in his management program, if the new technologies are to be successfully used. Life cycle costing appears the best acquisition management technique currently available to aid in making these considerations. LCC provides a method to discriminate among design alternatives proposed by a single contractor. In addition, LCC is compatible with the acquisition concept of OMB Circular No. A-109, in which parallel contracts are encouraged for development and production. The LCC model can then provide a comparison of acquisition and support costs, between proposed design approaches of two or more contractors, during source evaluation/selection. Whatever the phase of acquisition or size of the project, some tailored approach of LCC appears mandatory as an acquisition tool.

Reporting and review functions as defined by 5000.1 should not be directly affected by technology such that their formats should remain similar to those used today.

D. Integrated Logistics Support (ILS)

With the increased pace of technology, the ILS function will take on an even more important role in the acquisition of equipment. Currently the acquisition manager is responsible for the concurrent planning, design, and acquisition of logistics support resources. He normally accomplishes this through the AIR-04 assigned logistics manager. The logistics manager may be organizationally assigned to the logistics organization (AIR-04), but he is responsible for assuring that all logistic support requirements are defined and that the requirements are specified in appropriate contractual and project management documents.

Government directives such as AR-30, "Integrated Logistics Support Program Requirements for Aeronautical Systems and Equipment," and NAVMAT INST 4000.20, "Integrated Logistic Support Planning Policy," will require that ILS considerations be initiated during the program initiation phase of projects/programs. DoD Directive 5000.1 warns that during early development, only those ILS parameters that have significant impact on system readiness, capability, or cost should be considered and that premature introduction of detailed support considerations should be avoided. As a result, the acquisition manager, assisted by the logistics manager, must decide which logistic support considerations need to be addressed during each phase of the system development. With advances in technology, coupled with the realization that advanced technology devices may be procured for a relatively short period of time, the logistics manager must participate in the acquisition process at an earlier phase.

During the program initiation phase, AIR-03 and AIR-05 should provide AIR-04 with preliminary system design specifications, system effectiveness parameters, and proposed GFE. Due to the widespread use of advanced devices foreseen in the 1990's, the logistics manager will have to plan and influence the acquisition process at a much earlier point than is presently the case. New facility requirements, level or repair decisions, and GFE vs. CFE trade-offs are a few of the ILS considerations that must be addressed very early in the new system development cycle (program initiation phase). For example, 1985-1990 silicon device technology changes may require new types of facilities such as those for storage of microcircuit devices, as well as long term storage for unique tooling such as LSI production masks. Level of repair decisions may drastically affect the decision to utilize "well-established" technology in lieu of technologies still in early stages of development. AIR-05 and AIR-04 will work very closely in defining software/firmware requirements and then establishing support strategies. Firmware components such as EAROMs (electrically alterable read-only memories) have not been dealt with effectively to date, and their configuration management still remains somewhat of a mystery. Components of this type will become commonplace in the 1980's, offering greater flexibility and circuit performance, but unless properly controlled, their logistic management and support will become a nightmare.

Earlier ILS involvement is not restricted to the program initiation phase of the equipment development cycle. During full-scale development and production phases, other logistic considerations take on new importance and urgency. No longer can spare parts/provisioning support decisions be delayed until the end of the production phase. The need will exist for early ILS planning to determine if lifetime buys of parts should be made during equipment production for those devices which will likely be "procurable" for only short periods, or risk later redesign/requalification with a new replacement microcircuit.

It appears that the impact of advanced 1990 technology on ILS will:

- Require earlier consideration of ILS in the acquisition management cycle.

- Place new emphasis on the importance of ILS planning in all phases of acquisition management, i.e., review of utilization of existing instructions/guidelines to the fullest extent, as applicable, with rewrite as necessary.

- Require increased awareness by the logistics manager of advanced technologies and their potential impact upon equipment support.

While the ILS portion of the acquisition process will not be significantly different in the 1990's, better logistic planning will become an absolute necessity for successful project deployment. As a result, the acquisition manager and the logistics manager will change - they will be more "technologically aware" and will become actively involved during earlier stages of equipment acquisitions than their traditional counterparts. Together, they must insure that logistics-oriented concepts are designed and developed into new systems, subsystems, and components, and that increased awareness is placed upon maintenance concepts, support equipments, test concepts, engineering data packages, provisioning, and human engineering. New forms of aircraft, such as V/STOL A, which may be deployed upon small destroyer-type ships, must face the realities of restricted space allotted for maintenance, spares, and expendables. Therefore, future avionics systems must be acquired that emphasize modern logistic concepts on an equal basis with traditional design and operational performance requirements.

It is urged that NAVAIR review existing management programs to insure monitoring of advanced electronic technologies used in Fleet hardware. Specific objectives should be:

- Formats, and implementation and monitoring methods for contractor device data collection, correlation, and logistics planning and procurement.

- Specific change control requirements and processing procedures for application of advanced technologies.

- Source monitoring techniques relating to nonstandard custom advanced technology devices.

- Qualification procedures and specifications that are compatible with new highly reliable technologies.

E. Test and Evaluation (T&E)

SECNAVINST 5000.1 states, "The objective of the overall operational test and evaluation effort for any program is to aid in providing, at major decision points in the development and acquisition process, the best information possible at that point in time as to: the military utility of the prospective system; its expected operational effectiveness, operational suitability (including reliability, maintainability, simplicity, logistic, and training requirements); need for modifications; and the organization, doctrine, and tactics for system deployment." This objective is met by timely and predetermined periodic testing of components, subsystems, systems, and finally operational aircraft. Traditional aircraft/system test and evaluation (T&E) concepts will change little in the next decade unless affected by new Circular No. A-109 strategies; but component, module, and possibly subsystem testing qualification may require substantial revision, due to electronic technology acceleration. Adding significantly to the complex T&E function is the tremendous growth in software/firmware oriented hardware systems. Not only are mission requirements becoming more complex, requiring increased hardware complexity and resultant higher test costs, but sophisticated software/firmware packages are very expensive to debug, test, qualify, and configuration manage.

AIR-05 representatives must work together with AIR-03/04/06 to formulate new acquisition and qualification concepts to deal with advanced and potentially high reliability technologies needed for V/STOLs, RPVs, etc., such as large scale integrated circuits, fiber optics, surface acoustic wave devices, microwave integrated circuits, and others.

Traditional qualification techniques are not technically or economically practical when dealing with new methodologies such as LSI. The following paragraph, taken from NAFI TR-2042, "Application of Large Scale Integration (LSI) Technology to Design and Production of Advanced Military Airborne Systems (U)," demonstrates why new qualification concepts are needed.

"Failure rates could be more easily established if LSI devices were more failure-prone. Because of their inherent reliability, it would require, assuming a constant failure rate, in excess of 2300 devices operating 1000 hours (2.3 million accumulated test hours) each without a single failure to assure, at a 90 percent confidence level, a 0.1 percent per

1000 hour failure rate. By permitting just one device failure, the number of devices under test would increase to almost 3900 (3.9 million hours). An assured failure rate of 0.01 percent per 1000 hours would escalate the test device count to 23,000 (23 million hours) and 39,000 (39 million hours) respectively, for zero and one failure. Confidence levels, operational stresses, and test durations can all be manipulated to determine the number of devices that need to be tested, but the real reliability problem is difficult to grasp without sufficient standardization information such as that which can be obtained through studies of large quantities of LSI units. As a result, the employment of custom LSI in low volume avionics systems is frequently not compatible with standard military life test programs in determining failure rates, as the number of test devices required and the length of time needed to establish accurate reliability data would extend development cycles and costs beyond cost effective limitations."

One potential new methodology would be the qualification of certain electronic building block diagram elements, and subsequent qualification of production facilities for those elements, in highly reliable technologies such as LSI, MIC, and SAW devices. A custom military product, designed and fabricated using these guidelines/facilities, would then need not be qualified at the component level, but instead would be one-time qualified in an all-up status at the subsystem/system level. Periodic requalification of design elements, and production processes and facilities, would insure that military quality was not compromised.

Test and qualification of software must be thoroughly examined, and modern means of debugging, testing, and qualifying tactical software and firmware must evolve. Software and firmware costs in the late 1980's will be many times that of modularized computing hardware, such that software/firmware qualification costs can be expected to be the primary driving economic factor in future test, evaluation, and qualification programs.

NAVAIR must insist on standardized software languages, and minimize proliferation of programmable memory array types.

New innovative design concepts and systems architectures should be encouraged that would increase operational capability by only software modification, replacing/updating electronic modules, subsystems, etc., without requiring major system requalifications and aircraft overhauls. An example of this would be the plug-in expansion of memory capability (from 16K to 32K words of computer core) in a tactical computer system.

Other areas of qualification that should be examined or streamlined by AIR-05 in order to cope with advancing technologies are: GFE and, especially, CFE non-standard parts; tactical software; and the various forms of field programmable firmware. Many components that should be submitted for GFE and, especially, CFE non-standard parts scrutiny and approval and disapproval are often waived, perhaps because of insufficient test and qualification funds or insufficient lead times. In the case of complex digital circuitry, qualification testing is many times impractical due to insufficient and/or inadequate test equipments, insufficient program scheduling time, or high costs required for additional samples necessary for adequate testing.

Software programs and firmware forms of hardware must also be examined for innovative qualification concepts. New and aggressive software quality control and reliability proofing concepts must be pursued. The following three paragraphs address software reliability and are factors that must be addressed by the acquisition manager during the various phases of the acquisition cycle. The paragraphs are taken from the NAFI report "V/STOL Avionics Technology Management Concept Overview," Revision 1, of 21 January 1977.

"Reliability of software can be achieved by aggressive quality control during the software life cycle. The quality assurance procedures are used to systematically assure that the quality of the software will meet the needs of the users, will be in accordance with applicable standards and specifications, and will be designed to minimize the probability of system failure during operational use.

"Factors which influence the reliability of the software include:

1. Specifications, standards, system requirements, and the contract.

2. Software documentation.

3. Software standards and conventions, which include the developer's "in-house" procedures for developing software.

4. Software self-test and defensive programming, including input/output parameter reasonableness checks, smoothing, sum checking, overflow compensations, failure diagnostics, etc.

5. The software design, including its logic design, modularity, and the amount of interdependence between the program units.

6. The programming language.

7. The operating stability of the software, which is its ability to handle power interrupts and to perform orderly shutdown without the loss of resident data or program control.

"8. The provisions in the software for monitoring the status of the weapon system equipment and the computer on which it is running.

9. The provisions in the software for degraded modes of operation due to failure of the weapon system equipment and/or the computer on which it is running.

"The techniques for ensuring effective quality control and reliable software are:

1. Design review throughout the development phase to assure completeness and accuracy of the requirements and documentation materials, which include such items as specifications, documentation, flow-charts, and software.

2. Audits throughout the software life cycle to assess the conformance of the software system with technical and management requirements and standards.

3. Test and Evaluation (T&E) throughout the entire software life cycle.

4. Configuration management procedures, including the establishment of a software change review board at the end of the software development cycle.

5. Data management procedures.

"6. Close liaison between all activities responsible for avionic system hardware and software that interfaces with the weapon system software where modification of the avionic system hardware/ software would impact the weapon system performance."

It cannot be emphasized too much that unless properly managed, software test and evaluation will become an overwhelming burden, in terms of cost and time, in the life cycles of new weapons platforms.

F. Advance Procurement Planning

Advance procurement planning is the means by which the efforts of all personnel responsible for the procurement of systems and equipments by contract are coordinated as early as practical in the acquisition process. The advance procurement plan serves as the long-range procurement planning document for the program life cycle, and plays an important role in acquisition management. The procurement plan thus includes the total procurement "game plan" and associated acquisition strategies, from the program initiation phase through production and initial deployment phases. The acquisition manager is responsible for initiating and maintaining the plan. The plan shall include such fundamental considerations as funding, schedule, choice of procurement method, competition, source selection, GFE/CFE decisions, delivery, possible follow-on requirements, and contract and technical administration.

It is in this plan that the acquisition manager can formulate and document basic acquisition strategies. The formulation and application of these strategies will be influenced by revised DoD Directives 5000.1 and 5000.2 of 18 January 1977, which are in turn directed by OMB Circular No. A-109. The requirements to (1) solicit major weapons systems in terms of mission needs versus traditional requirements/specifications, and (2) award parallel contracts (when determined practical under economic, schedule, and management constraints) to two or more contractors to competitively explore and identify alternative design concepts, versus traditional follow-on series forms of contracting, are the primary factors that will affect procurement planning. The acquisition manager must rely heavily on his technical team in determining what constraints he must still mandate on contractors under this new, somewhat "loosely defined" form of procurement.

Early, difficult GFE/CFE decisions must be made. Will the element be multi-purpose, multi-mission, or will it be dedicated, mission-unique? The risks of CFE equipment designs that are closely aligned with narrowly based, commercially driven advanced electronic technologies must be evaluated. If the CFE approach is best, then early logistic planning must be initiated by AIR-05/04 to insure that long term supportability plans are developed, which may include such actions as early lifetime component buys to support follow-on production, repair parts, and potential large scale mobilization.

Standardization issues must be addressed, as commonality of subsystems between aircraft types may dictate that equipments be GFE. Will equipment be used by the NATO community, and if so, will subelements be produced by foreign contractors? Will those countries have access to CFE design and advanced technical processing, assembly, and test information? Who will be responsible for follow-on CFE foreign system support when technology passes by the components used in system mechanizations - the contractor, NAVAIR, DoD, or some other agency?

Logistic related software and firmware GFE/CFE decisions will play greater roles in determining the courses of future procurement strategy scenarios. With increased proliferation of platform wide, interactive computer architectures, the acquisition manager must decide at an earlier program stage just how he will manage these new and complex mechanizations.

It appears that the acquisition and logistic-related impacts of fast-paced, advanced technologies will drive the NAVAIR acquisition manager toward GFE subsystem forms of procurement in those applications that are multi-mission, multi-national, and highly technology-dependent. Subsystems that should be considered as GFE due to multi-aircraft applications include computers, communications, command, navigation and guidance, identification, flight control, and control and display.

G. Proposal Preparation, Evaluation, and Source Selection

The intent of proposal preparation, evaluation, and source selection, which is basically the comparison of industry-offered alternatives in response to a government-defined requirement, is not expected to change dramatically in the next decade. Even the process of proposal evaluation, and subsequent selection(s), should not vary from present methodology, with several exceptions. First, the acquisition manager will be required to rely more on the technical expertise available from government laboratories and field activities. Many technical considerations, trade-offs, and subsequent risk factors can only be judged and evaluated by knowledgeable individuals with "hands-on" experience. The acquisition manager must support and use this in-house technical capability in achieving the AIR-05 mission.

The acquisition team must investigate existing specifications and standards to determine if they are adequate and their requirements are compatible with technologies proposed by the various contractors. Certain specifications need to be revised to permit increased but controlled use of new, low-cost technologies. This may require the generation of subsystem specifications that emphasize, rather than discourage, use of advanced technologies. This will require the generation of new qualification, reliability demonstration, and second source requirements.

Improved configuration management data are, and will continue to be, required. NAVAIR-05 must establish new data submission requirements. In addition, it must establish formats, and implementation and control methods for contractor advanced technology data collection. A first step would be the creation of universal Data Item Description (DID) requirements for the following categories of advanced devices:

- Commercial (non-MIL-Standard) SSI/MSI/LSI
- Universal arrays (UA)
- Programmable logic arrays (PLA)
- Programmable read-only memories (PROM)
- Hybrids
- Custom LSI

This should be a first step in establishing a modern configuration management concept to suitably deal with new technology, but it can only be successfully dealt with at the beginning of a program, and thus must be considered during the proposal preparation.

Second, in accordance with the new acquisition concepts outlined by OMB Circular No. A-109, and further refined by subsequent DoD Directives 5000.1 and 5000.2 (Major System Acquisition Process), the acquisition manager will attempt to solicit a broader base of industry and government proposals, such that full potentials of new technologies can be considered and properly evaluated. This extensive solicitation foundation is needed to tap the ever-increasing technological advances that can offer solutions to complex mission requirements. Many proposals will offer systems' implementations that reflect technologies that are still in conceptual or early stages of development. The acquisition manager must recognize the risks; some concepts may not be feasible, others may be obsoleted quickly, and some will reach true fruition. The acquisition manager must avail himself of the technical expertise resident in laboratory and field activity personnel with "hands-on" experience. By relying on the total technical community, both at Headquarters and in the field, the acquisition manager will have greater confidence that he has identified the viable options for incorporation in the procurement specifications; that the selected design approach will be based on technologies which are approaching the apexes of their respective maturity cycles as the acquired avionic systems are entering the production phase, and that NAVAIR will be able to support the system in the Fleet for the anticipated service period.

Finally, the acquisition manager must place increased emphasis on requirements for identification of the "technology to be used" issues during contractor proposal evaluations. Acquisition management personnel and the directives they use should clearly indicate the need for proposals to include: (1) planned use of new technologies; (2) current status of these technologies in their development cycle; (3) plans to assure the mature state of the technology during the production phase of the equipment under development; and (4) options for life cycle support of high technology products. These evaluation criteria are not new, but the anticipated technology of the 1980's gives them significant new levels of importance. The acquisition management process of the future must encourage new technologies and their applications in equipment developments. However, the acquisition manager must be able to minimize the associated risks by evaluating parallel approaches (or proposals), and by critically reviewing the proposed applications to determine if the need justifies the risks, or whether the requirements can be fulfilled using more mature, "standard" mechanizations.

H. Review of Contract Work Statements and Related Technical Data

Review of contract work statements and technical data, as defined in the acquisition process of SECNAVINST 5000.1, includes a review of all technical data used in a solicitation. Among other things, the review of the "technical data shall be generated and modified so as to be affected by technical (state-of-the-art) . . . constraints." In addition, the review includes "the technical risks for the Government and the prospective contractor." If the acquisition process is to take advantage of rapid technological changes, the acquisition manager will have to remain "aware" of the latest advances. The acquisition manager, however, may not be aware of all state-of-the-art technologies, and consequently his review of technical data/contract work statements may be limited. Two alternate solutions exist.

First, a field activity can "fill the gap" by providing high technology data to the various cognizant NAVAIR organizations reviewing the technical data/contract work statements, or the field activity can provide actual review analysis of the data. In this manner, advanced technology expertise provided by Navy/government personnel can be quickly applied to the contract review. A second solution is the approach of OMB Circular No. A-109, in which requirements are provided by "mission or capability needs" to the contractors, and the individual contractor is allowed to propose his particular use of emerging technologies. The acquisition manager must not sidestep his responsibility to insure that the selected technologies are supportable when the hardware is delivered to the Fleet.

The acquisition manager will have similar problems in assessing "the technical risks for the Government and the prospective contractor." The two alternatives previously discussed would again apply. In-house technical monitoring is the more desirable approach to assure that technology can be satisfactorily applied to meet mission objectives. In addition, the technology review team must insure that the work statement addresses those standardization issues needed to meet Navy, Navy/Air Force, and NATO requirements. Data requirements, adequate to cover the utililization of advanced technologies, must also be included. Logistics considerations such as spare parts, maintenance levels, support equipments, data packages, and maintenance concepts cannot be left solely to the contractors' individual initiatives. These must be given careful consideration by the acquisition manager and his team during the generation and internal evaluation of the contractual document and associated technical review.

I. Management Information and Program Control Requirements

For effective management control, a management information system should be designed to provide adequate feedback information without unduly burdening the preparer. The Work Breakdown Structure (WBS) of MIL-STD-881 provides overall guidelines for development of a family tree of hardware, software, services, and other work tasks which define the project or equipment. This structure provides a framework for reporting progress and status of each element of a project. The WBS will remain a valid technique for information of future acquisitions.

The traditional SECNAVINST 5000.1 acquisition process recognizes the need for management information and control. Advanced technology and the accompanying need for early consideration of its life cycle impacts simply emphasizes and accelerates the need for management information. The acquisition manager cannot consider all consequences of technology without current threat analyses, current mission requirements, adequate life cycle studies, predicted state-of-the-art risk statements, and information stating advantages of state-of-the-art devices. Considering OMB Circular No. A-109, in regard to solicitations in terms of mission objectives and parallel short term contracting, there appears to be a greater need for management information - information to evaluate the validity of each contractor's approach toward the achievement of a mission requirement on an informed basis. Management information has been and will remain the manager's technique of evaluating program progress and making program decisions.

J. Contract Administration/Management

The purpose of contract management is to detect, define, and resolve cost, technical, and schedule problems. The NAVPRO-type organizations act as agents for AIR-05 by interfacing with the contractor on all matters affecting performance on existing or proposed contracts. If these agents are to be effective in alerting the Government managers to potential acquisition problem areas and in evaluating contractor data to determine its credibility/utility to the Government, then NAVPRO organization personnel must be knowledgeable of technological advances and subsequent potential impacts on acquisition and logistics. This will require that NAVPRO personnel periodically be trained in advanced technology-related areas if they are to review the credibility of the contractor data. In addition, NAVPRO personnel will have to be made aware of the high risks involved with the use of emerging technologies in hardware and resultant software development/ production contracts.

A "team effort" between the acquisition manager and NAVPRO personnel must be developed which emphasizes the importance of information/data feedback in regard to technical problems. SECNAVINST 5000.1 clearly states, "appropriate agreements shall be reached between responsible Headquarters elements and appropriate NAVPRO/SUPSHIP authorities with respect to the responsibility of each, relative to specific acquisition programs." Greater emphasis on this communication between the acquisition manager and NAVPRO will be required due to the increasingly complex technologies of the 1980's. If the acquisition process is to be successful while taking advantage of the latest technologies, accurate information and assessments concerning contractor performance via NAVPRO will be of utmost importance.

K. Projects/Contract Management Change Control

Advanced technology will have little effect upon the process of contract change control. Changes during the developmental phases of acquisition are normal and contracts should have provisions for them. As each succeeding phase in the acquisition process is reached, changes become less desirable and will require careful review before approval and implementation. As discussed earlier, hardware and software life cycle cost studies and the resultant trade-offs will become an increasingly useful tool to be used by the acquisition manager as a means of evaluating proposed hardware/software changes. These same life cycle models should be utilized by the contractor to consider his proposed changes before submission to NAVAIR. Otherwise, the review, approval, and implementation of changes will be managed in accordance with existing procedures.

L. Contract Cost Performance Measurement

The appropriate procedures for the monitoring of progress and reviews of contractor compliance should not be affected in the next decade.

M. Legal Review of Weapons

The appropriate process of review in accordance with the proper SECNAV instructions for legality of weapons should not be affected by technology.

IV. EXAMINATION OF NEW ACQUISITION MANAGEMENT CONCEPTS

Recent conceptual changes to acquisition management set forth in Circular No. A-109 and subsequent DoD Directives 5000.1 and 5000.2 will alter to some extent the methodology that AIR-05 will use in acquisition of major platforms and weapons systems. These directives are placing accentuated emphasis on marriage of mission needs and capabilities, priorities, and resources; from initial development extending through introduction of the system into Fleet operation.

A-109 outlines those acquisition management objectives that are to be followed in the acquisition of future major systems. Initial applications of these management objectives are to begin in FY 79. The following paragraphs list the new Federal acquisition objectives and are taken directly from Circular No. A-109:

"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 appropriate trade-off (sic) among investment costs, ownership costs, schedules, and performance characteristics.

d. Provide strong checks and balances by ensuring adequate system test and evaluation. Conduct such tests and evaluation independent, where practicable, of developer and user.

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 an acquisition strategy for each 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 for use 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 ° 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 the design-to-cost ° 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 state in the acquisition process ° Administration of contracts.

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) ° 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 significant costs, schedule, or performance variances occur ° 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."

In addition, Circular A-109 places increased demands on policies that agencies, when acquiring major systems, will (quoted from Circular A-109):

"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 on the initial activities of the system acquisition process to allow competitive exploration of alternate system design concepts in response to mission.

. . . .

d. Establish clear lines of authority, responsibility, and accountability for management of major system acquisition programs. Utilize appropriate managerial levels in decision making, 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."

The culmination of these management objectives and policies is realized in the major system acquisition process. A pictorial presentation of this process cycle is depicted in Figure 5. Examination of these new directives reveals variances from current acquisition methodologies.

First, from DoD Directive 5000.2, "the early planning is to emphasize competitive exploration of alternatives to avoid premature commitments to solutions that may prove costly and marginally effective. The solicitation for proposed solutions shall be in terms of mission needs and not explicit system requirements." Traditional approaches tend to be serial in nature and oriented toward fulfillment of detailed specification requirements.

While not charged with direct responsibility for exploratory and advanced development, the AIR-05 manager must insure that proper considerations are paid to those acquisition concerns affected by advanced technologies, and the subsequent consequences of rapid technological obsolescence. He should appoint technical representatives from AIR-05 Headquarters and/or field activities to monitor technological progress and to flag potential acquisition problems should they occur. In some situations this may require parallel project activity by the field activities.

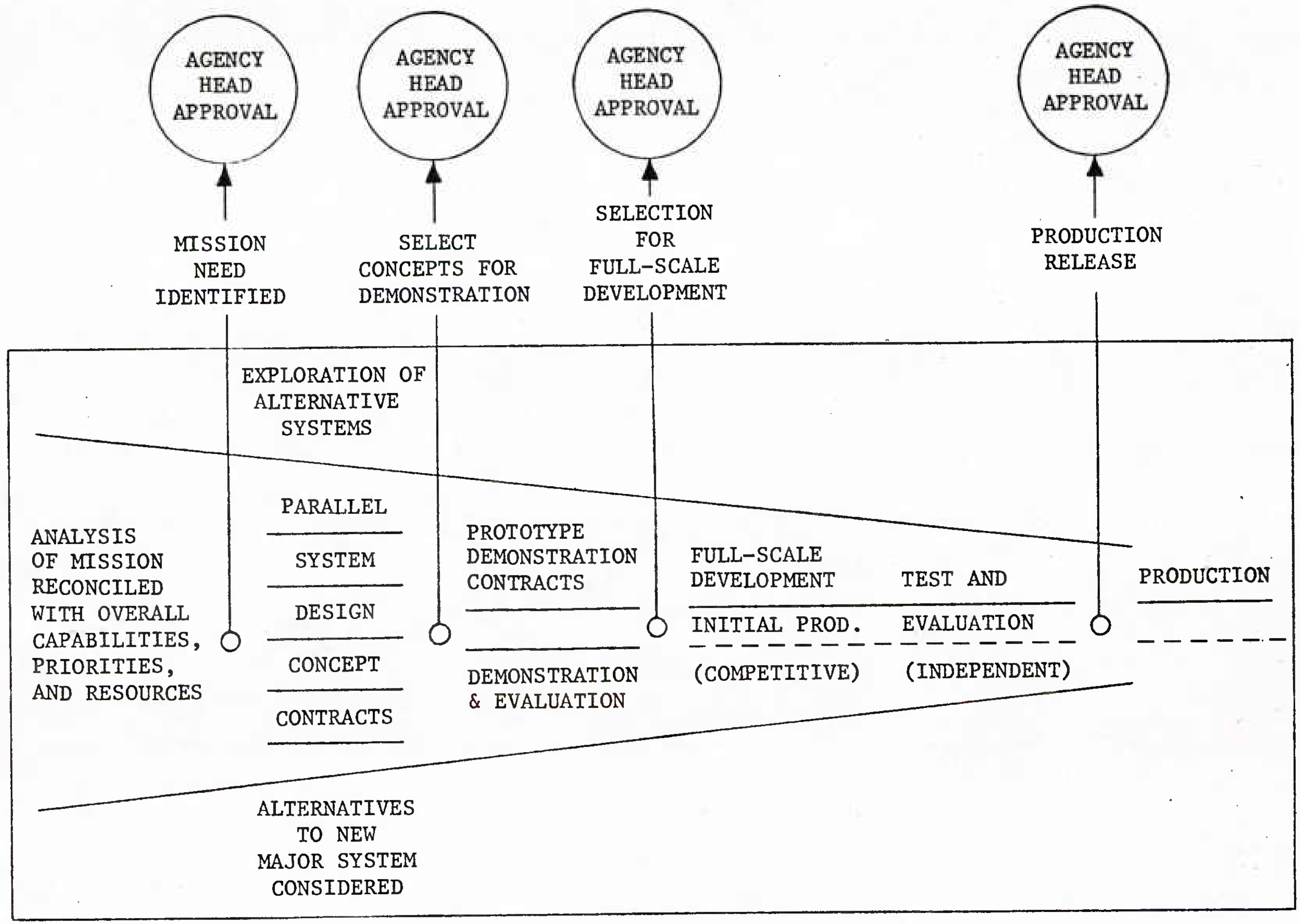


FIGURE 5. MAJOR SYSTEM ACQUISITION PROCESS

Second, again from DoD Directive 5000.2, "subsystems selected for use in a system acquisition program shall not be fully developed until the system program has been approved for full-scale enginering development." This concept contains several potential pitfalls to the acquisition manager. As electronic systems become increasingly complex, their true system performance characteristics and corresponding deficiencies cannot be determined unless there is some form of limited but controlled fabrication, test, and evaluation. This pilot build and corresponding documentation proofing could be performed very efficiently by a Navy field activity, resulting in a defined system whose characteristics are well understood by Naval technical personnel. In the event that the approach proves unsatisfactory, shortfalls could be identified and then remedied in follow-on full-scale engineering development stages. A second and most important factor that will confront the AIR-05 team is that the transfer of advanced development projects into full-scale engineering programs requires time, and with the passage of time comes technological obsolescence. Thus, the AIR-05 acquisition manager must be very aware of any potential obsolescence in the months/years that span the transition of 6.3/6.4 programs. These risks must be factored into his acquisition "game plan." Again, he must rely on his field activities for up-to-date technical information and guidance.

Third, from DoD Directive 5000.2, "the program manager shall develop the acquisition strategy tailored to the particular program and program phase following the Milestone 0 approval. The strategy will initially be limited in content but will be expanded and refined as the program progresses. Competition shall be a major factor in the strategy throughout the program to achieve technical innovation, reduced risks, and cost and (sic) effective management." The acquisition manager must work with the program manager, AIR-03, and others, either directly or through his appointed representative, to insure that short and long-term acquisition considerations are given proper attention. The AIR-05 representative(s) must have solid managerial, business, and technical expertise if AIR-05 objectives are to be realized, and satisfactory acquisition concepts are to be integrated into the program strategy. It must be noted, once again, that with increased contractor competition there generally occurs decreased standardization. The acquisition manager must continuously consult his technical team in formulating positions relating to GFE/CFE, modularization/standardization, long-term logistics, and other complex issues.

Finally, DoD Directive 5000.2 states, "costs of acquisition and ownership shall be established as separate cost elements and translated into firm design-to-cost and life cycle cost requirements for the system selected for full-scale engineering development. System program actions shall be evaluated against these requirements with the same rigor as the evaluation of technical requirements." As discussed in Section III, acquisitions based upon utilization of LCC must be considered in future acquisition management. Often system and subsystem high quantity production contracts are awarded to the development contractor, because competing contractors find difficulty in overcoming the high costs associated with sole source (in terms of specific processes, unique tooling, test equipments, etc.) data package developed during the engineering development phase.

With the advent of very complex systems' architectures and sophisticated technologies that promise operational performance advantages achieved with improved reliability and decreased maintenance, AIR-05 must turn to LCC to make proper acquisition decisions.

While demonstrating high management ideals, decisions based on LCC may be very difficult to sell to Congress and unsuccessful bidding contractors. Low life cycle cost architectured systems may require very high "front-end" investments. NAVAIR must take a hard line stand if the very real and complementary benefits of LCC and advanced technologies are to be realized.

V. SUMMARY

A. General

If future acquisitions of new aircraft are to gain the advantages offered by advancing technologies, the associated disadvantages must be minimized or eliminated. Decreased economic incentives, long design times and high costs, rapid device obsolescence, basic dichotomies between MIL-specifications/standards and new, evolving electronic mechanizations, and the new concepts of system procurements must be thoroughly addressed.

The acquisition process as described in SECNAVINST 5000.1 presently defines responsibilities and procedures of an acquisition manager. However, during the examination of the acquisition process as described in earlier portions of this paper, two main themes are projected. First, many of the existing acquisition management instructions, policies, and practices are found to be basically adequate, but simply require increased emphasis at earlier stages of the acquisition cycle. Therefore, these existing acquisition management techniques will take on renewed importance and urgency, i.e., life cycle costs (AIR-03/05/04) and ILS (AIR-04/05) involvement in the acquisition cycle. Second, some new management plans must be formulated for predicted advanced technologies. In these cases, either the existing management techniques are inadequate or unique problems resulting from anticipated technology advances will occur for which management techniques do not yet exist. These two topics requiring acquisition management attention will be summarized in the following paragraphs.

B. Existing Acquisition Management Techniques Requiring Re-emphasis

As just described, some of the existing acquisition management practices are still valid after considering potential requirements created by the use of advanced technologies. These include:

- Much earlier involvement by AIR-04, with AIR-05 and AIR-03, in the acquisition cycle to decide which technologies should be used and how they are to be logistically supported.

- Increased utilization of life cycle cost analysis to (1) justify the high initial development investments required by utilization of advanced technologies; and (2) to demonstrate advantages and payoffs realized during equipment operational life.

- Placement of logistics considerations on an equal basis with traditional design/operational requirements, for all evaluations and decisions of the acquisition cycle.

- Requirement for increased awareness by the logistics manager of advanced technologies and their support impacts.

- Increased emphasis on management information in order to consider all aspects of potential advanced technology.

- Better feedback from NAVPRO-type organizations during contract administration of high technology systems to identify problems and risks associated with uses of emerging technologies.

- Increased emphasis on proposal evaluation and selection by an in-house technical and management team to identify planned uses of advanced technologies and the potential risks.

- Improved criteria for making GFE/CFE decisions.

C. Acquisition Management Techniques to be Developed

As a result of advanced technologies, new acquisition management methodologies that require formulation include:

- Logistic support strategies for firmware, software, and advanced technologies that will emerge and then become obsoleted in the near future.

- Test and qualification procedures that are compatible with advanced forms of hardware, software, and firmware.

- Standardized Data Item Descriptions for documentation and control of advanced technology components.

- In-house technical review teams to review contract work statements and technical data prior to the release of contracts, to insure that technology can be satisfactorily applied to meet mission objectives.

- Short term parallel contracting (OMB Circular No. A-109) approaches to investigate alternative proposed uses of technology, in order to best meet mission objectives and minimize associated risks.

- Standardization of advanced, custom microcircuit design approaches such as universal arrays, standard cell families, programmable logic arrays, and others.

- Establishment of formats, and implementation and control methods for contractor device data collection, correlation, and subsequent technology monitoring.

- Establishment of new specifications providing for the option of data ownership and control of unique tooling such as custom LSI masks, universal arrays, programmable logic arrays, etc.

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This report examines current and anticipated acquisition management policies/practices, as they will be applied to advancing technologies, and attempts to forecast those shortfalls which require attention by those personnel involved in the Naval Air Systems Command material acquisition cycle.

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