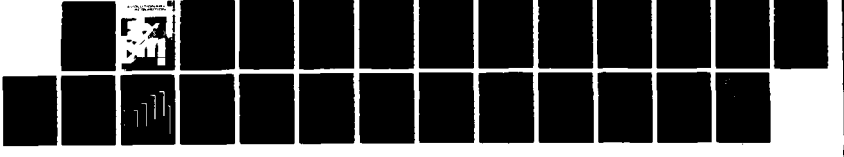
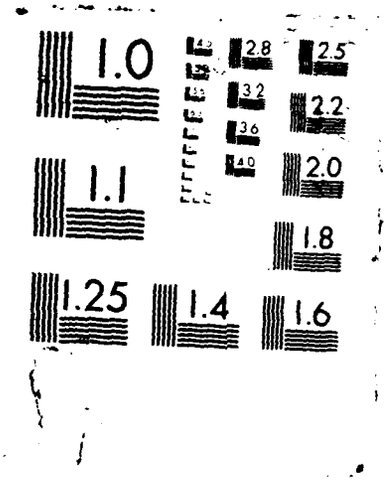
AD-A190 509 EVOLUTIONARY ACQUISITION: AN ALTERNATIVE STRATEGY FOR ACQUIRING COMMAND AND CONTROL (C2) SYSTEMS(U) DEFENSE SYSTEMS MANAGEMENT COLL FORT BELVOIR VA 1/1

UNCLASSIFIED F W M'HEARN ET AL. MAR 87 F/G 25/5 NL




1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

JOINT LOGISTICS COMMANDERS GUIDANCE MARCH 1987

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE AD-A190509

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public Release: Distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Defense Systems Management College (DSMC) 6b. OFFICE SYMBOL (If applicable) DRI-R	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Defense Systems Management College DSMC-DRI-R Fort Belvoir, Virginia 22060-5426	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION DSMC 8b. OFFICE SYMBOL (If applicable) DRI-P	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) DSMC-DRI-P Fort Belvoir, Virginia 22060-5426	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Evolutionary Acquisition, an alternative strategy for acquiring command and control (C^2) systems

12. PERSONAL AUTHOR(S)
Col. F. W. A'Hearn, USAF: Dr. C. E. Bergmen; PC Edward Hirsch, USA (Ret)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM _____ TO _____	March 1987	21

16. SUPPLEMENTARY NOTATION
Joint Logistics Commanders Guidance

17 COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Command and Control (C^2) Systems, Evolutionary Acquistion, Atternative Strategy, Acquisition Strategy

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This guide encourages consideration and use of an Evolutionary Acquition (EA) strategy by the services in acquiring C^2 systems. While this guidance is aimed specifically at the use of an EA strategy in acquiring Command and Control systems, the principles discussed may also be applicable to the acquisition of other kinds of systems. This EA strategy is of a character that the system is not required to have full capability when deployed, but will evolve to full capability through one or more incremental upgrades. Considered most broadly, FA consists of first definsequentially defining, funding, developing, testing, fielding, supporting and evaluating increments of the system.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Robert W. Ball	22b. TELEPHONE (Include Area Code) (703) 664-5082 22c. OFFICE SYMBOL DSMC-DRI-P

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

JOINT LOGISTICS COMMANDERS GUIDANCE

FOR THE USE OF AN

EVOLUTIONARY ACQUISITION (EA) STRATEGY

IN ACQUIRING

COMMAND AND CONTROL (C^2) SYSTEMS

MARCH 1987

THE DEFENSE SYSTEMS MANAGEMENT COLLEGE

FORT BELVOIR, VIRGINIA

TABLE OF CONTENTS

FOREWORD

The complexity, cost, and military value of defense Command and Control (C^2) systems continue to increase. Therefore, it is important that we acquire these systems efficiently and effectively. Two major studies of past acquisitions of C^2 systems conclude that use of conventional strategies for acquiring such systems often leads to unsatisfactory results. The findings of both studies stress the point that consideration be given to acquiring C^2 systems in an evolutionary way.

In consonance with these findings, current Office of the Secretary of Defense (OSD) guidance supports the use of an Evolutionary Acquisition (EA) strategy in acquiring systems of this kind, while at the same time noting that the unique circumstances of individual programs should be considered and that the strategy chosen must remain consistent with basic DOD acquisition policy.

The Joint Logistics Commanders endorse this OSD guidance. We are publishing this guide to encourage consideration and use of an EA strategy by the services in acquiring C^2 systems. While this guidance is aimed specifically at the use of an EA strategy in acquiring Command and Control systems, the principles discussed may also be applicable to the acquisition of other kinds of systems. This EA strategy is of a character that the system is not required to have full capability when deployed, but will evolve to full capability through one or more incremental upgrades. Considered most broadly, EA consists of first defining the general outline of an overall system; and then sequentially defining, funding, developing, testing, fielding, supporting and evaluating increments of the system.

This guide was prepared under the direction of the Commandant, Defense Systems Management College (DSMC), who also has accepted the responsibility for keeping this document current.

RICHARD H. THOMPSON
General, USA
Commander
US Army Materiel Command

T. J. HUGHES
Vice Admiral, USN
Deputy Chief of Naval
Operations (Logistics)

EARL T. O'LOUGHLIN
General, USAF
Commander
Air Force Logistics Command

LAWRENCE A. SKANTZE
General, USAF
Commander
Air Force Systems Command

PREFACE

Responding to a request of the Joint Logistics Commanders (JLC) that DSMC prepare policy guidelines for the use of an EA approach when acquiring C^2 systems, the Commandant, DSMC, established a project team comprising the undersigned persons. The findings of this project team are:

- Significant studies have been conducted in the field of EA by authoritative, learned and experienced groups representative of public and private sectors of our economy. These studies have concluded that for the acquisition of C^2 systems an EA approach should normally be used. While these studies have not been approved by the Secretary of Defense and the military services, the findings are judged to be such that an EA approach should be at least considered for application when warranted by the nature of the program.
- OSD senior executives have been of the view that, while OSD should not attempt to dictate to the services when they should use EA, OSD policy documents do delineate EA as an acceptable acquisition strategy for C^2 systems.
- Documentation defining OSD-level guidance concerning the use of EA, while available, is largely unknown by members of the acquisition community.
- The DSMC project team, as a result of its own deliberations, supports the use of EA as an alternative strategy for acquisition of C^2 systems.
- A JLC-endorsed guide for the use of evolutionary acquisition would be of value in: 1) expressing JLC support, 2) bringing together OSD-level guidance, 3) providing perspective on when and why to use EA, 4) explaining what EA is, and 5) identifying management and technical issues requiring special attention in successfully implementing an EA strategy.

This guide has been prepared with these five findings in mind.

We hope that the guide will prove to be of benefit to the acquisition community in general, and to program managers in particular, in appropriately and productively applying the EA approach in acquiring C^2 systems.

Comments on this document are invited and may be addressed to the Commandant, DSMC; Attn: DRI; Fort Belvoir, VA 22060-5426.

EDWARD HIRSCH
BG, USA (Ret)
Director, Center
for Acquisition
Management Policy
DSMC

FRANCIS W. A'HEARN
COL, USAF

DR. C. E. BERGMAN
Air Force Chair
Executive Institute
DSMC

SECTION 1

POLICY

Existing Office of Management and Budget (OMB) and Office of the Secretary of Defense (OSD) policy encourages the application of the EA approach to the acquisition of C^2 systems. OMB Circular A-109 and DOD Directive 5000.1 both explicitly call for tailoring an acquisition strategy to meet the specific needs and circumstances pertaining to an individual acquisition program. In support of this general guidance, DOD Instruction 5000.2 calls for consideration of "Evolutionary Development and Acquisition of Command and Control Systems." Providing more specific guidance, Defense Acquisition Circular 76-43 states that "C^2 systems generally require an evolutionary acquisition approach."[1]

The Joint Logistics Commanders endorse this guidance from OMB and OSD. Acquisition managers should become familiar with the contents of this guide, and should give deliberate and careful consideration to the possible use of an Evolutionary Acquisition (EA) strategy in the acquisition of Command and Control (C^2) systems.

When evolutionary acquisition is used for a particular program, it is imperative that all personnel concerned with the program give their full support and cooperation in the formulation and execution of the strategy—especially in those areas involving departure from customary practices.

An evolutionary acquisition program may involve a number of individuals and organizations outside of those organizations reporting to the Joint Logistics Commanders, and the support of these other persons and groups can be crucial to the success of the program. The Joint Logistics Commanders urge that such other persons and groups become familiar with the principles, potential benefits and potential pitfalls of EA, as outlined in this Guide.

Establishing effective patterns of interaction with external organizations involved in an evolutionary acquisition can be expected to be unusually difficult, because the very nature of EA requires relationships and interactions different from the norm. The Joint Logistics Commanders will, if necessary, assist subordinate commanders and their program managers in their efforts to negotiate effective patterns of interaction with external organizations.

Finally, use of an appropriate acquisition strategy—EA or any other—will not by itself lead to a successful program. Excellent management and strong support by all involved are vital also.

---

[1]The OMB AND OSD Policy guidelines are given in some detail in Section 6. The EA process is summarized in Section 2 and described in detail in Section 4.

SECTION 2

AN OVERVIEW OF EVOLUTIONARY ACQUISITION

Two major studies[1] of past acquisitions of Command and Control (C^2) systems have found that the use of conventional approaches to acquisition of such systems often has led to unsatisfactory results. The systems considered in these studies were large, software-dominated information systems intended to aid operational commanders in performing their command and control functions.

Difficulties have arisen primarily because for command and control systems it is often not feasible to define in detail—before starting full-scale development—what the operational capabilities and the functional characteristics of the entire system are to be. If full-scale development—on a *total-system* basis—of *any* system is undertaken without a clear definition of the operational concepts and capabilities and the functional characteristics the entire system is to have, then it is very likely that the development process will be long, costly, and unstable, and that the system developed will be unsatisfactory.

In consideration of these difficulties, the two studies referred to above recommend the use of an evolutionary acquisition strategy in acquiring C^2 systems.

Evolutionary Acquisition is defined as follows:

Definition of Evolutionary Acquisition

Evolutionary acquisition is an acquisition strategy which may be used to procure a system expected to evolve during development within an approved architectural framework to achieve an overall system capability. An underlying factor in evolutionary acquisition is the need to field a well-defined core capability quickly in response to a validated requirement, while planning through an incremental upgrade program to eventually enhance the system to provide the overall system capability. These increments are treated as individual acquisitions, with their scope and content being the result of both continuous feedback from developing and independent testing agencies and the user (operating forces), supporting organizations, and the desired application of new technology balanced against the constraints of time, requirements, and cost.

Evolutionary acquisition, as defined above, comprises the following elements:

- A concise statement of operational concepts and requirements for the full system.
- A general description of the functional capability desired for the full system. (The lack of specificity and detail in identifying the final system capability distinguishes EA from an acquisition strategy that is based on P^3I.)
- A flexible, well-planned overall architecture, to include process for change, which will allow the system to be designed and implemented in an incremental way.
- A plan for incremental achievement of the desired total capability.
- Early definition, funding, development, testing, fielding, supporting and operational evaluation of an initial increment of operational capability.
- Sequential definition, funding, development, testing, fielding, supporting and operational evaluation of additional increments of operational capability.
- Continual dialog and feedback among users, developers, supporters and testers.

Some important EA attributes which can help improve the probability of fielding successful C^2 systems are:

- Separate funding approval for each increment of operational capability, which should facilitate control of program costs.

[1] "Report of the Defense Science Board Task Force on Command and Control Systems Management," July 1978, Office of the Under Secretary of Defense Research and Engineering, Washington, D.C. "Command and Control (C^2) Systems Acquisition Study Final Report," September 1, 1982, The Armed Forces Communications and Electronic Association, Falls Church, Va.

- Careful planning so that development, operational testing, deployment, and support of the baseline system and incremental upgrades can proceed rapidly.
- Use of the "Build a little, Test a little, Field a little" development philosophy, which should result in timely fielding and support of each increment of operational capability.
- Continuous user involvement and feedback, which should enhance user satisfaction.
- Use of flexible system architecture, which should facilitate evolutionary enhancement and expansion of the system while the mission continues to be supported.

Successful execution of an evolutionary acquisition program requires a number of changes to relationships and practices common to more conventional acquisition programs. One difficult yet important area of change is the need for a much closer, interactive set of relationships among the real user (the Commander and staff who will use the system), the surrogate user (representative of the real user), the independent tester, the developer, and the supporter. Another difficult, important area is the need for streamlined procedures to allow each increment of capability to progress rapidly through definition, funding, development, testing, fielding, operational evaluation and integration into the support environment.

SECTION 3

C^2 SYSTEMS: THEIR CHARACTERISTICS, AND WHY THEY MAY REQUIRE AN ALTERNATIVE ACQUISITION STRATEGY

Command and Control systems have a number of characteristics which differentiate them from other systems. These systems:

- Are primarily information systems, aimed at assisting operational commanders in handling information concerning hostile and friendly forces, in deciding upon courses of action, and in monitoring execution of operational orders.
- Are computer-software dominant.
- May be tightly coupled with particular operational settings and, thus, may be aligned with specific geographical parameters, specific ranges of threats, and specific doctrines.
- May be "one-of-a-kind."
- May be in support of a unified or specified command; may connect with higher, lower and collateral commands; and may be required to be interoperable with multi-service or multi-national C^2 systems.
- May be required to meet the specific needs and desires of specific individual operational commanders.
- Must be highly adaptable to meet the many demands a commander may place upon them in the myriad of circumstances that can arise in battle.
- Must perform acceptably with imperfect information, and their performance should degrade gradually, rather than fail catastrophically, under damage and stress.
- Must have a highly responsive logistical support system to sustain high readiness and operational performance capabilities.

Stemming from the above are several additional characteristics, which are highly significant from an acquisition standpoint:

- Due to the complex interactions between the commander and his staff on the one hand, and the software and hardware of his C^2 system on the other, it may not be feasible to define the desired software and hardware characteristics by other than an iterative, trial and error process involving the actual user and portions of the system. It is, of course, necessary to define the architecture within which the software and hardware characteristics must evolve, the required broad capabilities of the fully evolved system, and the approximate date by which the full capability is required. (In considering command and control, it should be noted that command and control are the paramount functions of an operational commander, and that he and his staff are integral with and are the most important parts of his overall command and control capability.)
- Due to the fact that C^2 systems often must operate interactively with other such systems, defining external system interfaces and operational concepts are inherently difficult and sometimes may be done best on an iterative basis. Due to the impact this may have on development of other systems, this approach should be laid out carefully in Decision Coordination Papers and other program documentation. An iterative approach also may be best suited to defining certain internal system interfaces; for example, in developing protocols for handling multiple levels of security within a particular system. (As this example suggests, sometimes it might be difficult to define whether a particular functional capability is part of one system versus another, or whether it might be considered simultaneously to be part of two [or more] systems.)

For a system having the above characteristics, it most likely would not be feasible to define in detail—before starting full-scale development—what the operational capabilities and the functional characteristics of the *entire* system are to be.

However, if full-scale development for the *total system*—of *any* system is undertaken without a clear definition of the users operational concepts and capabilities and the functional characteristics of the *entire* system, then it is very likely that the

development process will be long, costly and unstable, and that the system developed will be unsatisfactory.

Thus, for C^2 systems, as characterized above, a conventional acquisition strategy is unlikely to lead to satisfactory results. A conventional acquisition strategy requires a detailed definition of the capabilities and characteristics of the *entire* system before starting full-scale development, and for the systems being discussed here, this is not possible. Therefore, using a conventional acquisition strategy to develop such a system could lead to many of the problems discussed above.

Evolutionary acquisition, an alternative approach to the acquisition of C^2 systems, is described in the next section.

SECTION 4

EVOLUTIONARY ACQUISITION: WHAT IT IS, WHAT IT IS NOT

General Description

Evolutionary acquisition is an acquisition approach especially well suited for large C^2 system acquisition. It is both adaptive and incremental. It requires a users concept of operations and a description of the overall system capability desired, issued by an accountable authority. This documentation defines the architectural framework within which evolution is to occur, defines the core or baseline capability necessary, and describes the final desired capability. This does not necessarily imply the need to develop the detailed system description prevalent in conventional systems acquisition documentation.

An initial core element is a well-defined, essential entity that:

- Will significantly enhance the users mission capability.
- Can be fielded quickly and sustained in its operational environment.

Combined user-developer-supporter effort, the key ingredient to assist the requirement-setter in optimum definition of the core element, is a principal characteristic of the EA approach. It:

- Continues throughout the system life cycle in order to develop recommendations for system operational and support requirements for each incremental upgrade.
- Provides the essential feedback from user to requirement-setter, developer, and supporter that is an integral part of the evolutionary process.

During core element testing, and even after portions of the system are fielded, the user continues to support an ongoing system evaluation by providing inputs from his unique perspective.

Incremental system development and sustaining support beyond the core element is governed by an evolutionary plan. The plan requires flexibility to accommodate periodic performance update through incremental upgrades defined based upon input from the developer-user-tester-supporter team as they test and assess system operational use. The plan is essentially a baseline from which adjustments are made as dictated by the results of continuing feedback from tests and assessments of operational use.

In summary, system operational capabilities are:

- Established by the requirement-setter in coordination with the developer-user-supporter.
- Fielded and supported as functional capabilities in the form of testable elements (the first of which is the core element).
- Operationally tested in the core configuration and later in incremental upgrade configurations as they are made ready for introduction.
- Sustained in its operational environment by the supporters.

The EA Model

Figure 1 represents graphically an EA model and its application over time. The model emphasizes the incremental nature of the EA approach and the essential continual user involvement in every phase of development.

- The Service Chief or his representative begins the process when he defines the *overall system* operational concept and requirements in functional terms based upon user input. At about the same time, he also defines in considerable *detail* the operational concept and functional requirements for the *first system operational element* to be fielded (the core element). When fielded, the *core element* must provide a *significant, identifiable operational capability* and be supportable in its intended operational environment.
- After the Service Chief or his representative formulates an overal system concept and identifies the overall capability required in the final configuration, the developer recommends for service approval a systems architecture capable of accommodating system evolution with minimum system redesign. The supporter identifies those minimum elements required to sustain the system in its intended operational environment. The architecture is a critical element that should be structured with care and some detail,

EA: *INCREMENTALLY* DEFINE, FUND, DEVELOP, FIELD, SUPPORT AND OPERATIONALLY TEST THE OPERATIONAL CAPABILITY TO SATISFY THE EVOLVING REQUIREMENT

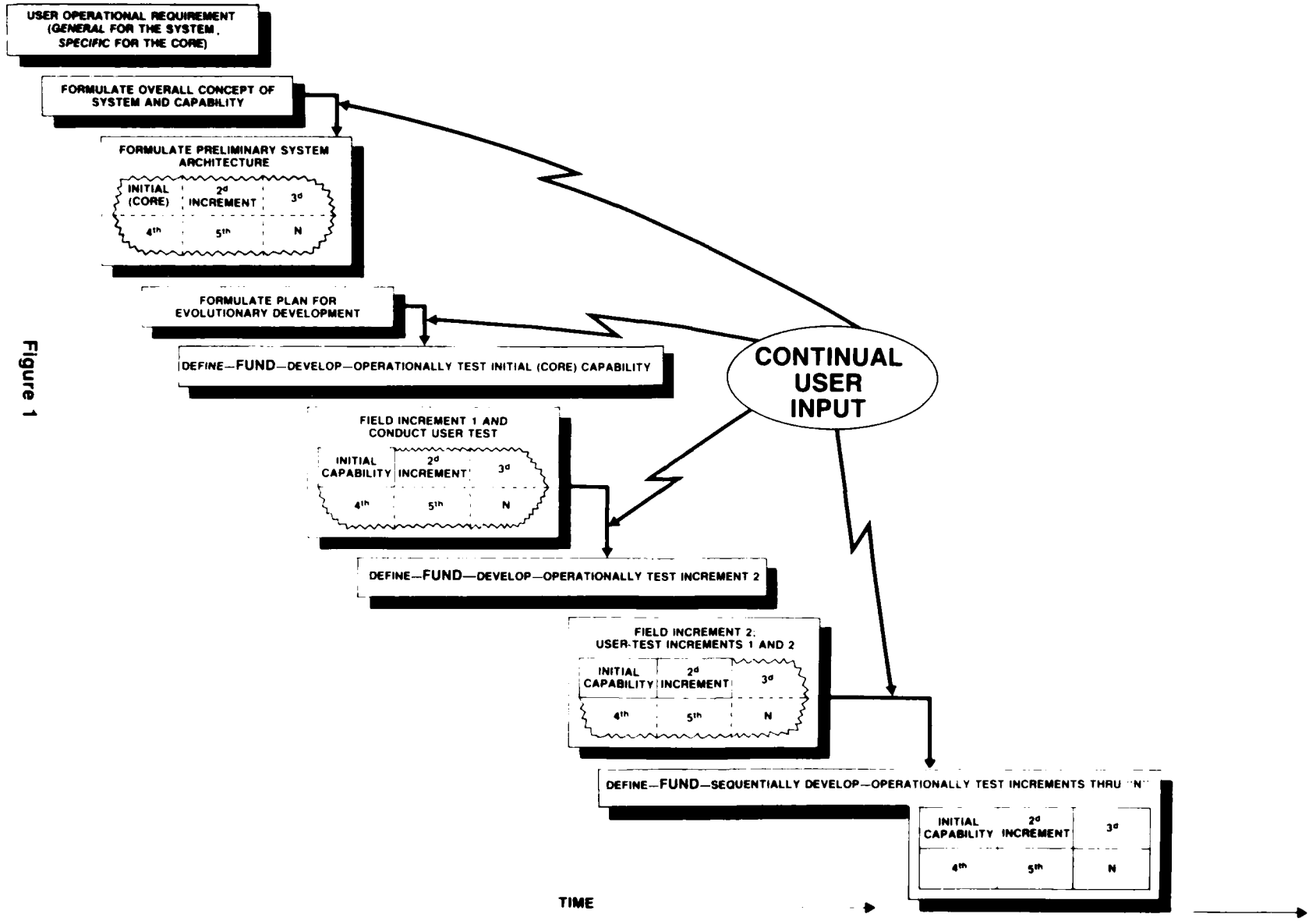


Figure 1

although a high degree of specificity as to details may be impossible at first.

- The evolutionary development plan is a service approved and funded product. Its goal is achievement of the overall capability through incremental development fielding and supporting of incremental upgrades to the "core," or baseline, operational capability.
- The Service Chief or his representative, with continuing developer, supporter, and user input, defines the initial (Core) capability to be developed, tested and fielded. Significantly, the Core element is not fielded until operationally tested to determine its effectiveness, suitability, and sustainability. The fielded incremental capability is then operated and exercised by the user and sustained by the supporter in its operational environment, and the user provides recommendations to be addressed in definition of later incremental upgrades.
- On a (most-likely overlapping) sequential basis, the additional increments of capability are defined, service approved, developed, operationally evaluated, fielded, and supported in the same way as the initial increment.

As highlighted in Figure 1, funding for the system elements is also incremental in nature. Budget approval and funding for each element is made available only after the operational, performance characteristics and support requirements of that element have been defined in sufficient detail for development of that element to begin.

In the interest of simplicity, the model does not present the contribution that an Off-Line Development, Test and Support Facility may make to the development process. Such a facility, utilizing operational mock-ups, simulations and a software laboratory will generally be required for system development, for development testing, and for system integration. The facility will also serve to help integrate the user and tester input with the development activities, and will provide the capability to develop and evaluate hardware and software updates.

Real-life applications of the EA strategy have been limited. One of the few programs currently using the EA approach is the WIS-World-Wide Military Command and Control System (WWMCCS) Information System. The WIS is a large, software dominant C^2 system with many of the characteristics that suggest use of an EA strategy. The WIS application of EA, as shown in Figure 2, can be seen to track fairly closely with the more generalized EA model (Figure 1).

What EA is Not

While evolutionary acquisition experience is limited, the approach is not totally unknown. In fact, in addition to its proponents, EA has already gained a few skeptics. Because the concept is not universally understood, it is well to underscore several things that EA clearly is *not*. The EA is *not*:

- An approach that provides for unconstrained requirements growth and an unbridled budget.
- A single strategy ready for application to all C^2 system acquisition efforts.
- A checklist approach that will greatly simplify C^2 acquisition.
- A strategy that is identical to those recommended in the studies referenced on page 3 of this guide.
- A free ticket to exemption from competition, disciplined configuration management, testing or ILS planning. (The EA poses additional challenges in these areas and requires careful tradeoff analysis to reach smart decisions that will benefit the total acquisition.)

It is important to recognize that once the decision is made to pursue an evolutionary acquisition strategy with incremental "deliverables," the decision itself is *not* incremental—for all practical purposes, it locks in a number of subsequent actions to an identified line of approach.

WIS SYSTEM EVOLUTION

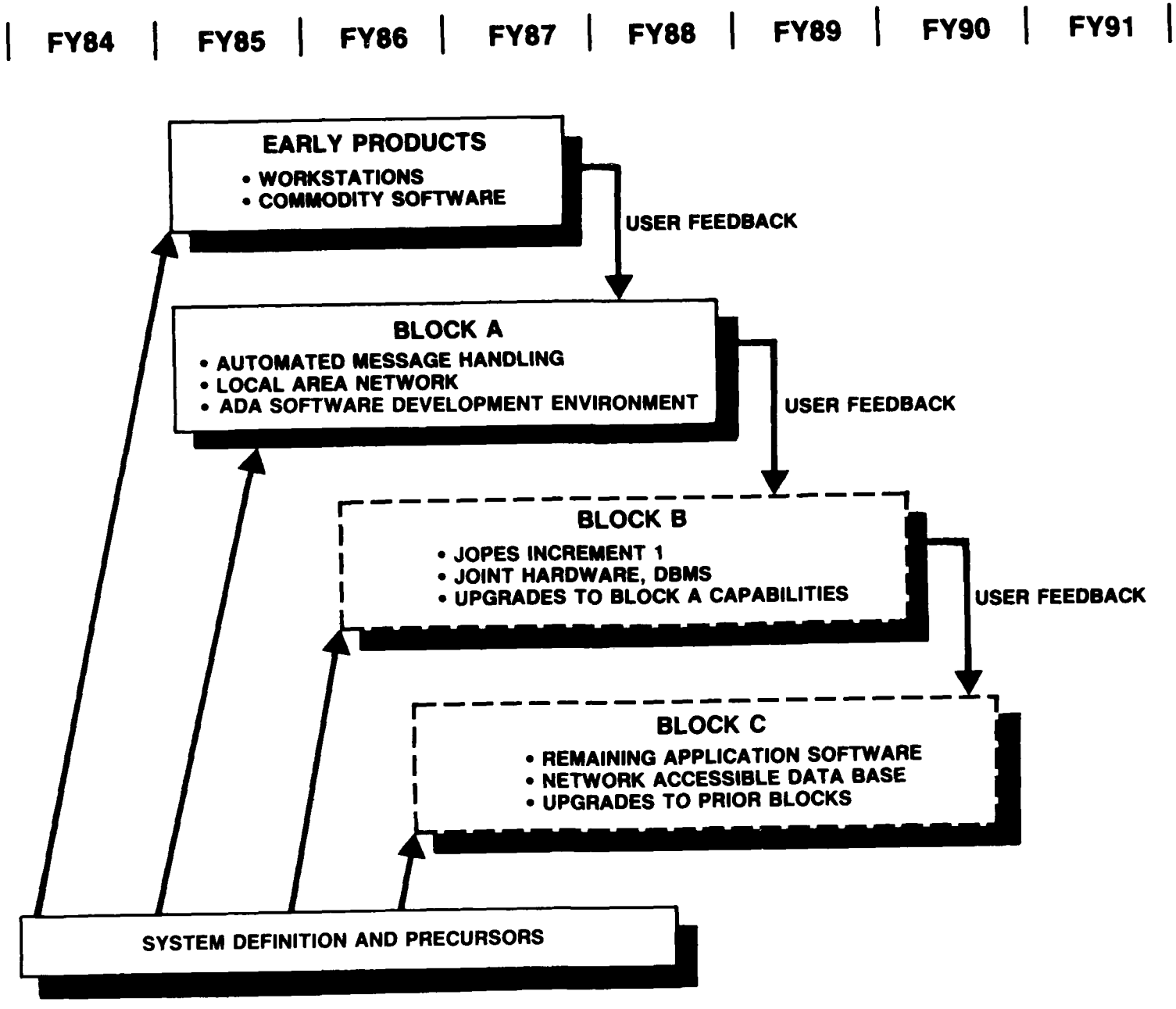


Figure 2

SECTION 5

AREAS REQUIRING SPECIAL CONSIDERATION WHEN USING EVOLUTIONARY ACQUISITION

While evolutionary acquisition could be the best alternative approach to use in acquiring certain software dominant C^2 systems, EA of course is no panacea. To successfully formulate and execute an EA strategy, a number of areas must be given special consideration. Key areas requiring such consideration are discussed below.

The Acquisition Executive, the User, the Surrogate User, the Supporter, the Independent Tester and the Developer

In conventional acquisition programs, relationships among these six entities sometimes may be rather formal, and negotiations among them may be conducted at arm's length. For EA to be successful, some of the roles of these entities may need to be redefined, and most of the relationships need to be closer and more cooperative than has been the norm. Five areas in which relations need to be carefully considered are as follows:

- System Operational Capabilities

  In system acquisition, a surrogate user frequently has the primary role in specifying the desired operational requirements for the system, while the real user may be rather far removed from this process, depending upon service procedures. In using EA to acquire C^2 systems, a major premise is that the real user—working in a close, continual relationship with the developer and supporter—should have a major voice in formulating operational requirements and in defining detailed system characteristics once operational requirements have been defined. Thus the traditional roles of the user and of the surrogate user may have to be redefined for a particular program, in accord with the needs of that program. The complexity of these relationships is likely to be even greater in cases where the real user is in a service different from that of the developer. A Memorandum of Understanding or Agreement is recommended in these instances.

- Operational Test and Evaluation

  Each service has within its organization an independent tester who is responsible for all Operational Test and Evaluation. A premise involved in using EA to acquire C^2 systems is that C^2 systems are tested, incrementally beginning with the core system, to determine whether the core system (or the core system plus incremental upgrades to that system) meets the operational requirement. The user, in operating the system, is a critical part of the system while he is using it in his operational environment. The independent tester evaluates the operational effectiveness and operational suitability of the system in the upgrade status in which it is presented, and is likely to employ user forces to do so. Therefore, the user gains more extensive experience and makes recommendations for establishment of operational requirements for subsequent system increments. This process of evolution of requirements and the introduction of upgrades, distinguishes the evolutionary approach from the more classical weapon acquisition process. The independent tester is an important player in this process. It is imperative that he become involved early in the program development phase and maintain a direct and continuous liaison with the developer and user throughout the EA process, so that operational test and evaluation can proceed with maximum rapidity.

- Test and Evaluation Planning

  Both the software-intensive nature of the systems and the evolutionary approach may affect conventional test planning and evaluation. In particular, there is likely to be greater concentration on contractor testing than government-conducted development testing. This should be addressed in the TEMP from the outset, with an objective of exploiting integrated testing without losing critical independence of contractor/developer/user views.

- Developer-User-Supporter Interaction

  In some conventional acquisition programs, the developer and the real user may have

little interaction with each other during the course of the development. For successful use of EA to acquire C^2 systems, the developer, user, and the supporter need to work more closely together, over a lengthy period of time.

- Program Review and Approval

  In conventional acquisition, there are normally only a few times that the program manager needs to obtain approval of the acquisition executive to allow him to proceed with his program. Such approval is normally required at each of the major program milestones. Associated with each such milestone (on a major program) the program manager may have to give 50-75 briefings over a period of a number of months. For an EA program, *each increment of capability* might require approval of the acquisition executive and, perhaps, at *each of several stages of development*. Under these circumstances, it would be necessary to greatly streamline the review and approval process. For example, in some instances involving a simple program where the final configuration can be defined in some detail, the total system might be validated as a single requirement and each increment treated as a "Release" so long as the program remains within designated performance and dollar thresholds.

Program Management

Frequently for conventional programs, a program office is not established until Milestone 1 or later. Often the program office is not well staffed with experienced people during the early phases of a program compared with later program phases.

In using EA, it is important that a capable program office be established very early in the program because: 1) the acquisition strategy must be defined early, 2) roles and relationships of the various key players in the acquisition process (as discussed above) need to be negotiated early, and 3) the program sponsor will need program office support in defining the fundamental architecture and support structure underlying the entire system.

Another consideration involving the program office is that the office must generally be staffed more heavily to allow it to manage all phases of the acquisition cycle concurrently; because, with the use of EA several increments may be under development at any one time, and these various increments may be at different stages of the acquisition cycle.

Competition in Contracting

Four closely related areas of work involved in evolutionary acquisition require special consideration relative to competition in contracting. These areas are: 1) system architecture; 2) development and maintenance of the Off-Line Development, Test and Support Facility; 3) system configuration management, and 4) logistics support. These areas of work may continue not only throughout the evolutionary acquisition period, but most likely throughout the lifetime of the C^2 system, since it is likely that the system will continue to evolve to some extent throughout its lifetime.

It is important that continuity be maintained in each of the above four functional areas throughout the acquisition process and continue for the operational lifetime of the system. Thus, these functions must be provided directly by the government; or, alternatively, the particular contractor(s) performing the functions must be retained for a number of years. Changing contractors in these areas at *infrequent* intervals might take place without *undue* impact on the program. However, *frequent* changes *in these areas* would be *highly disruptive* to the program, and it may be preferable that the government gear-up to perform the function "in-house."

On the other hand, normal practices concerning competition most likely could be employed for the tasks of developing *each of the increments* of the system's operational capability. Here, the inefficiencies of new contractors learning the system may or may not offset the positive values of competition.

In keeping with the evolutionary acquisition approach, special emphasis should be placed on early development of an Acquisition Plan to ensure that procurement leadtime constraints are noted and addressed up front. The EA "fast march" will necessitate innovative contracting approaches, and early planning would afford maximum opportunity to utilize effective competition practices. For example, a two-phase process might be used:

- The first phase would involve multiple awards with the resulting contracts addressing the core capability of the system. Potential teaming arrangements would be indicated. Conceptual segments and ap-

proaches to incremental upgrades would be discussed, and a system specification prepared. Demonstration models would be deliverables, where feasible.

- The second phase would involve selection of a contractor for a systems engineering integration contract. This would still permit competition at the second tier for individual increments.

This approach would tend to be time-intensive up front, but would pay off with a smoother transition in the second phase, and would provide much greater accountability and confidence in the adequacy of the final system capability.

Control and Stability of the Development Process

Although evolutionary acquisition is by definition evolutionary, it is important that it be partitioned into fairly distinct increments, and that once the development of a particular increment is well underway, changes in functional requirements pertaining to that increment be made only if the changes are very important. These points require strong emphasis because of a combination of several circumstances:

- A C^2 system is mostly made of software.
- The user, in the case of an EA program, most likely would continually be able to identify changes he would like to see made.
- Many people (including undoubtedly some users and some program management personnel) unfortunately and erroneously believe software changes are easy to make at any time, because "it's simply a matter of programming."
- In view of these last two circumstances, it might seem natural for the program management office frequently to want to explore with the development contractor the idea of making various "minor" software changes.
- Computer programmers are commonly very optimistic in assessing the impact of making "minor" software changes, particularly if the program management office seems interested in making the changes.
- In reality, such software changes made downstream in the development phase (of a given increment) are very expensive to make, and may lead to software "bugs" that might be very difficult to detect and correct. As a rule of thumb, adding a small additional capability to the system by a software change downstream in the development cycle is about ten times as expensive as it would be to achieve the same result by incorporating the capability into the system beginning at the start of a particular increment. Experience has shown that lack of tight configuration control of software leads to difficulty in operational testing and later during in-service use, with greatly increased cost often resulting as well as a delay in user satisfaction.
- Any changes to the configuration need to be assessed from a supportability aspect.

Configuration Management, and Documentation of System Design

For any acquisition program, configuration management and full documentation of the design of the system are important, and the technical data package is the key to disciplined documentation. For an evolutionary acquisition program—possibly involving both an evolving architecture and a series of system increments—it is especially important that configuration management and system documentation be comprehensive and of high quality.

Production and Installation

In considering evolutionary acquisition of C^2 systems, attention is normally focused primarily upon architecture, requirements, development, integration and evaluation; with relatively little attention given to production and installation of the systems.

Relative to hardware, most of the issues concerning production and supportability of the hardware of C^2 systems are not greatly different from the issues concerning production of the hardware of many other types of systems. One notable difference in hardware installation, however, is seated in the fact that many large C^2 systems are few in number or even "one-of-a-kind."

Concerning software, once the development is complete, production and distribution consists primarily of copying digital data from one storage medium to another. Thus, the cost of producing and distributing software is significantly less than its development.

Installation of software (exclusive of software integration and test) is also generally a trivial process, involving primarily simply reading digital data

from a magnetic tape or disk into a computer's internal memory. Installation includes testing to ensure it was installed correctly.

Thus, since most of the costs of C^2 systems typically are in software, and since the costs of production of software are negligible, it is appropriate that most of the attention in the acquisition of C^2 systems be given to requirements, architecture, development, evaluation, integration and support and the resultant life-cycle cost of support.

Software Maintenance and Control

Maintenance of hardware consists largely of actions to determine whether the hardware is functioning properly, actions to prevent wear-out of components, actions to correct for drift in the functional characteristics of components, and actions to repair or replace badly worn or failed components. While the extent of the need for maintenance and the ease with which maintenance can be performed are determined to a large extent by the design and manufacture of the hardware, maintenance itself is concerned primarily with the adjustment, repair and replacement of parts of the system which drift, wear out, burn out or break.

Even though the term "maintenance" is generally used in both cases, maintenance of hardware and maintenance of software are two radically different things. Software does not drift, wear out, burn out or break, and thus requires no maintenance of the kind required for hardware. But, software does malfunction when combinations of options are used that were never tested. Testing does not find all the bugs. These operational malfunctions do require software maintenance and support.

Software maintenance, rather than involving maintenance in the hardware sense, is concerned with two quite different activities. These two activities are:

- Detecting, localizing and analyzing software bugs (design deficiencies remaining in the software); and then either correcting the bugs—by changing the design of the software—or devising means to allow the system to operate adequately in spite of the bugs.
- Changing the existing functional characteristics of the system by modifying the design of the software, and adding additional functional capability to the system by designing and adding additional software.

Because software maintenance activities result in functional performance changes to the software, adequate configuration management procedures must be observed in the maintenance process, and systems documentation (technical data package) must be updated to reflect the program changes. This practice must be followed for each software increment or phase that is released for use.

For C^2 systems acquired by means of evolutionary acquisition, it seems almost axiomatic that the above software functions must be performed by the development community, rather than by the support community, during the full period of the acquisition. Indeed, this is mandatory if difficulty in operational test and evaluation is to be avoided. Moreover, even after completion of the basic acquisition cycle, C^2 systems are likely to undergo subsequent incremental changes to meet changing operational conditions and to incorporate significant new capabilities. Thus, it is likely that a software development capability and the Off-Line Development, Test and Support Facility would be maintained for the operational life of the C^2 system.

In view of the circumstances, the transition of software design, control, production and maintenance from the development community to the support community should be treated on a case-by-case basis for each major C^2 system. However, from the very beginning, the developer must consider support alternatives in the operational environment and either modify designs to increase supportability or plan for the necessary support to be available. Early in the conceptual stage, these tradeoffs should be assessed—to include consideration of diagnostics/prognostics, design for discard—while they are still feasible to achieve.

User Designed/Maintained Software

With the advent of low-cost computers, low-cost and easy-to-use high-level software (such as database management systems) and expanding software literacy, it is to be expected that some users will wish to design and maintain their own individual "micro" C^2 systems, including designing/maintaining their own software. Such software might be designed to run on separate micro (or mini) computers, or on large machines available to the users.

While a do-it-yourself micro system might sometime be desirable, such a system can also be a source of difficulties.

Difficulties might arise due to: 1) possible lack of integration of such a system within a larger C^2 framework, 2) possible lack of adequate system documentaion, and 3) possible lack of adequate configuration management.

The better the acquisition community can meet the user's needs in a timely and adequate way, the less likely the users will be to act as their own system developers.

Product Assurance

Solid product assurance planning must link all aspects/phases of the system and be visible at decision milestones. Such planning should highlight the fact that, in an evolutionary approach, the developer's responsibility must extend through user/fielded verification, and may entail special maintenance or warranty provisions.

Integrated Logistic Support

As with conventional acquisition approaches, ILS is critical in evolutionary acquisition to assure that design is influenced by support requirements and that support is available for operational sustainment. In the C^2 environment, supportability of the software and the equipment which operates the software is critical to the supportability of the overall weapon system.

SECTION 6

OMB AND OSD POLICY GUIDELINES

Background

Evolutionary Acquisition is an alternative to the acquisition process normally used to acquire selected command and control systems. Its genesis is found within the principles of flexibility and innovativeness stated and implied by policies promulgated by the Office of Management and Budget as well as OSD.

OMB Circular A-109 identifies seven "Major System Acquisition Management Objectives." One of these states:

> 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....

This objective, which emphasizes a unique strategy for each program, implies a requirement for flexibility that DOD supported in its 5000 series of directives and instructions. Among the 12 "procedures" contained in DODD 5000.1, *Major Systems Acquisitions*, March 12, 1986, is the following:

> 9. **Tailoring and Flexibility**. The acquisition strategy developed for each major system acquisition shall consider the unique circumstances of individual programs. Programs shall be executed with innovation and common sense. To this end, the flexibility inherent in this Directive shall be used to tailor an acquisition strategy to accommodate the unique aspects of a particular program as long as the strategy remains consistent with the basic logic for system acquisition problem-solving and the principles in this Directive for business and management considerations....

Applicability to C²

DODI 5000.2, *Major System Acquisition Procedures*, March 12, 1986, identifies 39 "Acquisition Management and System Design Principles" and states that, "The following principles shall be considered in planning major system acquisitions." Among these principles, the following is included:

> Evolutionary Development and Acquisition of Command and Control Systems.[1]

The footnote identified by [1] references Defense Acquisition Circular 76-43, "Acquisition Management and System Design Principles," February 28, 1983, which provides a discussion of Evolutionary Acquisition and other acquisition management principles. The circular was published as information guidance, not a substitute for regulations, directives or instructions. The discussion of Acquisition Strategy is reproduced below and reflects the DOD support of the principles of flexibility, innovativeness and uniqueness in the development of each program's acquisition strategy:

> 6. **Acquisition Strategy**
>
> a. An initial program acquisition strategy will be developed by the DOD Component concerned for each major system acquisition when a new start is proposed. The acquisition strategy should be tailored to the unique circumstances of the program. Proposed exceptions to applicable DOD Directive and Instructions will be identified in the acquisition strategy as it evolves. Advice and assistance should be sought from business and technical advisors and experienced managers of other major system programs.
>
> b. The acquisition strategy is the conceptual basis of the overall plan that a program manager follows in program execution. it reflects the management concepts that will be used in directing and controlling all elements of the acquisition to achieve specific goals and objectives of the program and to ensure that the new system satisfies the approved mission need. The acquisition strategy encompasses the entire acquisition process of the

basic system, preplanned product improvements (P^3I), and post-production support. The strategy must be developed in sufficient detail, at the time of issuing solicitations for the concept exploration phase, to permit competitive exploration of alternative system design concepts. Sufficient planning must be accomplished for succeeding program phases, that involve design, competition, provisioning and support economies, and production source availability.

c. The acquisition strategy must evolve through an iterative process and become increasingly definitive in describing the interrelationship of the management, technical, business, resource, force structure, support testing, equipment standardization, and other aspects of the program. Normally, the baselining and definition of a program will progress from establishment of oprational requirements (JMSNS) to functional characteristics (Milestone I) to an allocated functional baseline (Milestone II) to a production baseline (Milestone III).

d. Acquisition programs will be executed with innovation and common sense. The flexibility inherent in DODD 5000.1 and DODI 5000.2 will be used to tailor an acquisition strategy to accommodate the unique aspects of a particular program, as long as the strategy remains consistent with the basic logic for system acquisition problem solving and good business and management principles.

The Circular also provides a brief description of the characteristics of C^2 systems that may require an EA approach and discusses that approach in general terms:

27. **Command and Control C^2 Systems.**

a. The types of systems that augment the decision-making and decision executing functions of operational commanders and their staffs in the performance of C^2 require a tailored acquisition strategy. The principal characteristics of such systems are: (1) acquisition cost normally is software dominated; (2) the system is highly interactive with the actual mission users and is highly dependent on the specific doctrine, procedures, threat, geographic constraints, and mission scenarios of these users; and (3) these systems are characterized by complex and frequently changing internal and external interfaces at multiple organizational levels, some of which may be inter-Service and multinational.

b. The use of pre-planned product improvement (P^3I) is a procedure highly appropriate to such systems and should be considered when appropriate. C^2 systems generally require an evolutionary acquisition approach. This is an adaptive, incremental approach where a relatively quickly fieldable "core" (an essential increment in operational capability) is acquired initially. This approach also includes with the definition of the "core capability"; (1) a description of the overall capability desired; (2) an architectural framework where evolution can occur with minimum subsequent redesign; and (3) a plan for evolution that leads towards the desired capability.

c. Programming, budget approval, and acquisition management must be tailored to encourage and enable early implementation and field evaluation of a "core" system. Subsequent increments must be based on continuing feedback from operational use, testing in the operational environment, evaluation and (in some cases) application of new technology. Operational and interface requirements and operational utility criteria should be evolved with the participation of actual mission users (or lead user and appropriate surrogate for multi-user systems). There must be regular and continual interaction with developers, independent testers, and logisticians.

d. The user will support the independent T&E agency in determining readiness for operational use of the "core" system and work closely with the development activity and independent tester in evaluating subsequent increments of new technology. A centralized facility will be used to accomplish post deployment software support of fielded increments under centralized configuration management. Consideration must be given to the use of existing commercial equipment, related system software and firmware, and contractor maintenance (with warranties) whenever logistic, interoperability, readiness considerations, and field conditions permit it.

e. Those elements of C^2 systems that must survive and endure in strategic or theater nuclear warfare will be at least as survivable as the weapon system they directly or indirectly support. A proper mix of survivability techniques must be applied. Existing military and commercial hardware, software, and procedures should be used only if it can be demonstrated that they can be protected against and made resistance to wide-area threats such as jamming, spoofing and electromagnetic pulse, and that they can provide reasonable functional/system/path redundancy against direct attack and sabotage. Interoperability and battlefield sustainability will be key considerations.

f. The procedures described above are equally applicable to similar non-major C^2 systems as well as counter-C^3, electromagnetic countermeasures, and electronic warfare systems.

SECTION 7

SUMMARY

Evolutionary Acquisition is an alternative approach to acquisition of Command and Control Systems. The OSD policy makes available the use of EA for such systems whose capabilities are to be introduced incrementally, and the Joint Logistics Commanders endorse this OSD guidance.

Considered most broadly, EA consists of first defining the requirement and the general outline of the system; and then sequentially defining, funding, developing, testing, fielding, supporting, and evaluating increments of the system beginning with a core or baseline system, to be enhanced through incremental upgrades.

Successful use of EA requires a number of modifications to the normal practices of systems acquisition. Of particular importance are the relationships among the acquisition executive, the user, the surrogate user, the independent tester, the supporter and the developer; all of which must be of high quality for EA developments to be performed successfully. The Joint Logistics Commanders will, as necessary, assist subordinate commanders and their program managers in negotiating any special arrangements which might be required to successfully implement evolutionary acquisition.

☆ USGPO 1987 - 180-998/62330

END
DATE
FILMED
4-88
DTIC