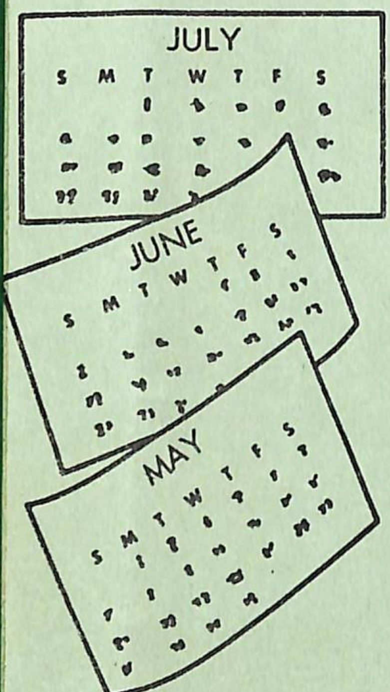
DEPARTMENT OF THE ARMY

ARMY SCIENTIFIC ADVISORY PANEL

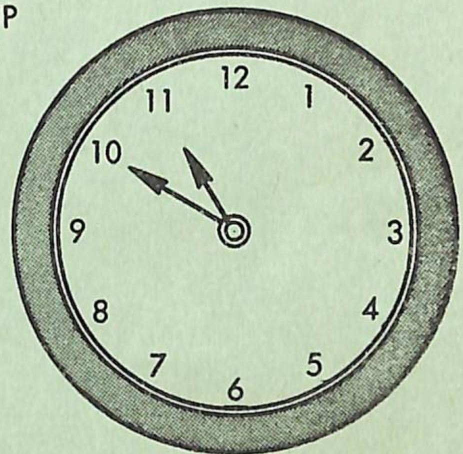


REPORT OF THE AD HOC GROUP

ON

DEVELOPMENTAL

LEAD TIME



A REPORT TO THE ASSISTANT SECRETARY OF THE ARMY

FOR RESEARCH AND DEVELOPMENT

APRIL 1969

Army Scientific Advisory Panel

REPORT OF THE AD HOC GROUP

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DEVELOPMENTAL LEAD TIME

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for Research and Development

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ACKNOWLEDGMENTS

The Group wishes to express its indebtedness to the many persons and organizations within the Army who briefed it, provided supporting documentation, and contributed to the Group's discussions. The majority of the briefings were specially prepared to highlight lead time aspects of the subjects presented; this imposed a substantial load on the briefers and their supporting agencies additional to their normal work load.

The briefings on particular projects are notable in that each represents in itself a valuable case study identifying factors which tended to increase or decrease lead time.

The Group is especially indebted to Colonel Merle F. Ormond who arranged for the many briefings, obtained and distributed to the Group a large quantity of background material, and assisted the Group in ways too numerous to delineate.

SECTION 1

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1.1 GENERAL

This report presents the observations, conclusions and recommendations of the Ad Hoc Group on Developmental Lead Time.

Since the Army last conducted an intensive study of lead time in 1961, there have been many procedural improvements in management of RDT&E with the establishment of CDC, AMC with its project managers; and ACSFOR with its planning, coordinating, and monitoring functions. We believe the present organizational structure is competent to deal with the problem of shortening lead time.

However, we find that time, and the advantage of doing things quickly, appear to play minor roles in the present management process and its descriptive documentation. The few remaining statements about lead time goals in the current Army Regulations are weak and represent substantial relaxations of the goals set in 1961.

We believe that short developmental lead time (measured from project initiation to first issue to troops) must be an essential consideration in the development process, although it must be fairly balanced against performance and cost. It will not be given this consideration unless it is established as a principal objective in development.

Success in development depends critically on R & D accomplishments prior to project initiation: good concept formulation and design definition, competent appraisal of suitability and availability of required technology and components, sound formulation of the requirements, and adequate funding.

In order that the timeliness of sound concept formulation not be dissipated by advancing technology, prompt program selection, approval, and initiation of development by DA is required.

Once the project has been initiated, we feel that quick realization is essential to forestall obsolescence, control costs, maintain continuity of project management, and provide most rapid upgrading of the Army's operational capability to best meet the enemy threat.

We believe that the key to developmental success in planned time is: (1) strong, experienced project management (2) administrative and review procedures which expedite program progress, (3) responsive support of the Project Manager within user agencies, and (4) aggressive use of concurrency in development of design and preparation for manufacture as well as in testing and operational planning.

Finally, we believe that the management system must be designed to be self-correcting: the ability of the Army to analyze its own performance is evidenced by the excellent series of briefings given us on the histories of specific materiel developments. We note that the Army has exercised initiative in beginning to measure administrative lead time, an aspect of major concern to us. What remains is to apply this activity on a continuing basis to the progressive simplification and strengthening of the management process.

Our principal conclusions and recommendations are presented in this section. Discussion and rationale are contained in the following sections. It is hoped that the observations, conclusions and recommendations of this report will be of assistance to HQ DA and other Army agencies in attacking aggressively and expeditiously the matter of shortening the time required to meet effectively the needs and wants of the Army for new materiel.

1.2 CONCLUSIONS

1.2.1 General

(1) We believe that the time from concept to operational use of Army systems can and must be shortened.

(2) The development process is necessarily a compromise among time, funding rate, assurance, and performance.

(3) Current emphasis is on cost and program assurance, almost to the exclusion of time.

(4) The present goal of four years, from project initiation in Engineering Development/Operational Systems Development to conditional type classification, covers only a segment of the process from establishment of requirements to first issue to troops. There appear to be no goals for the remaining segments, with the exception of Contract Definition. In the absence of Lead Time Goals, other criteria will dominate the rate of progress of a program.

1.2.2 Pre-Development Activities

(1) Good concept formulation and design definition, which appraise suitability and availability of the technology involved and of the required components, are of utmost importance for the success of a program.

(2) The Army's family of plans should in principle, provide a time table for progressive improvement in Army operational capability, to which the research and development agencies and commands should gear their programs. This relationship, although in process of being improved, still seems to us to be tenuous.

(3) The present emphasis on meeting the objectives of concept formulation before initiating engineering development has increased the requirement to demonstrate advanced technology prior to development. This should be done in short and intense QMDO or ADO programs.

(4) The Army's requirements and concept formulation activities must be intensified and focused in response to each of the Army's plans, beginning about five years before project initiation is required for the relevant plan.

(5) To be useful, any technology must be reduced to industrial or military state of practice. This transition may in itself be a major contributor to total program cost and time. The Army's in-house resources can play an essential role in providing objective assessments of technical feasibility and state of practice of a given technology.

(6) Program selection, approval and initiation of development has been a source of significant delay on some programs and must be expedited.

(7) The time currently required to prepare, review and approve QMDOs, QMRs, and related documents is excessive and can be reduced.

1.2.3 Establishment of Goals

(1) The establishment of goals for each major phase of the development and acquisition process is necessary to ensure the preparation and execution of an efficient development plan and to encourage simplification of the management process.

(2) Although program stretching may be necessary in some cases to achieve an integrated plan for the Army within budget constraints, the initial development plan should not exceed established goals without justification.

(3) Lead-Time Goals are desirable for certain pre-development activities and administrative actions.

1.2.4 Activities Subsequent to Project Initiation

(1) The current review process is undesirably sequential and time consuming.

(2) Once established, requirements tend to be relatively inflexible. Procedures for determining that a relaxation in a requirement is preferable to significant delay in development, increased cost, or acceptance date appear to be complex and slow.

(3) Personnel shortages and rotation on the user side appear to handicap the development of an efficient, responsive relationship between developer and user, and the timely planning and phasing of supporting activities.

(4) Shortages in qualified personnel and modern test facilities appear to constitute a significant cause of delay of some programs.

1.2.5 Contracts and the Development-Production Interface

(1) Lead time can be shortened significantly if the practice is followed of awarding the first procurement for inventory of new complex equipment to the contractor that developed the equipment.

(2) Hardware competition continuing through engineering service tests can be effective in reducing risk, costs, and increasing the assurance that a satisfactory item will be obtained. Significant lead-time penalty need not be incurred if proper advanced planning is done and production award is made to one of the competitors.

(3) In the case of Army in-house developments, the same lead-time problems may be encountered as in any production award to a contractor other than the developer.

1.2.6 Project and Product Management

(1) The key to successful, expeditious project execution is the assignment of a competent, continuing project manager and staff with progressive, specialized training and experience in project management. This management must have proper authorization to make all decisions necessary to execute his development plan, adequate resources, and strong in-house technical support.

(2) Most programs outlast the tour of duty of the project manager. Some, but not all programs, have career civilians as deputies who can provide continuity.

(3) Most development programs are too small for formal projectization. They require comparable application of principles of good management and, in many cases, may impose demands equal to those of large projects in coordinating component activities across commands.

(4) The Army's program for the development of project managers does not have adequate visibility, nor do we believe that the demands of Viet Nam have permitted it to acquire sufficient depth or magnitude.

1.2.7 Overall Management Process

(1) The Army has demonstrateo an excellent in-house capability to critique its development programs and identify causes of extended lead time.

(2) There does not appear to be an existing formal procedure for employing this capability on a continuing basis for periodic modification and simplification of the management process to shorten leadtime and improve efficiency.

(3) Much of the current effort in systematizing the management process appears to result in increased complexity. Administrative actions associated with the management system being implemented constitute a source of significant program delay. As an example, the elapsed time from an In-Process Review Meeting to DA approval has averaged seven months.

(4) We believe that the process, as presently defined, associates a disproportionate amount of administrative activity at high levels with the small development projects which comprise the principal portion of Army development activity by number, although not by cost.

(5) The Management Model describes the flow of activities through the Army system on a single project basis. What happens when the Model is applied in whole, or in part, to all of the Army's projects, when bottlenecks and excessive delays occur, and whether manpower to run the system is properly allocated, remains to be determined.

1.3 RECOMMENDATIONS

1.3.1 General

The Army establish as policy that lead time is to be given equal consideration with cost and performance in preparing development plans, and that project and product managers will be evaluated on their efforts to achieve short lead time, as well as on budget and technical performance.

1.3.2 Predevelopment Activities

(1) A concerted effort be made to tightly link the Army's family of plans (e.g. Army Force Development Plan), the QMRs, QMDOs and OCOs, and the concept studies (Army 85, etc.).

(2) This planning activity be made responsive to rapid modification to incorporate and exploit unexpected and unplanned technological achievements and to capitalize on exploratory development which proceeds more rapidly than anticipated.

(3) QMDO-responsive activity be subdivided into open-ended, long-term, and near-term programs. Administrative procedures for generating, staffing, and approving the first two categories should be simplified.

(4) QMDO-responsive activity intended to result in project initiation in the near term (less than five years) be planned, funded, directed, monitored, and reviewed in a manner which will expedite progress and ensure smooth transition through QMA, QMR, and project initiation without excessive administrative delays at any level.

(5) The Army's in-house R&D resources be increasingly tasked to assess the state of practice involved in the assessment of feasibility in concept formulation.

1.3.3 Establishment of Goals

(1) The Army establish lead-time goals for each major phase of the development-acquisition process. We suggest the following for major programs:

Phase	Desired Time
QMDO to QMR Approval	As short as possible consistent with desired IOC
QMR Approval to Project Initiation	6-12 months
Project Initiation to Type Class. Cond. Std. A	4 years
Type Class. Cond. Std. A to Type Class. Std. A	
Type Class Std. A. to First Issue	
Army-Wide Deployment	3 years

The desired goals are to be exceeded only with justification. Small developments should have appropriately shorter goals.

(2) Review of the System Development Plan specifically consider the degree to which the goals are met, and longer times be approved only upon explicit justification. Plans for programs which are not projectized be similarly critiqued at appropriate organizational levels.

(3) In adjusting project schedules in the AFDP and the Army portion of the FYDP, tradeoffs of performance versus cost versus date operational capability is fielded be considered to achieve the most rapid advance of Army operational capability. In some cases this may favor delaying project initiation, rather than reducing funding level and extending realization date, when this action permits the incorporation of a more advanced state of the art.

(4) The developing agency/program manager be directed to exercise initiative in recommending the most efficient management procedures to achieve the shortest feasible development time in preparing the System Development Plan.

(5) ACSFOR ensure that the most efficient procedures are followed for achieving short lead time by:

  (a) Advising on procedures for simplifying and expediting the review and administrative procedures.

  (b) Approving the Lead-Time Goals in the System Development Plan as compatible with Army Lead-Time Goals.

(6) Excessively stringent requirements be deleted from the QMR prior to initiation of engineering development.

1.3.4 Activities Subsequent to Project Initiation

(1) The procedures of the IPR, SSE, and MRRC reviews be consolidated and simplified to eliminate delays in decisions and approvals. Delegation of decision authority to attendees at the IPR should be the normal practice.

(2) Procedures be improved for maintaining some flexibility in requirements in the interests of time, cost, and/or performance.

(3) The responsibility of the user to maintain an effective, continuous, timely and responsive relationship with the developer be implemented by the establishment of sufficient priorities to hold personnel rotation to an acceptable level.

(4) Appropriate priorities be established for test operations to ensure the assignment of an adequate number of qualified test personnel and the acquisition and use of modern test facilities.

1.3.5 Contracting and the Development-Production Interface

(1) The advantages of concurrency be given greater weight in selecting the form of contract.

(2) For complex systems the RFP state that the contractor selected will be responsible for development plus production of a specified volume of first buy. PEMA funds must be available when needed in the development phase to realize this objective. When this cannot be shown to be in the Government's best interest, hardware competition through engineering tests, followed by production award to one of the competitors, is preferable to development followed by open competition, from a lead-time point of view.

(3) Hardware competition should be undertaken when R&D cost is small compared with life cycle cost.

(4) Formal concept formulation and Contract Definition be eliminated when requirements are clear cut and technical risk is negligible.

(5) In the case of in-house developments, the Army take early action to prevent delay in transferring know-how to the production contractor.

1.3.6 Project and Product Management

(1) The authority and responsibility of both project and product managers be maintained and extended. They should be directed to exercise initiative in proposing development plans and management procedures which will expedite development and meet or better the Army's lead-time goals.

(2) Rotation of managers during the interval from project initiation to type classification Standard A be minimized.

(3) In the case of projects too small to be organized on a formal project basis, the responsible manager be required to apply such principles of good management as preparation of a development plan, establishment of milestones, budget tracking, etc., be rated on success in achieving his objective on schedule, within budget.

(4) The Army further formalize, expand, and give greater visibility to its program for project management as a career specialty. It should make clear by example that genuine careers exist in project management leading to high rank through technical education and project management experience as well as field command.

(5) The Army extend its practice of aggregating small developments in compatible groups under the direction of a product area manager who can serve as a single point of contact with DA and who is responsible to HQ AMC for planning, budget control, and project direction in his assigned area. The manager should be delegated the control and authority required to work laterally in the command-to-command involvement required to mature the developments on time and within cost.

1.3.7 Overall Management Process

(1) ACSFOR direct an aggressive and continuing program to streamline and simplify the management process for Army systems. This program should include as a minimum:

(a) Counseling the Project Manager in the formulation of the development plan on procedures to minimize lead time, including appropriate abridgements of the full Management Model, and timely coordination with participating Army agencies.

(b) Review of each developmental project at completion to identify causes of schedule slippage, excessive administrative delays and cost overruns.

(c) Development and staffing of changes and simplifications in the system approximately annually to shorten lead time, improve efficiency, and reduce administrative manpower.

(2) The documentation of the Army Management Model be revised to emphasize more forcefully:

(a) A requirement to omit unnecessary steps.

(b) Designation of which steps are mandatory or optional; in the latter case the approval level, if any, for omission.

(c) Examples of simplified "road maps," i.e., typical flow diagrams, especially for small programs.

(d) Frequent statements of the necessity for doing things quickly.

(3) The Army continue and amplify its efforts to measure administrative lead time at all levels. In parallel,

the Army should develop estimates of the total administrative effort associated with each project on a "division-slice" type of basis as a first step in determining where its staff effort is disproportionate to program size. It should also determine those activities which should be delegated and consolidated at lower levels.

(4) The effects of reduced lead times and longer useful lives be given proper emphasis in analyzing the expected life-cycle effectiveness and costs of new items.

(5) The Army consider the feasibility of a limited computer simulation of its Management Model, using the administrative leadtimes currently being accumulated, the number of active projects in the system and expected projects, and the available man-hours with present personnel assignments, at all agencies involved, to provide a better basis for understanding which activities form the critical path, and to allow testing of proposed system improvements to reduce leadtime in advance of actual implementation. We feel that the system is too complex to obtain this understanding by simply examining PERT charts of individual projects.

SECTION 2

INTRODUCTION

"The ultimate objective of Army research and development is to develop for the Department of the Army weapons, equipment, and systems capable of being effectively manned and superior to those of any potential enemy, in any environment, and under all conditions of war."

AR 705-5

2.1 INTRODUCTION

With the rapid advancement of military technology, the Army must be periodically re-equipped with improved equipment to stay ahead of any potential enemy, who is drawing on a comparable base of advancing technology to improve his own capability.

Even under optimistic assumptions, it can take a decade to go from the requirement to Army-wide use of a complex system.* Initiation of development effectively freezes the technology as of that date. If one side can shorten the process by two years it can, in principle, elect to start a new system two years later, thus applying a technology advanced by two years, and field the system at the same time as the enemy's, which will be based on an earlier technology. Conversely, it can initiate development at the same time, and field the system two years earlier. In fact, averaging over many military systems and for an equal technological base, the side which consistently maintains a shorter time from project initiation to field use will maintain technological superiority of its force in being. Conversely, excessive "development lead time" may contribute to technical inferiority of the force in being.

Finally, the shorter the time required to go from project initiation to operational use, the longer the effective system life will be before it is overtaken by technical obsolescence.

2.2 MISSION OF THE AD HOC GROUP

The mission of the Ad Hoc Group on Developmental Lead Time, as approved by the ASAP Executive Committee on 15 October 1967, is as follows:

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*In civil life a new computer goes from design concept to peak use in about 8 years.

Problem: To determine the causes and remedies for the long lead time required to produce new military materiel and systems.

Considerations: Some large, important military programs have met the lead-time goal of four years, as established by Army Regulation 705-5, October 1964. Other equally important programs have not. In typical cases, the development lead time has been 8 to 10 years, a lead time similar to that existing subsequent to World War II. Because technology now evolves more rapidly than in the past, long developmental lead time is unacceptable, since this can result in an item technically obsolescent at the time it is accepted for service.

Terms of Reference: In studying this problem, the Ad Hoc Group should:

(1) Review and analyze the current developmental system, comparing that which has evolved with the concept delineated in AR 705-5.

(2) Based on a survey of items whose developmental lead time is significantly greater than four years, analyze the history of these items and evaluate the progress between milestones in the program - a PERT type analysis.

(3) Recommend course(s) of action, the adoption of which would remedy defects in the development system leading to excessive lead times.

The membership of the Group is given in Appendix A.

During 1968, the Ad Hoc Group was comprehensively briefed on the Army's organizational structure and management procedures for going from system concept and/or requirement to operational realization. It received specific briefings on the developmental history of 16 projects, ranging from combat boots to helicopters. Agendas for these and other briefings are contained in Appendix B of this report. In addition, several individual members of the group visited with Army agencies and discussed the problem of developmental lead time in areas of their particular interest.

2.3 PAST STUDIES OF LEAD TIME

Lead time and the military systems acquisition process have been matters of national concern at least since the mid-fifties. Each of the services has, at intervals, attempted to arrest the growth of developmental lead time by setting up investigating committees and acting on many of their recommendations.

In 1958, the Rockefeller Report concluded:

> "One of the major weaknesses in our strategic posture has been our inordinately long lead times."

Peck and Sherer stated in 1961 in "The Weapons Acquisition Process" that

> "...many knowledgeable persons...are dissatisfied with the length of time required on the average to develop U. S. weapon systems."

A definitive study of Army lead time was made by the Materiel Requirements Review Committee (MRRC) in 1961. The MRRC study referenced seven major prior studies of Army lead time performed in the period 1956 to 1960, three at Department of the Army level, two by ORO, one by SRI, and one in 1958 by the Army Scientific Advisory Panel.

A change in emphasis took place in 1962, when Secretary of Defense Robert McNamara stated that:

> "Shortening development lead time and reducing development costs shall be considered equal in importance in achieving performance in weapon systems and equipment."

The Group found no extensive studies devoted to reducing lead time subsequent to that date. A great deal of effort has been devoted to cost-effectiveness, with cost emphasized to the point that some popular writers apparently consider the phrase to refer to the effectiveness of cost. Operational date, which is the final measure of lead time, is rarely included in the measures of effectiveness of a cost-effectiveness study.

2.4 COMPARISON WITH FOREIGN LEAD TIME

An important measure of how our weapons acquisition system is doing is the comparative performance of our operational equipment on a unit-by-unit basis with that of potential enemies.

For this reason the group asked for, and received, an intelligence briefing on the relative performance of U. S. and Soviet equipment versus time.

The group found, without questioning the excellence of U. S. equipment being fielded, that the U. S. is not uniformly and substantially ahead of the Soviets in all land combat systems in the hands of troops, and this conclusion applies not only to quantity but also to quality. The group was not reassured by the estimates given on Soviet developmental lead time.

If we are not fielding better equipment sooner, on a continuous across the board basis, it seems a reasonable conclusion that our system must be speeded up.

An alternative is to spend more to advance the state of the art and choose more advanced technology to compensate for longer lead time. But technology is more difficult to keep secure. The side with the ability to go from a correctly perceived requirement to field in the least time will derive a distinct advantage.

We suggest one modification in the method of presenting information on foreign material. Since one object of an intelligence effort is show how we stand relative to a potential enemy, we feel that not only should equipment performance be compared, but the presentation should display in simple comparative form, the dates on which each equipment type became operational. Simple score sheets of this type would be the clearest indication of whether our weapons acquisition process is running fast enough to keep us ahead in the arms race.

2.5 DEFINITION OF DEVELOPMENTAL LEAD TIME AND ITS EROSION

One way of accomplishing a difficult objective is to change the definition of the objective. This appears to have been happening to the definition of developmental lead time in successive Army Regulations. We doubt that this has been intentional. It does demonstrate how an objective, which is not given prominence by well publicized top management attention will, inevitably, be pushed aside by those measures which are given such attention.

In 1961, the Materiel Requirements Review Committee (MRRC) report on lead time stated:

> "The U. S. Army Lead Time Objective is to reduce to four years, or less, the time required from project initiation to first production roll-off of materiel that offers significant new capability to the U. S. Army."

These words were used in AR 11-25 of 1961.

Three years later, AR 705-5 of 1964, defined the four-year span as extending from initiation of development effort to type classification as standard.

The 1968 draft of the latest revision of AR 705-5 defines the four-year development lead-time goal as extending from initiation of development to type classification as Conditional Standard A.

The relevant extracts from these and related ARs are presented in Appendix C.

In 1961, following a careful analysis of case histories of 23 materiel items, the MRRC found the following average lead times:

Average Total Lead Time (Project initiation to item availability for initial issue)	10 years, 10 months
Average R & D Lead Tiem (Project initiation to type classification)	5 years, 4 months
Average Time Utilized in Tests	2 years, 2 months
Average Production Delivery Time (Type classification to initial issue)	3 years, 9 months

In the sequence of activities depicted in the Army's "Management Model," conditional type classification is followed by award of a production contract, production acceptance tests, and a production validation SSE before type classification.

The MRRC sought to reduce an observed overall lead time of 11 years to 4 years. The present regulation seeks to reduce to four years a portion of a process, the whole of which required five years in 1961.

We feel that time must be brought back into the picture and given a position of equal importance to that of cost and performance. We cite the phrase "time-cost-performance" currently associated with trade off studies in Contract Definition, and we feel it essential to consider these three factors to a degree appropriate to the item under consideration in each stage of the military system acquisition process.

We feel that to assure that time is given proper consideration, lead-time goals must be specific, and development plans compared against these goals as a matter of routine. We feel that the goals must be specified to span the complete development and acquisition process as originally intended by the MRRC. We propose specific goals in this report. Lead time goals should be set project by project. However, ARs should set goals which may not be exceeded without extenuating circumstances.

SECTION 3

THE CURRENT DEVELOPMENTAL SYSTEM

3.1 GENERAL DISCUSSION

The Ad Hoc Group was asked to review and analyze the current developmental system, comparing that which has evolved with the concept delineated in AR 705-5.

The system is continually changing. So are the many ARs which describe it (of which AR 705-5 is only one document). We described earlier how successive AR revision has progressively weakened the emphasis on short developmental lead time.

Some of the significant characteristics of the current developmental system include:

(1) Implementation of a major continuing effort to project the Army's requirements into the future by development of a series of concept studies for Army-80, Army-85, etc.

(2) The sharp distinction between R&D activities prior to the establishment of a requirement, and post-approval activities based on "life cycle" planning and budgeting through development, acquisition, and operation.

(3) Implementation of a concept of "centralized management," which requires Department of Army approval (on major systems), to progress to each of about half a dozen successive phases of the system life cycle, and the associated potential delays in accomplishing all of the coordination and approval actions required Army-wide as a prelude to these decisions.

(4) Further strengthening of the project management system, with the project manager on major projects chartered by name by the Secretary of the Army and "assigned the responsibility and delegated the full line authority for the centralized management of a specific project" (AR 70-17).

(5) Systematizing the management process and defining it in more detail (The Department of the Army Management Model and associated documentation) than has ever been the case in the past.

These activities, in principle, provide the means for determining desired project by project lead-time goals to minimize excessive and costly lead time slippages, and for progressively revising and simplifying the development system to improve its effectiveness. In practice, however, some of them may result in longer lead time.

There is no doubt that important development programs, which have top level interest, can and do progress rapidly. Without this interest and attention, conscientious and meticulous attempts by project and product managers to follow the currently defined procedural requirements of the system are likely to result in disproportionately lengthy and costly development programs.

3.2 OVERVIEWS

The weapons acquisition process divides naturally for discussion into two parts differing in scope, content, objective and, possibly, in degree of urgency, and separated by the "establishment of a firm requirement."

Prior to the requirement, the objective is to develop the advanced technological base which allows the formulation of system concepts to satisfy requirements as they are evolved. Subsequent to the requirement, the objective is to field the system within budget and manpower constraints. When technology is advancing at a rapid rate, the sooner the system is fielded the longer its operational life is likely to be before it is made obsolete by enemy development (and the more years of operation over which its development and acquisition cost can be amortized).

It can take 12 years to go from the requirement to Army-wide use of a complex system. This includes two years to firm-up the requirement, considering projected need and technological options; five years to develop, test, and classify; and five years to equip and train the Army. Many systems have taken much longer than this.

Since the establishment of the requirement and initiation of engineering development essentially freeze the technology, this means that operational needs 12 years from today must be met with today's technology.

This is the most critical element of Army planning: the inherent lag between decision to develop and achievement of an operational capability.

Prudent planning will maintain as wide a range of options for development as the budget will permit and make no major commitment until required. Programs can be redirected in process (with added cost and delay) as requirements are clarified with the approach of the operational date. But the difficulty of forecasting the future a decade in advance makes developmental lead time a critical determinant of operational suitability and effectiveness.

Special-purpose systems, for less than full Army utilization, can be developed and fielded in less than 10 years, as has been demonstrated in every war, including Viet Nam. The Army has responded well to the demands of crises. But necessary as this response is, even a two-year response to a critical requirement of a going war can only be interpreted as a two-year lag in meeting an operational requirement.

In summary, the objectives of the research, development, and acquisition process are:

(1) Based on long-range estimates of future Army operational needs to develop the technological base, including component development, which will provide a range of options of advanced and feasible systems for selection for full development and acquisition.

(2) To select, develop, and field those systems most likely to satisfy projected requirements.

(3) To respond on an expedited basis to unanticipated requirements generated by crises.

3.3 LONG-RANGE PLANNING

Within the last few years, the Army formalized and strengthened its long-range planning process, which is typified by the development of a series of Land Combat Systems Studies for "Army-80, Army-85, etc."

Development of these documents is supported by the "triumvirate of institutes,": the Institute for Land Combat, the Advanced Materiel Concepts Agency, and the Directorate of Environments and Threats.

Our interest in this activity, from the point of view of developmental lead time, centers on our conviction that a clear definition of the requirement, plus good concept formulation and design definition, which accurately appraises suitability and availability of the technology involved, and of the required components, are of utmost importance for success in the development.

It is too early to comment on the likely effectiveness of this process of developing requirements. We are encouraged by the intimate interaction which may be developed between the tacticians and technologists. We would hope that the Advanced Materiel Concepts Agency, as part of AMC, would facilitate the flow of ideas and expressions of need among the user, the commodity commands of AMC, other Army agencies, and industry. We feel that there is a unique potential advantage in the ability of AMCA to work with concepts simultaneously involving specialties of many separate Army agencies.

We feel that the resulting series of Army plans should provide the initial goals for system performance, and the dates by year that they must be achieved. Working back through Lead-Time Goals would establish the time at which a system must enter engineering development. In the case of many QMDOs, it would establish the date at which exploratory and advanced development must be able to demonstrate that the requirements of concept formulation have been satisfied.

For the more advanced projections, we feel that the interaction between the plans and the Army's research and laboratories programs must be two-way and explicit. The laboratories must participate in, and relate their research programs to, the Army's long-range planning.

The Army is now developing a "Compendium of Plausible Materiel Options (CPMO)" for the post-1985 time period. This activity draws on all of the Army's technical resources, and those of industry. It is not clear to us how the Army can accomplish a similar intimate integration of its many resources to achieve concept formulation for systems based on current state of the art and for much earlier implementation. Some integration is being carried forward within commodity commands, such as the Weapons Command. However, we know of no single existing Army agency, with the exception of AMCA, which is responsible for initiating system concepts and doing preliminary design on systems which may eventually involve several commodity commands. We feel that AMCA may be a base on which to develop such a capability.

3.4 ACTIVITIES RESPONSIVE TO THE QMDO

We distinguish between two types of objectives to which basic and exploratory research are directed: the Operational Capability Objective (OCO), and the Qualitative Materiel Development Objective (QMDO).

The Army's family of plans should, in principle, provide a time table for progressive improvement in Army operational capability to which the research and development agencies and commands should gear their programs. This relationship, although in process of being improved, still seems to us to be tenuous. However, we are encouraged by our briefings on the energetic efforts in this regard.

Sample QMDO plans which were reviewed by the Group seemed to fall into two categories:

(1) Those which are end-item oriented and can reasonably be scheduled and phased into the overall system development process.

(2) Those of an "omnibus" type which are category oriented. R&D of this type may preferably be related to an OCO.

We feel that activity now carried on in response to a QMDO (or ADO) of the first type should be planned and scheduled as a part of a consistent development effort devoted to achieving a specified operational capability at a specified date. If the milestone dates are not met and the material cannot be deployed on the planned schedule, a re-evaluation of the requirement must be made to determine an alternate plan, which might vary all the way from modifying the schedule to deletion of the requirement.

We feel that this focusing of some of the exploratory research and advanced development activity to short-term objectives is essential to the rapid realization of advanced technology in systems concepts. We note one of the findings of Project Hindsight, namely that in past development projects, the majority of 'significant events', events qualifying as creative steps in research and exploratory development and necessary to system success, took place after project initiation, under the impetus of a well-defined objective.

With the present emphasis on meeting the seven objectives of Concept Formulation before initiating engineering development, the requirement to demonstrate advanced technology prior to development has been increased. We suggest that the place to do this is in comparatively short (two or three years) intense QMDO (or ADO) programs.

The fact that the QMDO is even now intended to be responsive to requirements is indicated by the fact that it is subject to review and approval at Department of the Army level. We have been given an estimate of over five months average approval time at this level. Although DA approval is consistent with our hypothesis that at least a portion of the QMDOs represent an integral and essential segment of the scheduled development process (as opposed to open-ended research),

a delay of this length seems inappropriate. We suggest that QMDO-responsive activity should be subdivided into open-ended, long-term, and near-term programs. Administrative procedures for generating, staffing, and approving the first two categories should be simplified.

We suggest that adjudication of the objective and creation of the QMDO may be managed jointly by CDC and AMC, with information copies circulated to interested General Staff agencies and principal negotiation for resources accomplished with OCRD.

On the other hand, QMDO-responsive activity intended to result in project initiation in the near term (less than five years) should be planned, funded, directed, monitored, and reviewed in a manner which will expedite progress and ensure smooth transition through QMA, QMR, and project initiation without excessive administrative delays at any level.

3.5.1 Concept Formulation Objectives

The clock for measuring developmental lead time, according to the current relaxed goals, starts to run on the date the Department of the Army approves the project and authorizes funds. Moving back in time, we find that (in AR 705-5) the Chief of Research and Development directs initiation of projects in the engineering and operational systems development categories, subsequent to Department of the Army approval of the QMR or SDR. And, still earlier, preparation of the PQMR which, when approved, becomes the QMR, is conditional on successful completion of the Concept Formulation phase, which has achieved the seven objectives:

(1) A determination that primarily engineering rather than experimental effort is required, and the technology needed is sufficiently in hand.

(2) Mission and performance envelopes are defined.

(3) A thorough trade-off study between alternative technical approaches and support concepts is completed.

(4) A thorough analysis of system trade-offs, including the results of the technical trade-off study is completed.

(5) The best technical approaches have been selected.

(6) The cost effectiveness of the proposed item has been determined to be favorable in relationship to the cost effectiveness of competing items on a Department of Defense-wide basis.

(7) Cost and schedule estimates are credible and acceptable.

Since the output of Concept Formulation includes a statement of system characteristics based on a state-of-the-art evaluation current to (optimistically) the date of issue, we submit that the clock measuring system obsolescence begins to run on the date Concept Formulation is completed.

We recognize that subsequent reviews and revisions of the program offer opportunities to modify the results of Concept Formulation but, in accordance with our thesis that it is better to proceed from requirement to operational use quickly, than to up-grade requirements in midstream, we are concerned by the length of time required to go from completion of Concept Formulation to Project Approval.

The need for close integration of the requirements and concept formulation activity, and for increased, well-focussed, and managed effort to secure sound concept formulation and determination of feasibility are most essential in the five-year period prior to the time at which project initiation must be accomplished to phase in to the relevant Army plan.

3.5.2 Assessment of Technology

In view of the programs which have experienced technical difficulties subsequent to project initiation, we question whether the Army is making proper and full use of the technical knowledge and skills of the personnel of its many laboratories. If these laboratories are up to their missions, then selected teams of experts should be able, with help from their advisory committees if necessary, to appraise in the concept formulation phase, the suitability, and availability of the technology involved.

Redeye, TOW, Little John, and Lance dragged along because of failure to anticipate technological problems, or to take early action to provide back-up approaches. The successful Jupiter and Pershing programs were based on design concepts developed by a strong in-house team. In the case of Lance, the in-house team apparently did their homework well on guidance, but underestimated the problems which the simplified guidance imposed on propulsion.

We have developed the impression that the fragmentation of Army in-house research and development among its many laboratories and commodity commands has often tended to cast the Project Manager in the role of an intruder who, unfortunately, must be served to some degree because he has budget control, but who diverts personnel from their long-term projects which are the "really interesting ones." Yet, the Army, with more in-house RDT&E personnel than the Air Force or Navy, more separate RDT&E installations, and the smallest RDT&E budget should be in the best position to apply in-house technical competence at the cutting edge: the translation of technology into Army operational capability.

The Army's in-house capability can be of particular value in providing objective estimates of the degree to which technological state of the art, as represented by laboratory or breadboard demonstration has been reduced to "state of practice," requiring only straightforward engineering design to implement. Prospective contractors are often optimistic in this regard, and underestimates of the difficulty in implementing advanced technology can plague a development program throughout its duration.

3.5.3 Approval of the QMR

The following table shows the number of QMR, QMDO, and SDR listed in the CDOG for several years.

About 50 development programs are currently directed by project managers chartered, or to be chartered by the Secretary of the Army.

Of the QMRs, about 40 to 50 new QMRs are approved each year, and the same number deleted, or about 16 percent.

This is an impressive requirements-related activity, considering that all items require DA approval. However, in our case study briefings, projects were cited in which activity was well underway before the QMR was approved. In the case of the AH-56A, the QMR arrived after source selection on the basis of the Contract Definition Phase reports. Chaparral, we were told, had experienced three years of development before the QMR was produced.

We conclude that there is basis for concern as to whether present methods of processing the QMR are consistent with short lead time and efficient development. The latter concern arises from the possibility that late arrival of the QMR may result in in-flight changes of the requirement affecting the system design, and causing delays.

We understand that the Army is currently making an effective effort to expedite QMR processing. We suggest the establishment of a Lead-Time Goal for the span from PQMR to QMR approval, and a critical review of the process to simplify and expedite it.

Numbers of Items

	1965	1966	1967 Total	1967 Inactive	1967 Being Deleted
QMR	274	247	262	69	41
QMDO	160	166	127	19	?
SDR	120	142	158	26	14

3.6 ESTABLISHMENT OF GOALS FOR DEVELOPMENT

A concept of developmental lead time is that it is an output of the planning process, rather than an imput. That is, given budget constraints, a list of systems desired by the Army, their priorities and cost, the planning process represented for example, by the Army Force Development Plan and the Five Year Defense Program, uniquely determine the development lead times.

We feel that this is necessarily true only on the assumption that all elements of the process are operating as efficiently as possible. In fact, the Army's weapons acquisition process is exceedingly complex. It is most unlikely that its resources are optimally apportioned.

We suggest a concept of the system which adapts and adjusts to meet those goals established by the highest level of Army direction. We feel that the establishment of Lead Time Goals, in addition to performance and cost, need not place an additional, impossible constraint on the system, but will, in fact, cause it to readjust to meet the goals. In the process, resources may be reallocated, communication and decision processes may be simplified, and internal administrative procedures modified. The result will be that lead time is a controlled rather than a free variable, and that this can be accomplished without loss of quality.

We feel that Parkinson's Law applies to this as to all problems involving human effort, "Work expands to fit the time available for its completion."

We conclude that the Army should establish lead time requirements for any specific materiel end item by scheduling from need date backward through: deployment/production/training/type classification/in-service tests/development/QMR/QMDO. The date of the desired IOC should be specified to the nearest year.

Specific target schedules must be established for each of these major milestones so that lead time may be controlled, entry to engineering development initiated no earlier than necessary and, when initiated, be used on the most advanced state of the art appropriate.

On an Army-wide deployment of a materiel, the committee feels that the following time periods should serve as guidelines for scheduling the development/acquisition cycle.

Phase	Desired Time
(1) QMDO to QMR Approval	As short as possible consistent with desired IOC
(2) QMR Approval to Project Initiation	6-12 months
(3) Project Initiation to Type Class. Cond. Std. A	4 years (phases 3–5)
(4) Type Class. Cond. Std. A to Type Class. Std. A	
(5) Type Class. Std. A to First Issue	
(6) Army Wide Deployment	3 years

Depending on circumstances (e.g., complexity of materiel being required and extent of deployment), any one of the six schedule options may be shortened or overlapped. In fact, a QMDO can be eliminated entirely if the technology base is well in hand.

Each of the six schedule elements is worthy of some discussion:

(1) QMDO to QMR: This refers to that portion of QMDO effort which is associated with near-term objectives, for example QMDOs initiated in 1971 for Army 85. The QMDO plan should spell out a level of effort and resources with detailed milestones to allow determination of feasibility leading to a QMR at the date required by the plan. If this is not achievable, then the objective must be re-evaluated and/or further broad-based exploratory development carried on. This phase can be eliminated when the technology base is "state of art."

(2) QMR to project initiation, 6-12 months: Under the present contract definition phase procedures 3 to 6 months is allowed from QMR approval to selection of CDP contractors, 3 to 6 months for CDP performance, and 3 to 6 months for CDP report evaluation and selection of development contractor. The contract definition phase approach must be significantly modified to shorten this cycle.

(3) Project initiation to type class conditional standard A: This phase involves the contractor design and development cycle as well as the in-service test cycle.

One and one-half to two years is allocated to the test cycle, the remainder to the design and development. It is felt that it will be difficult to shorten this four-year cycle and care must be taken lest efforts to do so greatly increase costs as well as lengthen the actual development/test cycle.

(4) Type class condition standard A to type class standard A: This involves the issuance of a limited production contract and a test and evaluation of production models. It is felt this period can be shortened or eliminated, if the development models have been built with production techniques and the redesign from the in-service test has not been significant.

(5) Type class standard A to first issue: This interval can be held to a minimum by advanced logistical planning and concurrency.

(6) Army wide deployment, 3 years: Early deployment will maximize the effective life of the system before it is overtaken by technological obsolescence.

Items (3) through (6) involve the development, in-service test, training, production, and deployment cycle of the acquisition process. It is felt that the cycle may be held to 7 years by implementing the recommendations of the committee of awarding the development and first production contract to the developing contractor. This contractor should proceed on a concurrency basis in the area of development, in-service test, production, spare parts and field support.

A year of this saving comes directly from the continuity of a single contractor, in that the technical data package does not have to be prepared (at this time), the time delay of recompetition is eliminated, and the inefficiency of start-up learning of a new (and inexperienced on the specific item) contractor. An additional two years savings results from the production-deployment cycles being concurrent with the development, in-service test, and type classification cycles. The attendant risk of this concurrency is the retrofit and retooling costs, which might occur due to production go ahead prior to recognition of materiel deficiencies discovered in the in-service test cycle. The provision of spare parts and field support by the developing contractor will contribute to the quality of operational equipment.

To develop a feeling for the feasibility of these considerations in terms of compatibility with contractor activities a portion of the flow diagram for the Management Model was expanded to include the contractor, and this is shown, for a hypothetical electronic system development, in Figure 3-1.

[illegible]

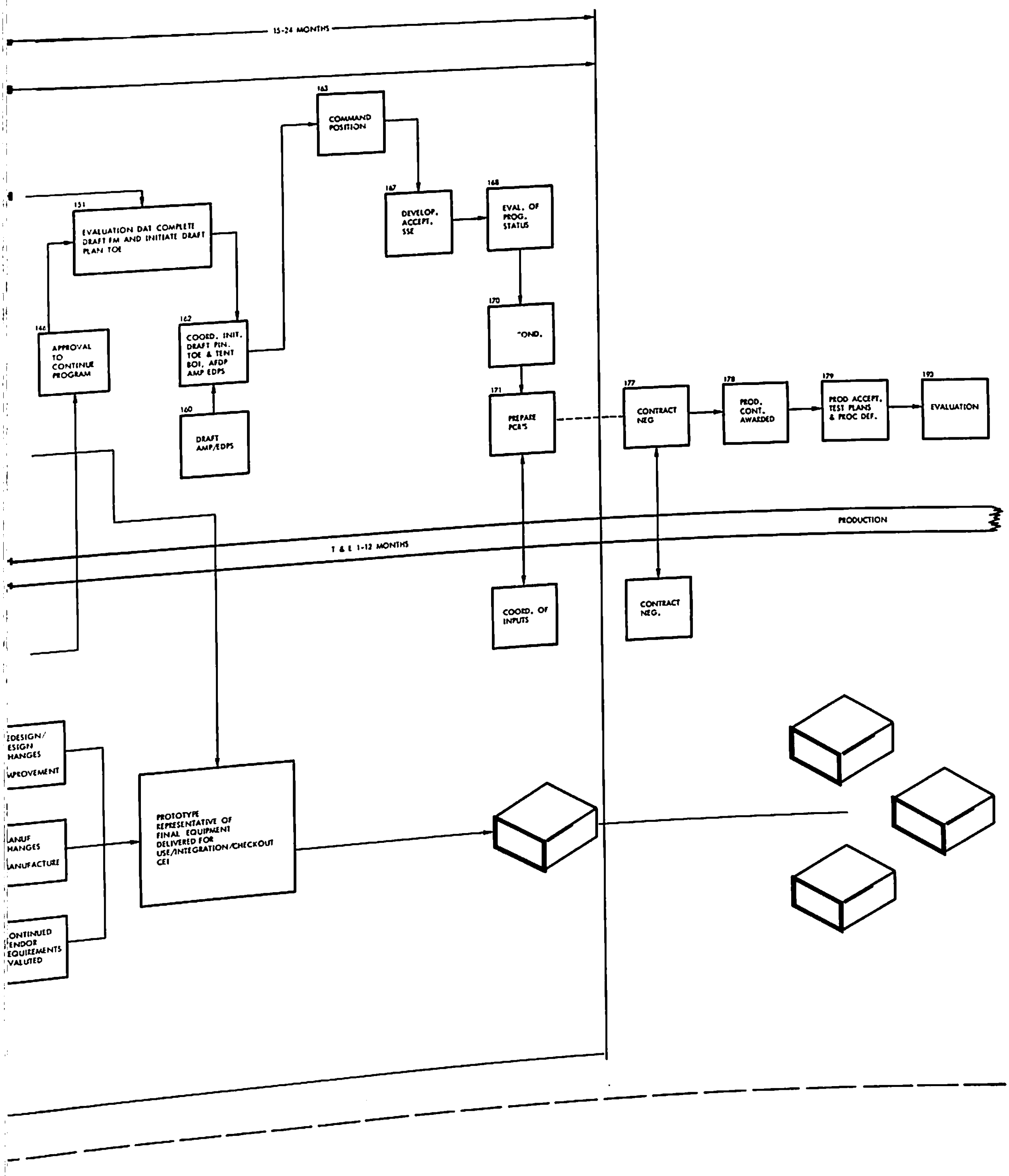
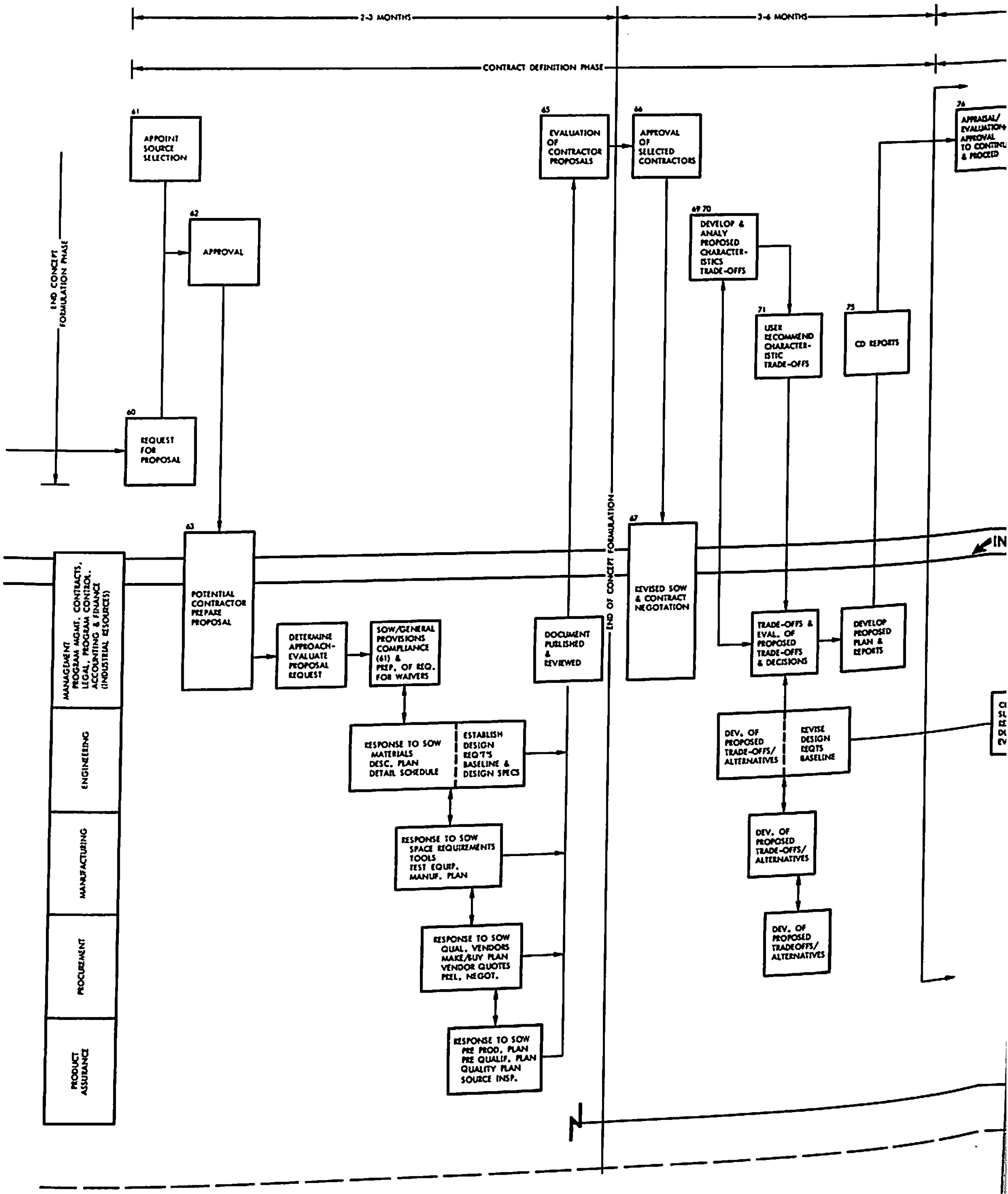
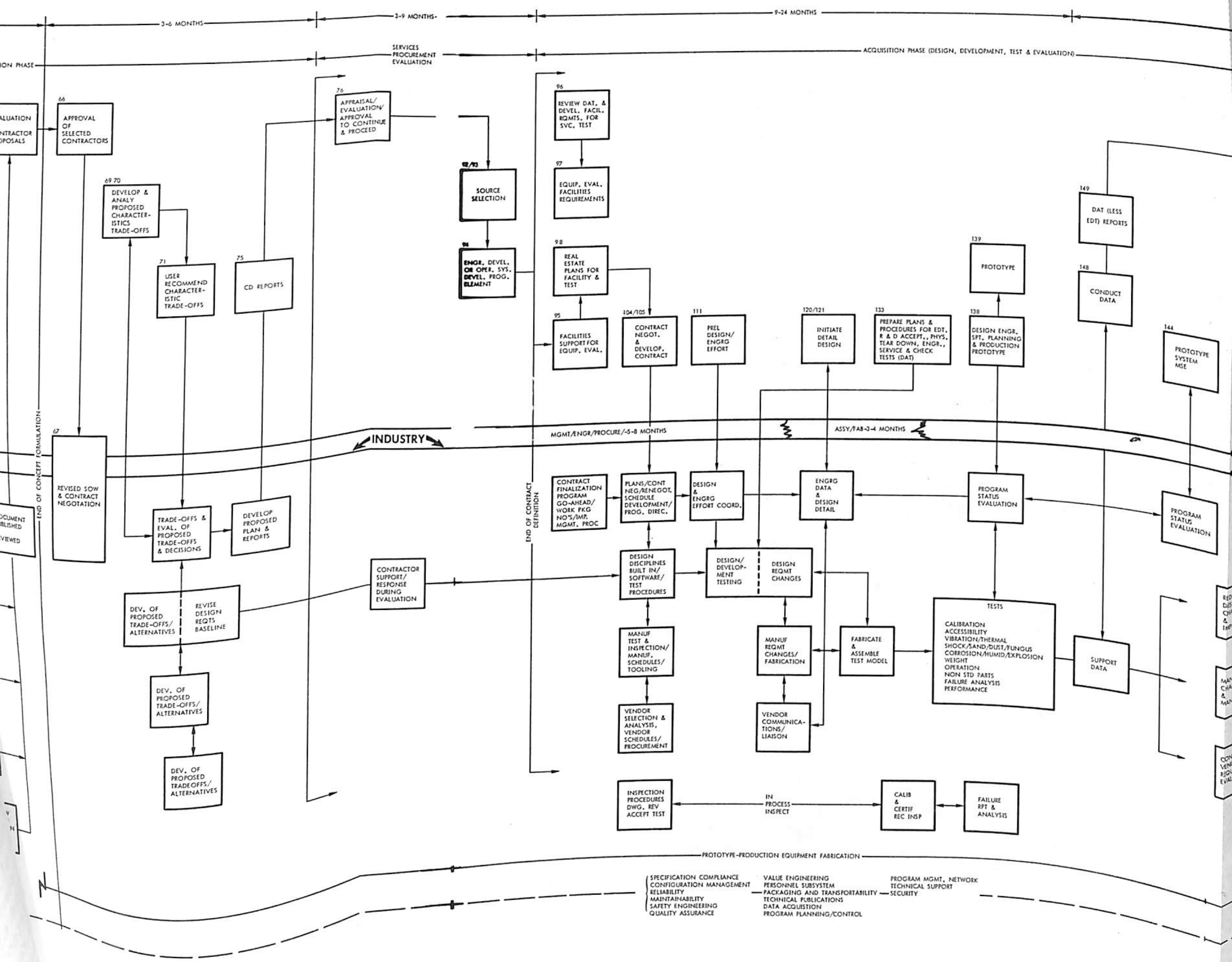


Figure 3-1 Industry/Army Interface



2-3 MONTHS
3-6 MONTHS
CONTRACT DEFINITION PHASE
END CONCEPT FORMULATION PHASE
61 APPOINT SOURCE SELECTION
62 APPROVAL
60 REQUEST FOR PROPOSAL
63 POTENTIAL CONTRACTOR PREPARE PROPOSAL
65 EVALUATION OF CONTRACTOR PROPOSALS
66 APPROVAL OF SELECTED CONTRACTORS
69 70 DEVELOP & ANALY PROPOSED CHARACTER-ISTICS TRADE-OFFS
71 USER RECOMMEND CHARACTER-ISTIC TRADE-OFFS
75 CD REPORTS
76 APPRAISAL/ EVALUATION APPROVAL TO CONTINU & PROCEED
67 REVISED SOW & CONTRACT NEGOTATION
END OF CONCEPT FORMULATION
MANAGEMENT PROGRAM MGMT, CONTRACTS, LEGAL, PROGRAM CONTROL, ACCOUNTING & FINANCE (INDUSTRIAL RESOURCES)
ENGINEERING
MANUFACTURING
PROCUREMENT
PRODUCT ASSURANCE
DETERMINE APPROACH-EVALUATE PROPOSAL REQUEST
SOW/GENERAL PROVISIONS COMPLIANCE (61) & PREP. OF REQ. FOR WAIVERS
DOCUMENT PUBLISHED & REVIEWED
RESPONSE TO SOW MATERIALS DESC. PLAN DETAIL SCHEDULE
ESTABLISH DESIGN REQ'T'S BASELINE & DESIGN SPECS
RESPONSE TO SOW SPACE REQUIREMENTS TOOLS TEST EQUIP. MANUF. PLAN
RESPONSE TO SOW QUAL. VENDORS MAKE/BUY PLAN VENDOR QUOTES PREL. NEGOT.
RESPONSE TO SOW PRE PROD. PLAN PRE QUALIF. PLAN QUALITY PLAN SOURCE INSP.
TRADE-OFFS & EVAL. OF PROPOSED TRADE-OFFS & DECISIONS
DEVELOP PROPOSED PLAN & REPORTS
DEV. OF PROPOSED TRADE-OFFS/ ALTERNATIVES
REVISE DESIGN REQTS BASELINE
DEV. OF PROPOSED TRADE-OFFS/ ALTERNATIVES
DEV. OF PROPOSED TRADEOFFS/ ALTERNATIVES
IN


3-6 MONTHS
3-9 MONTHS
9-24 MONTHS
ION PHASE
SERVICES PROCUREMENT EVALUATION
ACQUISITION PHASE (DESIGN, DEVELOPMENT, TEST & EVALUATION)
ALUATION NTRACTOR OPOSALS
66 APPROVAL OF SELECTED CONTRACTORS
76 APPRAISAL/ EVALUATION/ APPROVAL TO CONTINUE & PROCEED
96 REVIEW DAT. & DEVEL. FACIL. RQMTS. FOR SVC. TEST
97 EQUIP. EVAL. FACILITIES REQUIREMENTS
92/93 SOURCE SELECTION
94 ENGR. DEVEL. OR OPER. SYS. DEVEL. PROG. ELEMENT
98 REAL ESTATE PLANS FOR FACILITY & TEST
95 FACILITIES SUPPORT FOR EQUIP. EVAL.
69 70 DEVELOP & ANALY PROPOSED CHARACTER-ISTICS TRADE-OFFS
71 USER RECOMMEND CHARACTER-ISTIC TRADE-OFFS
75 CD REPORTS
104/105 CONTRACT NEGOT. & DEVELOP. CONTRACT
111 PREL DESIGN/ ENGRG EFFORT
120/121 INITIATE DETAIL DESIGN
133 PREPARE PLANS & PROCEDURES FOR EDT, R & D ACCEPT., PHYS. TEAR DOWN, ENGR., SERVICE & CHECK TESTS (DAT)
139 PROTOTYPE
138 DESIGN ENGR. SPT. PLANNING & PRODUCTION PROTOTYPE
149 DAT (LESS EDT) REPORTS
148 CONDUCT DATA
144 PROTOTYPE SYSTEM MSE
END OF CONCEPT FORMULATION
67 REVISED SOW & CONTRACT NEGOTATION
INDUSTRY
MGMT/ENGR/PROCURE/-5-8 MONTHS
ASSY/FAB-3-4 MONTHS
END OF CONTRACT DEFINITION
OCUMENT BLISHED VIEWED
TRADE-OFFS & EVAL. OF PROPOSED TRADE-OFFS & DECISIONS
DEVELOP PROPOSED PLAN & REPORTS
DEV. OF PROPOSED TRADE-OFFS/ ALTERNATIVES
REVISE DESIGN REQTS BASELINE
DEV. OF PROPOSED TRADE-OFFS/ ALTERNATIVES
DEV. OF PROPOSED TRADEOFFS/ ALTERNATIVES
CONTRACTOR SUPPORT/ RESPONSE DURING EVALUATION
CONTRACT FINALIZATION PROGRAM GO-AHEAD/ WORK PKG NO'S/IMP. MGMT. PROC
PLANS/CONT NEG/RENEGOT. SCHEDULE DEVELOPMENT/ PROG. DIREC.
DESIGN & ENGRG EFFORT COORD.
ENGRG DATA & DESIGN DETAIL
PROGRAM STATUS EVALUATION
PROGRAM STATUS EVALUATION
DESIGN DISCIPLINES BUILT IN/ SOFTWARE/ TEST PROCEDURES
DESIGN/ DEVELOP-MENT TESTING
DESIGN REQMT CHANGES
MANUF TEST & INSPECTION/ MANUF. SCHEDULES/ TOOLING
MANUF REQMT CHANGES/ FABRICATION
FABRICATE & ASSEMBLE TEST MODEL
TESTS
CALIBRATION
ACCESSIBILITY
VIBRATION/THERMAL
SHOCK/SAND/DUST/FUNGUS
CORROSION/HUMID/EXPLOSION
WEIGHT
OPERATION
NON STD PARTS
FAILURE ANALYSIS
PERFORMANCE
SUPPORT DATA
VENDOR SELECTION & ANALYSIS, VENDOR SCHEDULES/ PROCUREMENT
VENDOR COMMUNICA-TIONS/ LIAISON
INSPECTION PROCEDURES DWG. REV ACCEPT TEST
IN PROCESS INSPECT
CALIB & CERTIF REC INSP
FAILURE RPT & ANALYSIS
PROTOTYPE-PRODUCTION EQUIPMENT FABRICATION
SPECIFICATION COMPLIANCE
CONFIGURATION MANAGEMENT
RELIABILITY
MAINTAINABILITY
SAFETY ENGINEERING
QUALITY ASSURANCE
VALUE ENGINEERING
PERSONNEL SUBSYSTEM
PACKAGING AND TRANSPORTABILITY
TECHNICAL PUBLICATIONS
DATA ACQUISTION
PROGRAM PLANNING/CONTROL
PROGRAM MGMT. NETWORK
TECHNICAL SUPPORT
SECURITY

3.7 PROJECT PHASING

There must be a limit to the number of items which the Army has the capacity to manage and support simultaneously. This limit must also be a function of the mix of the priorities and lead-time objectives which are assigned to the projects planned to be concurrent. Consequently, in the overall plans for a concurrent group of projects, there must be interrelated adjustments of the number of projects and of the priorities and lead-time objectives assigned to each, in order to keep within the capacity of the Army to manage and support, including, of course, the expected available financing.

Such an overall plan with the necessary reviews and readjustments presents a difficult task, but one that is now being done. Involved in it is the matter of how lead time objectives should be applied. It may mean reserving the minimum practical lead times for the higher priority projects and applied only to such others as can be operated on a non-interference basis with the former. For the remainder of the projects, these objectives need to be adjusted to keep the performance on the whole group of projects under control. This may affect also the distribution of activities between in-house facilities and outside contractors.

We understand that the above considerations are addressed in the current process of developing the Army Force Development Plan and the Army's section of the Five Year Defense Program. Our concern is with whether the initial system development plans (before modification to fit the budget level) are prepared to propose appropriately short lead time, since we feel that the integration process is more likely to stretch out than compress the individual plans.

The necessity of short developmental lead time is directly related to the rate of advancement of state of the art. For those Army items in which there is little change in state of the art, lead time is of minor importance. Where technology is advancing rapidly overall force capability is improved most rapidly, within a specified budget level, by developing the total plan to favor short lead time and higher funding rate of on-going programs, even though fewer may be carried concurrently than if all are stretched in time. These considerations are implicit in our emphasis that time, cost, and effectiveness must be considered in relation to each other for each program and for the integrated plan.

3.8 ACTIVITIES SUBSEQUENT TO PROJECT INITIATION

3.8.1 General

If the requirement has been well stated, the concept soundly formulated, the technology properly assessed, a competent project manager and contractor selected, and adequate funding provided, the minimum requirements for program success in planned time have been met.

Smooth progress on schedule is then related to the following considerations:

> Continuity in project management. We discuss project management in Section 4. Consolidation of various reviews - IPR, SSE, MRRC, etc., and action in HQ-DA to eliminate delays in its decisions and approvals.
>
> Adequate contact of Army user agencies with Army development agency and contractor during development to consider suitability, as design is being defined.
>
> Flexibility in requirements to facilitate modifications in interests of time, cost, performance, and/or use of end item; as jointly considered desirable or necessary by contractor and Army development and user agencies. Also suitable procedures for quick consideration and implementations of such modifications.
>
> Concurrent with development/production, Army user agencies carry out plans, authorizations, and implementations required for operational availability and use.
>
> Competent development/production contractor, preferably same one for both development and initial production so as to have concurrency in development of design and in preparation for manufacture.

3.8.2 Consolidation of Reviews

We are seriously concerned by the inherent delay built into the review process by the requirement for sequential reviews at each level up to DA beginning with the IPR. We understand that one study of the time from IPR to DA approval indicated an average of seven months. Figure 3-2 shows these averages. In one case, the XM95 mortar, the program was delayed six months because a DA agency was unable to be present at an IPR and stated that its approval could not be assumed in a major decision involving selection of ammunition.

Complex programs which have moved rapidly in the past have been characterized by participation in the IPR or equivalent on-site review by agency representatives with decision authority.

We feel that the Army must recognize the sequential review process as a potential source of major delay and unnecessary increased cost, and that the review process should be structured to make DA authorized approval in a single review session the normal practice.

3.8.3 Interface with User

Another important matter in the timely success of the project is the informative and critical participation throughout the development/production and evaluation phases of representatives of the various support agencies responsible for the utilization of the end item. These include operations, logistic, personnel, and so on who have the functions of procurement, stocking, installation, supply, maintenance, training, and field use. This participation can be a major factor in ensuring the suitability and timely availability of the planning, personnel, and support required for operational use.

The object is to have a high degree of overlap in action and concurrency in thinking in carrying out the development/production, evaluation, and support phases of the cycle, rather than having these functions performed on an end-to-end basis. This calls for good planning, scheduling and management and, above all, close horizontal relationships at all levels of the involved agencies.

Although these activities are intended to be responsive to the project manager, and to phase their participation according to the System Development Plan, personnel rotation on the user side is, we understand, an extremely difficult problem to the degree that the project manager, and even more so, the manager of non-projectized programs, must often work "through channels" rather than on the basis of a well-developed personal relationship with his opposite numbers in other commands.

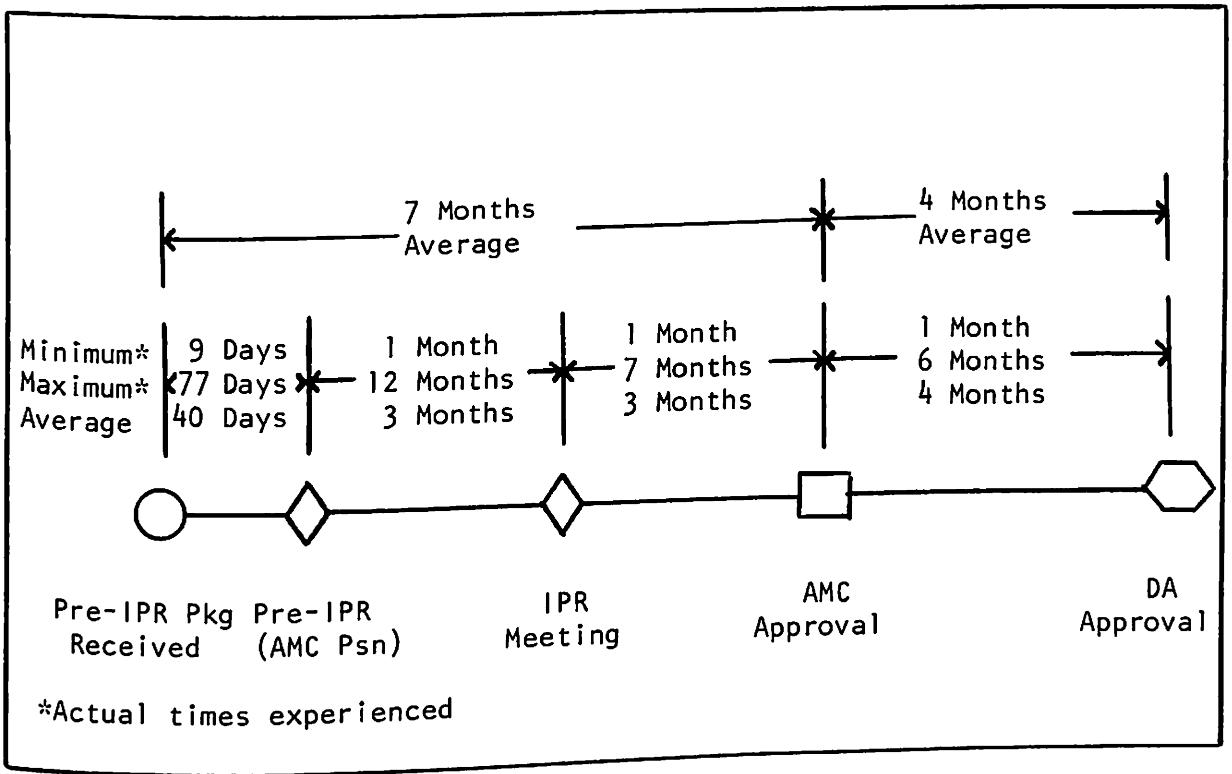


Figure 3-2 Typical In -Process Review Cycle Time

3.8.4 Flexibility of Requirements

The close working relationship that must exist between developer and user affects the degree to which requirements as stated by the QMR must be considered as "set in concrete." It is recognized that certain requirements are "must," such as those dealing with safety. Many others, however, should be considered as objectives which are open to question in the interests of time, cost, performance, simplicity, reliability, maintainability, and so on.

The development, production, and testing agencies, both Government and contractor, should therefore be encouraged to question the requirements in the interest of the overall goodness of the project. Contractors in a competition may feel constrained to avoid questioning requirements as possibly compromising their position. Nevertheless we feel that contractors should be encouraged to propose contractual modification which may expedite development, effect economies or improve capabilities at no additional cost. Cost of development, cost of product and cost of operation are all involved. There may be additional cost of a product that may reduce cost of its use. The latter consideration is presumably a characteristic of total package procurement but once a program is underway, we understand that the government has little flexibility in trading PEMA against RDT&E funds.

We understand that as a development goes forward, it is compared against the requirements which are categorized as required or desirable. The latter are easily and quickly modified if no increase in cost is involved. The former can be changed only with DA approval and maintenance of the requirement usually takes precedence over cost and schedule.

The Army cannot establish a policy of relaxing primary requirements after a project is underway for obvious reasons. We feel that the user should nevertheless consider carefully the trade between minor relaxations even in "essential" requirements when extension of development time is needed to meet the original requirement, and DA should consider this trade in conjunction with cost. We do not know whether the present system is sufficiently flexible to do this quickly once development is underway.

3.8.5 Test and Evaluation

Testing was identified by the MRRC as a major offender in generating long lead time. The pre-planning of the test program as displayed in the Management Model, the merging of engineering and service tests, etc., can, in principle, avoid excessive delays.

Test and evaluation activities should begin at an early stage of development. The project manager should vigorously schedule tests frequently throughout the program, in order to gather data on components and subsystems in search of potential difficulties which, if revealed late, could introduce substantial extensions in schedule and costs during the development cycle.

We feel there is much to be gained in better integration of the development and testing activities. It is our impression this integration is best (but not always) accomplished in the aircraft and missile developments, but is too often treated as a sequential test-and-correct process in the tank, automotive, ammunition, and artillery fields - the Army's classical product lines.

In some examples reviewed by the Group, the test and evaluation phase has taken up to half of the total lead time. Obviously if the system is not properly engineered the time spent in "fixing" errors is enormous.

We offer the following specific observations with regard to vehicle testing to give context to these generalizations. Our basis for selecting this area was the current involvement of one of our members in this testing activity, which he was uniquely able to view in the more general context of factors contributing to long lead time.

There is not enough component testing or component qualification in the tank engine program. Some of the components are tested; some are not. Some are shaken, jolted, etc.; others are not. The engine, coolers, radiators, etc. are normally not tested in the engine enclosure, so that the total engine heat transfer problems are not explored in the laboratory. In none of the programs are the engines ever given the "shake" tests commonly given to sub-and total missile assemblies. At some high initial cost, a facility could be built to subject an engine to its vibration and shock environment, as well as the various ambient conditions (at least hot environments) while the engine is in operation. As a result of the lack of component qualification, the field tests of the engine proceed at an unbelievably slow rate. The engine not only does not operate, but the tracks and everything else fail because they are not previously qualified, so that engine operating time averages one or two miles per hour of scheduled operational time during the field tests. In a program just reviewed, two years are allowed for field tests.

TACOM is, in fact, improving its ability to make component and engine tests in-house. But it does not appear that the project menagers take advantage of the talents and facilities that are available, and there appears to be no requirement, or even a suggestion, that the in-house abilities of the Army be employed by these project managers.

Currently, the self-propelled M110 howitzer has been under test for six months in conjunction with a major product improvement program. The engine radiators are positioned so that practically no cooling air flows through them and consequently the engine overheats. This is a contractor-developed system and a serious technical error. Modifications have been made during the test to improve the cooling of the engine so that a satisfactory system may be developed. However, this is an extremely costly and time-consuming method of correcting errors that good engineering would avoid. Unfortunately, there does not appear to be a sense of urgency to accomplish the modifications required to permit the vehicle to pass the requirements.

The Group's limited experience with test activities does not give it confidence that these are isolated cases. The testing seems to take a long period in every system. Again, the period is not uniform. Those systems the Army "wants" seem to move more rapidly than the others, but even these move slowly. Possibly some additional integration of the development tests and the acceptance tests would eliminate some of the "faults" of the system and make acceptance testing just testing, instead of additional development, or extensive product improvement.

In much Army testing there seems to be: (1) too rigid adherence to requirements, with the rejection of equipment that might improve the Army's capability; and (2) a tendency to test to the worst-worst case. While the Army must make certain the equipment will function under the rigors of combat conditions, it is not necessary to combine the worst environmental conditions with the maximum operating rate. This combination of conditions leads, for example, to very heavy diesel engines, similar to long life industrial engines. These engines are not compatible with air lift or air drop.

These test plans and their definition are part of the "management" function and must be strongly supported by all the technical help the Army can furnish. The committee would hope that the sense of urgency that the project manager can communicate to the contractor can also be communicated to the test and evaluation personnel. There is concern that this sense of urgency, and rapid and thorough testing, are not being accomplished.

We respect the significance which the Test and Evaluation Command attaches to their responsibility for affixing the "Soldier's Warranty" to the systems which they test. We are aware of their severe problems in obtaining and holding experienced test personnel, both civilian and military. We recognize the impact on the rigor and exhaustiveness of test activities when a piece of equipment issued to combat fails under conditions which "should have" been anticipated in the test process.

In summary, we recognize the test and evaluation activity as one of equal importance to the associated development activities, requiring the same careful planning and competent management, and the use of advanced test facilities and procedures.

3.8.6 Contracts and the Development-Production Interface

The Group developed a serious concern regarding the degree to which principles of concurrency have been reduced in importance

in present developmental practice. Concurrency is particularly important in advanced planning, engineering, and tooling for production. This related to the contracting form. If the R&D contractor has no assurance of follow-on production, he will have no incentive to invest his own resources in early preparation for production.

Competitive procurement in principle, and perhaps usually in fact, yields a lower cost to the government for the production buy. We doubt that all of the implicit costs of competitive procurement following completion of development, have ever been thoroughly assessed. These include the delay in achieving an operational capability (difficult to express in dollars) resulting from the time to prepare the bid package, conduct the competition, and choose a winner, as well as the unplanned for delays in transferring technical know-how, if the winner is not the developer. Procurement packages and specifications are seldom good enough to permit prompt, successful production by a contractor unfamiliar with development of the specific items.

On the other hand, the use of the same contractor for the development and first production, and flexibility in the stated requirements in the interests of time, cost, performance, and utility, can be highly effective in getting a suitable new item in reasonable time. The test and evaluation of the product can start during the development-production phase by the use of experimental and prototype models of all or part of the final item. The result at this stage can react back on the development and production design, and forecast to a valuable degree the results of the evaluation of the final production.

This concept is inherent in total package procurement. In principle, contract definition followed by TPP provides complete system planning, schedule, budget, and performance control from concept to obsolescence to the advantage of the government and, hopefully, to the contractor as well. An incentive formula can give the contractor a basis for trading performance against schedule and cost.

The concept does not allow complete funding flexibility within the program, for example, interchange of RDT&E and PEMA funds in process by the government to minimize total system cost. Major experienced contractors have been unwilling to bid a complete package based on their confidence in the concept which they generate in CD. There are serious problems in "transfusing" desirable technical characteristics developed by the losing CD contractors to the winner who is, after all, completely familiar only with the cost implications of his own design on which he based his package proposal.

In TPP, the incentive for the contractor to improve the design during development even at RDT&E cost saving is effectively dampened when production unit cost is thereby increased,because of the multiplying effect on total cost when large numbers of units are produced.

Whether these difficulties with TPP can be overcome is unknown. AMC has proposed extended competitive contract definition to include fabrication of prototype hardware and engineering design tests, then to be followed by total package procurement. This mode would be more acceptable to industry but could have unfavorable effects on lead time. It could probably not be used for very expensive developments.

To minimize undesirable effects on lead time when the AMC proposal is followed, it would appear that production capability must be an essential consideration in selecting the competitors, that the production award must be to the CD winner (as opposed to an open competition for production which might be won by a non-participant in the CD and which would involve transfer of know-how), and that administrative delays in negotiating the production contract must be minimized.

The competitive aspects of this procedure would undoubtedly result in a better product, lower cost to the government, and increased assurance in the contractor's ability to produce a satisfactory item. As in all competitive evaluations, the government must be careful to assess competence against bid price.

OSD is currently re-examining the use of Concept Formulation and Contract Definition in the light of the experience gained with them, and Dr. Foster has stated that for programs with clear-cut requirements and solutions and with negligible technical risk, the extra cost and delay introduced by using formal Concept Formulation and Contract Definition phases are not justified. <u>We concur</u>.

He also suggested the use of hardware competition to choose between alternative technologies or designs where R&D costs are a small fraction of the total procurement costs. We replace "procurement costs" with "total life cycle costs" and concur. Our feeling with regard to the advantages to the government, and precautions to be taken to keep lead time short, are identical with those listed above in conjunction with the similar AMC proposal.

Dr. Foster stated that in major weapon system programs, where considerable risk remains even after the Contract Definition phase, such hazards "should be accepted and flexibility shared by the government and the contractor." For such programs, where all of the well known causes of extended developmental lead time are likely to be encountered, we recommend very strongly that the "traditional" method of placing the initial production buy with the development contractor be a central consideration. The presence of "substantial risk" will operate against early production tooling, but the project manager must be alert to plan for and initiate concurrent production, training, personnel, and support actions as rapidly as risk is resolved.

When in-house development projects of the Army are put out to industry for production, our caveats regarding the difficulty of transferring know-how from the developer to producer again apply. The modus operandi employed in the Pershing and Jupiter programs can serve as a model of how to do this well, and with minimum delay.

3.9 EXPEDITED DEVELOPMENT

We were briefed on procedures for expediting development.

AR 705-5 states:

"Although formal requirements must be the normal stimuli for RDT&E, it is also necessary to conduct quick reaction RDT&E tasks without the benefit of the usual documentation in order that urgent field requirements can be met.

"If the responsible developing agency considers it in the best interests of the Government to waive application of any provisions of AR 705-5 to pursue expedited or quick reaction capabilities, a request for waiver with necessary justification will be submitted to the Chief of Research and Development.

"A special priority may be assigned to projects or tasks in support of requirements for an active theatre of operations."

Two current programs for expedited response are ENSURE and PROVOST.

ENSURE (procedures for expediting non-standard, urgent requirements for equipment) is activated by a request from an Army Component Commander to DA. The request can be approved by ACSFOR in coordination with CRD and other interested staff agencies and funds made available by reprogramming, by an emergency request to OSD, or by a supplementary budget request.

HQ DA assigns the request to the developing or procuring agency. Not all items are R&D; many are commercial buys. A typical response time is seven months, but it depends on complexity. We were told that "ENSURE digs in the barrel for what is already there."

PROVOST (Priority Research and Development Objectives for Viet Nam Operations) is for items which can be delivered within 18 months; most cost less than $500,000 per item. We were told that PROVOST is a DDR&E list which includes ENSURE and additional items the DA staff feels are required for Viet Nam.

We were briefed on several ENSURE items; these are discussed in Section 6, Case Studies.

We observe that the short fuze on these requirements did indeed have a salutary effect on simplification of the management process. Since these are relatively small items, the pressure point was usually a product manager with AMC. In our briefings, the fact that these were "high-risk" developments, because of the short time available, was repeatedly emphasized. It is our impression that in some cases technological risk was incurred because the development group was forced to bypass its customary methodical and sequential approach to development. Some groups, such as the Harry Diamond Laboratories, rose to the challenge and met it admirably. Others encountered problems inconsistent with their presumed expertize in their field.

Two unique characteristics of these programs are the elimination of the normal process of developing and approving the requirement, and the stimulus to all personnel involved at all levels to support the men in active combat. The latter will not exist in a peacetime period, and the former should not.

We suggest, however, that the uniform application of short developmental lead time goals, at all levels of project and product management at all times, even when there is no shooting war, will keep the Army's in-house capability fit for the occasions when fast response will be critical.

We also suggest that at an appropriate time the Army conduct an in-house critique of its performance on PROVOST and ENSURE.

3.10 ALTERNATE TO DEVELOPMENT

Another option for expediting development and conserving R&D resources is the purchase, or copying, of existing equipment developed by other countries. The U.S. has selectively applied this procedure in the past with some outstanding successes, as in the case of the Bofors 40mm gun. Other programs have been less successful, such as our attempt to copy the V-1 missile. If the design is to be copied and produced in the U.S., the problems we have noted in the separation of developer and producer must be carefully considered. If only operation is involved, the planning for supply, spares and maintenance must be done at a proper rate. However, the possibility of avoiding developmental delays in matching a weapon already in existence makes this an option that requires objective evaluation where it exists.

SECTION 4

PROJECT MANAGEMENT

> "The Project Manager, chartered by the Secretary of the Army, will have full and continuing responsibility for the development and initial logistic support of the system, in accordance with the system development plan. He will exercise full line authority, as defined in the final charter, over the planning, direction, and control of the approved project. He will also exercise authority over the allocation and utilization of all resources authorized for the execution of the approved project." AR 70-17 (January 1968)

4.1 PROJECT MANAGER

We consider the most significant characteristic of the management system being implemented to be the authority given to the project manager. The statement above appears to comply in full with the recommendation of the Army Scientific Advisory Panel which studied lead time in 1958, and recommended that:

> "The project management system should be more widely adopted with clear delegation of authority and responsibility to a single project officer."

The direction that the final charter explicitly set forth the name of the individual assigned as the project manager, and the objective that "whenever possible, tours of military project managers will be extended for the duration of the project," are consistent with clear delegation of authority, responsibility, and control of resources. It is hoped that this will be the practice. It has to be reconciled, however, with the idea that a competent officer has to be rotated frequently to develop his career and in order to get promotion.

This last statement raises the problem of the need for technically oriented officers on a long tour or career basis in many of the jobs involved in the development of today's types of equipment and systems. The need for such specialization was not eliminated with the abolishment of the technical services. We discuss this in Subsection 4.3.

As a basic element in considering ways of reducing development lead time, it seems appropriate to juxtapose AR 705-5 and AR 70-17, and determine if the functions and responsibilities of the project manager are properly set forth to this directive.

On the assumption that the Department of the Army, as a whole, is motivated to avoid excessive development lead time, it appears that paragraphs 2h, i, j and k of AR 70-17 and paragraph 7 of that AR in its entirety, should be revised to require the project manager to base his entire planning evolution on the basis of specified development Lead-Time Goals.

The "full line authority" indicated in paragraph 7b, AR 70-17 must include the authority to require tailoring of the time span of program elements to meet the lead-time objective. For example, the administrative lead times specified in AMCP 705-2 are not necessarily oriented to this objective. The program manager must, in his planning, state his maximum time allowance for these functions. The burden of proof for any necessary deviation from his planned interval should rest upon the developer, with that command accepting an appropriate share of the responsibility for the time in excess of the established goal.

In a similar manner, the project manager must plan time-phased budgets and all necessary resources toward the lead-time objective as an essential part of program planning. The manager must identify the technical, cost, and time risks that must be faced if his time span and resource demands are not met. He must, at the same time and to the extent possible, identify technical, cost, and schedule hazards inherent in his plan as stated.

In further considering the strengthening of the authority and responsibility of the project manager, the group developed a concern for the responsiveness of the contracting officer to the project direction. Although the contractor may wish to respond promptly to redirection by the project manager, he must be assured that the change will be promptly incorporated in the contract.

There are various degrees of separation between contracting officer and project manager, ranging from wide geographical separation of two individuals to collocation, or designation of the project manager as the contracting officer. The response time of the contracting activity must be an important consideration in setting up the project management structure. Present communication systems and staffing procedures are incompatible with prompt decision making.

Thus, if the Army is seriously dedicated to a reduction in development lead time, the real and absolute authority of the project manager must be re-examined to that end. It is equally important that the responsibility of the project manager to work his plan must be stated explicitly.

At formal System Status Evaluations, when the system is subjected to a "disciplined challenge" at DA level, approval is required by all "interested agencies" for the project to proceed to the next phase. We do not see, in the present system, strong encouragement for the user to mutually agree with the project manager on a day-to-day basis on details of the design meeting the essential elements of the analysis to avoid the possibility of major, costly, and time-consuming redirections of the program at the SSEs.

Personnel turnover in the major interfacing agencies such as CONARC and CDC, is, we believe, even greater than in the project offices. Since the project manager must consider user desires in making day-to-day project decisions, changing personnel places an added load on the project manager.

Clearly, the DA must condition all of its reflexes to development lead-time reduction. Within the complex of the DA organization, there exists competent and adequate resources for the full support of effective program management.

In furthering the professionalization of project management, the developing agencies should structure their organizations as far as possible to separately identify the project management function, supported by functional areas.

The enforcement of demand on the project manager, and adequate support of his planning and operations, will do much to reduce the OSD contribution to extended lead times.

4.2 MANAGEMENT OF SMALL PROJECTS

Most of the Army's developmental projects are small projects, i.e., less than $25 million RDT&E and $100 million PEMA.

About 60 large projects, run by project managers, account for 54 percent of AMC's $5 billion annual budget. Totaling approximately 250 QMRs, 150 SDRs, and 170 QMDOs active, it is apparent that the smaller projects far outnumber those which are projectized. Since all of the QMRs, SDRs, and QMDOs have DA approval, and are periodically reviewed and budgeted by DA, it appears that they must generate a top-level administrative workload which is disproportionate to their total dollar volume.

The Army already observes the good management practice of delegating certain approval and management responsibilities down to appropriate levels. The decision that the prerequisites for concept formulation have been met is delegated to the commodity commander for developments requiring less than $50 million RDT&E and PEMA. Product managers within AMC are chartered by the Commanding General of AMC, with authority to work across commodity commands.

However, there is little in the ARs on R&D management to encourage the small product manager to employ simplified management procedures or to expedite his program. In fact, when his project, even though small, involves many Army agencies, the small product manager will find it difficult to resist use of almost all of the procedures displayed for fully projectized developments.

The fact that a small project can have wide ramifications is illustrated by the $2.5 million development program for the XM95 Mortar. The program involved Canada for the baseplate, Picatinny for the ammunition, Frankford Arsenal for fire control, and ATAC for the self-propelled mortar carrier, with systems management assigned to HQ Army Weapons Command.

After the program was underway, Canada dropped out without providing the baseplate. Assembly of tube and ammunition revealed muzzle-blast problems. DCSLOG was unable to attend a meeting at which resulting ammunition problems were to be resolved and indicated concurrence could not be assumed; the required decision by DA came six months later. The MRRC introduced new direction for Viet Nam.

We observed that (1) this small development of a classical Army weapon could not be done at a single installation, and (2) that the interface with DA was as conspicuous as it was for large, complex projects.

Industry has the policy of grouping small projects in compatible areas under a single project manager who is responsible for all activity in his area. We understand that the Army does this to some degree. We suggest that the Army may profit from further extension of the project-manager structure to include an increasing fraction of small developments, so that there is a single point of contact between DA and the developer for each of a limited number of product areas, each comprised of a large number of related small developments. Each product area manager would be responsible for developing overall plans for his area of responsibility, including budgeting, schedules and milestones, and for directing the accomplishment of the developments according to plan.

Advantages to the Army could be the fact that a product area would integrate the support of many separate agencies. The product area manager, having rank commensurate with the total size of the aggregated effort under his direction, would be better able to secure the prompt cooperation of interfacing commands. The number of separate communications between the developer and DA could be greatly reduced. A similar recommendation was made by the ASAP ad hoc group on Vietnam.

4.3 CAREERS FOR PROJECT MANAGERS

We understand that the Army currently operates career programs for specialist officers. Included is a career program for R&D specialists. It is reported that contrary to common opinion, specialist officers have consistently fared well in promotions.

The R&D program, in mid-1967, had 533 officers (Col - 130, Lt Col - 194, Maj - 161, and Capt - 48) and a goal of 1000. Specialist officers normally alternate between their career branch and their specialty, and their career development patterns are monitored both by their basic branch and by the specialist branch. The number of 533 may be compared with the 465 officer personnel assigned to project offices in AMC in 1968.

Criteria for selection of project managers by AMC include B.S. in specialty field, M.S. in specialty field or business administration, and attendance at DOD Project Management School or equivalent plus relevant experience, including DA staff or higher.

We feel that this development program is of the utmost importance because of the critical position of the project and product managers in Army development. We are not able to assess how well it is operating, but we have been favorably impressed by many of the project managers who briefed us.

While a sound technical education is a minimum requirement for project management, we would hope that the career development program would rotate specialist officers through progressive assignments of increasing responsibility in program management. We note that in industry the branch point between program management and technical specialist is normally encountered by an engineer early in his career, and that a characteristic of a good program manager is the ability to manage, to resolve management problems, to understand, anticipate, and forestall technical problems, but to resist the attraction of technical involvement.

Unlike his civilian counterpart, the Army manager is periodically rotated between management of a technical activity and management of a field operation. This can be advantageous, but rotation is often too frequent.

We find it difficult to reconcile the existence of what appears to be a properly organized program for the career development and promotion of specialist officers, and the frequently expressed statements that the Army "system" prevents such a program from being implemented, or if implemented from being successful.

It appears that the structure exists for the development of competent career product and project managers. We feel that the importance to the Army of competent project management requires that this program be maintained, expanded, and given high priority. It should be made well known that genuine careers exist in project management leading to high rank through technical education, and industrial management experience, as well as field command.

SECTION 5

OVERALL MANAGEMENT PROCESS

5.1 THE DEPARTMENT OF ARMY MANAGEMENT MODEL

A top-level flow chart showing the interrelationships among the principle elements of the Army's RDT&E, acquisition, and operations activities is developed in the Department of Army Management Model, also known as the Life Cycle Management Model.

The schematic flow chart is provided (AR 11-25) as "a guide for the conduct of typical system developments and for development of supporting regulations and manuals." ACSFOR is responsible for revising and improving it in accordance with experience. In the form reviewed by this group, it links 239 blocks representing proposals, analyses, reviews, actions, decisions, approvals, and results at various levels of the organizations concerned.

Perusal of a supplementary manual, "Explanatory information for 'A Disciplined Management Model for the Department of the Army'" reveals a dozen or more additional blocks resulting from Brown Board recommendations and other sources, not yet incorporated in the diagram.

In spite of its complexity, the flow chart is an excellent method of displaying and interrelating the functions and responsibilities defined in the dozens of ARs. Its usefulness was demonstrated by the Committee of Four who used flow diagrams to exhibit deficiencies in the system then defined in ARs, and to recommend a more logical structure.

From the point of view of expediting the development process, the Life Cycle Management Model and its associated documentation suffer from lack of specific instruction on which blocks may be omitted, and on whose approval. The Group was briefed by more than one project manager who considered that all blocks were mandatory. No agency is now charged with the responsibility for ensuring that the Model is applied with proper selectivity.

AR 11-25 (Paragraph 5a) states:

> "The Model is applicable to those systems which meet the threshold criteria for project managed items* although those steps which become unnecessary are omitted. It is applied selectively to non-project managed items to the extent necessary to insure that developer-user-trainer-logistical interfaces are sufficiently defined to meet readiness objectives."

*Brick-Bat and those having RDT&E in excess of $25 million or of $100 million in production.

The supplementary DA Pamphlet 11-25, "Life Cycle Management Model for Army Systems", Oct. 1968 is a medium for specifying the conditions under which each block is mandatory or discretionary, and the level of authority to omit.

As a "how-to" guide, the DA Pamphlet seems an appropriate place to provide sample diagrams or "road maps" to show how the Model has been, and can be, simplified and the flow diagram configured for expedited programs and/or for programs not requiring the full treatment. We doubt that many projects can afford the "scenic" rather than the "fastest" route from origin to destination. Sample road-maps for small projects are particularly important.

The volume of explanatory information has been read with the object of determining where time may be introduced as a target, a constraint, a trade-off parameter, and a control. About 28 boxes have been identified as representing activities in which time may be given prominence. These are listed in Appendix D, with suggestions as to the aspect of time which may be addressed. These are illustrative only:

The tenor of the new AR 11-25 (which now makes no mention of lead time) is one of conservative resource management rather than expedited development, as illustrated by the following extracts:

> "The objective of the Management Process for the Development of Army Systems is to insure that the most effective possible Army, within the resources allotted, is provided for the defense of the nation."

> "Priority is placed on new capabilities which provide significant improvement in combat effectiveness.* Marginal improvements in the name of modernization are avoided."

> "Balance is maintained between pushing the state-of-the-art and utility as developed through cost effectiveness analysis."

The only implication in AR 11-25 that things should be done quickly is contained in the paragraph:

> "Information is exchanged freely and continuously between USACDC and other agencies engaged in combat development activities and between combat development and research and development agencies to insure

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*We are concerned that occasionally this objective is implemented as "keep effectiveness constant and reduce cost."

coordinated system development, timely exploitation of technological possibilities, responsiveness of the research and development community to requirements, and early integration of improved capabilities into the Army."

The format of the Management Model implies that activities are performed sequentially, whereas, in fact major reductions in lead time require concurrency. It implies a smooth, logical progression from long-range objectives to operational equipment. It does not express the need to hedge high-risk developments. It may not adequately represent the real world of crises, enemy technological surprises, or Viet Nams. There is no assurance that the system which it defines has a sufficiently short response time to quickly exploit our own technological breakthroughs. However, we consider it an excellent, lucid, and helpful exposition of the management structure defined in the many Army regulations.

We recognize that the system which the Army is defining and implementing is in response to direction from DOD and that it must be put together before it can be subjected to time trials. However, we are concerned by the absence of mention of the value of doing things as quickly as reasonably feasible in all of the documentation we have reviewed.

5.2 SYSTEMATIZATION OF THE MANAGEMENT PROCESS

The systematizing of the management process is similar to that which is underway in the Air Force and is described in the Air Force Systems Command Manual in the AFSCM 375-x series. Army Materiel Command is preparing a series of management manuals to cover the following areas:

System engineering (operations research).

Program management.

Configuration management.

Advanced production engineering.

Management controls under total packaging of funds.

Personnel development and human factors engineering.

Data management.

Integrated logistics support planning.

Quality/Product assurance.

We feel that these manuals also must give time equal consideration to performance and cost.

5.3 ADMINISTRATIVE LEAD TIME

Two kinds of activities are present in a development project. One is the technical development itself and its direct supervision. The other is the administrative activity concerned with fitting the project into the Army's overall program, justifying and rejustifying it in competition for funds and resources against other projects, maintaining the concurrence in its characteristics (or changing them) by the many agencies having a reasonable concern with what it will require and do (not only the user), and doing all this as the environment changes in temperature, electoral phase, and prosperity.

We feel that the latter type of activity is as likely to be the pacing item in determining leadtime as the development process itself.

A major problem of lead time is associated with the great diffusion of authority. It is possible for even the relaxed current lead time objective to be taken up in the process of reaching a decision within the Army structure, let alone the necessity for carrying many points to higher authority. The decision process as it is now invoked tends to solve a major communication problem by involving all of the Army elements in the decision process, but the rate of making useful decisions when such a large number of people must be informed and contribute to the process is necessarily low.

In fact, the organizational communication system by which decisions are reached and personnel are informed is completely inadequate to the performance of its mission. Whereas the technology of weaponry, transportation, and mobility have changed by orders of magnitude in the last 30 years, the technology of the staff communication system has hardly changed at all. The number of people involved in planning, developing, and deploying the new laborsaving technology of defense and the degree of relevance of the work of each person to that of all others are such that the decision-communication process must inevitably operate very slowly. The relevance can be reduced without disruptive effects only if modern information system technology is exploited.

The Group developed a serious concern for the number of people in the Army who are involved in the management of the RDT&E and acquisition process, especially in staff-type activities. We are inclined to feel that the R&D work would proceed faster, produce more, and cost less if many elements of staff now concerned with R&D were reduced and administrative procedures simplified. There appears to be ample indication that line activities such as testing and user representation to the project management function are shorthanded.

One might expect that the implementation of the system outlined in AR 11-25 and to be detailed in the coming set of management manuals would, if handled in the classical manner, result in still more people running the management system, as compared with the number directly supervising the development. The Brown Board did recommend additional personnel within DCSLOG "...to more thoroughly perform staff surveillance over procurement and production. Adequate personnel should be provided to insure that major problems are identified in a timely manner and corrective actions are initiated promptly..."

We think it not unlikely that these are the precursors of additional recommendations for more people to get a job done which cannot be done well simply by adding more people. If the system simply saturated and stopped we feel that the modern information systems, which we consider essential, would be implemented in short order. We fear that the system will "fail gracefully," it will just become slower and slower in spite of increasing manpower.

5.4 MEASUREMENT OF ADMINISTRATIVE LEAD TIME

Given the flow diagrams of the management model, a project manager laying out his PERT diagrams will be required to estimate administrative leadtime. Anticipating this requirement, an excellent pamphlet, AMCP 705-2, "Planning Guide for Estimating Development Cycle Administrative Lead Time," has been prepared.

The document refers to the current lead time goal of four years and states that to meet the goal it is necessary that the timing of constituent tasks be estimated, and that a basis for making estimates of administrative lead time has not been available in the past. Estimates are then presented for elapsed time of about 19 actions. Times are given in the form of envelopes, i.e., probable latest to probable earliest starting time to complete at a specified time.

The supporting analysis of 36 projects showed that development projects of small magnitude and dollar value often consumed more administrative lead time for a given event than large complex projects.

We consider the existence of this document to be a promising sign that the Army is coming to grips with administrative lead time. Studies of this kind show how long actions now take; if maximum overall lead time is specified for each new project, PERT charts will show how long each action can be allowed to take. If the project is now allowed to slip there is some hope that early recognition of likely administrative delay areas may allow them to be circumvented.

The Brown Board recommended:

> "...that AMC develop policy and procedural guidance to insure maximum application of procurement and supply management techniques that will result in...reduction of administrative lead time, and...application of realistic production lead times in supply studies."

We feel that similar action should be taken with regard to administrative lead time in all Army management activities.

5.5 SYSTEM SIMULATION

Given a flow diagram of the management system, the number of development projects entering, in process, and exiting, estimates of administrarive leadtime, and allocated manpower, it should be possible to develop a machine simulation of the process. This would permit a determination of whether all of the presently required actions are feasible in acceptable time, whether manpower is properly allocated, what the critical paths are, where bottlenecks are expected, etc.

The simulation need not be developed in much greater detail than the diagram of the present Management Model. The difficulty with the present model is that it is impossible to derive an impression of total activity when all of the development projects, each at a different state of progress, are superimposed and caused to move time-wise through the structure.

The same difficulty arises in observing PERT charts of individual system plans.

Such system simulation would have the advantage of serving as the focal point for the present and continuing measurement of administrative lead time. Its development would provide further clarification of how the management system operates, how it could be desirably improved, where improved communications, data retrieval, display, or processing would be of most value.

It could serve as a medium for estimating in advance the probable consequences of changes in procedures, organization, or policy as opposed to the slower traditional process of making changes, waiting for the organization to settle, then determining whether the desired improvements were achieved.

5.6 LEAD TIME TRADE-OFFS

If the Army is to do a proper job of balancing lead time against effectiveness and cost, it will require plausible and useful measures of force effectiveness.

The Army's job in this regard is particularly difficult because of the wide variety of missions, levels of activity, and theatres for which it must plan.

Defense presentations to the Congress for many years have established the precedent of showing systems analysis results of strategic weapons interactions.

In Secretary McNamara's statement before the Senate Armed Service Committee on February 1, 1968, he introduced for the first time indices of effectiveness of the General Purpose Forces.

Mr. McNamara said: "I will be discussing at times the capabilities of our forces in terms of quantitative indices of effectiveness. These indices are still quite primitive, and they do not in all cases measure our capabilities in relation to those of possible enemies. The needed improvements in the indices have yet to be made, but even in their present state they provide useful indications of the changes in the combat power of our forces over the years."

Such indices, to the degree they can be made plausible, provide a means for judging the growth of force capability against state-of-the-art advancement and for assessing the penalties of long lead time.

In the triumvirate of institutes now being implemented by CDC, in the Weapon Systems Analysis Directorate of the Office, Vice Chief of Staff, at BRL, within ACSFOR, and in other agencies, the Army has the potential for coming up with acceptable measures of effectiveness which can be used to trade lead time against effectiveness and cost.

The Assistant Vice Chief of Staff (CSM 67-64, 16 February 1967) is responsible:

> "For developing, prescribing guidance, and monitoring force planning/costing models and systems designed to assess cost/effectiveness and force alternative or resource changes."

For obtaining answers to such questions as:

> "At what point in time is the introduction of a new system justified?"
>
> "At what point in time can the system currently operational justifiably be replaced?"

And

> "...to provide the means for assessment of alternative force structures and their associated costs...and provide relative comparisons of effectiveness and resource implication."