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REPORT TO THE PRESIDENT AND THE SECRETARY OF DEFENSE ON THE DEPARTMENT OF DEFENSE BY THE BLUE RIBBON DEFENSE PANEL. APPENDIX E. STAFF REPORT ON MAJOR WEAPON SYSTEMS ACQUISITION PROCESS

Department of Defense
Washington, D. C.

July 1970

Report to The President and the Secretary of Defense on the Department of Defense

BY THE

Blue Ribbon Defense Panel

APPENDIX E

Staff Report on
Major Weapon Systems
Acquisition Process

July 1970

PREFACE

During the Blue Ribbon Defense Panel's study of the Department of Defense, it was fortunate to receive several staff studies analyzing aspects of the DOD Major Weapons Systems Acquisitions Process.

This staff report contains a review of several of the staff studies prepared for the Panel by the following individuals:

Mr. Albert W. Blackburn	--	Staff Consultant
Mr. Robert N. Brown	--	Singer Company
Mr. Ralph C. Nash	--	Staff Consultant
Mr. Herman E. Shipley, Jr.	--	General Electric Co.
Mr. Julian C. Wheeler	--	General Electric Co.

This staff report to the Panel is considered to be of sufficient interest to top-management personnel of the Department of Defense to be included as an Appendix to the Panel's Report. However, your attention is invited to Page 20 of the Panel's Report which states that Staff Reports are being printed as information, without necessarily implying endorsement by the Panel on each of their findings and recommendations.

The Panel is grateful to the above individuals for their studies, and to Mr. Shipley for compiling this report from these studies. The Panel is especially grateful to the Singer Company and to General Electric Company for donating the services of Mr. Brown, Mr. Shipley and Mr. Wheeler.

CONTENTS

I. MAJOR WEAPON SYSTEMS ACQUISITION PROCESS

The current Department of Defense policy setting forth the procedures to be followed in weapon system acquisition is quite definitive. It is based on the premise that no sizeable weapon should be allowed to enter the development phase until the necessary technology is demonstrably available (see Directive 3200.9). Preceding development, the Military Services are expected to undertake a concerted effort called Concept Formulation where they: (a) clarify their requirements; (b) analyze the alternative means of accomplishing these requirements; and (c) undertake Exploratory and Advanced Development efforts to prove out the necessary technology. After this phase has been successfully completed, the Services are authorized to undertake development but are required, at the outset, to conduct a Contract Definition effort where two or three contractors competitively define the development effort as to technical accomplishment, development schedule and cost. After a detailed source selection process a development contract is awarded to one contractor, on a fixed-price or fixed-price incentive basis. This contract contains a very definitive statement of the work including precise goals to be accomplished. In recent years, production quantities and support equipment have frequently been included in the contract as firmly priced items - a technique known as Total Package Procurement.

The theory of this acquisition policy is that the Military Services should thoroughly plan their development programs prior to commencing full-scale development work and that thereafter they should undertake the development effort under firm contractual commitments from contractors. It is reasoned that if a contractor fully participates in the effort during Contract Definition, he will be in a position to make a realistic appraisal of the technical difficulties inherent in the work and the use of fixed-price type contracts will prevent him from making a contractual commitment at an unrealistically low price. The result should be a better understanding of the technology and of the cost of the program prior to the management decision to commit large sums of money to the program. It is evident at the present time that this seemingly sound theory has not worked in practice. The reasons for its failure appear to include the following:

(a) The necessary technical work has not been accomplished in the Concept Formulation phase. Insufficient funds have been made available for solid technical accomplishment in Exploratory and Advanced Development programs. Further, the Services have continued their long-standing bias for systems development rather than component work. As a result, a proliferation of studies has occurred in Concept Formulation but frequently the necessary technology has not been advanced. This problem is defined and discussed in the Defense Science Board Report on Systems Acquisition, dated 31 July 1969.

(b) The implicit assumption that technical risks can be foreseen prior to the commencement of development has proved wrong. The Aerospace Industries Association Report* clearly demonstrates that technical risk is inherent in the development process and that paper studies will not enable Government or industry personnel to forecast all the problems that will arise. It follows that the belief that detailed pricing techniques for the total systems acquisition effort can be accomplished during the Contract Definition is equally false. Only gross pricing techniques such as parametric pricing are likely to provide accurate forecasts of ultimate costs of weapon systems.

(c) Competitive pricing during Contract Definition has led to significant underpricing in numerous procurements. There is a result not only of the false technical optimism discussed above, but also of the extreme irrationality induced by the present climate where few major weapons systems have entered the development phase and numerous contractors vie for the opportunity to be systems contractors. Furthermore, the process of Contract Definition hastended to equalize the technical and management elements of contractors' proposals with the result that price has become the most important factor in a number of cases. This places extreme pressure on competitive contractors to propose over-optimistically low prices.

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* Aerospace Industries Association Reports, Phase I - May 1968, Phase II - September 1968, and Phase III - October 1969, all entitled, "Essential Technical Steps and Related Uncertainties in DOD Weapon Systems Development"

(d) There has been a large proliferation of paper work during Contract Definition. The basic idea that it is good management to plan before doing the work has been used by every special interest group (reliability, maintainability, logistics, cost and pricing, training and other people) to obtain detailed information and plans at the outset of each program. The result is contractor proposals of huge volume submitted at the end of Contract Definition. This effort now consumes approximately one year during which very little actual technical effort is done and almost no developmental hardware is produced or tested. Recent AIA* and Air Force** studies of Requests for Proposals (RFPs) identify and discuss this problem.

(e) Source selection procedures have become very intricate. They have furthermore come under fire for credibility. The mass of paper required of each contractor dictates that a large number of Government people (400 - 500 in several recent cases) must read parts of the proposals and rate the competing contractors. But, there is a real question whether the massively detailed numerical systems that have been used have contributed in any significant way to the judgmental process that lies behind each source selection. In fact, these numerical rating systems tend to obscure the most important issues and thereby create the risk that good judgment will not be brought to bear.

(f) Management of development contracts has been characterized by great inflexibility. Strong Government management effort has been exerted to assure that the contractor make good on all of his promises. The fixed-price type contract places the Government manager in an adversary role with respect to his contractor(s). As a result the contract provisions have sometimes been considered more important than the technical realities and sensible steps to correct technical difficulties have often not been taken.

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* Aerospace Industries Association, December 1969, "An AIA Study of United States Air Force Requests for Proposals, Critique and Recommendations"

** Air Force Request for Proposal Study Team Final Report, November 1969

(g) The emphasis on detailed constraints has been continued throughout the life of the program. A multitude of management systems are imposed on contractors and there is continual attempt to achieve uniformity among contractors. The functional special interest groups each have a role in assuring that the contractor meet his specific promises to them and there is often little measure of the relative importance of all these promises. The result is constant high volume harassment of the contractor during performance of the contract.

(h) Sufficient funds are increasingly difficult to obtain. Late Congressional appropriations and continual scrutiny of programs by the Office of the Secretary of Defense (OSD) and Congressional Committees have caused the program manager to work in an atmosphere of insufficient funds and too much advice. This scarcity of resources greatly increases the problems created by underpriced contracts and unrecognized technical difficulties.

(i) Disproportionate amounts of contractor capital at a high level of risk are required to support the necessary underlying technical effort. While independent research and development (IR&D) efforts are partially government-supported through overhead recovery, Contract Definition efforts are notoriously underfunded and must be covered by contractor expenditures. In addition, other bidding efforts required at the present time bring the total pre-sale technical expenditures to unacceptable economic level.

(j) Contractor employment is very unstable with large program build-ups and scale-downs the rule, rather than the exception. This is particularly unhealthy for engineering and scientific personnel who become industrial nomads under this system.

As a result of these problems there has been much searching for alternate procedures in the past year. Many changes have occurred and others are forthcoming. Most of these changes have been introduced on an ad hoc basis and are not reflected in the policy statements of the Department. This study addresses the major areas where changes are recommended.

A. Acquisition Strategies

The present policy on acquisition strategies is set forth, for the most part, in Department Directive 3200.9. It is highly inflexible and does not reflect the fact that much developmental effort occurs in an unstructured manner. It is also based on the false premise that technological difficulties can be foreseen prior to the detailed engineering effort on specific hardware. A major revision of policy is called for to clarify this area. This revised policy should emphasize the following points:

(a) Flexibility in selecting the technique best suited to each system and recognition of the numerous alternate sources of new technology.

(b) Proof of technology by building and testing hardware including system prototypes where appropriate.

(c) Incremental development of subsystems and components separate from the development of major weapon systems.

(d) More gradual program build-ups and reductions.

In order to show the effect of this new policy, Figure 1 was prepared comparing its concept of the major elements of the proposed policy with the current published policy.

This proposed acquisition strategy is actually three different but related technology advancement programs proceeding in parallel. The upper bands of the proposed strategy shown in Figure 1, depicts the normal flow of technology from a broad base of research through Exploratory and Advanced Development. Many components and parts are developed through this channel and occasionally a subsystem of some size may be processed in this manner. In these cases the Service will issue a series of contracts specifically intended to exploit new technology where a need can be foreseen. Similarly, major contractors develop new items through independent research and development programs. In recent years, there has been a trend toward less funding of his channel as illustrated in Table 1.

TABLE 1

FY 64 to FY 70
$ Millions

	FY64	FY65	FY66	FY67	FY68	FY69	FY70
Operational System Development Funds	2028.0	1615.0	1671.0	2130.0	3173.0	3136.8	2868.2
Other R&D Funds to Industry	2401.9	2174.8	2463.4	2216.4	1159.5	1616.8	1607.2

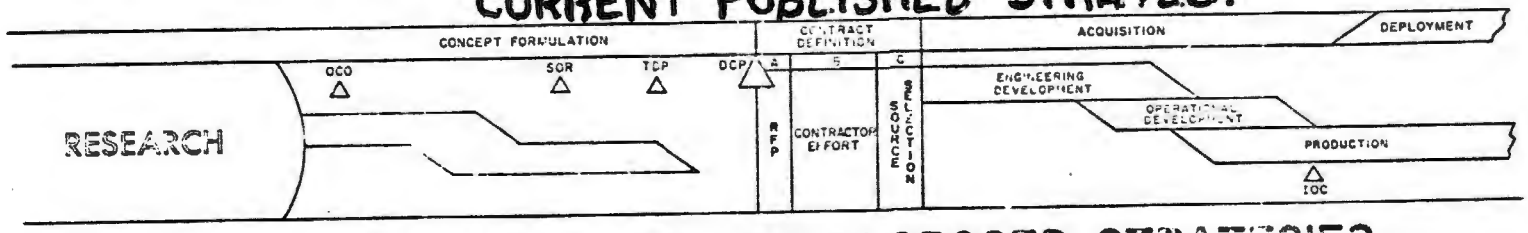
In addition, independent research and development is now coming under question. Since history demonstrates that many of the most important technological improvements in weapons have come through this channel, it is believed that the Department should strongly reaffirm its continued support of this channel of development. This could be done by increasing the funding given to Services for the research and development of subsystems, components and parts apart from major weapon system acquisition projects and by giving full support to the concept of independent research and development.

The second development channel, the lower band on the proposed strategy shown in Figure 1, is the ongoing development of subsystems and components by stable development teams, again working with the support of a broad base of research. At the present time, most of this effort is conducted by Government laboratories. However, it is believed that the concept of stabilizing the technical teams in given areas of technology is one which the Department should adopt more widely.

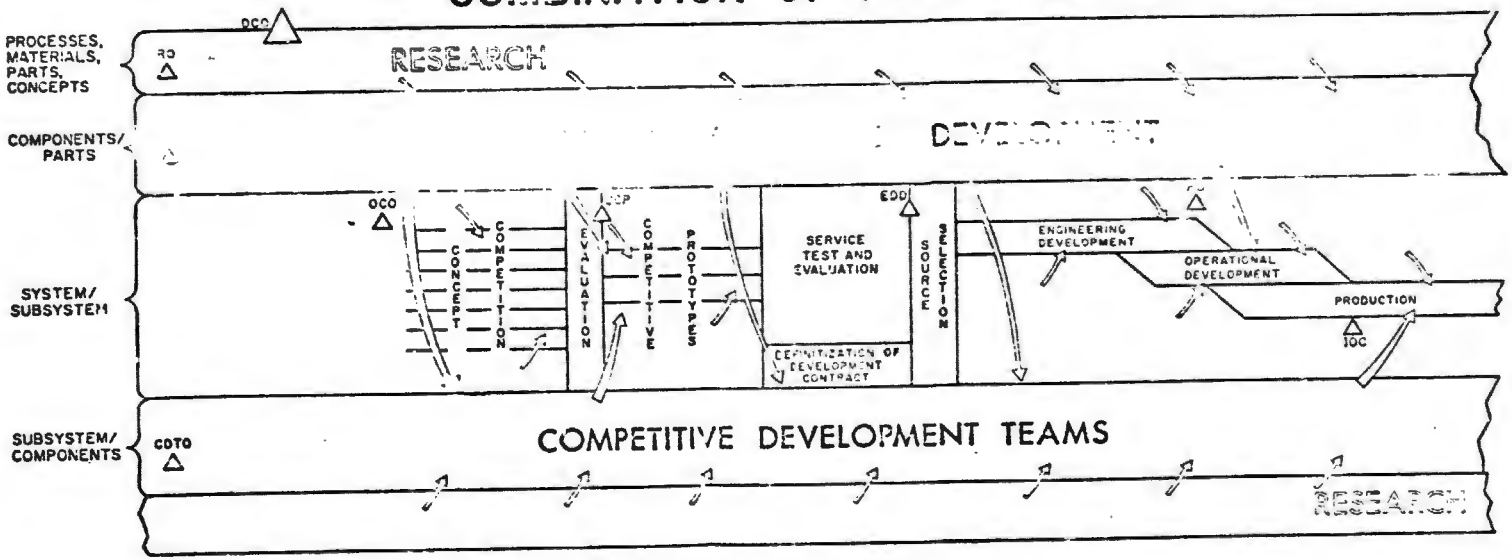
When there is a known long range need for continual improvements in performance, such as in the area of jet engines, there is much to be said for a relatively level funded effort which will enable the contractor or the

ACQUISITION OF MAJOR WEAPON SYSTEMS

CURRENT PUBLISHED STRATEGY



COMBINATION OF PROPOSED STRATEGIES



LEGEND
(OF DECISION POINTS)

- CDTO – COMPETITIVE DEVELOPMENT TEAM OBJECTIVES
- DCO – DEFENCE CAPABILITY OBJECTIVE
- DCP – DEVELOPMENT CONCEPT PAPER
- E/ADO – EXPLORATORY/ADVANCED DEVELOPMENT OBJECTIVES
- EDD – ENGINEERING DEVELOPMENT DECISION
- IOC – INITIAL OPERATIONAL CAPABILITY
- OCO – OPERATIONAL CAPABILITY OBJECTIVE
- PD – PRODUCTION DECISION
- RD – RESEARCH OBJECTIVE
- SOR – SPECIFIC OPERATIONAL REQUIREMENT
- TDP – TECHNICAL DEVELOPMENT PLAN

FIGURE 1

Government laboratory to devote its full attention to that area. Improvements should not depend on the justification of an individual new weapon system but should be allowed to occur as quickly as the technology will permit. The team should be encouraged to build and test prototype hardware whenever the technology dictates that a breakthrough is possible with the Services picking up components and subsystems whenever they can be efficiently introduced into a new or an operational weapon system. Care must be taken to assure that these technical teams are continuously competing with other teams but the competition should not be for funds to continue working but to have their new items used by the Services. Of course, if a team proved to be incapable of developing new products of use to the Services over a period of years, a new contractor or Government laboratory should be substituted for the unsuccessful organization. When a contractor is placed in this role a level of effort type contract will probably have to be used and it may be necessary to restrict the manufacturing role of that contractor in order to assure other competing contractors of fair treatment. On the other hand, in cases where there were only a few contractors working in an area, they could be level funded for development work without such manufacturing restrictions.

The third development channel, depicted in the middle band of the proposed strategy on Figure 1, is the path followed by major weapon systems. As soon as a major system is designated for development, concepts should be explored competitively and evaluated by the Service. If possible, contracts should be issued to two or more contractors to build and test prototypes proving out their concepts. In some cases, the system may be so large that full system prototypes are not economically feasible. In such case, the critical subsystems could be prototyped and tested at this stage. Following this period, the Service will conduct tests to determine which contractor's prototype gives the greatest chance of success and the full-scale development contract will be defined (with each contractor). One contractor will then be selected for the systems development effort. This strategy substitutes a competitive prototype effort for the contract definition effort in Directive 3200.9 and allows the Services to undertake this effort much earlier in the development cycle than has been true in recent years.

Thus, it places emphasis on hardware efforts in the early stages of weapon systems development rather than paper studies. It is believed that the change of emphasis will provide the Services better assurance that systems carried into operational development will meet their performance, cost and schedule goals. In order to carry out this strategy, however, it will be necessary to provide early funding for systems development. It must be emphasized that it is envisioned that the approach to weapon system development would have the initial and continuing benefit of the overall broad base of research and the outputs of the Exploratory/Advanced developments and of the competitive development teams. This benefit and support is depicted by the arrows in Figure 1.

The proposed strategies are based on a fundamental concept that the current Department policy places too much emphasis on the development of full weapon systems to the detriment of the development of subsystems, components and parts. The proposed strategies greatly fragment the development process allowing subsystems, components and parts to be developed independently. Under such a policy, the system developer or developers must be given substantial freedom to incorporate subsystems and components into their system during the various stages of development; and in most cases systems developers may indeed be looking for a subsystem development to improve the performance of their system. Again, this regular flow of items between the different development channels is depicted by the arrows in Figure 1 and should be recognized as an integral part of the process. Figure 2 depicts the typical activities which support the major outputs (the larger arrows) of the Exploratory/Advanced development and competitive development teams shown in Figure 1. As shown on Figure 2, these activities are hardware development, test and evaluation oriented.

The study considered three additional facets of the acquisition strategies used by the Department which are depicted in Figure 3. The first of these is stretched-out production following the pattern of System "A". A thorough study of this strategy was conducted which indicated that there are major benefits to be derived by producing weapon systems at a lower rate of production over a greater number of years. The major

TYPICAL ACTIVITIES IN SUPPORT OF MAJOR OUTPUTS

EXPLORATORY/ADVANCED DEVELOPMENT AND COMPETITIVE DEVELOPMENT TEAMS TO SYSTEM DEVELOPMENTS

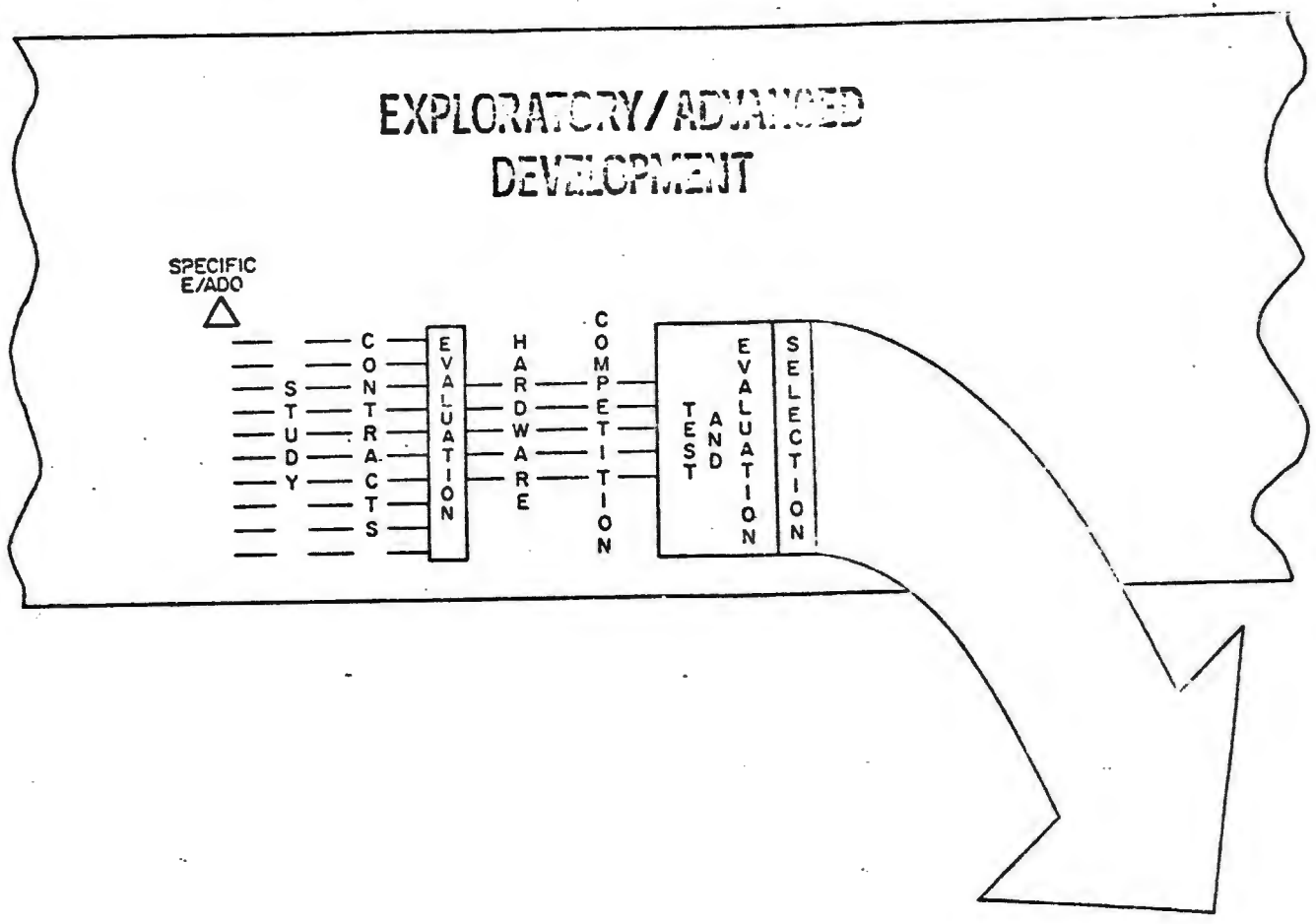


FIGURE 2

SYSTEM ACQUISITIONS IN SUPPORT OF A DCO

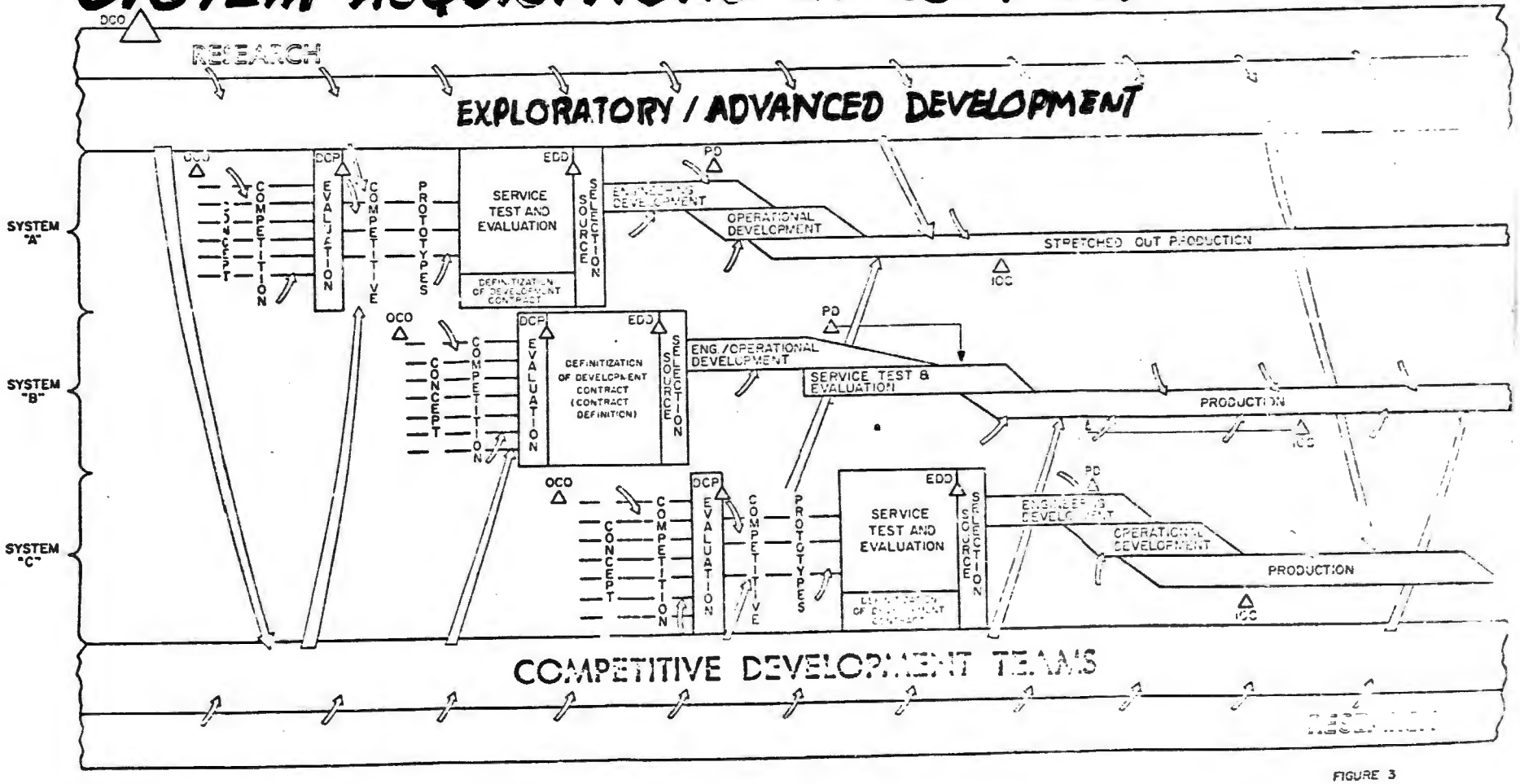


FIGURE 3

benefits are the reduced cost of modifications introduced into the system during production and the increased flexibility gained by keeping contractors in production for a longer period of time. Since the staff study indicated that stretched-out production is no more expensive to the Government, this strategy should be considered in many cases.

Another strategy worthy of consideration is nonconcurrent development and production following the pattern of System "B". In this strategy, the Service uses a competitive system similar to the present contract definition to define a development effort. Thereafter, the development effort is awarded to one contractor. However, no production effort is programmed until after the development prototypes have been tested and demonstrate their ability. Then the production decision is made and the contractor can proceed to full scale production. This strategy has the advantage of delaying the expenditure of production funds until the system is proved out in contrast to a concurrent strategy which greatly overlaps the development and production efforts. At the present time, the Services are following a nonconcurrent strategy in several programs and its benefits are well understood.

A final aspect of the proposed strategies is the opportunity for trade-off between the development of a new weapon system and the modification of weapon systems currently in production. For example, in the situation depicted in Figure 3 when System "C" had completed its service test and evaluation, the prototype test results would be evaluated against any modification proposed by the contractors producing Systems "A" and "B". Since this evaluation provides substantial competition, the prototype effort conducted for System "C" could be developed on a sole-source basis. Each of the System "A" and "B" contractors would be drawing on the results of the ongoing efforts in the Exploratory/Advanced Development area by the Competitive Development Teams. Thus, by combining all of the strategies proposed, the Department would have a much greater spectrum of options from which to choose.

Based on the above discussion, it is recommended that the Secretary of Defense should issue policy guidance giving the Services wide latitude in the strategies which can be used to develop major weapon systems. It is suggested that this policy should encourage greater use of the following strategies:

(a) Exploratory and Advanced Development of components and parts independent of the development of weapon systems.

(b) The use of Government laboratories and contractors to develop subsystems and components on a long term level of effort basis.

(c) The development of weapon systems making greater use of competitive prototypes rather than paper studies.

(d) Stretched-out production efforts keeping systems in production over a greater span of 4 years.

(e) Nonconcurrent development and production efforts where the production decision is deferred until successful demonstration of developmental prototypes.

(f) Continual trade-off between new weapon systems and modifications to existing weapon systems currently in production.

B. Decision Process

The present policy set forth in Department Directive 3200.9 calls for one major decision by the Secretary of Defense allowing the commencement of a major weapon system development effort. While this policy has served its intended purpose of giving the Secretary greater control over new program starts, it has created serious detrimental side effects:

(a) It is so difficult for a Service to obtain the decision to proceed that there is a tendency not to review the decision once it is made. The result is that meaningful review of the system during development has not always occurred.

(b) The single decision point has led to a greatly increased amount of detailed justification which has forced the Services to concentrate more efforts on studies to justify the system rather than on technical development effort on critical components of the system. This has occurred even though the Directive specifically calls for work on difficult components rather than the entire system if the technology is wanting on those components.

(c) The environment in which approvals are obtained induces the Services and their contractors into genuine, but nevertheless over-optimistic conviction of their ability to deal with technical unknowns. This has resulted in some cost and schedule overruns, and in some instances deficient hardware.

(d) The very nature of the decision inhibits major innovation once a system is approved for development because any change challenges the creditability of the decision.

There is general recognition that the single decision point is no longer a viable management mechanism. The study concurs with this view and believes that its proposed strategies are ideally suited for a multi-decision management system. Figure 1 illustrates such a system with three points where the Services would have to obtain the approval of the Secretary of Defense to proceed with a major weapon system.

Development Concept Paper - Approval of this paper would allow a Service to proceed into the prototype phase or contract definition at the system or subsystem level. It would be based on a demonstrated need for a new system.

Engineering Development Decision - This decision will allow a Service to proceed to Engineering/Operational System Development. It would be based on clear proof, preferably in the form of hardware demonstrations, that a system meeting the needs of the Service can be developed.

Production Decision - This decision will allow the system to proceed on production. It would be based on a thorough evaluation of all feasible alternative means of fulfilling the requirement by modifying existing systems or producing a new system or subsystem.

It is believed that this type of multi-decision process will improve Departmental management. It requires the Services to obtain more approvals from the Secretary of Defense but no single approval is as important as before. It allows work to proceed in incremental steps with the Service and its contractors knowing that it must demonstrate success in order to proceed to the next phase. Finally, it should encourage continual review of the requirements of the Services during the development phase.

In support of the recommendation giving wide latitude in the strategies which can be used to develop major weapon systems, it is recommended that the Secretary of Defense should issue policy guidance providing for multiple decision points during the acquisition of a weapon system.

C. Requirements

Traditionally requirements flow from the operational and materiel commands into the Military Service and Military Department staffs. Each have a large section of its Headquarters staff which has the sole function of translating the broadly stated requirements from the field into much more specific statements of their desires for new weapons. These staffs also determine informally the relative priority of the new weapons requirements. In recent years, the formalized requirements documents have been much too specific. Mission capabilities are spelled out in detail. In addition, configuration characteristics such as maintainability, reliability, weight, etc., are usually specified. Requirements issued in this manner severely limit the ingenuity of would-be developers.

Another major fault of the requirements process as practiced today is the inability of a Military Service staff to divorce itself from Service interests in establishing priorities for requirements. Thus, the needs of

the user in the field must take second place to those major weapons developments most important to the Service in question for the protection and/or expansion of its assigned roles and missions. A related inadequacy of the system is the lack of attention given to requirements which are of only partial interest to more than one Service.

There is a third characteristic of Service-developed requirements which relates to arbitrary force level ceilings. Thus, whenever the Tactical Air Forces are limited by policy to a given number of tactical aircraft wings, the aircraft which the Air Force will seek to develop and procure for equipping those wings will be the most advanced and sophisticated that technology can provide. Any pressure to equip a portion of these wings with simple, daylight, close-support aircraft will be strenuously resisted. Similarly, if the Navy is limited by policy to some fixed number of attack aircraft carriers, it is a certainty that no thought whatsoever will be given to experimentation with smaller simpler carriers or perhaps to one specially designed for vertical take-off aircraft.

In order to be more responsive to the needs of the user and to meet those urgent requirements which have multi-Service interest, it is believed that the first ordering of requirements as received from the operating commands and the technological community should be accomplished in the Office of the Secretary of Defense. The requirements documents received from the field would be translated at the OSD level into Defense Capabilities Objectives (DCO). These DCOs would be given a priority order and assigned to one or more of the Services for preparation of a plan for realizing the DCO in accordance with one or more of the overall strategies previously discussed. The implementation of a DCO may result after a period of component and subsystem development. On the other hand, advances in technology for improving elements of already operational systems may be the end result.

This new requirements development process thus would generate Research Objectives (ROs) for identifying those processes, materiels, concepts and parts related to the broadly stated DCO. The realization of

the new requirement would at the same time identify Exploratory and Advanced Development Objectives (E/ADOs) which would direct effort toward the pacing and critical parts, components and subsystems. As the DCO is more explicitly defined by the responsible Service in an Operational Capability Objective (OCO), there may develop one or more occasions to put competitive development teams to work on Competitive Development Team Objectives (CDTOs) which would yield competitive prototype hardware of critical subsystems for comparative evaluation and selection. Thus throughout the requirement development process, there is a continuing hard look at technology with appropriate funding of development for pacing items. The result from the continuing development program as illustrated in Figures 1, 2 & 3, will be incremental steps toward realization of the stated DCO which may be achieved by improvement to existing systems or through the full-scale development of an entirely new system, or both.

The purpose of this new approach to the handling of requirements is to encourage more realistic trade-offs between totally new weapon systems programs versus component or subsystem development for upgrading of existing systems. Another desired result is an objective evaluation of the comparative merits of larger number of relatively simple weapons as opposed to much smaller numbers of more sophisticated systems. It is believed that the proposed changes will significantly improve the effectiveness with which these critically important major weapons decision processes can be accomplished.

The method employed by the Military Services in developing requirements for major weapons has serious deficiencies. Among these are:

(a) Subordination of the needs of the operating forces to parochial Service interests.

(b) Low priority given to those needs of only half interest to more than one Service.

(c) Oversophistication of systems which have an acquisition objective limitation as a result of force level ceilings.

(d) Statement of requirements in detailed performance and configuration specifications, thereby limiting innovation and imagination in the early conceptual and development phases.

It is recommended that:

(a) The Secretary of Defense take appropriate steps to insure that operational requirements from the operating commands be submitted directly to his office for establishment of priorities and assignment to the proper Service or Services for implementation.

(b) The Secretary of Defense issue policy guidance to insure that operational requirements be stated in terms of broad objectives to encourage imaginative and innovative responses from potential developers.

As a result of the study, it is believed that these recommendations can be accomplished by:

(a) Establishing a small planning element in the Secretary's office which would have competence in both analysis and technology.

(b) Establishing broad base Research Objectives, Exploratory/ Advanced Development Objectives, and Competitive Development Team Objectives to provide continuing support to weapon systems development.

(c) Developing appropriate guidelines for the submission and processing of requirements documents from the operating commands to the Office of the Secretary of Defense to establish Defense Capability Objectives and the implementing Operational Capability Objectives.

D. Source Selection

The source selection process that has evolved out of the present weapon system acquisition procedure is time consuming and complex. A large amount of information is generated in the course of Contract Definition and there has been a tendency to factor almost all of this information into the source selection process. The result has been contractor proposals of massive size - in some cases weighing over one ton. In order to re-evaluate these proposals, the Services break them into segments which are assigned for evaluation to a small number of technical or management experts drawn from a large team of several hundred such specailists. Each team evaluates its assigned element without knowing the weight of its element or the evaluation results from other elements. In this way, the system attempts to reduce the effects of personal biases by a large number of independently evaluated elements. The number of elements considered for major program awards will run to several hundred, to each of which some relative figure of merit or numerical score is assigned based for the most part on the value judgments of the small teams of experts who attempt to be completely objective.

The Air Force and Army seek to place numerical values on these various items, whereas the Navy relies more on qualitative evaluation and, where measurement is feasible, on the degree to which the proposal exceeds or fails to meet the desired characteristics in the Request for Proposal. In either case, the scores or merit assigned to each aspect of the proposals are summed up and this raw data is forwarded to a top level selection board normally made up of flag officers, which then computes the weighted score of each contractor based on previously assigned weights for each element of the proposal. This selection board then recommends a final selection based on these weighted scores plus other factors such as price and past performance which have no assigned weights.

Past experience indicates that both weighted and raw scores tend to be very close in major source selections. In some instances, contractors reverse positions in going from raw scores to weighted scores but even

then the competitors tend to be almost equal. See House Army Services Committee Report No. 91-14, 1969, Page 3167 on how the Army picked AAFSS contract definition winners. In this situation, it is generally agreed that the unweighted factors, such as cost and past performance, have a large and perhaps controlling impact on the final selection.

Apparently the large number of peripheral technical elements included in the ratings is the major factor which normalizes the scores of the competitors. However, there is a real question whether the massively detailed numerical systems that have been used have contributed in any significant way to the judgmental process that lies behind each source selection. See "Concerning Principles Underlying the Construction of Evaluation Criteria and Scoring Systems for Use in the Source Selection Process," Navy BuWeps R-14 Report No. 36, November 10, 1965. In fact, these numerical rating systems tend to obscure the most important issues and thereby create the risk that good judgment will not be brought to bear. Reduction of the number of elements rated would focus attention on the more fundamental considerations and would give a broader perspective of the relative technical merits of each contractor's proposal. Further, such reduction would speed the evaluation process and greatly reduce the cost of source selections. It could be expected that these steps would also give the source selection board a clearer choice through the larger raw and weighted score differentials which would result. As the source selection process is simplified and focused on the more fundamental technical aspects of the procurement in this manner, it would be possible to use outside technical experts on the source selection board. This use of acknowledged experts would add credibility to the process and would assure the Services that the final selection was based on technical judgment of a broad cross-section of the technical community.

Over and above the incredibility and complexity of the system as currently practiced, a considerable waste of time and scarce resources is involved. The top technical talent of two, three or more corporations will be involved in the Contract Definition competition for 6 months to more than a year. Each team may be made up of as many as 1,000 engineers.

The funded portion of the competition may amount to more than $50 million. An equal or greater amount is indirectly charged to the Government via additional overhead on other Defense contracts or as a write-off against profits which reduces the corporations' tax liability. An additional cost is, of course, that associated with the 500 or more evaluators who may be involved for a period of three to six months. This cost including salaries, travel, etc., for a major system evaluation effort can easily exceed $3 million.

The recent Air Force* and Aerospace Industries Association** studies of Requests for Proposals (RFP) both conclude that forthright steps should be taken to reduce the amount of information called for by the RFP thereby reducing the amount of information which must be evaluated in the source selection process. The study agreed with these conclusions. It also believes that substantial simplification of the source selection process can be accomplished if the proposed acquisition strategies it has recommended are adopted. The availability of test results of prototype hardware should remove much of the emphasis on detailed written proposals. Undertaking development of subsystems and components separately from major systems should also reduce the complexity of the source selection decision on the system itself. Such simplification could be furthered if the Department would take forthright action to reduce the complexity of source selections through a direct policy statement.

It is recommended that the Secretary of Defense should direct that source selection practices and procedures be simplified to the greatest extent possible on all future procurements. It is suggested that this policy could be implemented by:

(a) Requests for Proposals should call for a greatly reduced volume of information in order to eliminate the large number of elements in the evaluation which deal with peripheral and minor aspects of the proposed system thereby focusing attention on these elements of the proposal which bear critically on the ability of the system to meet the new requirements.

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* Air Force Request for Proposal Study Team Final Report, November 1969

** Aerospace Industries Association, December 1969, "An AIA Study of United States Air Force Requests for Proposals, Critique and Recommendations"

(b) The Services should be encouraged to experiment with the use of outside experts on source selection boards to determine if this will produce a broader perspective in making source selection decisions.

II. PROGRAM MANAGEMENT

Program (or Project) Management has long been used both by Government and Industry in the management of Major Weapon System Acquisitions processes. While it is generally recognized that the caliber and effectiveness of a program's management have major impact on the successful acquisition of a useful weapon, it has been less generally recognized that the characteristics of that acquisition process must be a major determinant in the creation of a program management structure including the selection and ranking of its personnel.

Current Department of Defense Program Management policy (Directive 5010.14) and those of the three services* clearly describe a matrix organization for the management of Major Weapons Systems Acquisition. In a matrix organization "the Project Management structure is superimposed upon the functional organization,"** and draws its staffing from it on a dotted line basis. Further, for major weapons systems the Program Manager is normally a full Colonel or Navy Captain and reports to the Deputy for Systems Management of the Procuring Command.

In this type of organization, the Program Manager is located perhaps five levels below the service secretary and is frequently out-ranked by the functional and staff organizations with whom he must deal. Adequate opportunity exists above the project manager in the vertical line of authority, and alongside the project manager in the horizontal chain for other authority to impinge on his. Hence,** "it is easy for a project manager's responsibility to exceed his authority."

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* Army Regulation (AR) 70-17, 19 January 1968, "Research and Development, System/Project Management." Navy Material Instructions 5000.5B, 3 December 1968, "Project Management in the Naval Materiel Command." Air Force Systems Command Manual (AFSCM) 375-3, 15 June 1964, "System Program Office Manual."

** Logistics Management Institute Task 69-28A, July 1969, "Project Management in the Department of Defense -- a Brief Survey."

Recognition of this fundamental management problem is found in many formal studies on this subject dating from over 15 years ago. A number of these are quoted here:

In 1969, "The project manager must rely on functional specialists outside the project, and if he is not able to call upon the appropriate ones and they are not motivated to work in concert with him, the project is in jeopardy. It is possible for project management to be too remote from functional support, to have insufficient status to obtain adequate cooperation, or to be so situated as to be considered a potneital threat to functional managers."*

"The program manager is a sort of official champion of the system. In a hostile world, in which most of the senior people with whom he must deal seem bent on stopping, changing, delaying, or otherwise attacking his system, his people, or his money, he is the one dedicated support . . . Because authority is at present so highly centralized in the Department of Defense, the program manager has little authority and is separated from those that have it by a number of intermediate staff levels which can distort and interfere but cannot help."**

In 1963, "The rule today is that, . . . the program managers . . . have neither a substantial, well delegated, clearly defined responsibility, nor do they have authority commensurate with exercising the responsibility. . . ."***

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* Logistics Management Institute Task 69-28A, July 1969, "Project Management in the Department of Defense -- a Brief Survey."

** Defense Science Board, Office of the Director of Defense Research and Engineering, 18 July 1969, "Report of the Panel on R&D Management."

*** Defense Industry Advisory Council (DIAC), 1963, "Fundamental Issues Affecting Defense - Industry Relationships," pages 137 - 151.

In 1961, "Those concerned should provide positive and prompt support to strengthen the position of System Program Directors and Staff Officers."*

In 1959, "Contractors quickly adapt their project administration to vertical lines; government offices are slower to effect this and have mixed requirements that prevent full organizationl change."**

In 1956, "A Study of the Services, weapons systems and industrial relations has revealed that:

- o Project management conflicts with functional department management.
- o Project management units exist at a low organizational level.
- o Project officers lack sufficient training, rank, and continuity of assignment.
- o Project officers lack proper approval authority, and receive operational direction from higher authority."***

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* Systems Management Study Committee (Rawlings) Report to Secretary of the Air Force, 26 May 1961.

** Department of the Navy Aviation Division Notice 5410, 15 May 1959, "Analysis Into Short and Long Range Military Technical Effects of the Introduction of the Weapon System Concept."

*** Ad Hoc Study Group (Robertson Panel) on Manned Aircraft Weapon Systems, Volume V, August 1956, "A More Vigorous Project Management."

Conversely, one study of 1934 Air Force History states of a successful program. "There was an intimate relationship and mutual trust between the contractor and the Service project officer." And, further, in early days the Project Officer was "but one step removed from the Chief of the Air Corps;" -- "the project office acted with a clear understanding of top level policy and with adequate authority."

In light of the criticisms noted above, and apparent lack of progress toward solving problems of long duration, the following approach was used in the investigation into Major Weapons Systems program management. A technique was used which compared the characteristics found in a greater or lesser degree on each program examined, to program management attributes (organizational, derivation of authority, and manning considerations) and the impact of both on the program. The attributes were further considered in light of the environment or external influences surrounding the program.

Some program characteristis which were evaluated are:

(a) Degree of Urgency
(b) Degree of Concurrency
(c) Technical Content
(d) System Cost
(e) Production Volume
(f) Multi-service
(g) Multi-national
(h) Multi-system application
(i) Off-the-shelf hardware
(j) Program-Product Mix

Some management attributes considered are:

Organizational

(a) Type of organization
    (1) Functional
    (2) Coordinating
    (3) Matrix
    (4) Vertical (all on one payroll)
(b) Location
(c) Size and quality of staff

Derivation of Authority

(a) Reporting level
(b) Dotted line to top
(c) Rank, status
(d) Colocation of personnel
(e) Binding of personnel
(f) Merit Review
(g) Recruiting authority
(h) Representation of using commands

Manning Considerations

(a) Training level
(b) Duration of assignment
(c) Capability and background
    (1) Technical
    (2) Management
    (3) Operational
(d) Planned transition
(e) Rank
(f) Promotional opportunities

Environment

(a) Funding priority
(b) Sufficiency of resources (money and manpower)
(c) Political
    (1) Controversial requirement
    (2) Controversial solution
    (3) Recognized need
    (4) National priority
(d) Competitive
    (1) Sole source
    (2) Fly-a-way then sole source
    (3) Paper thru contract definition
(e) Type of contract
    (1) Total package
    (2) Fixed price
    (3) Cost

From the interviews with individual military and industry program managers, it was found that there was not a unanimity of opinion between all the services and industry on how programs should be managed and how program managers should be selected. Practically everyone agreed, however, that there is no one best way to organize management for a program but rather the program organization and the caliber of the program managers should be determined by the magnitude and technical complexity of the program, the degree of urgency and concurrency, and the overall environment surrounding the program.

In practice, however, programs were found to be organized and staffed according to prevailing procedures and preferences of the individual agencies and were generally quite rigid in structure, being within any one service relatively the same for large or small projects. They ranged from the highly structured 200-man Project Offices of the Air Force to 12-man System Project Offices (SPO) in the Navy with the Army falling somewhere in between. The size generally had more to do with procedural workload than with problems. Another important factor is the way in which the services use the functional people. Regardless of size, the SPO's find difficulty in keeping up with their workload. There was little to choose between them in performance. Apparently small, competent organizations can perform as well as large ones on most programs; providing the environment and the procedures allow them to concentrate on the important actions.

A common finding is a lack of authority of the program office and the ned to improve their external communications. The reporting level and rank of the program team is often not commensurate with the dimensions of the program. This is particularly disrupting when the program has great political consequences and authority is retained close to OSD.

Exceptions exist. Most recently, General Officers have been appointed Program Managers of the ABM and F-15 procurements. They report one and two levels, respectively, below the Service Secretaries. Another notable

exception is the Polaris program; the program office in this case has not only been headed by a General Officer since inception, it is also organized in classical vertical [illegible] with the bulk of its supporting functions on the program office payroll. Delegation of authority further down in the service should be possible on programs of lesser importance with equivalently reduced level of visibility required.

Staffing of programs; motivation and retention of personnel are major problems. Regardless of reporting level or rank:

(a) The caliber of the Program Manager is all important. The successful program manager has been characterized as "a person who usually found a way to work around the regulations" by carefully utilizing the source of authority from which the program draws its sponsorship. It was also noted that persuasion is high in the successful program manager's bag of tricks.

(b) There are not enough qualified program managers or support personnel. Their tour of duty is too short as is their overlap with their successor. LMI reported that recent Army data* shows an average tenure of project managers to be only 20 months, considerably less than the Directive 5010.14 requirement of at least three years. It was estimated that Air Force and Navy tenure fell between two and three years.

(c) Program Management is generally not considered an assignment which furthers a man's career. Therefore, it is difficult to attract and retain top quality personnel.

Today's major weapons systems have a life cycle of 8 to 10 years, a good deal of which time is taken up with substantial, complex, technical developments having far-reaching impact on cost and performance. The

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* Logistics Management Institute Task 69-28A, July 1969, "Project Management in the Department of Defense -- a Brief Survey."

military program manager frequently finds himself taking on a program in midstream and being forced to operate in an environment not of his own making and to follow decisions made for him by someone no longer responsible. Frequently he must make decisions himself under complex circumstances well before he has had an opportunity to learn all of the intricacies and history of the project.

The services have recognized this problem. Admiral Galantin has recently recommended to VCNO a training program to develop "weapons system acquisition officers" as a career equal in importance to the present line and supply corps positions. These managers to be trained in the "engineering, development, operational system development and production of our weapons system, including all aspects of integrated logistics."* General Chesarek, U.S. Army, has submitted a draft proposed memorandum outlining requirements for training, tenure and incentives for "Career Specialties in Development Project Management."** General Ferguson, Commander, Air Force Systems Command, has issued similar instructions. Despite this, it is not clear that the military in general is ready to put the same emphasis upon the "buying" function as they do on the fighting and supply function.

For this reason and others, there have been serious recommendations that the Armed Services develop a cadre of civilian program managers, particularly for the highly technical development phase of a program. The reaction of the military to this suggestion is understandably negative: - the lack of operation experience, the lack of respect and authority deriving from the uniform, and the relative immobility of civilian personnel are some reasons cited.

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* Headquarters Naval Materiel Command Memorandum for the Vice Chief of Naval Operations, 8 October 1968, "Procurement/Weapon System Acquisition Officer Personnel Career Requirements."

** Headquarters Army Materiel Command Draft Memorandum, 6 Januay 1970, "Career Specialty in Development Project Management."

The management of the supporting staff is primarily a matter of internal authority. In a vertical program organization, the authority of the program manager is unquestioned since he has hiring and firing control over his functional staffs. In a matrix organization program authority is over the what, when, and why work must be done. The functional supervisor retains authority to determine who will do it, where, and how.

This divided authority has led to many of the problems cited in the references above. The most serious have to do with the divided loyalty of the functional personnel assigned, late or inadequate staffing, and outright loss of personnel to other higher priority programs.

Both industry and government have used apparently simple techniques to overcome some of these problems. Colocation of members of the program team under one roof is one of the most effective. This usually gives the program an esprit de corps, a sense of belonging, and a common goal which will reduce conflicts with functional duties. Binding of personnel to the program unless released by the Program Manager, and participation of the Program Manager in the merit review of functional personnel assigned are also effective. In practice, however, these latter two have proven difficult to implement and require continual policing by higher authority.

In comparing characteristics of Major Weapons Systems Programs with program management attributes and the overall environment, it was quickly revealed that programs which had a high degree of such characteristics as urgency, concurrency, technical content, cost, and production volume required exceptional management. Some of the more successful ones were organized in a strong vertical structure with all key elements reporting directly to the program manager. Examples are the Polaris Program, the Atomic Energy Program, and the early days of the Ballistic Missile Program. These programs also had the necessary priorities to acquire adequate funds and people. Hence it is difficult to say whether the organizational structure or the priorities made the programs successful. There is little doubt, however, that all other things being equal, the vertical structure is more efficient at the onset of its life. It later can suffer from technical obsolescence.

However, it was further noted, that because of the natural reluctance of the functional organizations (such as engineering, testing, etc.) to give up their personnel to a vertical program organization for the duration of a program, it is much more common, indeed, almost universally applied, to run programs with a matrix organization wherein the program manager draws functional organization staffing on a dotted line basis.

The advantages of the matrix organization are obvious. The program management organization can be more quickly staffed and more easily dissolved when no longer required. Critical personnel can be shared between programs. The programs do not tend to become self-perpetuating as they do with a vertical organization. The problems with the matrix organization are also obvious. The principal problem being the lack of direct authority by the program manager over the assigned functional staff.

With regard to using a functional organization for program management, the investigation determined that it was not used for anything other than low complexity, off-the-shelf hardware procurement, so it was not examined in any detail.

Certain variations of these organizational structures have been used. Others are possible. However, by definition, today's major weapons systems involve a high technical content, high cost and usually a high degree of concurrency. In addition they are in competition with other programs for manpower, money, and prestige. In this environment there are only a few program management structures with a reasonable chance of success. These are:

(a) Permanent vertical organizations,
(b) Temporary vertical organizations,
(c) Strong matrix organizations, and
(d) Weak matrix organizations.

The last of these can only succeed if the program team and the involved functional organization are both highly motivated toward a common goal. Such motivation is difficult to obtain and more difficult to maintain.

Co-ordinator and pure functional structures are not used for Major Weapons Systems Acquisition.

Certain pros and cons of the above approaches follow:

Permanent Vertical Organizations for continuing development; e. g., AEC laboratories

PRO	CON
- initially at forefront of technology	- self-perpetuating even if not required
- permanent experienced team	- quasi-nationalism, politically difficult to establish
- management responsibility and authority clear	- competitive labs are required to prevent technical obsolescence
- level funding	- personnel incentives difficult to maintain
- efficient	

Temporary Vertical Organizations for special (urgent or extremely complex) projects; e. g., Polaris

PRO	CON
- management responsibility and authority clear	- dissolution bad for morale; loss of good people
- most responsive to sense of urgeny	- tries to be self-perpetuating
- ideally less expensive than matrix	- no check and balance -- i. e., competition
- rank not as important	- tenure and overlap a problem
	- damages functional organization

Strong Matrix Organization; e.g., F-15

(1) Reports to the source of authority
(2) Fitness report originator
(3) Colocation of personnel
(4) Binding of personnel
(5) Rank of Program Manager commensurate with task

PRO

- responsibility clear
- authority reasonably clear
- staffing reasonably easy
- can be adjusted to program requirements
- most flexible

CON

- authority depends on caliber of leadership
- tends to become outsized
- submerges functional organization
- tenure and overlap not solved
- functional line supervision often lose interest

Weak Matrix Organization (This is the structure most often used and is closest to that described as typical by the service manuals)

(1) Assignment of personnel but not colocation or binding
(2) Fitness report reviewed
(3) Report at functional level (Deputy for Systems)
(4) Normally headed by full Colonel or Navy Captain

PRO

- Responsibility clear
- does not bypass intermediate supervision
- little disturbance to functional organization
- can readily share scarce personnel
- can be adjusted to program requirements
- flexible

CON

- authority unclear
- performance highly dependent on caliber of Program Manager and his team
- staffing difficult
- loss of assigned personnel frequent
- tenure and overlap serious problem

Co-ordinator (old-time WSPO, Weapons System Project Office, Class Desk, etc.)

PRO	CON
- improves communication between functional organizations	- no clearcut identification of responsibility and authority
- very little disturbance to functional organizations	- no protection of personnel
	- cannot cope with workload on major programs
	- no one wants the job

Functional

PRO	CON
- least expensive for very simple programs	- really not in the scope of major weapons systems acquisition program

External influences have a major impact on the management of a Major Weapon System Program. The sheer magnitude of such programs, and their impact upon national resources, bring them attention of friend and foe alike. Externally there are many nay-sayers and nit-pickers, but few helpers. Coping with the seemingly insatiable demands for information and explanation frequently overloads and distracts the Program Office to where it cannot cope with the day-to-day problems of internal management. This is not to say that external interest is not genuine or legitimate; the question is: - Is it all necessary? and, Is it counter-productive?

In approximate order of descending capability of a Program Office to handle them, external influences impacting a program come from:

(a) Parallel Functional Organizations
(b) Competing Program Organizations
(c) Contractor(s)
(d) Using Command(s)
(e) Chain of Command and Staff
(f) Office of the Secretary of Defense
(g) Congress
(h) The Press and Public

Parallel Functional Organizations: Enough has been said about the matrix organization to recognize that conflict is a way of life. A text on the subject states:- "The Project Manager and the functional managers must resolve the recurring conflicts that arise during the course of the project's life," and further "The chief executives expect the managers to work out their conflicts."*

Competing Program Organizations: When these conflicts involve competition with other programs for the same scarce people, funds, and facilities, any management is strained. Unfortunately, these conflicts usually occur during the early, formative days of a program when a cohesive, properly staffed, smoothly running team is most required to handle the substantial technical tradeoffs which must be made.

Contractors: Contractors dilute program management effectiveness in direct proportion to the financial risk they are taking. Technical innovation cannot be scheduled nor its cost precisely forecast. When caught in a contractual situation demanding both, the contractor and military program office become adversaries. One military Program Manager stated it thus: "I must now stand an arm's length from my counter-part and stress that I'm no longer development co-chairman, but a very demanding customer."**

Virtually all major programs have technical requirements of a substantial nature. Few require only moderate technical breakthroughs. Hency the emphasis in the past on strong, engineering oriented personnel for program management assignments. In recent years, although programs still had high technical content, they additionally required a high degree of concurrency. Procurement was most often done on fixed price development contracts with fixed price production options.

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* Cleland and King, McGraw-Hill, 1968, "Systems Analysis and Project Management.

** Aerospace Management, Volume 2, Number 1, Spring/Summer 1967, (General Electric Company, Missile and Space Division).

In this environment industry, and to a certain degree the government, were inclined to sacrifice technical capability in their program manager for general management talent and cost awareness. This had serious drawbacks:

(1) The program manager was not able to make the technical judgments necessary early enough to predict difficulties. The contractor furthermore did not have funds to provide parallel paths around difficult technical problems.

(2) The program's natural inclination to continually watch the cost and schedule aspects of the program de-emphasized the technical problems.

Technical corner cutting and risk taking resulted. Program office and the contractor soon became adversaries rather than partners in solving problems. The program office because of inevitable schedule slippage and deteriorated performance; the contractor because of the (sometime disastrous) financial impact.

Using Commands, and Chain of Command and Staff: The using command(s) and the chain of command above the Program Office all feel the need for program visibility; with much of it necessary but much of it not. The degree of detail demanded over the past decade is due in large part to the increasing centralization of authority in Office of Secretary of Defense (OSD) and now most lately in Congress.

However, a good deal is also due to the increasing trend toward multiple usage of a system. Multi-service programs, such as the F-111 and the A-7, have become common in the last decade. Multi-application of a weapon, such as the SRAM missile being carried by the B-52, B-1A and the FB-111, brought in more users demanding a program overview. When other nations are involved, such as Australia and England -- also in the F-111, the sensitivity of upper levels becomes even greater.

Time consuming demands for briefings and clarifications at many levels forced harried program managers to act primarily as an outside

man, appointing deputies at home to get on with the work. Intermediate management can often make little use of detailed program information except to prepare for questions from still higher authority. Serious suggestions have been made to locate Program Offices in the Washington, D. C. area in order to cope more readily with these demands. The availability of program personnel at the procuring command has so far outweighed this suggestion. It is interesting to note, however, that the Navy, with both functions in the Washington area, gets by with far fewer and lower ranking program personnel (except for Polaris) than does the Air Force.

Office of the Secretary of Defense: OSD recognizes, as Secretary Laird has said, "the scope of the management problem in the Department of Defense is unmatched in all the world;" and "a substantial portion of defense activities falls into fields of rapidly changing technology increasing the risks that decisions may be wrong or quickly outmoded."* In such an environment it is natural for OSD to take unto itself centralized authority. It is furthermore natural for this to happen when dealing with an organization as large as the Department of Defense. However, when program decisions come out of this without the expert participation and concurrence of the program team, it"leads to a kind of paralysis. Many decisions -- if they are made, lack full coordination and commitment by those who must implement the decisions."*

OSD is attempting to reverse this trend by decentralizing lower-level decisions and making "lines of authority -- clear, direct and uncluttered by staff layering."* To monitor major program milestones Deputy Secretary Packard has established DSARC (the Defense Systems Acquisition Review Council)** made up of four Assistant Secretaries of Defense. However, the Program Manager is not included.

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* "FY 1971 Defense Program and Budget," A Statement by Secretary of Defense Melvin R. Laird, 25 February 1970.

** Department of Defense Memorandum signed by Deputy Secretary Packard, July 1969, "Establishment of a Defense Systems Acquisition Review Council."

Congress: It must be said that Congress is fast replacing OSD as the pre-dominant external influence upon major programs. Many program activities have solely to do with "papering Pearl Harbor files" to back-up decisions which have been made for possible justification later. Others have to do with increased demand for detailed visibility; the most recent has given rise to the SAR's (Selected Acquisition Reports), quarterly progress reports filed on major programs which eventually find their way to the GAO for review and presentation to Congress.

The Press and Public: The press and public directly affect Program Management through its impact on morale. Additionally, public criticism has a cascading effect through Congress and the Administration, and so on back down the line above.

The following are the conclusions reached as a result of the investigation:

Organizational Structure

Today's major weapons systems involve a high technical content, high cost and usually a high degree of concurrency. In addition they compete with other programs for manpower, money, and prestige. In this environment the program management structures with a reasonable chance of success are:

(a) Permanent vertical organizations for competitive, continuing development; e.g., AEC laboratories.

(b) Temporary vertical organizations for special (urgent or extremely complex) projects; e.g., Polaris.

(c) Strong matrix organizations, and

(d) Weak matrix organizations.

The last of these can only succeed if, in the uncommon circumstances, the program team and the involved functional organizations are both highly motivated toward a common goal. The principal pros and cons of the above structures are:

(a) The vertically organized, "all on one payroll" organization has the best record of success in programs with a high degree of urgency, concurrency, technical content, and cost. However, it prospers at the expense of the functional organizations.

(b) If government and industry to not wish to cope with the self-perpetuating tendencies of vertically organized programs and/or the trauma that attends their dissolution, they must find a way to strengthen the matrix organization.

(c) The advantages of the matrix organization are obvious. The program management organization can be more quickly staffed and more easily dissolved when no longer required. Vritical personnel can be shared between programs. The programs do not tend to become self-perpetuating as they do with a vertical organization.

The problems with the matrix organization are also obvious. The principal problem being the lack of direct authority by the program manager over the assigned functional staff.

Techniques to strengthen the matrix organization are available and permitted by the Services' program management procedures:

(1) Reporting level and rank of the Program Team must be commensurate with the dimensions of the Program.

(2) Continuity of management can be improved by increasing the tour of duty of key personnel and programming sufficient overlap with their successors.

(3) Motivation and retention of personnel can be aided by such techniques as co-location and binding of functional personnel assigned to the program, and participation of the program office in their merit review.

(d) The selection of a program management structure; its reporting level; its caliber, rank, and number of personnel should be determined by the characteristics of each individual program; namely, the degree of urgency, concurrency, technical content, program size, and cost.

Manning Considerations

(a) There is no substitute for a superior program manager and sufficient resources.

(b) Prompt, adequate staffing and support of the SPO both prior to, in preparation of the RFP, and subsequent to contract go-ahead are a must.

(c) The business strategy and resultant type of contract greatly influences the effectiveness of a program. The program manager should participate fully in deciding both. If contract requirements are at odds with the true goals of the program, an adversary situation is inevitably created between program manager and contractor.

(d) Government and industry tend to use highly involved reporting procedures requiring large numbers of people to cope with diffused management. What is needed is "more reliance on competent individuals and less enmeshment in bureaucratic procedures."

External Influences

(a) Over-optimism is the Program Manager's first defense against the hostile world of nay-sayers. Preparing his "Pearl Harbor" file is the second.

(b) The tremendous inertia of any organization as large as DoD makes any Program Manager's task difficult.

(c) Assumption of the Program Manager's authority by higher level is a poor solution. The F-111 is a prime example.

Based on the investigation and the conclusions reached, the following recommendations are offered:

(a) Military Program Managers should be given the authority in program management decisions commensurate with the responsibility placed upon them.

(b) The layers of management between the program manager and the source of authority should be reduced.

(c) The matrix approach organizationally and in quality, not numbers, of personnel should be strengthened. Caliber, rank, and experience of personnel should be determined by the requirements of the program.

(d) Management systems should be streamlined and external demands should be reduced to enable personnel to concentrate on the important problems.

(e) The military Program Manager should serve as an ad hoc member of the recently established Defense System Acquisition Review Council (DSARC) when his program is being reviewed.

(f) Service as a Military Program Manager should be important for career advancement.

(g) Serious consideration should be given to other alternative program management structures; i. e., vertical organizations.

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* See Management Systems Section of this Appendix

III. MANAGEMENT SYSTEMS

The area of management systems which are imposed by the Department of Defense on weapon systems contractors was reviewed to determine if the cost of management of major weapon systems was disproportionately high as compared with the total cost of the weapon systems themselves.

During the late fifties and early sixties, weapon systems development and acquisition was accomplished by detailed government project management of all contractor activities and was under a cost-plus contracting environment. Later in the sixties this contracting environment was changed from predominately cost-plus to a predominately fixed-price contracting. The emphasis on fixed-price contracts was to effect a large measure of economy in defense procurements by having defense contractors accept a larger share of the risk involved. The acceptance of this risk by defense contractors was made possible because the industry had developed during this time period an expertise in systems management. However, the management control requirements remained to be the detailed procedural constraints many of which may have been appropriate under cost-plus contracting and government control but which have proven to be incompatible with the concept of fixed-price contracting. Under fixed-price contracting the proper posture for the Defense Department is to state requirements of what needs to be done, not to dictate through detailed procedural documents how the individual contractors will manage their activities.

In exploring the history of development of management control systems, it was found that some military specifications and standards had always contained one or more paragraphs which set forth management control requirements. In the late fifties with the advent of the more sophisticated weapon systems and with the introduction of the overall management concept for development and acquisition known as systems management, a great deal of attention was given to the development of more sophisticated and detailed procedural aspects of the total spectrum of management control requirements. Examples of the subjects covered by these management control requirements are cost/schedule planning and control, systems engineering, configuration management, integrated logistics support, quality assurance, etc.

It was found that the current inventory of management control systems documents for multi-program application is approximately 700. It has been estimated that the number of documents currently in use which have been specifically tailored for a single program application is approximately 3,300. In addition, it has been estimated that 10,000 military specifications and standards contain paragraphs which specify management controls. The grand total of formally published documents within the Defense Department covering the contractually imposed management control requirements upon the defense industry today then totals 14,000.

With the introduction of the Project Definition Phase, which was subsequently re-defined as Contract Definition,* on all major weapon systems, an increasing amount of paper studies and contractor management plans were introduced to be used in source selection. The majority of these plans and most of the volume of paper created came directly from the contractual imposition of the management control system requirements. The Defense Department conducted studies to determine the appropriateness of the growing mass of paper work that was being required and has specifically found on the C5A that more paper had been required to be prepared by the Contract Definition contracts than could possibly have been used or was used in making the source selection decision.

It was found that many studies had been conducted in the past with the end objective of "paper work reduction" or "reports controls," and that none of these projects had been successful. However, there is a currently active project within the Defense Department which promises to be successful if given the proper attention because it is dealing with the root of the problem, not the paper symptom. This project is under the auspices of the Assistant Secretary of Defense (Comptroller) and the

* Department of Defense Directive 3200.9, "Project Definition Phase" dated 26 February 1964, superseded on 1 July 1965 and retitled, "Initiation of Engineering and Operational System Development."

execution of his responsibility as delineated in Department Directive 7000.1, "Resource Management Systems." The project is dealing specifically with bringing order to the vast proliferation of redundant and many times conflicting management control system requirements contractually imposed on the defense industry.

It was interesting to note that in early 1966 both industry and the Department of Defense had independently arrived at the same identification of the problem. From the industry prospective the problem was stated as a "great proliferation of management systems coming at us from many directions at an ever increasing rate. . . we find that many of them are divergent, conflicting, unintegrated, and inconsistently applied." * Within the Department the then Assistant Secretary of Defense (Comptroller) Robert Anthony was expressing the Department's concern with this problem.

In May 1966, top level industry representatives met with the then Deputy Secretary of Defense, Cyrus Vance, and discussed the problem. The industry representatives stated that "we believe this overall problem to be the most serious operational problem facing industry today." They further noted that even though a quantified estimate had not been developed, that it was believed that the waste and inefficiency associated with the multitude of paper studies, reports, management plans and related management requirements represents at least one out of every seven contracted dollars. The requirements are in the general area of management of contractor activities through contractually imposed management control systems. At that meeting it was agreed that this was a mutual problem and not an issues, and that major steps needed to be taken to eliminate the problem.

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* Two volume report on Government Management Systems prepared by the Aerospace Industries Association (AIA), dated May 1966.

The rough order of magnitude estimate (one out of every seven dollars) has been continually used since that meeting and there appears to be general agreement among both industry and Defense Department management that the estimate is realistic. In Fiscal Year 1969* this estimate represented 4.4 billion dollars of the Defense Budget.

In August 1966 the aforementioned Directive 7000.1 was issued assigning the specific responsibility to provide for the design and installation of resource management systems throughout the Department of Defense to the Assistant Secretary of Defense (Comptroller).

In October 1966 a meeting was held by the top level representatives of the Department of Defense, NASA and the defense industry (represented through the Council of Defense and Space Industries Associations - CODSIA). This resulted in the formation of a DOD-CODSIA Advisory Committee for Management Systems Control. This advisory committee undertook as one of its first tasks the development of an initial inventory of all management control system documents used by the Department. Subsequently, in a fifteen month effort involving thousands of man hours and tens of thousands of dollars, the Advisory Committee issued its ten volume final report.**

In Volume I, "Summary," of the Advisory Committee's final report, the chairman, George W. Bergquist, Deputy Assistant Secretary of Defense (Comptroller), stated: "The simple fact is that the operation of these systems costs money. If a contractor is required to organize, generate, collect and transmit varieties of data to numbers of defense project managers and contracting officers, it is inevitable that there will be instances where he

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* Estimate was derived by 14.3% (1/7) of $23,283 million for procurement and $7,747 million for research, development, test and evaluation.

** DOD-CODSIA Advisory Committee for Management Systems Control Final Report, Volumes I - IV and Appendices A - F, dated March 1968.

provides the same information, organized differently or printed differently, to two or more of these customers; or worse, differently defined information on the same subject; or still worse, data with the same labels but with different contents, aggregations or time frames. The reason for attacking this proliferation problem is not that it causes trouble or inconvenience, but primarily that it needlessly costs time and money. Proliferation can be costly because it involves not only paper and ink and postage, but more important -- organizations, procedures, accounting systems, computers and the efforts of people."

During the fifteen month effort of the Advisory Committee, draft Department Instructions for the control of development of management systems and the control of selection and application of those systems where developed. In addition, several need/use analysis groups, manned with Department of industry managers, examined hundreds of the existing management control system documents and offered specific recommendations for their cancellation, consolidation, or revision.

In January 1968, then Deputy Secretary of Defense, Paul H. Nitze, issued a policy memorandum to the Secretaries of the Military Departments, the Director of Defense Research and Engineering, the Assistant Secretaries of Defense and the Directors of Defense Agencies, on the subject of "Standards for DOD Management Control Systems Used in the Acquisition Process." The following is the contents of that memorandum:

> "One aspect of the implementation of DOD Directive 7000.1, 'Resource Management Systems of the Department of Defense,' has been the establishment of a directorate in the Office of the Assistant Secretary of Defense (Comptroller) which will have centralized control over all existing and proposed management control systems which may be applied on contract. It is expected that this action will lead both to a reduction of the reporting load imposed on industry and to cost savings for the Department of Defense.
>
> "The ASD (Comptroller) has been preparing instructions governing the development of management control systems and

their application on contract. He has also prepared a statement of 'Standards for DOD management control systems used in the acquisition process' which serves as a foundation for the control operation. These important pieces of policy guidance have been under review by your staffs and by the DOD/CODSIA Advisory Committee on Management Systems Control, and will soon be published officially.

"I believe that the following four basic principles extracted from the standards paper referred to above represent guidelines for systems management to which all managers should address their attention:

> "1. DOD management control systems should be structured to maximize compatibility with contractors' internal management and accounting systems.
>
> "2. Provision of the proper level of government management requires a balance of the exercise of prior approval, progress review (surveillance), and reliance upon reviewable contractor management (visibility).
>
> "3. Reporting requirements should be tailored to provide, from a common data base, the appropriate level of detail needed for each management echelon, based on a uniform work breakdown structure which permits summarization.
>
> "4. Existing and proposed management control systems must meet demonstrated needs not met by other systems.

"Your help and cooperation in implementing these objectives will be needed in order to achieve the goal of reversing management control systems proliferation as well as improving the effectiveness of existing management control systems."

To implement this policy statement, two Department Instructions (7000.6, "Development of Management Control Systems for Use in the Acquisition Process" and 7000.7, "Selection and Application of Management Control Systems for Use in the Acquisition Process") were issued in June 1968. These instructions established control procedures within the Department to effect the reversal of management control systems and the reduction of the reporting load imposed in industry, as well as to effect a substantial cost savings for the Department of Defense.

Unfortunately, no real progress has been made in implementing the two Instructions (7000.6 and 7000.7) and the potential cost savings has not been realized. Under the auspices of the DOD-CODSIA Advisory Committee for Management Systems Control, a number of review and analysis groups have this year developed specific recommendations for the revision, consolidation and/or cancellation of the thousands of existing management control system documents. However, no scheduled plan exists to implement these recommendations.

This project was reviewed with both the responsible Department and industry people involved and they believe that if this project were carried to its conclusion, a substantial amount of waste and inefficiency previously noted would be eliminated. However, it was found that this project had experienced substantial schedule delays (up to ten months). These delays stem directly from the loss of top level support within the Department that the project once enjoyed. In addition, it was noted that the Assistant Secretary of Defense (Comptroller) had, in a September 1969 reorganization, de-emphasized this activity by reducing it to a lower echelon (four levels below the Assistant Secretary) and that the many over-zealous supporters of the fragments of overall management requirements were fighting the planned implementation of the formally issued controls in order to protect their specialty areas. (These specialists may have rightly earned the name of "cultists.")

Akin to the problems identified here of contractual imposed management control system requirements, the same problems exist with respect

tointernal Department management information/control requirements. The documents in which the requirements are defined all stem from the Department's Directive/Guidance System and takes many forms in OSD, the Services and the Defense Agencies. Directive 7000.1, "Resource Management Systems," also assigned to the ASD (Comptroller) the central responsibility in the Department for management information/control requirements internal to the Department. As is true of the subject area of contractually imposed management control requirements, no real progress has been made to implement the 7000.1 direction.

The trend of the past decade toward excessive control by the Department of Defense of defense contractors, toward standardization of defense contractors' internal management techniques and toward a growing mass of unused paper work generated as a result of these highly structured controls and management techniques must be reversed. Proper emphasis and reliance must be made on the management ingenuity of American industry to enable the Department to stem the rising cost of weapon systems.

Today, with the continuing revisions to existing and introduction of new management control system documents, defense contractors are required to change (sometimes a total change) in operation for each project/contract. This should also be reversed by stabilizing Department of Defense management control system requirements and by having the defense contractors establish demonstrated modus operandi that would apply to all defense acquisitions. This would further enable the Department to stem the cost of weapon systems.

Further, the growing mass of unused paper work generated within the Department as a result of the management information/control requirements must be halted and more emphasis and reliance must be placed on the management of the Services and Defense Agencies.

Based on the above the following recommendations are offered:

(a) A top level Defense Department monitor and review group to be chaired by the Deputy Secretary to follow the current Management System Control project, which has as its objective the improvement and reduction of the current large inventory of documents used to define the management control requirements used in the Department's contracting interface with industry, throughout its successful conclusion, should be immediately implemented.

(b) Formal organizational recognition should be given to this important control function (the central responsibility for management information/control system) now assigned to a lower level within the office of the Assistant Secretary of Defense (Comptroller) by assigning it as a staff function to the Deputy Secretary of Defense.

(c) The further reduction to the basic management control system requirements needed and stabilization of those requirements to enable the Department components and industry to establish demonstrated modus operandi that would apply to all defense acquisitions should be established as a Department policy objective.