DoD-Contractor Relationship--

Preliminary Review

Task 69-21

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DOD-CONTRACTOR RELATIONSHIP--PRELIMINARY REVIEW

History and Purpose of the Task

For several years there have been periodic informal discussions between DoD procurement officials and LMI staff members on the DoD-contractor relationship--as it is reflected in policy and regulation, and as it is reflected in practice. Those discussions usually have focused on whether DoD policy adequately recognizes the mutual dependency which is essential between the DoD and its contractors in major acquisition programs. It was suggested that LMI, because of its experience in defense procurement studies and its independent position as a private organization outside both governmental structures and industrial attachments, was an appropriate group to pursue the subject in greater depth.

A short paper was prepared by LMI for use in weighing task possibilities with the Deputy Assistant Secretary of Defense (Procurement). That paper is attached to this report as Appendix A.

Subsequent discussions led to the conclusion that a study of the DoD-contractor relationship should be launched, but that a full-scale effort on that subject could not be outlined without additional investigation. More thought needed to be given to the issues to be addressed; and some testing of the possible research methods was considered appropriate.

The Acting Assistant Secretary of Defense (Installations and Logistics) issued a "Preliminary Review" task order to LMI on 14 March 1969. That task order is attached as Appendix B.

The background and objective of the preliminary review were stated in the task order as follows:

> The complexity of DoD programs, their cost, the criticality of timely completion, and the necessity for frequent contract change lead to a continuing dialogue and close working relationship between the DoD and its major system suppliers. The relationship is particularly close in those situations where facilities, skills, and experience unique to the national defense effort are involved, or when substantial technical guidance must be provided by the DoD. The size, length and importance of DoD programs rarely leave any opportunity for curtailment or for re-direction which would entail major delay. Mutual dependency between the DoD and its contractors is much greater than the buyer-seller inter-dependency in the vast majority of non-defense industries, and also much greater than that expressed by the textbook definition of a free enterprise relationship. There also is a carry-down effect on the contractor-subcontractor relationship.
>
> At the same time, the DoD lists competition and disengagement among its procurement policy objectives, employs profit incentives, and tries to preserve or simulate the classic buyer-seller relationship of a free enterprise system.
>
> In short, there is a dichotomy between operating practice, which recognizes mutual dependency and a need for Government control, and procurement policy, which resists impairment of a free market relationship. Policies imply certain roles for the DoD and its contractors; different roles are manifested in practice. This task is to gain insight into the extent to which that dichotomy constitutes a significant problem in the DoD industry relationship.

The "Scope of Work" called for a review of current and completed studies relating to the subject and limited consultation with knowledgeable individuals.

In summary, the task order was a request for LMI to probe into the DoD-contractor relationship on major acquisition programs to locate any important problems which are not being given adequate attention and to identify any promising ideas or approaches to solution which are being neglected. There was an understanding

between the DoD and LMI that, if any such problems, ideas, or approaches were discovered in the preliminary review, advice on how to fill the void would be offered in the concluding report.

This document is the report that completes the preliminary review. It does not present all the work performed during Task 69-21, but simply the findings produced and the recommended focus of future investigation. It does not address the DoD-contractor relationship in all its forms, but only on major DoD programs, where the dichotomy described in the task order exists.

Task Execution

Prior to final synthesis of findings, determination of what recommendation should be made, and drafting of the report, there were two main types of activity on the task. One was a literature review; the other was a series of visits with private firms. The intent of the literature review was to highlight the key problems relating to the DoD-contractor relationship, to trace their origins, and to learn what was being done about them. The object of the visits was to generate ideas for beneficial change in the DoD-contractor relationship by drawing analogies between that relationship and commercial buyer-seller relationships.

The literature review was separated into two parts: history of the DoD-contractor relationship in weapon systems acquisition; and commentary on current DoD problems in such acquisition. The review of history was accomplished primarily by using books, reports, articles, and speeches prepared by DoD organizations, DoD officials or ex-officials, and organizations or individuals under contract with the DoD. The review of comment on current problems used some of the same material, plus a wide variety of reports and articles issued by the academic community, defense industry, and the public press. A bibliography, part of which

is annotated, is attached as Appendix C.

Visits were limited to seven organizations because the task order placed more emphasis on review of studies than on consultation with individuals. Since the intent of the visits was to generate new ideas for defense business, the plan was to discuss other kinds of business. It was essential, however, that the business discussed allow comparisons with defense business. An attempt, therefore, was made to find firms with non-government purchases of large dollar value and long duration, and requiring large investment on the part of the producer. It was preferred that some of the purchases be non-competitive and amount to the majority of the producer's business in some product lines. There also was a desire that some of the items bought represent substantial technological advance and require both technical input by the buyer and numerous changes in the specifications and contract terms.

It was extremely difficult to find organizations which met all of the preferred conditions--especially if those organizations also were to cover several different industries. Therefore not all organizations visited satisfied all conditions, but each condition was met by at least several of the firms.

One visit was used to discuss the Government-industry relationship in aircraft development and production with a member of a foreign research team which had investigated that problem.

The list of seven organizations visited is attached as Appendix D.

In keeping with the preliminary and exploratory nature of the task, the discussions with the six domestic firms were informal and unstructured. It developed, however, that most of the same issues were addressed at the various meetings; e.g., use of

competition, conduct of "should cost" studies, monitoring of suppliers' operations, use of differ types of contract, special procedures in the event of heavy reliance on a given contractor or heavy reliance of the supplier on the purchaser, revision of contracts, recommendations made to (or conditions levied upon) suppliers, and reports required. A representative list of topics discussed is presented in Appendix E.

Findings from the Literature Review

History

A summary of the evolution of the DoD-contractor relationship in weapon systems acquisition was a product of the task.[1] It is attached as Appendix F. Review of history made at least three points abundantly clear.

First, management of weapon systems acquisition is increasingly difficult as technology advances. Technological progress leads to systems which are costlier and more complex and take longer to develop and produce. All of those factors complicate management of acquisition of the systems.

Gradually less and less of the scientific basis, engineering design, production process, and operational characteristics can be understood by one individual. More and more highly specialized people, firms, and facilities must be coordinated. Furthermore, as weapon systems grow to be more significant individual items in the DoD budget, they attract more public attention. Direct participation in the public debate over program need, level, and achievement is added to managers' responsibilities.

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[1] That summary served a dual purpose, being a part of LMI Task 70-4, Preparation of Briefings for the Defense Blue Ribbon Panel, as well as of Task 69-21.

A second point made clear by history is that new management approaches and techniques continually are generated. Mere enumeration suffices to establish this point: project management, systems analysis, the planning-programming-budgeting system, concept formulation, contract definition, value engineering, the weighted guidelines, contractor weighted average share in cost risk, life cycle costing, multiple incentive contracting, component breakout, two-step formal advertising, integrated logistic support, total package procurement, development concept papers, draft presidential memoranda, cost information reports, work breakdown structures, selected acquisition reports, cost/schedule control system criteria, and uniform cost accounting standards. While the mechanics of new approaches and techniques do not conflict, it is highly questionable whether the underlying theories are compatible. Some approaches, for example, emphasize contractor freedom and motivation by reward, while others are directed at increased DoD monitoring of contractor operations.

A third point is that the DoD-contractor relationship has been marked by vacillation and confusion over the years. The DoD has reversed itself from time to time on such matters as type of contract and type of competition to be used. Witness the pronounced swings over decades from fixed-price contracting to CPFF to incentives to fixed-price and again to cost-reimbursement contracting. Or note the vacillation between paper design competition, prototype competition, then paper design competition again; and now competitive hardware development--with or without full system prototypes--is becoming popular. The DoD has tried in some ways to establish an arm's length buyer-seller relationship with contractors, when it has simultaneously increased on-site review and approval of internal company procedures. It uses the words "buyer," "seller," "price," "competition," "investment," and "profit" in ways that have different meaning from commercial

business usage. It has attempted to simulate free market forces in its procurement policy, while at the same time instituting a rigid, centrally monitored approach to research and development management that is the antithesis of the uncoordinated, highly duplicative approach of non-defense business.

Analogies are drawn to the free market, but outstanding differences are recognized. Conduct of weapon systems business directly by the Government or as a public utility is rejected even though it is well known that the Government must provide a substantial part of the capital and that it dictates what research and development efforts are to be undertaken. The vastness and complexity of weapon systems and the extent to which they are pressing the frontiers of knowledge are recognized, yet cost and schedule growth is expected to be less than that experienced in commercial construction.

The DoD operates under a law and a regulation which espouse formal advertising as the preferred method of procurement, yet the great bulk of procurements are negotiated. The latter method is employed in spite of attempts by some to persuade the public that formal advertising is the embodiment of virtue and negotiation is sinister and evil.

Posing a few questions may help demonstrate the lack of clear understanding of the DoD-contractor relationship:

- Can the Government extend to a major contractor, working on a critical weapon system, the free enterprise privilege of going bankrupt?
- Can the nation afford the cost in resources of unbridled competition for its major systems programs?
- Are there too many suppliers for the few

programs and, if so, does the Government have the obligation or right to ration its contract awards to maintain a broad industrial base or to achieve socio-economic objectives?

- Can the Government substantially shift risk from itself to the contractor?
- Should the Government increase or decrease its involvement in contract management which in all other situations, including public utilities, has been the prerogative of company management?
- Is the objective of disengagement feasible or is government control inevitable where national security is at stake?
- If disengagement is not feasible, would open acknowledgment of that fact help bring about a more workable DoD-contractor relationship?

Current Commentary

There has been no dearth of criticism of the DoD-contractor relationship in the past few years. It has come from those involved in the relationship and those outside it. It has been based on profound and superficial knowledge alike. No summary of the length that can be afforded here can do justice to the hundreds of thousands of pages of commentary that have been written. However, some of the observations and allegations most frequently made will be summarized in four points. (The points are selected only for their prominence in current discussion and do not represent LMI positions.)

First is the observation that the weapon systems acquisition process apparently is out of control. Initial time and

cost estimates--and even updated estimates--cannot be depended upon. Mandatory engineering changes arise continually throughout the process. Management information and control systems do not identify impending problems in time for preventive action to be taken.

A second point is the claim that bargaining positions are unbalanced. First one side, then the other has the advantage. The theory of countervailing pressures acting to produce fair and realistic contract terms does not hold. With emphasis on economies of scale and series production there are only a small number of weapon systems competitions each year and prospective contractors believe that their very existence may be jeopardized by failure to win. Hence the DoD is in the dominant position and can compel an unreasonable bargain. Following award of the contract the DoD, committed to the timely success of the program, is in the weaker position as the sole source contractor negotiates for contract changes, product acceptance, and follow-on business.

A third point made about the DoD-contractor relationship is that inducements both for efficient operation and for candor about expectations are lacking. Heavy reliance on historical costs in pricing, lack of adequate consideration of capital required in negotiating profit rates, and the high risk of low future utilization of contractor-owned facilities impedes investment and modernization of plant. The hazard to program survival of high cost, long duration, or looming technical difficulties, as each program competes with others in and out of the DoD, motivates extreme optimism by DoD and contractor personnel alike.

Fourth are allegations of confusion, connivance, and deception by the DoD-contractor combination. Close cooperation and common interest are held in contrast to the arm's length

relationship preferred by much of regulation and policy. Policy notwithstanding, the military departments receive advice and assistance from prospective contractors in preparation of requests for proposals. Contractors receive aid from government personnel in performance of contracts. Contracts fail as instruments of control.

Changes Being Undertaken

Numerous studies are underway which may lead to change in the DoD-contractor relationship. Many are related to cost estimating early in weapon systems development. Some of the studies are aimed at providing a more complete base of information upon which to construct estimates; but most of them are directed at improved mathematical and statistical estimating techniques.

Other studies have the goal of providing the Government increased and more useful visibility of contractor operations, both before and after contract award. Such efforts include "should cost" methods based largely on industrial and production engineering, information systems such as cost/schedule control system criteria, and establishment of uniform cost accounting standards.

Among additional studies that could affect the DoD-contractor relationship are ones examining acceptance of a role for contractors in preparation of requests for proposals, looking into the feasibility of contract change for unanticipated research and development voids as they are discovered, and establishing procedures to give both DoD and contractor logistic support personnel more voice in early planning for weapon systems.

Of greater interest than the studies which are likely to have influence on the DoD-contractor relationship are the changes which already are having such influence. The management emphases of one period generally grow out of the problems of the

preceding period. And so it is at the present time, as a new round of DoD management changes seems to be starting in response to difficulties recently experienced.

One change is greater flexibility in choice of contract type for weapon system development. Total package procurement and fixed-price development contracting are now regarded as appropriate only when stringent conditions of program definition and demonstrated technology are satisfied. Cost-reimbursement contracting once again is recognized as having a role in engineering development. In short, there is increased acceptance of the notion that the contract type is dictated by the specific situation, not by overall rules.

Another change is stronger project management. Ways are being sought to increase the authority of project managers, and steps already have been taken to reduce the number of links in the chain through which they get review and approval. The resolution of DoD-contractor problems on major programs should be facilitated by this change.

Hand-in-hand with stronger project management is an emphasis on decentralization. The Office of the Secretary of Defense is attempting to give more autonomy to the military departments in management of weapon systems acquisition, and to restrict its own role to review at specific points (milestones) in programs and when established thresholds of cost, schedule, or performance have been reached.

The largest change, however, which appears about to take place in weapon system acquisition is a partial return to the use of prototype competition, or parallel development, as it sometimes is called. Experience has shown that differences among competing paper designs often are not significant when compared with design changes which occur during full-scale development. Experience

also has shown that many critical unknowns usually are not identified and removed during paper design exercises. Therefore neither sound technical evaluations nor sound prices can be expected from paper design competition. Parallel development appears to remedy those two problems and to provide added inducement for creativity during full-scale development. In addition, it may provide more flexibility in the event of a change in threat as well as the ability to "back away from trouble," as alternate design approaches are sustained longer.

Some of the most avid proponents of parallel development have cited as an advantage that documentation and DoD review during engineering development could be reduced substantially, because contract awards for follow-on work could be based primarily on prototype demonstration. A few have gone so far as to propose "parallel undocumented development." Whether or not increased use of prototype competition is accompanied by decreased documentation and DoD monitoring remains to be seen.

Findings from Visits

One visit--the one held with a researcher from the Institute for Strategic Studies--differed widely from the rest. For one thing, it did not involve an organization whose business was research, development, production, or marketing of hardware. More fundamental, its purpose was different. It was not conducted to seek ideas that might be applied to the DoD-contractor relationship, but to see whether foreign governments had problems similar to those of the United States, and whether their research, experimentation, and adopted approaches warranted scrutiny in a full-scale study.

The Plowden Report[1] on the British aircraft industry was

[1]See reference in Appendix C, page C-17.

discussed. Special attention was given to the reasons for concluding that the public interest called for a large government share in ownership.

It was concluded that some attention to government-industry relationships in foreign nations should be a part of any future study. It should provide insights additional to those otherwise obtainable, and should aid in the difficult task of transcending existing organizational, regulatory, and procedural frameworks in the search for new ideas and concepts. Expected benefit from investigation of the experience, thinking, and practice of other nations, however, does not in itself justify future study of the DoD-contractor relationship.

Differences between DoD and industry practice in dealing with suppliers, as perceived in the six visits to companies, constitute the main reason that continued study of the DoD-contractor relationship is being recommended. This is not to say, however, that comparison of defense and commercial business was straightforward.

Many attempted analogies between defense and commercial business did not stand up. In such areas as technological advance sought, total investment required, and engineering changes made, few commercial programs fit into the same category as the large defense programs. Restrictions on supplier selection methods are much less in non-government business.

Despite those impediments in utilizing commercial business experience, and despite the subsequent judgment that some appropriate types of organizations were overlooked, the visits produced findings which are considered useful in generating ideas for beneficial change in the DoD-contractor relationship:

a) The private sector is extremely flexible with respect to the relationship between a firm (manufacturer or

merchandiser) and a supplier of that firm. The relationship often is tailored to the product, the producer, personal preferences and peculiarities, history of the relationship, and market exigencies of the moment. The flexibility extends to proceeding temporarily without a formal agreement and deferring specifics on certain parts of the agreement for many months. Motivation for trust and reasonable settlement of issues without recourse to litigation results from the advantage to both parties of a long-term harmonious relationship. The possibility of being dropped from consideration for future business prevents a supplier from pressing his advantage too strongly. The chance of losing a proven good supplier causes a buyer to refrain from taking undue advantage of temporary bargaining power. A high implicit cost is placed on changing suppliers.

b) Except for very simple items, open competition is not employed. Competitors are selected or qualified and agreements are negotiated.

c) Contract award criteria are held to be the private business of the buyer. There usually are general guidelines, but no rigid rules except for financial justification of capital purchases. Often the rationale for choice of key suppliers is known only to executive management and the purchasing director.

d) Use of past experience in dealing with a supplier generally is given heavy weight in award of a contract. Past experience, in this sense, covers ease of managing the relationship as well as technical performance of the product or quality of the work. Some companies are put on favored lists; others are barred from future awards.

e) It is considered essential that the purchasing staff are knowledgeable about the products and processes of key

suppliers or have such knowledge readily at hand. Satisfying that condition sometimes is an easy matter because the purchasing firm has similar operations to those of its suppliers and therefore has the required expertise. In some cases the purchasing firm produces internally some of the same items it obtains from suppliers; in fact, it is not rare for a large manufacturer to set up a production capability to enhance his ability to deal with suppliers. In other cases, as with merchandising companies, the needed technical know-how is not automatically available and the development of purchasing specialists includes thorough schooling in the business of the suppliers who must be dealt with. In general much greater emphasis is placed on technical and market knowledge in commercial purchasing than in defense procurement. Commercial companies draw to a much greater extent on varied backgrounds (e.g., engineering, production, sales) than does the Government.

f) The processes, management structure, financial condition, and reputation of a potential new supplier of a key item are carefully examined before that supplier is approved as a candidate for a share of the business. The reviews conducted relate the operations and practices of the prospective supplier to those of others in the same industry. Recommendations for improvement are made, and often are a condition for qualification as a supplier. The reviews and advice are not routinely continued once the firm becomes a supplier, but there is no hesitation on the part of the purchaser to move in with a review team if quality or timely delivery is in jeopardy or if such service is called for by the supplier (which situation evidently is not rare). Chronic demand for assistance from the purchaser, however, can lead to discontinuance of the relationship.

g) Purchasers recognize the potential peril to them

if key suppliers develop serious problems. They protect against such problems by maintaining two or more sources of supply which are unlikely to be affected by the same calamity (e.g., strike, flood, financial failure). They follow the financial condition and market success of suppliers carefully. If multiple sources of supply are not needed to achieve sound price agreements, if a sole source supplier is in sound financial condition, and if additional sources are not a means for avoiding possible problems (e.g., if a strike that would affect one supplier would affect all his competitors), then the purchasing company does not have any reluctance about the sole source arrangement. There is aversion, though, to relationships which account for the bulk of the supplier's business in the given product line. It is believed that motivation for efficiency and innovation is likely to be lacking in such cases.

h) Research and development by suppliers on their products is very rarely paid for by their customers as a distinct service. Research and development for the purchaser's end item rarely is performed by outside organizations. Suppliers usually are not asked to expand the state-of-the-art when purchase agreements are made. Research and development activities of suppliers are evaluated, however, and made a factor in award of future business. Suppliers sometimes are dropped for failure to devote adequate attention to generation and testing of new concepts for both their products and their processes.

i) When substantial research and development work by a supplier is closely interrelated with research, development, and production planning of the purchaser, however, the situation is different. Personnel of the companies work together, almost as a single team, and the contractual agreement generally is merely a statement of purpose and tentative ceiling cost. Typically a

letter contract is used for an extended period. (In one case observed a letter contract covered two and one-half years of technical effort involving hundreds of engineers.)

j) Quality tests usually are specified by purchasing companies but few other controls or information requirements are levied on suppliers except in huge undertakings such as major aircraft subcontracts. Even then information requirements are much less than in DoD programs. In commercial projects there is much more reliance on direct personal review of activities--engineers reviewing the work of engineers, financial analysts checking costing procedures, etc.

k) Fixed-price contracts almost always are used. Infrequently there are incentive arrangements for cost reduction. No evidence has been found of contractual arrangements to share cost overruns, although contract work statements and prices on large efforts frequently are revised for unforeseen technical difficulties. Progress payments are made on large projects but are much less (as a fraction of total price) than DoD progress payments.

Recommendation

The many findings which were produced by the visits suggest numerous types of future study and experimentation on the DoD-contractor relationship. Any research effort built on them collectively would be so diffusive that likelihood of a useful product would be low. Therefore the last activity of the DoD-contractor preliminary review task was a selection among possible areas of future work.

A recommendation for study resulted from three observations:

a) The currently most troublesome problems to the DoD relate to the period from system development plan

(SDP) preparation through completion of engineering development.

b) The closest non-defense business analogies that have been drawn to engineering development on DoD programs reflect views of the buyer-seller relationship that are fundamentally different from the one specified in DoD directives and instructions.

c) Current attempts to eliminate the key difficulties experienced in DoD engineering development are not addressing the possibility that the whole current approach to conduct of engineering development may be unsound.

The recommendation is: Effort should be undertaken to formulate and evaluate alternatives to (not merely modifications of) the approach outlined in DoD Directive 3200.9, "Initiation of Engineering and Operational Systems Development."

It is desirable to investigate arrangements which give greater recognition to the way in which DoD and contractor efforts are inextricably tied together during engineering development, and to the necessary role of contractor expertise in the SDP effort preceding engineering development. It is desirable to face directly the extent to which credible cost and schedule estimates are possible (technically or politically) before engineering development, as well as the extent to which it is realistic to assess whether required technology is in hand at that stage of development. Further, it is desirable to question whether the transfer of risk and responsibility from Government to contractor, and hence the motivation, that is implied by the existing approach to engineering development is meaningful.

Certainly the effort proposed is speculative. A product which merits implementation cannot be assured. More direct

involvement of the Government in development of major systems would not be achieved without cost--direct cost of government activity plus indirect costs such as reduced contractor accountability for failure to achieve goals. But there also is a good chance of substantial benefits in such areas as early problem identification and resolution, work statement interpretation, required documentation and review, and competitive evaluation. Such gains would have an indirect but pervasive impact on cost and performance of major defense systems. It is the position of LMI that the potential outcome--overall net improvement in cost and in satisfaction of program objectives--easily justifies the expense and risk of the effort.

The study which is recommended, then, is based on the possibility (a) that existing regulation and directives preclude the kind of DoD-contractor relationship necessary for substantial improvement in weapon systems acquisition and (b) that the price the nation is paying for unrealistic policy may be greater than the price of more direct DoD involvement.

We advise that the search for ideas that has been started under Task 69-21 be continued, with special emphasis on concepts and experience that might be related to the period from SDP preparation through award of contracts for initial production.

Extension of the historical review is not considered necessary, but need for concentrated study of a few elements of past experience may arise. Maintaining currency with related current studies, and perhaps coordination with some study groups, is important to the suggested effort.

Private industry is regarded as a fruitful source of ideas that has not been adequately tapped. Visits should be continued. In addition to the types of companies with which dialogue already has been started, firms procuring specially made equipment in

order to market a service should be visited. Such firms might include, for example, transportation service companies--land, sea, and air.

New concepts also might be inspired by visits within the public sector, including agencies that perform a production function as well as some which purchase equipment to provide services. Comsat, TVA, AEC, the Port Authority of New York, and various large municipal governments are possibilities.

In the non-United States public sector, ideas might be generated by looking into the experience and practices of technologically advanced nations which have industry capable of supporting, in major part, large standing military forces.

Hand-in-hand and of equal importance with idea generation is analysis. Construction and challenge of possible DoD-contractor relationships should constitute a major part of the activity. Pros and cons of all hypothesized arrangements should be identified and weighed. Possible contracting approaches and proposal evaluation schemes should be addressed. Cost should be considered, both in the narrow sense of total dollar expense and in the broad sense of resources--especially scarce resources--consumed. Organizational and personnel requirements should be considered. Risks created should be pitted against risks eliminated.

Such a task necessarily will be long--perhaps one and one-half years. It should be anticipated, however, that findings or concepts will be generated throughout its execution which are of interest to DoD procurement policymakers and to people performing other procurement studies. Therefore the task products should include unscheduled intermediate "think pieces" as well as the final report and any attendant briefings.

10 September 1968

APPENDIX A

DEPARTMENT OF DEFENSE - DEFENSE INDUSTRY RELATIONSHIP

The period since World War II has witnessed a substantial change in the relationship between DoD and that segment of the private economic sector called "defense industry." These changes have been caused primarily by the great technological innovations in weapons and methods of waging war. The relationship, in many respects, has become more intimate. And here we come face to face with the dilemma which disturbs and confuses many who adopt the simplistic view of complete separation of the public and private sectors, with free enterprise arrayed on one side and the DoD on the other side. The fact is that, in the development and production of major weapon systems, a substantial portion of the defense industry does not operate as free enterprise in its prime contractual relationship with the Department of Defense.[1] Because the Government, in its role as buyer, and industry, in its role as seller, do not interact in a free and open market, it is considered by some that the relationship is counter to the principles of free enterprise and thus is inherently bad and unethical. Perhaps this attitude has resulted in a concerted effort to cling to features of a free enterprise relationship, even when those features may not be suitable in development and production of modern weapon systems.

If we accept as fact that the relationship between the DoD and industry finds its greatest intimacy through the procurement function, then it is convenient and useful to focus on the

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[1] See Notes to Appendix A, page A-5

contractual relationship. It is at that interface that a unique relationship has evolved which does not conform to the classic principles of free enterprise. On the contrary, spokesmen for both government and industry have fallen into the habit of characterizing the relationship as a partnership.[2]

If it is true that, in a sense, a partnership or principal and agency relationship has evolved which compromises the principles of free enterprise, it would seem desirable to examine the causes and to evaluate the effects. It is not the purpose of this paper to do either in depth. A brief discussion of cause and effect may, however, contribute to a definition of the problem.

Current and foreseeable force structures demand weapons of great complexity. Such weapons are exceedingly costly but limited in variety and numbers. There is a lively and effective competition in the conceptual and development phases of weapon systems. As systems progress from the conceptual phase through development and prototype production to full production, there are a diminishing number of competitors and at some stage a single source is selected, creating a sole-source situation. Henceforth, the only residual competition is competition in which that particular weapon system competes with other systems for accomplishing the same military mission. Indeed, even that mission competes with others for pricrity and its proportionate share of a limited budget.

It is also interesting to observe that while the Government creates the competitive alternatives and ultimately chooses one as the appropriate system to achieve a selected mission, by its very act of selecting the Government usually commits itself to

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[2]See Notes to Appendix A, page A-5

making the system work. Frequently this involves greater cost than originally anticipated. In such circumstances it is apparent that the Government retains a major portion of the risk regardless of its desires and efforts to transfer risks of performance and costs to the contractor involved. This is not to say, of course, that contractors are free of all such risk.

The risk involved in undertaking the development and production of a weapon system is not solely that of performance and cost. There is also great risk relating to the constancy of the mission, the effectiveness of the weapon, and the dynamics of potential military threats.[3]

Hence the DoD is burdened with risks, responsibilities, and commitments which, by their nature, are non-transferable. So while it is expected to deal with its contractors as a buyer in a free enterprise system, it must often advise, guide, monitor, and regulate those same contractors. Those two roles constitute a dichotomy and make the establishment of appropriate procurement policy an exceedingly difficult undertaking.

In practice, the DoD-contractor relationship manifests itself not only in the formal channels and instruments established by statutes, regulations, and contracts, but also through informal channels which have arisen to provide adequate and timely dialogue and operational flexibility. It would not seem likely for an informal system of communication and control to develop if the formal one were capable of serving its full purpose. Hence it is logical to question whether the formal system is well suited to the true nature of the required DoD-contractor relationship and whether the informal system does not result in unnecessary cost and time or impede technological advance.[4]

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[3] and [4] See Notes to Appendix A, page A-5

In short, we believe it is advisable for the DoD to examine whether it has adopted policy which does not adequately recognize the mutual dependency which is essential between itself and its contractors in major procurement programs.

NOTES TO APPENDIX A

1. The Weapons Acquisition Process: Economic Incentives, Frederic M. Scherer, Division of Research, Graduate School of Business Administration, Harvard University, Boston, 1964.

> "Private enterprise, in the strict sense, has not been employed for at least two decades to develop and produce advanced weapon systems, nor is it likely that true private enterprise is possible at all in the non-market environment of weapon acquisition. A substantial degree of government intervention--socialistic, if you like--is inescapable."

(In contrast with the few but very significant weapon systems procurements, the great majority of DoD procurement actions take place in a free and open market where competition abounds. In these circumstances, DoD is much like a private enterprise in its role as a contracting party. Even here, however, the Government's sovereign responsibility sometimes is evident, as exemplified by small business set-asides and contractual requirements regarding overtime, shift premiums, and non-discrimination in employment.)

2. Dr. Rubin F. Mettler, President, TRW Space Technology Laboratories, before the Advanced Planning Briefings for Industry, Los Angeles, California, March 3, 1965.

> "We have developed . . . a marvelously flexible and extremely powerful partnership between industry and Government in the field of national security."

Gen. Thomas P. Gerrity, Commander, AFLC, before the Dayton Chapter, National Security Industrial Association, January 25, 1968.

> "If anybody thinks that we are less than a partnership . . . they are fundamentally wrong."

(It is assumed that the word "partnership" is not used by these spokesmen to mean a legal partnership but rather a practical, working relationship.)

3. Mr. Thomas V. Jones, President and Chairman, Northrop Corporation, before the DoD-NASA Advanced Planning Briefings for Industry, Los Angeles, California, March 3, 1965.

> "We know that in making plans for the support of national objectives, Government must have available to it a wide range of choices, a wide variety of means for carrying out their programs. We realize that they must further have the freedom to shift readily from one alternative approach to another, as the situation changes, as the strategic and tactical requirements change. We understand that the process by which the Government arrives at a selection from its menu of choices is a complex one--an iterative process, in which a certain approach is formulated or developed and then measured or evaluated repeatedly against a series of the possible consequences that could flow from its use. We agree that, having arrived at a satisfactory set of alternatives, the Government must be free to proceed with one or more of them and to alter or abandon any that seem inappropriate or unrealistic. We want the Government to have that freedom."

4. In The Industry-Government Aerospace Relationship, Vol. I, 1963, Stanford Research Institute identified as major problems present in the Government-industry relationship the following:

> "1. Industry's growing concern that its technical performance, costs, income, and reputation are being affected adversely by
>
> over-regulation,
> conflicting regulations,
> ineffective administration of regulations,
> surveillance of its activities, and
> burdening of the procurement process with
> socio-economic objectives.
>
> "2. The attitude of many government officials, based on past experience, that without close supervision or risk-carrying incentives, industry cannot always be depended upon to fulfill its contractual obligations on time or at reasonable cost.

"3. The general belief of industry's executives that the Government's often inconsistent, loosely specified, but increasingly stringent attitude concerning allowable costs is detrimental to the industry's well-being.

"4. Disagreement between industry and government over the profit rate that constitutes an adequate return. This disagreement stems largely from varying opinions concerning the extent of risks to be borne by the industry and industry's cost in maintaining an advancing technical capability.

"5. The absence of a "free-market" environment in which industry and government do business, which requires special attention to the balancing of capacity with requirements. The means to accomplish this desirable objective have yet to be worked out."

APPENDIX B

ASSISTANT SECRETARY OF DEFENSE
Washington, D. C.

Installations and Logistics DATE: 14 March 1969

TASK ORDER SD-271-113
(Task 69-21)

1. Pursuant to Articles I and III of the Department of Defense Contract No. SD-271 with the Logistics Management Institute, the Institute is requested to undertake the following task:

A. TITLE: DoD-Contractor Relationship--Preliminary Review

B. BACKGROUND: The complexity of DoD programs, their cost, the criticality of timely completion, and the necessity for frequent contract change lead to a continuing dialogue and close working relationship between the DoD and its major system suppliers. The relationship is particularly close in those situations where facilities, skills, and experience unique to the national defense effort are involved, or when substantial technical guidance must be provided by the DoD. The size, length and importance of DoD programs rarely leave any opportunity for curtailment or for re-direction which would entail major delay. Mutual dependency between the DoD and its contractors is much greater than the buyer-seller inter-dependency in the vast majority of non-defense industries, and also much greater than that expressed by the textbook definition of a free enterprise relationship. There also is a carry-down effect on the contractor-subcontractor relationship.

At the same time, the DoD lists competition and disengagement among its procurement policy objectives, employs profit incentives, and tries to preserve or simulate the classic buyer-seller relationship of a free enterprise system.

In short, there is a dichotomy between operating practice, which recognizes mutual dependency and a need for government control, and procurement policy, which resists impairment of a free market relationship. Policies imply certain roles for the DoD and its contractors; different roles are manifested in practice. This task is to gain insight into the extent

to which that dichotomy constitutes a significant problem in the DoD-industry relationship.

C. SCOPE OF WORK: Conduct an investigation through a review of current and completed studies by people in the Government, industry and the academic community. The effort will include, where necessary, limited consultation with knowledgeable individuals engaged in major weapons systems planning and acquisition.

2. SCHEDULE: A memorandum report will be issued by 30 September 1969.*

GLENN V. GIBSON
Acting Assistant Secretary of Defense
(Installations and Logistics)

ACCEPTED_____

DATE_____

*As a result of an unavoidable delay in commencement of task effort and subsequent interruption for work for the Defense Blue Ribbon Panel, the report date was revised to 31 March 1970.

APPENDIX C

BIBLIOGRAPHY

ANNOTATED

AIA Aerospace Technical Council,
Essential Technical Steps and Related Uncertainties in DoD Weapon Systems Development, October 1969

In earlier phases of this study, conducted by the ATC's Weapon System Development Group, the problem was stated as one of too early commitment of resources by both industry and government and fixing of performance, schedule, and cost of a program without the requisite technical information and without regard for the residual uncertainties in the program. The group recommended that the DoD try to solve the problem through more appropriate use of contract types; i.e., through use of CPFF or CPIF contracts during the development stages of a program. The final phase of the study results in an expansion of that recommendation into the following:

(1) Establish guidelines for more flexibility in tailoring a program to its degree of certainty.

(2) Allow greater industry input into the drafting of the RFP that precedes Contract Definition.

(3) Consider the use of prototype competition.

(4) Formalize risk assessment procedures and criteria and implement them.

(5) Change procurement practices and the acquisition process to provide incentives for the early identification of uncertainties, rather than for the reverse.

Possibly the most significant contribution of this AIA report is the detailing of the essential technical steps in the development of a weapon system and the relating of those steps to the DoD structure of concept formulation, contract definition, and full-scale development. This conceptual model can serve for the development of any very complex system regardless of the relationship of the many participants in the process.

The report serves to illustrate that the intractability of the development process results in part from the multiple roles of the participants and the conflicts such multiplicity implies. It also illustrates that any attempt to fragment the development process temporally, functionally, or operationally results in arbitrary distinctions which provide analytical convenience at the expense of rigor. All functions are conducted in parallel; only emphasis changes with time. Development is not complete until hardware produced with production tooling is verified under field conditions. Production tooling and planning are impossible if they are not initiated early enough to feed back their requirements into the development process.

Baumol, W. J.
"On the Social Rate of Discount," American Economic Review, LVIII, September 1968, and "Comments," American Economic Review, LIX, December 1969, pages 909-930

Professor Baumol shows that the corporate income tax creates a divergence between the subjective time preference rate (controlling savings) equivalent to the initial government borrowing rate, and the marginal rate of return on private investment. Equating the marginal rate of return to opportunity cost of capital, at least for resources derived from the corporate sector, should provide an approximation of the optimum social discount rate for independent and non-substitutable investments by government. However, in the case where public and private outputs are

substitutes, where the question is not what should be produced but who should provide (the investment for) the production, the optimum social discount rate would revert to that prevailing before the "distortions" caused by the tax. Clearly the latter instance is relevant to an understanding of the government-industry relationship, providing, as it does, a theoretical base for the analysis of a preferred ratio of private and public "equity" in defense production. It might even be extended to an objective analysis of the role and function of a quasi-public non-profit, or at least non-taxed, series of defense-oriented research and development organizations that could provide the separation of development and production expounded as a possible solution to some of the ills of the government-industry relationship.

Bickner, Robert E.
The Changing Relationship Between the Air Force and the Aerospace Industry
The RAND Corporation, RM-4101-PR, July 1964

"This memorandum is an effort to identify the recent trends which are fundamentally altering the nature of the Air Force-aerospace industry relationship; to indicate basic dilemmas which are the roots of current difficulties in the relationship; and to suggest alternatives available for maintaining the efficiency of the relationship."

The report is in four sections. The first two give an historical perspective to the relationship at that time (1964) military and technological environment that had produced strains in the "Air Force-aerospace industry partnership" that threatened its effectiveness in providing for the national defense.

The third section of the report lists the dimensions of the dilemmas: competition or monopoly; free enterprise or government

enterprise; cost reduction or profit squeeze; production efficiency or development efficiency; and centralization or decentralization.

The final section suggests solutions to the dilemma, the elements of which include:

(1) Better cost estimating through increased emphasis and improved procedures.

(2) More emphasis on production profit incentives.

(3) Use of profit incentives solely on production contracts.

(4) Extended competition throughout the development program.

(5) A naive approach to the problem of management evaluation for the sake of gaining more management freedom.

(6) An extension of the application, in rudimentary form, of systems analysis and the price system.

Brunner, G. L. and Hall, G. R.
Air Force Procurement Practices 1964-1966
The RAND Corporation, RM-5439-PR, April 1968

The authors summarize their report as a "descriptive analysis of Air Force procurement practices" during the years 1964 through 1966. As such it is long on description and short on analysis. It provides an extensive tabulation of Air Force procurements categorized by type of product or service, and by type of contract used in the procurement. Thus it is a ready-made, if incomplete, data base for estimating the relative dimensions of those procurements which represent the monopoly power of a contractor in a sole source, follow-on negotiation. It also illustrates the danger in accepting categorical descriptions, such as

Advanced Development, as representative of the work that actually is performed under a contract so classified. There are similar dangers in the differentiation of product classes for contract analysis because, for example, "The specialized items of military hardware classified as Major Components and Accessories, Airborne, share many of the properties of complete systems."

Cherington, Paul W.
"The Interaction of Government and Contractor Organizations in Weapons Acquisitions," from Economics of Research and Development, edited by R. A. Tybout, Ohio State University Press, 1965.

(The author was the Research Director of the Weapons Acquisition Research Project at Harvard University.)

Quantity production over a long period of time engenders a "monopoly-monopolistic (SIC) situation" in the government-industry relationship. Government's intense involvement in industry's affairs is said to be an attempt to break loose. The point is made that it might be cheaper in the long run for the DoD to promote second sources or break out subsystems or components for competitive bidding. In comparing this situation with the supplier-producer market in industrial production, the author claims that industry is better staffed and more competent to cope with the sole-source supplier syndrome than is the Government.

A detailed description of the development and predevelopment activities of government and industry personnel is given, leading after source selection to a shift of the balance of power from the Government to the contractor. Pervading the description is a sense of the venality of the contractor and the connivance of the buying office in the interest of getting the program launched before another military department is assigned the mission based on a competitive system. Because of continual changes in mission definition and specifications and the long lead time to negotiate

changes, weapons acquisition is "an administrative rather than a market process."

The emphasis throughout is on industry's pre-eminence in negotiation because of more and better personnel.

Enke, Stephen, editor
Defense Management
Prentice-Hall, Englewood Cliffs, 1967

Most of the articles in this collection are peripheral to LMI's DoD-contractor relationship task, addressing themselves to problems of resource allocation within the DoD and the use of Cost Effectiveness as a tool for decision-making. The one article that is of most interest is Martin J. Bailey's "Defense Decentralization Through Internal Prices."

This article in its brief discussion of the merits of decentralization serves to remind us that the alternative solutions to the DoD-industry relationship problem in greatest favor--either increased supervision and engagement or semi-nationalization--are in the direction of more centralized decision-making, and thus greater conformity and less innovation. Its prime contribution is its description of the use of the Planning-Programming-Budgeting System (PPBS) in the DoD and the interservice rivalry for missions and funds before and after the introduction of the PPBS as a control. That this competition affects the government-industry relationship is clear. The extent or depth of this effect is not discussed.

Professor Murray Weidenbaum's article on "Defense Expenditure and the Domestic Economy" could be useful in considering the effect of changes in development and procurement policy on regional distribution of defense spending and of the regional distribution of our resources for development.

Galbraith, J. K.
"The Big Defense Firms Are Really Public Firms"
New York Times, November 16, 1969

Professor Galbraith proposes the nationalization of major defense suppliers through government acquisition of their shares and assumption of their debts. In his view such action would merely constitute recognition of the reality of those companies' roles as public firms. They are said to be public firms because: (1) most of their working capital is supplied by government, (2) most procurement of their products and services is non-competitive, and (3) they are sustained by the Government despite their faults and failings in performance.

It is argued that nationalization would provide increased public control over the military and the elimination of arms lobbying and other political activity by defense industry executives. It also is argued that "fully responsible public firms would be more efficient."

That this article is politically motivated is patently obvious, which is not to say that it is not a serious extension of Galbraith's earlier treatise on the advantages of nationalization of some industry in "The New Industrial State." However, in this instance his interest is not economic efficiency but political control over the military and their principle agents, the defense-oriented corporations.

Hall, G. R., and Johnson, R. E.
Competition in the Procurement of Military Hard Goods,
The RAND Corporation, P-3796-1. June 1968

This report was prepared for the use of the Senate's Sub-committee on Anti-trust and Monopoly. It provides an analysis of the proportion of military competitive and non-competitive procurement and the reasons offered by government buyers for non-competitive procurements. Data are cited both from other RAND reports

and from the GAO which purport to show that competitive procurement provides, on average, a twenty-five percent saving in procurement costs. That saving is based on an evaluation of the ratio of mean to low bids in formally advertised procurement and in subcontracting on the Lockheed C-141.

Admitting the difficulty, if not the impossibility, of obtaining the benefits of competition throughout the weapon systems acquisition process, several alternative strategies for injecting competition into as many stages of the process as possible are examined. Some provide competition in more advanced stages of development, others in follow-on production, but none in the final stages of development or in initial production. Some recognition is given the extended cycle time that might result from injecting competition further into the development phase because of the intrinsic overlap of the development and production phases of systems acquisition and the possible degradation of the benefits of competition because of the costs and institutional difficulties of achieving the transfer of technology necessary for second sourcing.

Handel, Sidney S. and Paulson, Robert M.
A Study of Formally Advertised Procurement
The RAND Corporation, RM-4984, June 1966

The authors have conducted a study in which they examined the dispersion in prices of some 2300 contracts let under formally advertised procedures.

Using as a measure of dispersion the normalized standard deviation, they find that the number of bidders for each contract is the only explanatory variable of statistical significance, and even that shows weak correlation. Neither cost per item nor size of bidding firms has a statistically significant influence on dispersion of bid prices.

Profits in the aerospace industry are indicated to average about 6% of sales; defense profits are lower--about 3%. The variance of profits on individual procurements is some unknown percent of the mean. Yet each individual DoD project carries a fee of about 8% to 10% of cost or 7% to 9% of price. The total effect of the uncertainties of cost, schedule and performance, when translated to cost at constant performance, are such that the ratio of final cost to estimated cost has a standard deviation of at least 26%. (Professor Frederic M. Scherer's book, The Weapons Acquisition Process: Economic Incentives, shows that the ratio has a 30% standard deviation.) Further, profits are bounded at the upper end by renegotiation on all contracts and are unbounded on the lower end except for cost type contracts.

This RAND study contains no information on the results of contract performance--whether the low bid price was sufficient to show a profit, whether the items were delivered on schedule or met performance requirements. Nor is there a satisfactory investigation or discussion of the underlying uncertainty in the firms' costing procedures.

Klein, Burton H. (of The RAND Corporation)
"Policy Issues Involved in the Conduct of Military Development Programs," from Economics of Research and Development, edited by Richard Tybout, Ohio State University Press, 1965.

Military R & D is characterized by violent changes in both the demand for the weapon systems involved and the conditions under which the R & D is carried out. It is further characterized by the demand for large-step advancements and by large errors in the estimating of final cost, schedule, and performance.

Among the policy implications of this ambiance of R & D is one concerning the interface between Government and industry.

The author argues that industry's incentive for efficiency in development is insufficient and that incentives within the DoD are positively counterproductive. He cites suppression of alternatives and decisions influenced by past investments rather than future worth. He rejects the British system of a Ministry of Supply for centralized procurement based on its history of improving "efficiency in the small" at the expense of research and development in the large. The major emphasis is, however, on revising the entire system of development phasing and control by the Government. The author calls for a totally new approach to development decision-making and program selection, and a rejection of the "total package" method of procurement.

Stanford Research Institute
The Industry-Government Aerospace Relationship, May 1963

This study was undertaken for the Aerospace Industries Association of America. It is in two parts: a central thesis of some 56 pages, and a second volume of 318 pages containing supporting research.

The theme of the report is set in the summary which refers to the Industry Government Aerospace Relationship as a remarkable politico-economic innovation--a "unique American invention of which the nation can be proud."

That relationship is concluded to be under strain and thus unable to fulfill its promise. The major problem is that Industry performance is adversely affected by:

(1) Government overregulation and oversupervision.

(2) Government officials' attitude that industry, left to itself, is either incompetent, venal, or both.

(3) Government's inconsistent but increasingly stringent attitude on allowable costs.

(4) Disagreement over adequate profit rates.

(5) Overcapacity--a result of the absence of a "free-market" environment.

The report lists thirteen possible causes of those problems, many of which are reiterations of the problem elements themselves. They can, in general, be categorized as follows:

(1) A lack of mutual confidence.

(2) A lack of clear understanding of the proper roles of industry and Government in the relationship; and a similar lack of understanding of each other's mode of operation and objectives.

(3) Conflicting regulations and changes in some regulations or policies without balancing and compatible changes in others.

Suggested actions to relieve the problems are:

(1) By industry: a greater concordance within industry and more dialogue with Government based on intra-industry studies.

(2) By Government: improvement of early definition of requirements; clarification and enforced observance of policy; disengagement and thus reduction in the effort and cost of contract surveillance.

(3) Jointly by industry and Government: simplification of regulations, eliminating those which conflict; establishment of additional avenues

for dialogue at all levels.

The proper roles of Government and industry are held to be those of the buyer and seller in the classic free market under perfect competition.

Although not emphasized in the report's summary, much of the report and most of the volume of supporting research is devoted to a comparative financial-profitability study of the aerospace industry. The results show aerospace to be lower than other industry in rate of return on total assets, net worth, and sales.

A 33-page unannotated bibliography is appended.

Weidenbaum, Murray L.
"Arms and The American Economy: A Domestic Convergence Hypothesis," American Economic Review, December 1968.

Professor Weidenbaum's thesis is that the close continuing relationship between the DoD and industry is resulting in a convergence between the two in which the distinction between private and public activity is becoming increasingly blurred. The DoD's suppliers are becoming part of the government administrative complex, like arsenals or other agencies of the federal government. The prime evidence for this is the DoD's assumption of what are normally industry's decision-making functions in three areas:

(1) Which product to produce--through massive funding of the R&D which industry uses to evolve its new products.

(2) Provision of capital funds--provision of plant and equipment to industry plus "a major portion of the working capital they require" through progress payments that at times exceed their total book assets.

(3) Procurement legislation and regulation--

especially the ASPR emphasis on unallowable cost categories and the spelling out of the Government's right to review the contractor's management efforts.

The long-range effect is argued to be stifling of innovation and reduction in resourcefulness and efficiency. The demise of our shipbuilding industry is used as a model of what might happen if the trend is not reversed. There is reference to the relatively low stock market evaluation of "Government-oriented corporations."

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APPENDIX D

ORGANIZATIONS VISITED

The Boeing Company
Seattle, Washington

Ford Motor Company
Dearborn, Michigan

General Dynamics Corporation
Convair Division
San Diego, California

The Institute for Strategic Studies
*London, England

Northrop Corporation
Beverly Hills and Hawthorne, California

RCA Corporation
Camden, New Jersey

Sears Roebuck and Company
Chicago, Illinois

*Visit conducted at Logistics Management Institute offices, Washington, D. C.

APPENDIX E

REPRESENTATIVE TOPICS OF DISCUSSION IN VISITS

Methods for obtaining good prices from major suppliers.

- Use of open competition.
- Maintenance of dual sources.
- Market analysis.
- Conduct "should cost" studies.

Extent of monitoring of suppliers' operations.

Pros and cons of heavy stock ownership in a supplier company.

Pros and cons of long-term single-source arrangements.

- Types of contracts used in such arrangements.
- Types of monitoring, auditing, and inspection used in such arrangements. Types of reports required.

Degree of resistance to situations in which a supplier does almost all his business with X Corporation (company visited).

- Approach to negotiation and control in such situations.

Use of long-term (e.g., 4 year) contracts with suppliers.

- Absolute quantities versus fixed percentages of X Corporation's total purchases of the product for future years covered by the contract.
- Immediate versus deferred pricing. Use of escalation provisions.
- Circumstances for renegotiation of prices, quantities, or technical requirements.

Circumstances under which X Corporation makes specific recommendations for change in supplier operations.

- Modernization.
- Other process change.
- Personnel change.
- Procedural change.
- X Corporation's stake in consequences when changes which it prompted are made and, as a result, the ensuing contract runs into difficulty.

Use of research and development contracts.

Use of letter contracts.

APPENDIX F

EVOLUTION OF THE DOD-CONTRACTOR RELATIONSHIP IN WEAPON SYSTEMS ACQUISITION

I. INTRODUCTION

The purpose of this review of history is to provide background information for evaluating current DoD management practices and seeking ideas for improvement. We are not necessarily interested in a comprehensive history of weapons acquisition, but only in that history which can be related to the current or future situation and the problems associated with that situation.

"Weapon system" has come to refer exclusively to the major items of equipment used in the national defense--costly and technically complex items such as planes, missiles, ships, and tanks. However, it covers not only the major item itself, including on-board subsystems such as the power plant, electronics gear, and armament, but also detached auxiliary facilities and equipment for such purposes as guidance, communication, supply, maintenance, training, and data processing. Even operating and support personnel are included.

An example of a weapon system, then, is the F-4 aircraft, complete with all its armament and ammunition, guidance and navigation equipment, ground support equipment, test and checkout equipment, maintenance facilities and equipment, spare parts, communication equipment, training equipment, technical data including operating and maintenance handbooks and parts catalogs, operating and support personnel, and all other hardware and people needed to operate and support the aircraft.

Another example is the Ballistic Missile Early Warning system (BMEWS), with all its related personnel, facilities, and equipment. To include an electronic command and control system stretches the word "weapon" to include items which do not in themselves have destructive capability. Such items now are as important to the national defense as are ships and planes, and they can be as costly and technically complex; so they are accepted as weapon systems.

"Acquisition," in the context of weapon systems, is a process rather than a single event. It covers the conception, development, and production of such systems, for the Government is deeply involved in all those activities even when development and production are performed by commercial firms on a contract basis.

II. PRIOR TO WORLD WAR I

From the colonial period through the early part of the twentieth century civilian technology was sufficiently similar to military technology that conversion from one to the other posed few problems. Gunsmiths who made muskets or rifles for hunting and household protection could turn out rifles for military use in times of hostility. Manufacturers who made blasting powder for railroad construction could produce gunpowder for battle. With few exceptions the Government relied on civilian production capability for items having a civilian as well as a military function.

We cannot generalize so easily about items unique to military operations; for example, artillery. Both arsenals and civilian production plants were employed, and the relative emphasis continually shifted.

The only weapon system (by our definition) of that period was the warship; and it was produced both by private industry and by Naval shipyards from the beginning of the nineteenth century. A shifting mix of private and public production became the rule.

The first steam warship, Robert Fulton's Demologos, was built in a private yard. The construction of the Monitor was by contract with a private firm; the Merrimack was built in the Norfolk Navy Yard.

For private construction, fixed-price contracts were used. Financial advances (progress payments, in today's parlance) often, but not always, were made as the work proceeded. Dimensions, weight, and minimum performance characteristics were stated in detail in the contracts. Design was not fully stipulated, however, so the contracts were for development as well

as production.

While both ships and the contracting arrangements under which they were built prior to World War I were simpler than those of today, acquisition problems still existed. The Demologos was intended for the defense of New York harbor against the British in the War of 1812 but was completed too late to see any service in that war. On the Monitor, twenty-five percent of the payment was to be withheld until construction was complete and satisfactory performance was established. The contractor received his payment in full and never was held to the terms of the contract for performance or delivery of specific auxiliary equipments. The Government's payment for the Monitor, incidentally, was $275,000; construction cost the contractor $195,000.

Not all contractors were so fortunate financially. Competitive bidding generally was employed, with the contract award going to the firm offering the lowest fixed price. Competition was not as severe, however, and losses and terminations not as common, as with items less complex and requiring less contractor investment.

In addition to competition among companies for contract awards, another kind of competition existed--that between private and public producers. The Government maintained a production capability in many items. The Naval shipyards, gun factory, torpedo station, and air factory are well-known examples. That competition affected both groups and clearly resulted in some benefit to the Government. Military personnel in charge of Navy yards (and arsenals too, incidentally) and some private citizens criticized the "higher cost" of private production, and thus stimulated effort toward more efficient operation. Private manufacturers argued that their products were superior to those

made in Navy yards (or arsenals) and offered suggestions for improvement of the military plants as a way of making their point.

Two quotations from James Huston's The Sinews of War: Army Logistics 1775-1953 may help to place many of today's problems, which will be discussed later, in the proper historical perspective:

> The twenty-seven contractors . . . were to have delivered all their 40,200 [weapons] by 30 September . . . . At that time the Government had received just 1,000. Only one or two ever completed their contracts. [One contractor] again and again had to ask for extensions of time . . . and finally delivered the last 500 [weapons] . . .--nearly eleven years after signing the contract, and nine years behind schedule.

That contract was signed in 1798. The weapons were muskets and the contractor was Eli Whitney--better known, and deservedly so, for his introduction of standardization and interchangeable parts on the contract. In another case:

> The Purveyor of Public Supplies . . . advertised in the newspapers of leading cities for bids, and between 30 June and 9 November of that year [1808] . . . let contracts to nineteen different firms for a total of 85,200 muskets. The delivery terms were for five years, with one-fifth of the total number, in most cases, due each year [a multi-year procurement]. . . . not a single contractor met the first year's schedule, and more than half of them made no deliveries at all the first year. By July 1813 [almost 5 years after signing] . . . , 34,477 muskets had been delivered. Some of the contractors proposed to deliver enough muskets to meet the financial advances the Government had made [progress payments], and then to terminate their contracts. . . . the muskets had been patterned on poor models at a price for which it was impossible to make good muskets [buy-in bids] . . . .

III. WORLD WAR I AND THE INTERWAR PERIOD

World War I brought the introduction of airplanes, submarines, and tanks as vital instruments of combat. Military aircraft had been acquired on a contract basis since 1907, and submarines were in production at both public and private yards at the outset of the war. Most of the tanks employed were British, but American tanks were introduced during the latter part of the conflict. Aircraft carriers were ready for deployment by the end of the war, but did not enter it.

After the United States entered the war, an attempt was made to convert private industry to war production on a mass basis. Little prior planning had been performed, however, and the conversion was not readily accomplished. The War Industries Board, headed by Bernard Baruch, was formed to provide coordination and guidance. Still progress was slow, especially for weapon systems. The main problem was not getting manufacturers to cooperate, but preventing them from making the wrong changes. Not until late 1917 was a successful scheme devised. It consisted of a regional organization of industry, a Resources and Conversion Section of the War Industries Board in Washington, and close coordination with the Army and Navy.

Attempts were made to put every possible facility into use for the war effort. Large numbers of government-owned and government-financed plants were constructed.

Competitive bidding and fixed-price contracting were required at the beginning of the war. The National Defense Act of 1916, however, empowered certain officials to place contracts without formal advertising. In fact, the act allowed those officials to fix prices and, when the producers refused the arrangements, to commandeer their plants and operate them.

During the war the cost-plus-a-percent-of-cost contract was adopted as an emergency measure and used extensively. In recognition of the built-in motivation for cost increase and in response to public dissatisfaction with that type contract, precautions sometimes were taken. Maximum fees were stipulated; sliding scale percentages were used so that fee increased in less than direct proportion to cost; and bonuses sometimes were provided for cost decreases.

Industrial mobilization for the war could hardly be called an unqualified success, despite the measures taken. Inter-Allied coordination, with Americans making substantial use of British and French equipment, was necessary throughout much of the war. Materiel contributions of the United States came late.

After the armistice the War Industries Board made a study to establish how the industrial mobilization problems experienced during the war could be avoided in the future. Its report in 1921 recommended establishment of certain peacetime skeleton organizations to facilitate mobilization for war and certain systems to assure availability of essential war materials.

No formal action was taken on the report, but planning for mobilization was pursued in the War and Navy Departments under the Army and Navy Munitions Board. The assumption was made that the mobilization program would be carried out by a civilian board.

An Industrial Mobilization Plan was completed in 1930 and revised several times during the next decade. It was discarded, however, in 1940 and the stage was set for repetition of World War I problems.

Technical advances in weapon systems continued during the interwar period, and the Air Corps made a significant change in the way in which it acquired airplanes. Disillusioned by the tendency for winning designs to be altered substantially during subsequent development, it abandoned paper design competition in the early 1930's. Full-scale flying prototypes came to be required with the bids--ostensibly at the competitors' financial risks. In practice the Air Corps purchased (at prices not exceeding cost) the prototypes submitted to allow the competing companies to recoup their investment and remain in business. Prototypes at that time cost as much as $600,000.

The establishment of the National Defense Research Committee in 1940 indicated recognition of the increasing role of science and technology in the national security. That committee made history in its single year of existence, before being expanded into the Office of Scientific Research and Development, by being the initial sponsor of the Manhattan Project.

IV. WORLD WAR II

Despite the advances of the interwar period, when the United States entered World War II it was not ready to meet the materiel needs of full-scale combat. Troops were mobilized before equipment could possibly be available for them and severe shortages existed for more than a year. The World War I pattern of conversion of civilian plants to war production, expansion of arsenals, and construction of new facilities had to be repeated as rapidly as possible. (The one exception was ship-building, where the development of armor plate, naval gunnery, the submarine, and the torpedo had given rise to what might be called a specialized defense industry.)

The Government allowed accelerated depreciation (twenty percent per year) for facilities built or acquired for national defense purposes, provided low-interest loans, reimbursed companies over a five-year period for industrial expansion, and expanded its own facilities for production. The Defense Plants Corporation, a subsidiary of the Reconstruction Finance Corporation, constructed $8 billion of plants for lease to private firms. In 1942 the War Production Board was created as an independent civilian agency and given authority over the procurement programs of all the military services and over the Army and Navy Munitions Board.

Formal advertising was abandoned for the duration of the war. Contracts were of the cost-plus-a-fixed-fee, firm fixed-price, and fixed-price redeterminable types. The cost-plus-a-percentage-of-cost type was outlawed.

Progressive pricing was an innovation of World War II. Under that method contract prices were reviewed from time to time while the contracts were in effect. On the basis of experience and unforeseen circumstances, prices could be adjusted up or down.

Despite the industrial unpreparedness for war and the difficulties of mobilization adequate for the scale of the conflict, the United States was overwhelmingly successful in overcoming the enemy's weapons advantage. World War II was more than twice as long as World War I for the United States and turned out to be one in which mass production skills were critical. Once conversion from peacetime product lines was made, there were capabilities in such places as Detroit and Pittsburgh that were uniquely suited to the task.

But science and technology made outstanding contributions too. Weapons development tends to press the limits of existing knowledge more than does commercial product development, and the wartime environment accentuated that tendency. Numerous new devices and systems were introduced, including the proximity fuse and the atomic bomb. In addition, vast improvements were made in already-existing weaponry.

The military services coordinated their activities more than ever before, both in research and development and in procurement. They drew on common technology more than in the past, and the new systems that were developed prompted strategies utilizing mixed forces.

In the aftermath of the war, scientific and technological effort for military purposes continued on a relatively small scale. Primary attention was turned to "catching up" in the civilian economy. Both military and civilian uses of atomic energy were pursued.

Two important organizational changes took place in the late 1940's. Under the National Security Act of 1947 the Air Force was established as a separate military service and a central

coordinating body, the National Military Establishment, was created under a Secretary of Defense. In 1949 the Department of Defense replaced the National Military Establishment and the Departments of the Army, Navy, and Air Force lost their status as separate executive departments.

While demobilization, "mothballing," and disposal were the order of things immediately following surrender of the Axis forces, the defense establishment did not return to its prewar level. The international situation grew tense toward the end of the 1940's and relaxation of our defense posture ("reconversion to recomplacency") came to a halt.

V. THE 1950's

Although it brought no world war, the decade of the 1950's was perhaps the most significant one in the history of weaponry. It brought a technological revolution, acceptance of a large-scale defense effort on a permanent basis, creation of what appeared to be a permanent specialized defense industry, and intensified management of weapon system programs.

Technological Revolution

Programs of the 1950's gave us missiles, supersonic aircraft, thermo-nuclear weapons, a new generation of complex electronic equipment, and the beginning of spacecraft. The advances that were made truly constituted a revolution, as can be seen by using the weapon systems of World War II as a frame of reference and observing the partial list of systems of the next decade, as depicted in the chart on the following page.

Large Standing Force

The destructive power of the new weapon systems made it clear that in another major war there would not be time for industrial mobilization and upgrading of weapons capability. The Korean conflict and the Cold War convinced the public and its elected officials that a permanent state of military readiness was essential. Rapid technological advance called for a high degree of specialization.

Permanent Defense Industry

There never was much doubt that the industry to develop and produce the new systems would be private rather than public. There had been a trend away from the arsenal system over a long period of time. The public believed in the free-enterprise

REPRESENTATIVE SYSTEMS

THE 1950's

TYPE	ARMY	NAVY	AIR FORCE
Aircraft		F-4 Phantom II (fighter)	B-58 Hustler (supersonic bomber) C-130 Hercules (assault transport) F-105 Thunderchief (fighter)
Missiles	Nike (surface to air missiles)	Polaris (submarine launched fleet ballistic missile)	Atlas Minuteman Thor Titan
Ships		Nuclear-Powered Submarines Guided Missile Warships	
Ordnance	M-48 Patton Tank		
Electronics and Communication Systems		Very Low Frequency Communication Systems	SAGE Air Defense System

system as "the American way." And the World War II experience was regarded as proof that industry could do the defense materiel job.

Except in aircraft, most of the key technological breakthroughs of World War II actually did not come from industry. That fact evidently was not considered to be of great importance as the new defense industry seemed destined to grow out of the aircraft industry.

Aircraft and missile programs dominated major hard goods categories in the defense budget. Electronics strengthened its position, serving as a program in its own right and also being an important part of aircraft and missile work. Companies in the aircraft and missile (aerospace) and electronics industries came to occupy all the high-ranking positions on the DoD prime contractor list. Companies like General Motors, Ford, Bethlehem Steel, and duPont dropped out of the top twenty.

Twenty Largest Defense Prime Contractors
Fiscal Years 1958-60

1.	Boeing	11.	Sperry Rand
2.	General Dynamics	12.	Raytheon
3.	Lockheed	13.	McDonnell
4.	General Electric	14.	RCA
5.	North American Aviation	15.	IBM
6.	United Aircraft	16.	Republic Aviation
7.	AT&T	17.	Grumman Aircraft
8.	Douglas	18.	Chrysler
9.	Martin	19.	Westinghouse Electric
10.	Hughes Aircraft	20.	Bendix

By the late 1950's more than half of the top twenty prime contractors were almost totally dependent on defense business. Others had entire divisions exclusively engaged in defense work. Never before had such a situation existed in the absence of major war.

Intensified Management

(a) Criticality of Time

In dealing with the defense industry the Government relied heavily upon cost-plus-a-fixed-fee contracts, monitoring of contractor operations, and concurrence of development and production. The main reason, at least initially, was urgency. An acute value was placed upon time. Tensions of Korea and the Cold War and weapons system competition (the beginning of the "arms race") with Russia precluded the kind of program definition necessary for competitive bidding and fixed-price contracting, as well as the risk of obsolescence inherent in solving all development problems before approving production. Delays in engineering development, production, and deployment were intolerable and Government visibility of contractor operations was required to assure that urgent needs were being fulfilled. The Government did what would be expected in a critical situation: it turned to some of the means which had served it well in the last crisis--World War II.

(b) Impossibility of a Free Market

The contracting approach taken, however, was not regarded merely as an emergency course of action. It continued throughout the 1950's because it had a logic which recommended it as more than a temporary approach. It was considered

necessary because weapon systems acquisition could not make use of the free-enterprise market--at least not in the textbook sense of that word. Several reasons for the impossibility of a free market were recognized.

First, development of the new weapon systems required more investment than was possible on a private basis. The large programs in general required development investment of hundreds of millions of dollars; and in some cases that figure exceeded one billion dollars. Such requirements vastly exceeded even the largest commercial ventures, such as color television and jet aircraft (in which, incidentally, the Government participated through the funding of predecessor and related projects). Hence the Government could not be merely a free-enterprise buyer of weapon systems, but had to play the dual role of investor and buyer. And the purchase agreement had to be entered into before the product existed.

Second, the uncertainties of weapon system development posed other risks which private companies could not bear. Not only were probabilities of unforeseen technical difficulty and early obsolescence large, but programs could end abruptly as a result of changes in strategic planning or government policy. It was not considered possible (or appropriate) for individual groups of shareholders to take on such risks. They had to be distributed over the general body of taxpayers.

Third, the weapon system developer could not establish with reasonable certainty the product characteristics desired by the buyer. There was nothing comparable to a good market survey. The weapon systems usually had multiple missions, and prospective users were in conflict over the desirable mix of operational characteristics. Development and production covered such long

periods that it was considered essential to respond to changes in threat, strategy, policy, and technology as they occurred. The engineering changes that plagued government aircraft buyers of the 1930's were multiplied many times as the time span was longer, hardware more complex, and technology moving at a much more rapid pace.

Fourth, free-enterprise competition could not be counted on to yield a fair price. The ability of anyone to produce a credible cost estimate was subject to question because of uncertainties already mentioned--and especially because the barriers of scientific knowledge were being hard-pressed. The lack of normal market competition made the problem even worse. The Government usually was the only buyer. Sometimes there was only a single commercial capability appropriate for the development, as a result of past experience or because a prior study had been made and time was short. (Feasibility studies based on unsolicited proposals were common in the 1950's.) After initial development by a single firm, that firm had such an "inside track" that meaningful competition was not possible. The huge cost of development caused the Government to rule out prototype competition in most cases and revert to paper design competition, if any. Programs became larger and fewer in number, so that sometimes companies considered it a matter of survival to obtain the business. Failure to win a specific award could result in an idle plant, loss of key personnel, and dropping from the technological frontier. Not only could cost estimates not be relied on, but the assurance with which preliminary designs were proposed belied the real situation. Free-market competition was further impeded by the requirement for a broad industrial base (although it would be difficult to find a contracting officer who would admit making an award to enlarge that base).

So long as parallel courses could not be afforded, the Government did not have an effective remedy for "competition in exaggeration." Programs were not undertaken unless they were thought to be essential to the national security; and if they were so essential they could not be abandoned or jeopardized. As technical changes became necessary to preserve the effectiveness of the weapon system, whether or not the contractor caused them through optimism, exaggeration, or too much design detail at an early stage, the Government had no recourse but to approve them. As military requirements, technology, and design were in continual revision, changes were generated on a daily basis by both parties to the contract. Responsibility was hard to pin down; pricing of the changes could not be made before implementation without causing program delay. The risk of delayed pricing and the consequent risk of greater-than-anticipated cost were considered less dangerous than delay of the program, which in itself would have added to the cost. In short, the Government was "over the barrel."

Forces at work within the Government further aggravated the situation. Weapon systems of the Army, Navy, and Air Force were not distinct in mission, as was primarily the case in the two world wars. All the departments now had aircraft, missiles, and advanced electronic systems, and capabilities for accomplishment of specific missions overlapped substantially. Hence the establishment of a program in one department carried with it the prospect of a decision not to proceed with a program in another department. The Thor-Jupiter-Polaris competition was an example. Similar conditions existed within a given department. Consequently military and civil service personnel interested in the survival of specific programs had the same motivation as did prospective contractors for optimism and exaggeration.

Under the circumstances fixed-price contracting seemed ludicrous. The initial price would have had little meaning and the Government would have been deprived of the visibility and control that c' viously were required. The most fitting DoD management approach seemed to be use of cost-plus-a-fixed-fee contracts and close monitoring of contractor operations. The negotiated contract was acknowledged as little more than a beginning statement of work along with some cost and schedule goals unlikely to be attained; and it was recognized that contract changes lagged behind the work they covered. Therefore the contract and its amendments were not considered to be adequate instruments of program control, and the "watchdog" technique was considered essential. Exceptions were the development and construction of surface ships, an area in which much of the design know-how and effort resided in the Navy and in which firm fixed-price contracting had long been the practice, and follow-on production buys, when technical cost uncertainties had been removed.

(c) Management Trends and Innovations

The functions of plant cognizance and program review grew rapidly in the 1950's. More and more approvals by resident government personnel were required for operating procedures, releases of material to and in the plant, and shipments. Scrutiny of contractor records increased. New management control systems were imposed, although the emphasis was more on information than on process control, and mandatory reports and data grew steadily in number and detail. As contracts included many more procedural and reporting requirements than in the past, and as engineering changes were in the thousands on programs, the contract administration function also increased.

Although the Government recognized the absence of a free market and the need for cost reimbursement contracts and close DoD control of contractor activities, it did not accept as a necessity the same degree of government financing or provision of facilities as had existed in prior years in the aircraft industry. Aerospace firms fought for continuation of World War II practices and the amount of government-furnished facilities became an issue at the bargaining table. As a result, the percentage of plant facilities provided by the Government came to vary widely among companies. Progress in inducing contractor investment in plant facilities was slow, however. Almost all such investment by aerospace companies in the first half of the decade was through earnings. Between 1955 and 1960 they made substantial use of stocks and bonds. In the defense electronics industry the Government generally did not have to apply as much pressure for private facilities investment.

A DoD innovation of the 1950's which foreshadowed management practice in the 1960's was project management. Project management is an approach in which an office is formed to direct and control all activities of a hardware program or project, from early development through delivery of the last item to the Government. That office pulls together specialists from the various parts of DoD functional organizations to give their full attention to the subject program; that is, it assembles people from such functions as engineering, programming and budgeting, procurement, production, supply, maintenance, and quality assurance. Large project management organizations came into being in all of the military departments. The Army's Ballistic Missile Agency managed the Jupiter program. The Special Projects Office of the Navy was responsible for the Polaris program. And the Air Force's Ballistic Missile Division had teams managing the Atlas, Thor, and Titan programs.

Another innovation was the prime contractor concept. Rather than assume responsibility for coordinating the efforts of the numerous contractors in a weapon system program, the Government passed that responsibility on to one of the contractors, known as the prime. As a result, most of the system components which previously had been contracted for by the Government were obtained on a subcontract basis by the prime. As an alternate to the prime contractor concept, sometimes an integrating contractor was used to coordinate the efforts of various firms having contracts with the Government in the same program. Another approach to integration was to use independent non-profit institutes, laboratories, and "think factories." Such organizations also augmented or supplanted in part the traditionally in-house government capabilities of defining technological requirements and evaluating proposals.

Results

The technical success of weapon systems acquisition in the 1950's was outstanding. Tremendous advances were made in United States defense capability. In general, technical performance and quality outcomes on programs exceeded original expectations.

The management of weapon system acquisition in the 1950's did not appear outstanding. Studies revealed that many defense contractors had inefficient purchasing methods, poor overhead control, and low professional and nonprofessional manpower productivity. Cost and schedule almost always exceeded original estimates by substantial margins. The Harvard Weapons Acquisition Research Project findings indicate that cost was overrun 220 percent and schedule 36 percent, on the average.

While there is no doubt that cost and schedule control were serious problems, interpretation of the data on overruns is not easy. On cost, for example, some of the overage was due to economic escalation; some was due to program upgrading to take advantage of technological breakthroughs or to satisfy new military requirements; some was due to initial exaggeration to enhance the likelihood of program survival and to win the award; and some of the overage was a consequence of inadequate or ineffective management.

In summary, the 1950's were a decade of overwhelmingly successful technological revolution, which brought with it management problems which no one was equipped to handle and for which solutions were not readily available. Application of the free market system, in general, was considered impossible and direct DoD monitoring and control of contractor development and production were adopted as the management approach. Early forms of project management were introduced. Cost-plus-a-fixed-fee contracts were the predominant practice, except in ships and follow-on production buys. Concurrency of development and production was practiced. Competition was sought, and in fact increased, but became paper design competition in most cases instead of prototype competition. Contractor investment in facilities increased at a modest rate.

There was no tapering off of the technological revolution as the decade ended. In fact, it was responding to the added impetus provided by Sputnik in 1957. In 1958 the National Security Act was amended to increase the authority and responsibility of the Secretary of Defense and to create the post of Director, Defense Research and Engineering. Stronger centralized management of research and development activities was a key objective.

VI. THE 1960's

Continued Technological Advance

Rapid technological advance continued into the 1960's, but was no longer regarded as a revolution because such advance was not considered to be a new thing. While we have grown accustomed to steady technological progress, it is still impressive to observe some of the gains which have been made since World War II.

Cost changes mainly indicate increasing technical complexity of weapon systems. The B-17 bomber of World War II cost $210,000; the B-52 being used in Southeast Asia costs $8.5 million; the B-1A, now in development, is estimated to cost between $22 million and $25 million. The P-51 fighter of World War II cost $55,000; the F-4 used in Southeast Asia costs $2 million; and the F-14, currently being developed, is expected to cost about $11 million. A World War II destroyer cost $12.5 million; estimates of the cost of the new destroyer, now in development, are as high as $65 million. And despite the breakthroughs in electronics which allow much greater capability per unit of weight, the new destroyer will be equipped with thirteen times as many pounds of electronics and communication equipment as a World War II destroyer.

Centralized Decision-Making

The 1960's are not known for their technical gains, however, as much as they are for the dramatic management changes which they brought. One change was centralization of decision-making.

The military departments, as a result of the changes in the National Security Act in 1958, no longer were "separately administered," but were merely "separately organized." The Secretary of Defense took advantage of his new authority to exercise

strong central direction to attack the management problems which had been highlighted by the experiences of the 1950's. The 1960's witnessed a management revolution.

A strong Office of the Secretary of Defense was built up which became involved in weapon system program management by rendering guidance and review and by advising the Secretary on decisions for program establishment, continuation, enlargement, redirection, or curtailment. The Secretary relied heavily on formal studies in the exercise of his expanding decision role.

New groups were set up to conduct formal analyses to weigh the utility, benefit, or effectiveness to be gained from a weapon system against the cost that it would entail. Efforts of those groups became known as "cost-effectiveness" studies and were characterized by extensive use of mathematical models and techniques and computer simulation.

Formal Management System

Another outstanding feature of the DoD management of the 1960's was heavy reliance on formal management systems, including creation of numerous new ones. At the highest level were the Five-Year Defense Plan (initially called the Five-Year Force Structure and Financial Program) and the Planning-Programming-Budgeting System. The purposes of those systems were the merger of military planning and budgeting, extension of the budgeting horizon, and an improved basis for relating inputs--resources--to outputs--which included weapon systems. DoD management desired a system that brought together, in the words of the Assistant Secretary of Defense (Comptroller), "at one time and in one place all the relevant information that they need(ed) to make sound decisions on the forward program and to control the execution of that program." Consequently the new planning systems

were built around mission-oriented categories, like Strategic Retaliatory Forces and Airlift and Sealift.

The Office of the Secretary of Defense and the military departments issued scores of directives, instructions, manuals, handbooks, and guides to modernize and standardize procedures. Weapon system program personnel in both the DoD and contractor organizations were affected, as the documents covered such subjects as reliability and maintainability analysis, quality assurance, cost analysis, pricing, audit, production planning and scheduling, configuration management, and supply management. Many of the documents called for more complete and thorough planning for operation and logistic support activities.

Increased Contractor Risk/Reward

In the area of contracting, a basic tenet of the new management approach was that even if the free market could not exist in weapon system acquisition, some of its key motivational forces could be simulated. Emphasis was placed on increased contractor risk and commensurate opportunities for reward. Contracting methods and techniques were changed to give contractors more stake in program efficiency and technical results.

A strong drive was made to increase the use of fixed-price contracts, in development as well as in production. Fixed-price incentive and cost-plus-incentive-fee contracts were encouraged where firm fixed-price contracts were not possible, to motivate efficient management and achievement of high performance products. The Weighted Guidelines method of negotiating profit was established so that profit opportunities would better reflect the skills required, cost risk assumed, past performance, and investment undertaken. The policy to induce contractor investment in facilities for defense work was strengthened. A goal of reducing

DoD involvement in internal contractor operations ("to disengage") was announced.

Increased competition was a key objective; and in the interest of reduced cost, paper design competition was favored. It was recognized that searching analysis of alternatives was essential if competition was to be completed before any hardware was built. It also was recognized that the management capabilities and proposed approaches of prospective contractors would have to play a role in the competition along with the designs offered. Interdepartmental competition was promoted.

Structuring of Development

Another change in weapon system acquisition was the formal structuring of the development process. Even the earliest dialogue, before a program was even established, was to follow certain rules.

Concepts for new weapon system programs were written up, with their assumptions, rationale, and supporting analyses. The Development Concept Papers, as they were called, then were circulated through the Office of the Secretary of Defense, the Joint Chiefs of Staff, and the military departments concerned, accumulating critique and recommendations. Eventually they became Secretary of Defense decision documents for program establishment.

Concept Formulation was instituted as an exercise each proposed program would go through in order to demonstrate that it satisfied certain prerequisites and therefore should be given conditional approval to proceed into engineering development. Military missions had to be defined, and required weapon system performance had to be established. Alternate technical approaches had to be examined and the best selected on a cost-effectiveness

basis. Technology for the selected approach had to be in-hand. And cost and schedule estimates had to be credible. Hence the "concurrency" of the 1950's was abandoned for a sequential process in which one step was completed before the next could be started.

Much of the analysis in Concept Formulation is done by the Government. Nevertheless, there are numerous small contracts--primarily for two kinds of work: (1) independent engineering studies, and (2) management studies to aid in project organization, program planning, and cost estimating.

Contract Definition, the next part of the development process, was created to accomplish or verify preliminary design. It had several objectives. First, it was to yield firm and realistic performance specifications. Second, it was to result in firm and realistic cost and schedule estimates for all remaining development. Third, it was to produce cost and schedule estimates for production, operation, and logistic support that were adequate for planning purposes. All outputs were to be justified on a cost-effectiveness basis.

The underlying directive states that Contract Definition will lead "to the point at which competition is no longer required." It also states that remaining development will be carried out under a firm fixed-price or an incentive contract.

Generally companies participate in Contract Definition on a competitive basis. They are paid for their work. In response to a government request they submit proposals.

Usually two or three are selected and are given firm fixed-price contracts for about six months to prepare the required specifications, preliminary designs, estimates, and plans. The DoD conducts design reviews during the work, spends several months making an evaluation, and finally makes the contract award

decision.

The cost-effectiveness approach on Concept Formulation and Contract Definition led to an emphasis on economies of scale, series production, weapon system standardization, and plant modernization. Hence it reduced the opportunity for production competition after full-scale development or for dividing up the production job among companies. That circumstance, along with the increased confidence in plans that came from more extensive analysis of alternatives prior to full-scale development, led to the concept of combining full-scale development, production, and contractor logistic support in a single contract. Use of such a contract was called Total Package Procurement. It became the preferred way of doing business after Contract Definition in programs where major advances in technology were not contemplated.

Project Management

The use of the project management technique for direction and control of weapon system program activities increased during the early 1960's and became mandatory for all major programs in 1965. Project management in some of its early applications was more coordination than actual management, but the policy finally adopted was an attempt to give the project manager the authority and specialized functional support to achieve program objectives within the allocated resources and prescribed schedule.

Change in the Defense Industry

The industry which in the 1950's became heavily dependent upon defense business underwent a new kind of change in the 1960's. By diversification, merger, and acquisition, and by cultivation of already-existing commercial product lines, that industry decreased its reliance upon defense business. Many of the major defense contractors became conglomerates. Of forty

high and medium volume defense contractors in the LMI Profit Review sample for 1953, twenty had more than 70 percent of their sales with the DoD, and thirteen of the twenty had more than 90 percent of their sales with the DoD. In 1967, only eight had more than 70 percent and none had more than 90 percent. Many of the top twenty DoD prime contractors were conglomerates by the late 1960's.

Twenty Largest Defense Prime Contractors
Fiscal Year 1969

1.	Lockheed	11.	Raytheon
2.	General Electric	12.	Sperry Rand
3.	General Dynamics	13.	Avco
4.	McDonnell Douglas	14.	Hughes Aircraft
5.	United Aircraft	15.	Westinghouse Electric
6.	AT&T	16.	Textron
7.	Ling Temco Vought	17.	Grumman
8.	North American Rockwell	18.	Honeywell
9.	Boeing	19.	Ford
10.	General Motors	20.	Olin Mathieson

Results

In contrast to the 1950's, the main technological achievements of the 1960's were not in weapon systems, but in the space program. Numerous new weapon systems were introduced into the development process or were produced, as is indicated by the chart on the next page, but they did not rival the weapon systems of the 1950's as "technological breakthroughs." Furthermore, some (for example, the F-111, Shillelagh, and SRAM) presented problems which have not yet been solved. The reasons are not yet clear. Numerous possibilities have been cited, including:

REPRESENTATIVE SYSTEMS

THE 1960's

TYPE	ARMY	NAVY	AIR FORCE
Aircraft	Hueycobra (armed helicopter)	A-7 (attack aircraft)	C-5 Galaxy F-111 (tactical fighter)
Missiles	Safeguard (anti-ballistic missile system) Shillelagh (lightweight guided missile)	Poseidon (fleet ballistic missile) Phoenix (air-to-air missile for F-111)	Short Range Attack Missile (SRAM)
Ships		FDL (fast deployment logistics ship) LHA (amphibious assault ship) DD963 (destroyer system)	
Ordnance	Main Battle Tank (MBT) Sheridan Assault Vehicle		
Electronics and Communication Systems		Extremely Low Frequency Communication System (under test)	AWACS (airborne warning system)

primary attention given to the space program by the aerospace industry, concentration on conventional weapons for the conflict in Southeast Asia, the technological barriers which were being attacked, the management approach, and chance phenomena.

In the area of management in the 1960's, some of the results also were disappointing. Cost and schedule overruns continued to be substantial. Unrealistic initial estimates remained a serious problem as the motivation for understatement still existed for both government and contractor program personnel. In addition, the cost of the mushrooming management procedures intended to arrest cost growth became a concern in itself.

There was some evidence, however, of progress. A study of the Office of the Director, Defense Research and Engineering, indicated that development cost, on the average, was overrun 79 percent and schedule 32 percent on post-1961 programs. Those figures imply that cost control has improved markedly since the Harvard study of the weapon system programs of the 1950's, and that schedule control was about the same as in the 1950's. They cannot be considered as conclusive, however, because development is not yet complete on some of the programs included in the data, and because there is some controversy about the equivalence of initial estimates (from which growth was measured) on the two studies.

Despite the effort devoted to complete and thorough planning, Contract Definition commenced in almost all programs before its prerequisites were satisfied. Some of the technology required did not exist, and cost and schedule estimates were not credible.

Interdepartmental competition was intense, as was demonstrated by the vigorous debates over the relative merits of the C-5 Galaxy aircraft and the Fast Deployment Logistic Ship for getting Army equipment into a combat area.

Industry competition also was intense--especially during Contract Definition. Contractors spent far more than the fixed prices of their Contract Definition contracts and performed design engineering far beyond what was intended in order to enhance the probability that they would win the full-scale development or total package contract and to reduce their subsequent risk in that contract, which generally was fixed-price incentive. Reports submitted at the end of the contract period of Contract Definition (that is, proposals for follow-on development work) contained tens of thousands of pages. The teams which evaluated those reports consisted of several hundred government personnel in many instances.

Nevertheless, unknowns remained at that stage of the acquisition process and engineering changes occurred by the thousands during full-scale development. The Government still had no effective remedy for the problem of change. Fewer programs were launched under the new structure of weapon system development, and therefore pressure for the Government to "stay with" a program was even greater than it was in the 1950's.

The goal of substantial "disengagement" from internal company operations was not met, as the need for monitoring contractor operations remained. Once the Government had established a program and selected a contractor, its commitment to the success of the contractor's efforts was such that it had to know if the program was getting out of control or failing to achieve its objectives. Procedures and reporting requirements imposed on contractors were proliferated, but the result usually was after-the-fact data rather than instruments of meaningful control.

Contractor investment in facilities increased at a modest rate as a result of the strengthened DoD policy. Contractor working capital likewise increased as a result of less use of

cost-reimbursement contracts by the DoD.

Greater cost risk and higher investment on the part of contractors were, in general, accompanied neither by higher profit nor increased freedom of operation. The Government still was not satisfied with the control it had of programs. Studies of the effectiveness of contractual incentives indicated little impact. By the late 1960's disillusionment with fixed-price contracting and incentive arrangements in full-scale development became widespread, as did dissatisfaction with total package contracting.

The additional weight given to operation and logistic support in the development of the weapon systems of the 1960's, however, paid dividends. Impressive gains were made in reliability, ease of maintenance, and availability of component parts.

VII. CURRENT TRENDS

A new set of changes in weapon system acquisition management seems to be underway in direct response to problems of the 1960's. The effect on the DoD-contractor relationship could be substantial.

One such change is greater latitude in the selection of contract type. Increased attention is being paid to the specifics of each program, and less reliance is placed on overall rules. Either cost-reimbursement or fixed-price contracting may be appropriate for engineering development, depending on the degree to which the system is defined and the technology proven.

Another change is reversal of the trend to central direction of acquisition management. The Office of the Secretary of Defense is restricting its role, for the most part, to review and approval or redirection at established thresholds of cost, schedule, or performance. In so doing, it is allowing the military departments more management autonomy.

Project management is receiving special emphasis in the decentralization effort. Review prerogatives of the hierarchy over the project manager have been reduced and ways are being pursued to strengthen the project manager's operating authority.

Revival of prototype competition, however, is probably the most substantial current change in weapon system acquisition. There is general agreement among DoD officials, contractor management, and independent analysts that the significance of differences among competing paper designs at the end of Contract Definition exaggerated. Many critical unknowns usually are not identified and removed until the latter part of full-scale development. Some remain until construction of prototypes. As a result neither sound technical evaluations nor realistic cost estimates can be expected from the kind of paper design

competition that has been favored in the 1960's. Extension of competition beyond early engineering development is gaining approval as a way to upgrade both technical evaluation and pricing and further stimulate innovation throughout the development process. Most supporters of the approach encourage maintenance of competition through some level of prototyping. A corollary advantage is the decrease in probability of program failure, as dual technical courses are sustained for a longer period.

Although there has been some concern about increasing development time, the primary argument against prototype competition always has been the added cost it brings to full-scale development, since parallel courses are pursued and funded. That argument still is persuasive when the full-scale development cost is a substantial percentage of the total program cost, as is the case with space vehicles, aircraft carriers, and submarines. At the other extreme, state-of-the-art weapon systems in which there is little potential benefit from pursuing parallel courses, prototype competition cannot be economically justified. In between the two extremes, when substantial technological advances are attempted yet full-scale development cost is a relatively small part of total program cost, it is thought that prototype competition may well be worth the additional cost and time it requires.

Can we expect solutions to the problems of the DoD-contractor relationship through application of the concepts of contract type flexibility, decentralization, stronger project management, and prototype competition? We doubt that final solutions will result; only progress. We have come to accept a situation in which management problems continue to outrun abilities to solve them and "gaining a few steps instead of losing a few" is considered a noteworthy achievement.

Is this simply the nature of management of programs of such vast size and technical complexity as weapon systems? Or are we missing something basic? Are we perhaps chasing symptoms and failing to address some fundamental issue which gives birth to them? As a result of the preliminary review of the DoD-contractor relationship made during the conduct of Task 69-21, we are convinced that much of the attempted management improvement has been symtomatic. A depth study of the DoD-contractor relationship is needed to identify and analyze the fundamental issues.

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13. ABSTRACT

This study was a preliminary investigation to define the scope of the basic problems in the DoD-Industry interface. The results of the study are: 1) the defense-industry relationship has been marked by discord and controversy since the Revolution; 2) attempts at solving the problems have resulted in confusion and vacillation in both theory and practice over the years; 3) although new management approaches and techniques are continually being generated, the increase in the technological complexity of weapon systems causes acquisition management to become more difficult; 4) it is recommended that the DoD continue its efforts to formulate and evaluate alternatives to (not merely modifications of) the approach outlined in DoD Directive 3200.9. Ideas should be actively sought from both the private and public sectors and the alternatives developed subjected to rigorous evaluation and discussion.

The report includes a partially annotated bibliography, a conceptual paper on the DoD-contractor relationship, an historical summary of weapon systems acquisition, and a review of current management techniques.

14. KEY WORDS

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