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TOTAL PACKAGE PROCUREMENT CONCEPT,
SYNTHESIS OF FINDINGS
LMI Task 67-3

June 1967

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TOTAL PACKAGE PROCUREMENT CONCEPT,

SYNTHESIS OF FINDINGS

LMI Task 67-3

June 1967

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LOGISTICS MANAGEMENT INSTITUTE

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PREFACE

Since June, 1965, the Logistics Management Institute has been engaged in studying contracts which have been placed under the Total Package Procurement concept. The initial portion of this study was performed under Task Order 65-31 (Appendix A). Three progress reports were made with limited distribution within the Department of Defense. Contributions were also made to reports of a DIAC Working Group.

This report represents the completion of the second portion of the study performed under Task Order 67-3 (Appendix B), and includes an integration of the findings and conclusions of the earlier progress reports under Task 65-31, as well as the results of our additional efforts. The purpose of this study effort was to analyze in detail this new procurement concept as manifested in several initial program applications. LMI has assessed the impact of this procurement concept on both the Government and industry.

Many of the findings and opinions presented herein were obtained from Government and industrial personnel. LMI gratefully acknowledges the contributions and assistance of these people to this study.

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I. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A. Major Conclusions

1. The Total Package method of procurement offers significant advantages over development-only type contracts for both the Government and industry.

Advantages include cost savings, shorter development schedules, design for producibility, long range planning, and from the Government's point of view, increased competition.

Disadvantages include greater financial risk, premature program definition, and severe competition and increased proposal expenses from the contractor's point of view

2. TPP should be applied to operational systems development programs and to smaller programs below the DoD Directive 3200.9 threshold criteria. TPP should not be applied to systems where the technology is rapidly changing and responsive to changing military needs or to systems which require an interface application.

3. There is a greater need for an integrated management information system for TPP programs than there is for development-only programs.

The Government should disengage from the contractor in TPP programs, and retain visibility but not control unless program redirection is necessary

4. On balance, the influential factors of cost, schedule, and system performance in the TPP programs studied tend to support rather than constrain technical innovation.

If TPP is applied only to operational systems development programs, then the discouragement of development innovation above and beyond the minimum performance requirements can be beneficial.

5. A major problem exists in the defining and pricing of elements of logistic support for TPP programs.

B. Major Recommendations

It is recommended that:

1. The objective of the TPP concept be to contract for, in a single contract, as much design, development, production, and logistic support as can be adequately defined and priced at the highest level of detail sufficient for contract purposes.

2. CD efforts for TPP programs be fully funded within the scope of a very carefully scrutinized work statement as opposed to cost sharing.

3. Substantially less pricing data be required for submission under TPP programs where competition is anticipated.

Data for TPP programs should be requested only when clear demonstrated need exists.

4. A major DoD effort be initiated to develop a cost data base of operating and maintenance cost information, as well as the methodology for employing this information on new TPP programs.

5. Integrated logistic support requirements planning be initiated concurrently with systems requirements during concept formulation.

II. INTRODUCTION

A. Definition of Total Package Procurement

The Total Package Procurement concept, "... as conceived by the Air Force envisions that all anticipated development, production, and as much support as is feasible of a system throughout its anticipated life is to be procured as one total package and incorporated into one contract containing price and performance commitments at the outset of the acquisition phase of a system procurement."[1]

The concept is an attempt to eliminate the long standing practice of the DoD to incrementally procure development, production, and logistic support requirements for major systems programs.

B. Study Background

In June, 1965, LMI began an initial reconnaissance effort with the objective of appraising the Total Package Procurement Concept (Task 65-31) as implemented by the Air Force. The first report (November 1965) under this study presented a general evaluation of Total Package Procurement (TPP), and also discussed specific aspects of the Air Force C-5A contract definition effort. The second report (February 1966) presented an analysis of the impact of this procurement technique upon prime contractors as well as LMI conclusions concerning the findings obtained to date. The third report (July 1966) presented an appraisal of the impact of the C-5A Total Package contract upon subcontractors. The report also contained a summary appraisal of several of the specialized contract clauses contained in the C-5A program.

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[1] "Total Package Procurement Concept," Department of the Air Force, 10 May 1966, P.1.

LMI was then requested to study Total Package Procurement from the expanded viewpoint of at least three other TPP programs (Task 67-3). The Short Range Attack Missile (SRAM), Fast Deployment Logistic (FDL) Ship, A-7A and the Light Observation Helicopter Avionics Package (LOHAP) programs were selected for study during the second phase of this project. This final report includes our findings and conclusions from both study efforts. (65-31 and 67-3).

The C-5A program consists of two Total Package contracts; the airframe portion under contract to Lockheed-Georgia, and the propulsion system with General Electric. Both contracts were awarded in September 1965. The Air Force SRAM program is being procured with a Total Package contract to the Boeing Company. The Navy FDL program underwent formal contract definition prior to a Total Package contract award which had been anticipated in mid 1967. The A-7A program has been in production for a few years with the LTV company, and a follow-on buy is now being negotiated. The Army's LOHAP program has been under contract for about a year.

Late in the study program, a cursory review was made of the procurement methods employed in the acquisition of Advanced Aerial Fire Support System (AAFSS).

Many other Total Package programs are now being embarked upon by the military departments. The population of such programs will be substantially expanded in the next year or so, and should provide increased knowledge about the benefits and problems associated with the concept.

C. Purpose of Report

The purpose of this report is to bring together the available knowledge concerning implementation and lessons learned on the initial Total Package Procurement (TPP) programs. It is clear that a need exists for a comprehensive volume on TPP which could be distributed to industry and Government, and it is our hope that this report fulfills the need.

The report contains a discussion of the Total Package concept and the background preceding its formation. The need for special contract provisions is discussed, and the advantages to be realized from Total Package Procurement are presented.

The approach to presenting the impact of TPP in the programs studied was to isolate the effects of this procurement concept with respect to past similar programs. This has been difficult to do in many cases; some changes have been so interrelated with the use of contract definition and fixed-price contracting as to make the task of TPP isolation one of imputation. Nevertheless, the report presents the impact of TPP on various aspects of defense programs.

The report recommends some modification of the concept--primarily with regard to the extent of "totality" of a TPP. Application of the TPP concept to DoD programs should be limited only by the extent of technical risk, responsiveness to rapidly changing technology, and the area of poorly defined system interfaces. The need for disengagement and integrated management information systems is pointed out, as well as the increased importance of the concept formulation period of a TPP program.

Nine recommendations are presented including several changes for data requirements for TPP programs. Major efforts are needed to develop a cost data base of logistic support cost information for use in accurately projecting life cycle costs for weapon systems. This need has been recognized, and some efforts are currently underway.

The appendix of this report also contains a brief description of the major TPP programs studied and an annotated summary of studies related to the LMI TPP tasks.

D. Conduct of the Study

Throughout this study it has been difficult to isolate and evaluate the effects upon the programs reviewed of the Total Package Procurement concept. One effect of particular interest is that of the cost associated in contracting for a TPP program. Many comments of interviewees indicated that they were not reacting to the new Total Package Procurement concept, but rather to the process of Contract Definition (CD), which is also relatively new. Both concepts were applied to the C-5A and SRAM programs and became almost completely blended in the minds of many contractor and Air Force personnel. Similarly, the many unique contract clauses contained in C-5A and SRAM contracts have added significantly to the problem of identification of specific reactions to and effects of Total Package Procurement.

The initial task order for this study (6F-31) specified that LMI review the various concepts encompassed within "Total Package" Procurement from inception to completion. In addition to concept evaluation, we were asked to establish the

TPP effect upon procurement procedure, contract definition, competition, and management methodology. To accomplish this, it was necessary to fully understand the concept and the programs chosen for implementation of the concept, as well as problems, advantages, and disadvantages for both the Government and industry. It was necessary to analyze concept formulation, contract definition, the contract, and the acquisition phase of all programs involved. Technical development plans, request for proposals (RFP), and contractor proposals as well as the resulting contracts were all reviewed.

Interviews were conducted with Government representatives at all levels of the OSD, headquarters of the military services, project offices, and supporting organizations such as technical laboratories, procurement, financial, and legal offices. On the industry side, interviews were conducted with over 200 individuals at the prime contractor and subcontractor levels of both successful and unsuccessful competitors. In this manner, we attempted to reconstruct what occurred (and why it did) both prior and during the formal competitions, as well as the actual conduct of the program with the contractors selected.

We specifically avoided any information associated with source selection procedures and decisions which were essentially beyond the scope of the inquiry. In some cases we deliberately postponed visits and analyses until after the military department awarded a contract or until after prime contractors awarded subcontracts.

The study efforts were also coordinated with those of the Air Force offices involved in studying various aspects

of the C-5A acquisition program, as well as in reviewing reports and articles published by various Government organizations. LMI also observed the work of the Armed Services Procurement Regulation (ASPR) Subcommittee established to draft TPP direction. In addition LMI participated as a member of the DoD Field Survey Group for the DIAC Subcommittee formed to study the impact of TPP on technical innovation.

During the study period, the Logistics Management Institute was called upon to provide numerous briefings to various DoD organizations in order to disseminate our findings in a timely manner, and to act as consultants to assist project offices planning Total Package contracts.

III. THE TOTAL PACKAGE PROCUREMENT CONCEPT

A. Background

During the normal acquisition and operating phases of a major weapons system, all or a substantial portion of the contracting situations and contract types delineated in the Armed Services Procurement Regulation (ASPR) will be employed in meeting systems' needs.

The systems approach to weapons acquisition has eliminated the need for separate concurrent contracts for development of specific hardware, software, training equipment, AGE, etc., by including all the acquired aspects of the total system into one contract at the development stage (except where Government furnished equipment is specified). This systems approach has demonstrated substantial advantages over prior procurement methodology in which separate contracts were used for development of discrete end items of hardware and software. This trend toward inclusiveness relates only to the combination of pieces of the system and has not been applied with similar impact to the functional categories of work that will be required over the total life of a defense system. Thus, DoD has contracted separately for research, development, test and evaluation (RDT&E) and for production of the system in fiscal year increments.

Similarly, contracts for support, training, spares, maintenance equipment, facilities, and continuing systems responsibility are negotiated separately and sequentially. Without regard to the administrative difficulties involved in negotiating and administering each of these separate contracts, a case can be made for a broadened contract functional approach, both on the grounds of increased competition and on the grounds of improved systems performance.

In the past, the Military Departments have generally competed only the development portion of major acquisition programs. Typically, this competition has been almost exclusively a design or technical competition. Production contracts which follow sequentially from the development contracts have generally been negotiated in a sole source environment with the development contractor, despite the fact that the dollar value of these contracts over the total life of the system will far exceed that of the initial development contract. This situation has caused contractors to "buy-in" (quoting a price for development work which may be substantially less than anticipated costs, or at the very least results in a very low profit) on development contracts. Having won the developmental competition, the contractor is then virtually in a sole source position for the extensive production portion of the program, and can "get well" through negotiation rather than performance on the production contracts.

Under the sequential contract approach, the contractor's preoccupation with the functional tasks on contract may motivate him to maximize certain aspects of the system which may have a less than desirable effect on the price and work package that will ultimately be required to operate and support the system. Thus, a contractor maximizing design for technical performance may fail to give sufficient attention to the producibility of the system, and specifically reliability and maintainability in some instances. Systems engineering methodology as evolved in the ballistic missiles programs has alleviated many of these problems. Nevertheless, application of the separate development and production contract philosophy frequently places the contractor and the Government in a position of conflict and requires that the Government exercise considerable control in the design stages of the program.

B. The Requirement for Special Contract Provisions

Total Package Procurement requires the inclusion of certain special purpose provisions. The special financial provisions in Total Package contracts can be placed in one of three categories: (1) those intended to maintain the integrity of the established target prices, schedule, and system performance during the course of the program; (2) those created to provide reasonable protection for the contractor against cost increases that are beyond his control; and (3) those that encourage the contractor, where economically possible, to improve upon the price, performance, and schedule commitments contained in the Total Package contract. The provisions necessary to maintain price integrity are the most important, and will be discussed in greater detail.

The clauses directed toward maintaining contractor commitments during the course of the program are of three kinds -- those which seek to maintain price commitments, those which seek to maintain performance commitments, and those which seek to maintain schedule commitments.

The price commitment clauses consist primarily of clauses pertaining to pricing of changes. Performance commitments have generally been enforced through inspection clauses in Government contracts. Government acceptance becomes conclusive on the matter of meeting contract requirements except in rare circumstances.

Schedule commitments have often been difficult to maintain in large programs. Such commitments require efficient management techniques on the part of the contractor to determine that the myriad items of material and labor involved in creating a

total system will, in fact, be interrelated and integrated in order to deliver a finished product on schedule. In order to provide greater motivation to contractors to maintain schedule commitments, a liquidated damages approach is often used. The basis for using this approach is to calculate a reasonable amount of damage which might accrue to the Government in the event of late delivery.

Three provisions necessary to maintain performance and price commitments are outlined below:

1. Total Systems Responsibility

A keystone of a major weapons system acquisition is the systems performance specification. This specification which results from the Government's systems performance requirement, as refined by the contractors during contract definition, becomes the overriding contractual document. When government-furnished equipment is specified for a system, or when contract end item specifications are inadequate, there is need for a total systems responsibility clause to shift to the contractor the burden for overall systems performance.

The main decision to be made is whether emphasis is to be given to the total system, as defined in the parameters of the total systems responsibility clause, or to the various dependent systems that may go into making it up. Under total systems responsibility, it would seem that a CFE approach should generally be taken, especially in a competitive type Total Package procurement where the Government has reasonable assurance that overall costs will be less and improved management will result.

2. Correction of Deficiencies

Use of a correction of deficiencies clause which extends the period of time for discovery of defects into the operational life of the program is a necessity in a TPP contract. Without such a clause the Government would in fact have no way of knowing whether the deliverable end items that they were accepting would ultimately serve to produce the capability required by the systems specification. The correction of deficiencies clause does not provide substantive requirements for the system or for any item of equipment delivered thereunder. The value of such a clause, therefore, stands or falls upon the systems specification and the contract end items specifications which it is intended to support. Requirements for parameters of system performance, including maintainability and reliability, are clearly set forth in the system and end item specifications. Adequate testing procedures are clearly set forth in the contract in order that the extended period of time allowed by the clause for final acceptance is of value.

3. Changes to Specifications and Drawings

In a Total Package Procurement, more so than in development-only contracts, sole-source negotiation generally occurs in the area of changes to the drawings, system design, and specifications. Such changes cannot be avoided entirely, since often they result from changes in system performance requirements. Optimally, only those changes which can be justified from a cost/effectiveness point of view, or those changes which are absolutely necessary in order to up-grade the contracted-for systems performance to fulfill new requirements are incorporated into an existing program. To date, the problem has been the creation of a

technique that would discourage both Government and contractor program managers from making changes which do not, from a cost/effectiveness standpoint, enhance program or system performance.

In spite of weighted guidelines suggestions, the general practice has been to negotiate the same profit percentage on changes as that negotiated on the basic contract. In order to provide the contractor with an incentive to keep changes to an optimal minimum and to discourage the imposition of changes by the procuring activity, a new change pricing structure has been applied in some Total Package contracts. The basic tenet of this approach is that by restricting the contractor's profit on changes over and above a certain aggregate percentage amount, the contractor can be expected to resist rather than encourage changes. In order to avoid the administrative time and expense of pricing minor change proposals, a dollar limit can be established below which individual changes will not be priced and will not result in adjustment of the target cost, target profit, or ceiling price.

C. Anticipated Advantages

The Total Package Procurement concept envisions that all anticipated development, production, and as much support as is feasible for a system throughout its anticipated useful life, be procured under one contract which contains price and performance commitments obtained at the outset of the acquisition phase of a systems procurement. TPP is an attempt to extend both competition and contractor responsibility over the entire acquisition period of a system, as well as extending contractor concern for the operating life of a system.

Six principal benefits are anticipated under the concept and it is against these that the success or failure of Total Package contracting should be measured.

(1) TPP requires a tightening of design and configuration discipline, both in the specifications on which the competitors' proposals are based and in the work under the contract. TPP also acts as an internal DoD discipline in resisting change once the program is underway.

(2) TPP inhibits unrealistic "salesmanship" or buy-in bidding; it increases competition for more of the complete program cost.

(3) Commitments to cost and performance in connection with production and operation prior to the completion of detailed design motivate the contractor to design initially for economical production, reliability, and simplicity of maintenance and operation. There is little motivation in the absence of a production or support commitment to consider the production and support cost factors which are strongly influenced by the initial design approach.

(4) A TPP contractor is motivated to obtain supplies and services from the most reliable and efficient source, whether in-house or by outside contract.

(5) The Government is able to make a choice between competing contractors, based not on mere estimates but on binding commitments as to price and performance, and can phase these costs and performance figures into programming and budgeting with greater confidence than those obtained from estimates.

(6) Both the Government and the TPP contractor derive benefit from long run program stability and continuity, specifically with regard to planning for funding, personnel, facilities, and overhead.

While the ultimate goal of Total Package contracting would be the incorporation of complete development, production and support in a single contract, TPP contracts to date have evolved into something less, inasmuch as parts of the support requirements, notably spares and depot AGE, have not been included. The problems that these (and other) gaps present and the difficulties involved in filling these gaps will be discussed as part of this report.

IV. ANALYSIS AND IMPACT OF TOTAL PACKAGE PROCUREMENT

Although it is not yet two years since the formal introduction and titular announcement of the Total Package Procurement concept, this change in systems procurement has had a substantial effect upon the defense community. The full impact of the concept may not be realized for several years, although it is possible at this time to note some definite effects of TPP upon the nature of defense procurement and upon the concepts involved in the contracting function.

TPP has an effect on Government and contractor actions during the entire procurement planning, proposal, and acquisition phases, and will have an effect upon the operational phase of a program. The impact of TPP upon major areas of interest is presented below.

A. The TPP Concept

Separating and analyzing the concept of Total Package Procurement independently from the relationship to other aspects of the programs studied has been the most difficult portion of this task. The concept causes and requires different methods of program management and systems acquisition than are employed for development-only programs.

To begin with, none of the programs studied is theoretically a total package contract. All of the programs included with development, known production hardware requirements on contract (or as a firm-priced option). Two of the programs included major elements of logistic support as a part of the initial Total Package contract. When contrasted with the traditional methods of systems acquisition, i.e., sequential development, production, and logistic support contracts, any movement toward package procurement seems advantageous to both the Government and industry.

The concept also necessitates a change in the criteria used for source selection. The concept of life cycle costing,[1] should be an integral part of the TPP concept. In some of the programs studied, there was an attempt to select a TPP contractor by considering the lowest operating costs over the life of the system. The capability to perform such an analysis is apparently not yet available. Many Government and industry personnel were greatly disappointed in not being able to fully apply the life cycle cost approach to TPP selection. Efforts have been underway to rectify this situation, by: applying life cycle costing to major systems procurement, LMI Task 67-21; the preparation of DoD Directive 4100.35, Development of Integrated Logistic Support for Systems and Equipment; and preparation of an integrated logistic support planning handbook, LMI Task 66-15.

B. Cost of Defining TPP Programs

In all but one case, firms who participated in the programs studied provided LMI with their contract definition and bid and proposal costs. An analysis was made to ascertain the total industry expenditures for C-5A TPP contract definition. The prime contract competitors stated that they spent $46 million in addition to the $25 million the Air Force funded. After discussions with subcontractors, LMI estimated (see Section G) that C-5A subcontract competitors spent $99 million. This amounts to a total of about $170 million as the cost of C-5A TPP contract definition.

These costs, as a percent of the contract price they were used to define, are summarized in Table I by industry group.

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[1] See Appendix C, "Life Cycle Costing in Equipment Procurement."

TABLE I

CONTRACT DEFINITION EXPENDITURES FOR THE C-5A PROGRAM

	Airframe Primes (3 Companies)	Engine Prime (2 Companies)	Major Sub-Contractors (6 Companies)	Minor Sub-Contractors (4 Companies)
Average Contract Value	$ 1.4 Bil.	$ 460 Mil.	$ 23 Mil.	$ 3.5 Mil.
Average Proposal Expenditure	22.5 Mil.	2 Mil.*	500,000	175,000
Proposal Expense as Percent of Contract Value	1.5	0.5	2.1	5.0

*Does not include concurrent technical development program funded by the Air Force

The total of $170 million of C-5A contract definition costs may also be viewed as a percent of the entire C-5A program it defined. This total program has been estimated at some $2.6 billion, including the options for follow-on production. The $170 million, therefore, amounts to 6.5 percent of the total program price. LMI could not obtain data for comparable costs associated with other major non-TPP system procurements, and therefore is unable to suggest whether these total C-5A costs represent an increase or a decrease over past experience. From Table I it may be observed that a sampling of subcontract competitors indicates that they spent appreciably more per contract dollar than prime contract competitors; again, we do not know how this compares with non-TPP procurements.

Contract definition costs (bid and proposal costs in the case of the LOHAP program) for the other programs studied are presented in Table 2.[1]

The C-5A and SRAM competitors told us that the funds provided were insufficient for the level of effort indicated by the Air Force, and therefore company funding was required. These firms also hastened to add that they would be willing to (in fact, have to) engage in any future contract definition effort even if they have to again finance portions of the effort comparable to these programs.

One C-5A airframe competitor estimated that it spent ten times more of company funds on the C-5A contract definition than it did on a recent similar aircraft program (not a TPP) under contract definition. It attributed the major portion of these added costs to defining the logistic support aspects of the C-5A program.

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[1] Bid and proposal costs were not obtained for the A-7A Program.

TABLE 2

CONTRACT DEFINITION COSTS

Program	No. of Competing Firms	Concept Formulation and Prime Contract Definition Costs			Program Price		Definition Costs as % Initial Contract	Total Program
		Company Funded[b]	Govt. Funded	Total	Initial Contract	Total (with Options)		
C-5A[a]	5	$46.0 Mil.	$25.0 Mil.	$71.0 Mil.	$ 1.8 Bil.	$ 2.6 Bil.	3.9%	2.7%
FDL[c]	3	9.0 Mil.	17.2 Mil.	26.2 Mil.	500.0 Mil.	1.0 Bil.	5.2%	2.6%
LOHAP	6	1.35Mil.[d]	0	1.35Mil.	16.1 Mil.	22.8 Mil.	8.4%	5.9%
SRAM	2	12.0 Mil.[e]	5.5 Mil.	17.5 Mil.	144.0 Mil.	521.0 Mil.	10.8%	3.0%

[a]Combined airframe and engine contracts

[b]Excluding subcontractors and suppliers

[c]Estimated

[d]Total prime competitor costs extrapolated from sample

[e]Estimated

C. Technological Innovation

During the course of the TPP study, LMI made many individual visits to defense contractors and Government agencies seeking information relative to the effect of TPP upon technological innovation. In September 1966, the Logistics Management Institute was invited to serve as a working member of the Defense Industry Advisory Council (DIAC) Subgroup which was formed at the request of the Assistant Secretary of the Air Force (I&L) (See Appendix C). The DIAC participation required fifteen additional visitations for the purpose of answering the question, "Will Total Package Procurement (TPP) stifle innovation and creative technology?"

Of concern here are technical innovations of two kinds: inventions, engineering developments and unique components and assembly, which are deliberate attempts to achieve the stated technical requirements of the system under contract (engineering - development innovations); and the second category of technical innovations are concerned with engineering or scientific improvements aimed at improving on system performance capabilities beyond the stated requirements (growth innovations).

In attempting to assess the effect of TPP upon technological innovation, LMI used the following assumptions:

(1) Technical innovation primarily occurs at the lowest levels of design and engineering organizations.

(2) The environment in which technical personnel work will affect the quantity and quality of technical innovations.

(3) A primary source of technical innovations, whether it be innovation required to meet performance requirements or for product improvement is the normal engineering iterative process of investigating alternative technical approaches.

(4) Innovation (especially growth innovation) is often a response to satisfy customer needs for something new or greatly improved.

LMI's study of TPP and technological innovation included the interviewing of approximately 75 designers and engineers who worked on the programs studied. Questions concerning technological innovation were posed in unstructured interviews to all those visited. Some of these questions were: "What is different about your work under this program from other past (non-Total Package) programs?" "Would having a Total Package contract cause you to manage the technical aspects of the program any differently than other contracts?" "Does the change in procurement method have an effect on Technological innovation?"

The majority of designers interviewed believed that Total Package Procurement does (would) not inhibit technical innovations. A comment of one designer which illustrates this point was: "It's not my job to worry about the overrun. My job is just to design a good product." In fact, many of the factors affecting technical people in the Total Package programs studied tend to <u>encourage</u> technical innovation rather than to constrain it. Factors promoting innovation are such things as; technical performance requirements, company prestige, market potential, and system cost.

In addition to designers, an equal number of program and engineering managers (both industry and Government) were interviewed on this subject. They also were of the opinion that technical innovation would not be affected by TPP since they don't "put brakes" on their engineers because of a firm dollar commitment. There are, however, several cases where technical innovation had been (or was) clearly inhibited because of the

emphasis on cost and schedule associated with the Total Package contract. In some cases, performance improvement innovations were not included in the system because of the added technical risk involved and/or cost and schedule limitations. This seems to be the result of having large numbers of production units and elements of logistic support on contract during development.

The earlier LMI progress reports on TPP (November 1965 and February 1966) stated that a total program price (secured under competition) may result in the contractor possessing a strong incentive to reduce costs and consequently design for minimum cost and minimum performance. The report also stated that in some cases the fact that TPP causes design definitions to be made at an earlier point in the "normal" design cycle could result in some sacrifice in system design capability. C-5A prime contract competitors interviewed in this study stated that because of this earlier definition and substantial price competition, TPP may discourage ingenuity and that early technical definitization may cause later problems because the design is "locked in" too soon. Another firm estimated that Total Package Procurement has the effect of freezing design one to one and one-half years earlier than conventional procurement methods.

It appears to LMI that at least part of this "compression" of development is a result of the process of contract definition, and would occur whenever contract definition were applied. It was difficult for some interviewees to distinguish between the effects on early program definition due to contract definition and Total Package requirements. It also appears that the fixed-price type contract which has always been used for TPPs acts as a discipline on contractors by limiting the amount of money available for study and investigation of alternate approaches and derivative products.

There also were opinions to support the point that design freeze at an earlier time causes acceptance of a more conservative design, and in the end could result in less of a weapon system. A subcontractor in the C-5A program confirmed that his subsystem design was a very conservative approach, but that the growth potential of the system would not be hampered by the procurement method. Another subcontractor stated that although there were substantial technological innovations in its design approach prior to and during CD, there is no incentive for him to propose growth changes other than the potential of other applications of the subsystem. One successful prime contractor representative stated that he did get locked in early but this is good insofar as it will tend to discourage engineers' desires to continually change and improve. The connotation of "getting locked in early" refers to the early design definitization which occurred in some programs partly as a result of Government engineers' desires and partly as a result of the contractor's production and pricing people forcing earlier definitization. However, the design is not "locked in" contractually in the TPP contract until first article approval.

Other people interviewed indicated that TPP developed systems will be less than "we usually design," but what the customer is paying for. The designer is constrained by the original cost proposal and the production people. The project manager of one system carefully told his personnel (most of whom had previously worked on cost-plus contracts) that they should <u>not</u> conduct any special studies or exercises for the Government project office, and in fact should not engage in discussions with Government representatives that might lead to technical effort unless absolutely necessary. The project manager explained that the

contractor couldn't bid the price he did unless we could enforce this approach. The majority of TPP subcontract competitors stated that it was business as usual for them as far as technical and design methodology was concerned; i.e., there would be no effect of TPP upon technical innovation. Engineers of one subcontractor firm said they thought that the subsystem they were designing would not have any growth potential because Total Package is placing emphasis on price.

In three companies visited, there was some difference between what management thought the effect of Total Package Procurement would be upon innovation versus what the technical people believed to be the case. In these companies, management stated there should be a change in the actual conduct of Total Package programs, so that program costs and production planning are emphasized more so than on past contracts. Technical representatives of these firms did not believe any change did (or should) take place in design and development as a result of TPP.

D. Price Competition

The majority of firms interviewed in three of the four Total Package programs currently on contract indicated that strong price competition existed for the systems they were in competition for. As a result, several of these firms made substantial price reductions during the contract negotiation process. These reductions ranged up to as much as 30 percent of the initially proposed contract price. Most of the firms indicated that they were willing to accept the Total Package contracts involved at something less than the customary fixed-price-type contract profit. In the C-5A program, the desire

for additional follow-on procurement as well as the commercial potential involved was clearly a motivating factor. In the LOHAP program, the potential for applying this subsystem to other major aircraft programs was the strongest motivating factor upon the contractor. For the SRAM and A-7A contractors, follow-on production was the reason for contractors' desires to make price reductions since it was estimated that the total program requirements were not firmly on contract.

One contractor representative interviewed stated that competition in general had increased in the aerospace field for major programs since there are fewer major programs coming along these days and if you "miss one, you'll have to wait eight years for the next opportunity." Further increased competition also manifests itself in the fact that the contractors interviewed for the most part were willing to accept the terms and conditions specified by the Government; these were fairly stringent in some cases. It's the contractors' opinions these terms and conditions are a major source of increasing the contractor's financial risks associated with the various programs studied.

Contractors interviewed often made the analogy between TPP programs and commercial programs. The commercial profits (as a percentage of sales) that were cited, however, were substantially greater than defense profits for non-TPP programs. Since the risks and responsibility of TPP are more akin to that of commercial contracting, it may be that it is appropriate for profit levels to be increased to something greater than that provided on development-only contracts. This would be commensurate with the increased financial risk and greater responsibility assumed by the industry under Total Package Procurement.

E. TPP Data

Total Package Procurements have been characterized by massive data generation on the part of both industry and the Government. In large part, these data may merely be symptomatic of the vast effort undertaken by all parties involved in the Total Package acquisition of a major weapons system. (The quantity of data will also be discussed later in this chapter in connection with personnel requirements for TPP competitors.)

Virtually all of the prime contractors involved in this study stated that the RFP requested considerable detailed technical and financial data which were unnecessary. They pointed out that the amount of data requested for these TPP programs was far in excess of that of any prior military program. According to the C-5A and SRAM contractors, much of the request for data, and the ensuing proposals, was due to the imposition of the Air Force Systems Command 375-1 and -5 series manuals, in addition to normal source selection data requirements. In addition to technical data, the requirement to price most of the support aspects of the program added appreciably to the data submitted. One contractor estimated that the financial data requested was 32 times the amount requested on another recent aircraft program. Another estimated that 50 - 60 percent of its entire technical effort was involved with defining the support aspects of the program; that is, defining support in sufficient detail to price. This firm further noted as an indication of the extent of the problem that (as in most major programs) it was necessary to develop twice as much, and in some aspects five times as much data internally as were actually submitted in response to the RFP.

F. Management and Control

1. Visibility Versus Control

The majority of firms interviewed concerning their participation in the Total Package programs studied expressed concern that the Government was exercising an undue amount of managerial control. In general, these firms wanted authority commensurate with the increased responsibility that TPP places on the contractor. Further, since in their opinion TPP provides greater financial risk, this too necessitates greater authority for the contractors involved. Several of these firms mentioned that detailed management and control needed in a cost-plus environment is wholly inappropriate in a TPP program. Comparable control is exercised, however.

One firm which participated in the C-5A competition estimated a six to ten percent added cost (which is included in the contract price) for detailed management reporting required as a part of the contract. Another company vice-president said, "The Government wants to buy professional management under a competitive situation but is scared to do so, and therefore imposes detailed management on top of this."

These management controls in the financial and technical area primarily are manifested in management information systems. In the case of the C-5A and the SRAM programs, the Air Force imposed its 375 series regulations as well as PERT cost, Cost Information Reports and other management reporting controls. The A-7A program is a firm-fixed-price contract, and apparently as a result has far less of these kinds of detailed controls than the other Total Package programs studied. As a result of the C-5A experience, the Air Force has suspended further application of the 375-5 (systems engineering) specification pending study of existing requirements. In accordance with the

recommendations made by the Special Air Force Task Group which studied the C-5A program, the C-5A SPO (and to a lesser extent the SRAM SPO) has adopted a policy of "disengagement" with regard to the contractors involved in these programs.

The basic tenet of disengagement is the elimination of many contracting officer or plant representative approval requirements. The requirement is removed for affirmative Government action before program decisions are made. Thus, approval of subcontractors and preliminary and final design reviews are eliminated. The application of disengagement has, however, placed increased emphasis on visibility intended to provide the Government with confidence in the progress of the program that is necessary to allow for disengagement. Elimination of prior Government approvals will not facilitate contractor responsibility and authority unless the Government judiciously uses the fruits of its increased visibility. Frequent requirements for explanation of lower level aberrations or discrepancies in program data can handcuff a contractor as tightly as a requirement for prior Government approval. A DIAC Working Group has been formed to study in depth the matter of disengagement (see Appendix C).

2. Management Systems

Most firms interviewed on the question of management information systems felt the Government was placing an inordinate amount of data information requirements in their Total Package programs. Much of this, they felt, was unnecessary, duplicative, and quite detailed. In some cases, the Government's required work breakdown structure for reporting purposes was not consistent with that which the company had developed for its own internal use. There were therefore two independent but duplicate systems in force for information gathering and presentation to management.

As a result of the Air Force's C-5A experience and ensuing analyses, the Air Force Systems Command has established a management systems control board that is responsible for the control, development and judicious application of a management system for each new acquisition program. This is an attempt to reduce the numbers of independent management systems that would be in force within one service. This observation confirms the finding of the recent Aerospace Industry Association's Systems and Management Analysis Group report which addressed the problem of the proliferation of management information systems. A conclusion is presented on this point in Chapter V.

3. Organizational Effects

During the course of our study, LMI has been impressed with the importance of viewing changes in the existing defense environment as an impact not only of TPP but of contract definition, of increasing shifts to fixed price contracting and of increasing price competition. All these factors have caused changes that are being felt both at the prime contractor and subcontractor levels as well as within the Government agencies. In general, the response to the new procurement and management practices has been for the technically oriented defense industry to emphasize more and more the business aspects of weapons acquisition. Total Package procurement places great emphasis on cost and production and has therefore caused some management and organizational changes so as to emphasize the role of cost, production, and logistics support at a much earlier time in the development phase of a program. One subcontractor vice president said, "We need business managers to

manage these programs, not engineers. We are still too technically oriented--production should have a stronger say. Our engineers are not oriented toward cost--we haven't faced the fact that we will not release a design for production because it is too expensive, but we may have to."

As a result of having a Total Package contract, another firm initially assigned project managers to run the complete development program as well as production, instead of changing management at the prototype point as they had previously done. They expected this to result in lower overall costs and program stability. Still another contractor interviewed noted that he assigned a program manager for a subsystem for the first time in the company's history since they had not been organized along project lines. Another prime contractor made a major organizational change to emphasize the financial and schedule control aspects of his Total Package program. He assigned engineers to the purchasing department as buyers to act as restrictors on designers--to filter out "gold plating" and data requests.

These specific changes mentioned above appear to be indicative of the change in philosophy on the part of contractors with Total Package programs. The orientation is definitely toward cost, toward schedule, toward the producibility aspects of systems under Total Package contracts.

G. Logistic Support

Perhaps no other area has been affected so completely and radically by the Total Package Procurement concept as that of logistics support. Virtually every contractor interviewed during the course of this study who had elements of logistics

support in their Total Package contract, cited the difficulties and risks associated with planning and pricing the elements of logistics support in the pre-contractual period. Substantial amounts of technical and non-technical manpower were consumed in this definition and pricing effort. Aerospace ground equipment, initial spare parts, maintenance, training equipment, data and documentation, and technical services were the elements of logistics support most frequently required in the Total Package programs studied. Of the four Total Package programs currently in the acquisition phase, the C-5A has the greatest degree of completeness insofar as logistics support is concerned. The SRAM program follows very closely behind. In the A-7A and LOHAP programs the difficulties associated with planning and pricing logistic support elements caused these project offices to essentially abandon the inclusion of major elements of logistic support in the initial contract.

In the C-5A program the Air Force found it most difficult to assess the credibility of contractor estimates submitted for elements of logistics support such as initial spares, replacement spares, maintenance and ground support equipment. The three airframe prime contractor proposals varied substantially in their estimates of logistic support costs. Contractor estimates for replacement spares and maintenance varied by a factor of almost two to one from one contractor to another, and for initial spares by more than a factor of three to one from one contractor's estimates to another.

The primary problem cited by both Government representatives and industrial representatives was that of the requirement to define logistic support elements concurrently with the definition of the weapons system. Historically, the military departments and the defense industry have sequentially defined,

priced, and produced spares, training equipment, AGE, etc., after the initial development contract has been placed, and in fact, virtually completed in some cases. In a Total Package procurement, contractors are asked to concurrently define and price these same elements of logistic support. This necessitated earlier definition of the system involved in order for the logistic support planners and designers to then be in a position to define the requirements for AGE, spares, maintenance, etc.

In the case of the C-5A program, spare parts of over $500 in unit cost were defined and priced individually as a part of the contract definition effort. If the Air Force orders spare parts within a specified period, it could order them from the contractor at the price listed. Both the Air Force and the contractors involved agreed they had reservations as to the specifics of definition of the spare parts involved; although the price is specific, definition of what is to be procured is questionable. The SRAM program benefited from this lesson in that this contract calls for spares to be priced during the production process at a maximum price determined on the basis of the total item or sub-item price less assembly and testing costs. That is to say, the Government will order spares during the production period at the contractor's cost of producing the subsystem or sub-item. The C-5A contractors priced AGE, training equipment, and contractor technical services without specifying a required quantity level. These elements of logistic support are to be procured on an "as required" basis.

The problem of defining and pricing logistics support for a Total Package contract is further compounded during contract definition insofar as logistics support costs are normally used for a life cycle cost analysis, and hence source selection purposes. If the contractor and the Government are unable to

decide on the definition and reasonable pricing of elements of logistic support, this complicates the source selection problem and eliminates an important function of a Total Package contract. This is a major problem area in Total Package procurements and will be discussed in Chapters V and VI.

H. Effect Upon Subcontractors of Total Package Procurement

Subcontractor reactions and opinions on Total Package Procurement effects have been almost entirely obtained from the C-5A program experience. With the help of the Lockheed-Georgia Company, the prime C-5A airframe contractor, the five largest dollar Total Package subcontracts were identified. These subcontracts resemble the Air Force's prime Total Package contract with respect to totality and terms and conditions. The five winning subcontractors, as well as each of their primary competitors, were visited. In this manner a picture of each of the five subcontract programs could be constructed from both the successful and unsuccessful contractors' points of view. These five subsystems being procured under the Total Package concept represent some $75 million of an anticipated $400 million subcontract program. In addition to the ten firms who competed for these five subsystems, two other subcontractors were interviewed after the initial portion of this study was completed; they were the TASK Corporation, a subcontractor to Lockheed in the C-5A program, and Texas Instruments, a subcontractor to LTV in the A-7A program.

The five C-5A subsystems and the contractors interviewed are presented in the following table:

C-5A Subsystems	Firms Interviewed
Multi-Mode Radar	Norden Division, United Aircraft Sperry Gyroscope
Navigation System	Nortronics Division, Northrop Corp. North American Aviation, Autonetics Div.
Landing Gear	Bendix Product Aerospace Division, Bendix Corporation Cleveland Pneumatic Tool Co.
Electrical Power	Specialty Control Division, General Electric Aerospace Div. Westinghouse Electric
Attitude and Heading Reference	Lear Seigler, Incorporated Eclipse-Pioneer Div., Bendix Corporation

Significant time was spent with each company discussing the C-5A program, with from two to ten people in each firm being brought into the discussions. Those interviewed ranged in position from company president or general manager to individual engineers and accountants. A wide range of functional areas was covered in conjunction with each firm's proposal efforts, the contract definition process, proposal costs, and--for the successful firms--the actual contract.

The reactions, interpretations, and evaluations of subsystem competitors are presented in the following section.

1. Cost of Contract Definition

Each of the ten subsystem competitors was asked to provide the total cost of its C-5A subsystem proposal effort. This included all costs incurred before and during the formal contract definition period from December 1964 to 1 October 1965, as well as the recompetition after October 1965 to actual contract award. In most cases, the firms interviewed submitted bids to all three of the airframe prime contractors, and also made substantial proposal revisions to Lockheed during the recompetition. The average amount spent on these proposal efforts was $375,000 per company, and virtually none of this was paid for by prime contractors or the Government. The amounts varied from as little as 0.5 percent to as much as 15 percent of the bid price of the contract. The average spent for proposal work by those firms interviewed was 2.5 percent of the contract price. The majority of the firms stated that this was somewhat more than had been spent in past comparable subcontract proposal efforts. (Not enough actual data were obtained to make accurate comparisons.) One firm stated that the amount spent by his firm was more than six times as much as on recent comparable programs. Despite the costs incurred in this subcontract effort, several of the firms interviewed believed that it was still more expensive to bid to the Government than to a prime. Three companies considered their proposal expenditures to be high but generally in line with other recent contract definition programs. Four firms also indicated that from one - to two-thirds of their proposal costs were incurred during the recompetition phase, i.e., in that period of subcontract competition after the prime contract was awarded.

The majority of firms interviewed expressed the opinion that the formal contract definition process causes the cost of proposals to be run up, and not the Total Package Procurement method, and that a large part of the costs could be saved by shortening the contract definition (plus recompetition) phase. One subcontractor said, "Contract definition means you do it twice," indicating the extent to which he had to revise his proposal during the recompetition.

Based on the data received from the firms interviewed, the average number of competing firms, and the dollar value of subcontract effort, we calculate that almost $100 million may have been spent by subcontract competitors in preparing proposals related to the C-5A TPP program employing the contract definition technique. This is calculated as follows:

	<u>Airframe Subcontractors</u>		
(1)	Average firm's proposal expenditure (as percent of potential subcontract)	=	2.5 percent
(2)	Total subcontract dollar value	=	$400 million
(3)	Average number of firms competing/ subsystem	=	8
	Total to be spent by competing airframe subcontractors	=	(1)x(2)x(3) = $80.0 million
	<u>Engine Subcontractors</u>		
(1)	Average firm's proposal expenditure (as percent of potential subcontract)	=	2.5 percent
(2)	Total subcontract dollar value	=	$125 million
(3)	Average number of firms competing/ subsystems	=	6
	Total to be spent by competing engine subcontractors	=	(1)x(2)x(3) = $18.8 million
	Total	=	$98.8 million

This total amount does not include third-tier subcontractor and other material procurements by primes and their suppliers. (One subcontractor estimated that he requested data and quotes from over 100 suppliers. He estimated that it cost each company about $1,000 to submit a proposal.)

2. Contract Definition Data

The subcontract competitors were unanimous in stating that potential subcontractors were asked to supply more detailed data than were required in previous (non-TPP) competitions. The subcontract and prime contract competitors stated that the proposal data requirements were, next to logistic support, the most costly and least useful items of their proposals. These proposal data were generally in the form of greater justification for a contractor's specific technical approach and substantially more cost information than had normally been requested. In addition, prime contractors requested substantial amounts of technical and cost data for logistic support aspects of C-5A subsystems in question. This was essentially a new requirement for the firms interviewed.

The majority of companies interviewed stated that although more technical data were being requested by primes, no additional technical work was necessarily required when compared to previous competitions. The non-technical aspects (i.e., plans and programs, cost detail, support, etc.) of the proposal effort were substantially more costly than previous proposal efforts. One subcontractor stated that contract definition for TPP programs required longer time and greater detail but has the advantage of reduced risks via greater detailed analysis. The C-5A contract definition plus recompetition lasted from 15 to 18 months for most subcontractors visited and this time was considered too long by the majority of these firms. They

emphasized that shrinking this time would significantly decrease their proposal costs.

Another item of concern to several firms interviewed was the large amount of management-type data required by the three prime contractors during contract definition. These data included such things as manufacturing plan, quality assurance program, purchasing plan, management report, field service organization, and others. In most cases the three prime contractors' requests for these reports were different enough so as to require the subcontractor to write a significantly different proposal for each prime. This was effort these subcontractors considered to be unnecessary and greatly added to the size of proposals. Even though the prime contractor assumed certain data reporting requirements instead of passing them along to subcontractors, one subcontractor stated he must still provide 72 items of data whereas a previous comparable aircraft program required that he submit only 8. His comment was, "Data is getting to be the end item these days."

Proposals varied from two to ten times greater in size than on past programs, with one firm submitting an 8-inch proposal for a similar subsystem they propose, ". . . a few years ago in five pages." Three firms stated that their proposal size was comparable to another recent (non-Total Package) aircraft programs, except for the increase in logistic support and maintenance efforts.

3. Competitive Pressure

Eight of ten competing firms interviewed indicated that strong price competition existed in C-5A airframe subsystems. Six of these firms stated they made substantial price reductions during the process of contract negotiations. These

reductions varied from 8 to 30 percent of the contract price, with an average reduction of 17 percent (one of these reductions was due in part to a change in contract terms). One contractor went so far as to say, "Competition made this a financially risky contract." The two subcontractors that did not make such price reductions were also successful in resisting other aspects of the procurements in question: One subcontractor would not agree to contractually accept a requirement to provide AGE as a part of his Total Package contract, while another successfully resisted both the AGE requirement and several other contract clauses, such as liquidated damages and the changes pricing clause. (See Chapter V.)

In the case of five competitors, price reductions were justified on the basis of potentially applying these C-5A subsystems to other aircraft programs rather than as an attempt to "buy in" to the C-5A program. In fact, most subcontractors interviewed stated that for their items the C-5A program is a very low volume program, and as such represents an "inefficient" production rate. One subcontractor suggested that the competition for a Total Package subcontract "may be less, due to the larger risks" associated with these programs. (Both C-5A prime contractors' comments on this point are discussed below.)

Lockheed and General Electric were queried on the question of competition for C-5A subcontracts. In their opinion, less vigorous competition existed for C-5A subcontracts than for recent comparable programs. This difference was attributed to the fact that many subcontract competitors were heavily backlogged due to increased defense expenditures for Vietnam. Three subcontractors stated that several of their competitors

dropped out of the C-5A subsystem competition due to the severity of price negotiations and terms and conditions. There appeared to be vigorous price competition among some subcontract competitors and a lack of such competition amongst others in the C-5A program.

4. Technical Transfusion

A majority of subcontractors interviewed said that technical transfusion did take place in one form or another at the subcontractor level. The technical transfusion at the subsystem level represented fairly minor ideas and equipment, except for at least one major subsystem requirement that was transfused. The most prevalent form of these transfusions was the prime contractor's revision of RFP requirements--particularly in the recompetition phase. One firm was outwardly critical of the process of technical transfusion, stating that it reduced its incentive to innovate; "What good is it to be smart," indicating that his "smart" ideas would be passed freely to his competitors.

Several subcontractors commented that the effect of contract definition--as of technical transfusion--was to assure that all competitors at least met the minimum requirements. A representative of another company interviewed noted that the contract definition process independent of Total Package Procurement was causing a major change in the formation of the technical aspect of his proposals. "We learned a lesson; submit only the minimum acceptable system." The implication of a contractor's statement, ". . . submit only the minimum acceptable system,"

is that any subsystem exceeding the minimum technical requirements would generally be more costly and probably not be competitive. The same company representative quoted above also suggested that an analogy exists between contract definition and two-step formal advertising procurement, insofar as both attempted to technically equate all proposals, and then emphasize price competition.

5. Logistic Support

All companies interviewed said the C-5A contract definition required them to define and price the elements of logistic support, primarily AGE, spares and data. One contractor did "very little" added work, and another did "no added design work" to meet that requirement. The majority, however, expended considerable amounts of technical and non-technical effort on support definition and pricing. Contractors provided estimates of this effort which varied from 10 to 40 percent of the total contract definition work, and AGE definition constituted the major portion of this effort. Most subcontractors visited had requirements for AGE identification in past subcontracts, but in the case of the C-5A they were also required to price AGE, and guarantee its adequacy and completeness. One firm said this added effort was twice as much as the support aspects of previous programs. Another said 50 percent of this total technical effort was expended on support--"and the customer never asked us a question on it. . .this was a paper exercise." Another competitor said the AGE requirement represented the most risky part of his proposal, and he had to include a 25 percent contingency in pricing AGE.

As in the case of the prime contracts, the logistic support aspects of subcontracts amounted to a fairly small portion of the total acquisition cost--in most cases less than 5 percent. Several subcontract firms asserted that much of their support proposal efforts would not be useful in the actual conduct of the program. They had limited confidence in logistic support elements defined at such an early time, and because of the many (normal) changes they anticipated in the subsystem.

6. Contract Terms and Conditions

Two of the subcontracts examined were firm-fixed-price (FFP) in form, while the other three were fixed-price-incentive (FPI). The FPI contracts have price ceilings that vary from 120-125 percent of target cost and cost sharing of either 50/50 (underrun) - 70/30 (overrun), or 85/15 (underrun/overrun). All of the subcontracts included a development phase, an initial firm production order (production run A), plus an option for follow-on quantities to support production run B.

This arrangement of options and firm production requirements was analyzed with the firms interviewed in order to acquire an understanding of the value of options to a subcontractor. The Total Package feature of initially contracting for development and production was not at all new to most of the firms interviewed. Some subcontractors noted that other recent (non-TPP) programs have included options and/or firm production commitments. In discussing the question of the value of an option versus a firm production commitment, five firms stated it made no difference to them whether they had an option or a firm production commitment. Two of the other firms interviewed said it is good to have a large backlog, and therefore

a firm production commitment is worth something; one said it makes a difference in his bid price, but he could not quantify the difference. Another company representative said he assumed options as firm and planned accordingly. The remaining firm interviewed said that having an option does not change its price, but it does change the way they do business; i.e., "a half-million dollar development expense can save one million in production costs," which indicates the extent to which planning for production and flexibility between development and production could result in substantial cost savings.

The majority of the subcontracts studied also included a maximum labor rate to be utilized in pricing follow-on production quantities beyond production run B. Several potential subcontractors thought that this requirement was oppressive insofar as their commitment to these rates could extend as long as ten years in some cases. Although many firms asked the prime for protection, none of the subcontractors was able to successfully negotiate an economic escalation clause into its contract. Three firms did, however, escalate their rates on a stated three percent level, while one added a ten percent contingency in his price for protection against inflationary effects.

Two other contract terms also provided considerable concern among subcontractors. These are the change pricing clause and the correction of deficiencies requirement. Although the changes clause varies from subcontract to subcontract, the basic changes clause which the prime attempted to negotiate provided for payment only for those subcontract costs resulting from changes to material and tooling which arise from engineering or specification changes. Most companies interviewed reluctantly accepted some form of this basic clause, although two firms would not accept the clause at all.

The correction of deficiencies clause basically follows that form contained in the prime/Air Force contract for the C-5A airframe. Five subcontract competitors stated they included a contingency in their price for this clause. The contingencies varied from 0.5 to 10 percent of the contract price, with an average of 5.5 percent. Two firms stated that in the C-5A program, a greater risk associated with this clause was the fact that production chronologically follows design so closely. As such the schedule exposed a large percentage of in-process hardware to any changes required. Two other subcontractors said this clause presented no problem to them insofar as they normally assume this responsibility (both the changes and correction of deficiencies clause), and amounted to just formalizing past moral commitments in a TPP contract.

Although several subcontractors knew the specific terms and conditions contained in the prime contractor's contract, they were mostly unsuccessful in negotiating for some of the advantageous clauses contained in the prime contract, such as Government paid for changes, economic fluctuations, and changes in federal law which impact on the contract.

I. Manpower Requirements

1. During Contract Definition

Virtually all of the firms interviewed (primes and subcontractors) during this study noted that TPP program competition required a much greater quantity of manpower input than had any previous comparable program. There is no doubt that formal contract definition is a major cause of this high manpower requirement. When the concept of contract definition was first

introduced by the DoD some four years ago, it was promoted as a means of conserving the nation's scientific and technical manpower by reducing the number of firms who would engage in large scale proposal efforts, as well as reducing the probability of program cancellation by earlier program definition. It is believed that CD has accomplished an aggregate savings in national talent even though firms competing for a particular program, and the corresponding project office, are faced with increased manpower needs.

In the C-5A program, a 3000 page (including additions) RFP provided the basis of a mammoth CD effort. The Air Force used some 400 people, representing over 130,000 man-hours, during the Phase C period alone. Putting together a group this size for three months is a substantial in-house Government manpower drain, which may also have an adverse psychological and organizational impact. From the individual competing companies point of view, the cost of such an effort is staggering, not only in monetary terms but in the consumption of limited scientific and technical manpower. Four firms also noted proposal opportunities they had to forego because their people were tied up on the TPP programs studied. Two other firms stated that they incurred schedule slippages on other programs as a result of having spread their key people too thin.

Staffing needs for both the Government and industry in the pre-Total Package contract period stem from three basic sources--the RFP statement of work, the data requested during CD, and the source selection criteria and procedure. Aside from the source selection criteria, which might well be made the subject of a separate study, the manifestation of the first two sources is the RFP itself. This study has shown that Total

Package programs require early staffing of both contractor and Government project offices including the procurement area.

2. Government/Industry Information Interchange

Several CD contractors interviewed stated that Government representatives were extremely cautious in their discussions with CD contractors so as not to disclose any of the details of their competitors' approach. Three contractors related that they believed these Government representatives to be over zealous in safeguarding such information, and resulted in project office personnel "shielding" technical evaluators from their counterparts in the contractor's organization. A successful CD contractor said, "The _____ system will be less of a system because we didn't have (the usual) opportunity to bounce ideas off the technical people in the labs." This study has pointed out the need for improved communications between buyer and seller, both at the prime contractor and subcontractor levels. Such communications, as manifested in the RFP as well as during the CD period can insure that proposals are responsive to the buyers' needs. In the CD programs studied, Government and industry representatives stated that industry proposals, and hence the selected systems, could be improved if greater freedom of communication were permitted during Phase B. Such communication is, of course, normally restricted in order to guard against claims of unfair competitive advantage.

3. Requirements for Naval Architects and Marine Engineers

During the course of this study, LMI was asked to analyze the requirements for naval architects and marine engineers for Total Package ship programs. This was prompted by the possibility that at any given time a large number of specialized scientific and engineering professionals may be engaged in several Total Package programs. Since the number of naval architects

and marine engineers is substantially smaller than other technical disciplines, and inasmuch as there are only three major schools providing this specialized education, Total Package Procurement of ships may have an effect on the naval architecture and marine engineering professions. This analysis is contained in Appendix F.

J. Special Purpose Contract Provisions

The Air Force developed several unique contract provisions and applied these to the C-5A and SRAM TPP programs In particular, three clauses caused substantial concern among both Government and contractor personnel; total system responsibility, correction of defects, and the changes clause.

1. Total Systems Responsibility

Two of the contractors involved in the C-5A contract definition thought that the total responsibility provision was workable and would satisfy its intended purpose. Two other firms interviewed stated that the total responsibility provision is "not workable." One went so far as to say that "total package won't work due to total responsibility." These latter firms believed that both conceptual and administrative problems are associated with the prime contractor having responsibility for the performance of government-furnished equipment.

Both of the contractors interviewed in the SRAM competition felt that the total systems responsibility clause, as it pertains to systems performance on the FB-111 program (including SRAM) was a major difficulty in the contract. The failure to agree upon a missile/aircraft interface specification during contract definition was a matter of great concern to the

missile system contractors. Furthermore, the fact that the missile system's performance testing on the FB-111 program is planned to be performed in conjunction with the FB-111 flight test program (actually on alternate days) caused consternation among the contractors. In their opinions this dual testing procedure provides a large gap through which either the carrier aircraft or missile system contractors, or both, might alleviate their responsibility.

The Aeronautical Systems Division in their lessons learned report concluded that:

> . . . if the total system responsibility clause is used, it is essential during Phase B to obtain agreement between the system contractor and the GFE contractors regarding interfaces, and design and performance characteristics to be specified.

The Headquarters USAF study group examined the total systems responsibility clause in the context of whether the engines on the C-5A should have been bought CFE or GFE. They concluded:

(1) The Air Force would have been involved in decisions affecting the engine procurement whether it was GFE or CFE because of the criticality of the item not only to the system being procured, but to contemplated future systems as well.

(2) To the maximum extent practicable the Air Force should place the responsibility for the performance of the total system on the contractor, whether there is GFE or CFE involved.

(3) When the engine is GFE the enforcing of total systems responsibility on the airframe contractor will be more difficult than when the engine is CFE.

(4) The engine or any other critical component could have been bought CFE.

(5) The real issue will be one of "changes" without regard to whether the item is CFE or GFE.

Although neither ASD or Headquarters USAF has expressed any opinion on the total responsibility clause as included in the SRAM contract, it seems clear that there are questions as to the validity and workable nature of the clause in conjunction with the FB-111 program. Originally it was intended that interfaces would be worked out between the FB-111 carrier and the FB-111 avionics programs during the SRAM contract definition period. No interface control documents resulted from this exercise and it remains incumbent upon the Air Force to provide this document to the missile system contractor sometime in the future. At that point it is possible that the missile system contractor may object to the proposed interfaces. This problem is supported by the extent of discussion over the desirability of a total package approach on a dependent system where interrelated systems are undergoing concurrent contract definition or development.

The question of total systems responsibility is a difficult one, and as suggested by the Headquarters USAF study group, does not hinge upon GFE or CFE, although use of either method might provide for a greater contractual and administrative complexity or simplicity. The real question involved is one of the Government's implementation approach to the weapons systems

concept. In the C-5A procurement the Air Force stated clearly that it was "primarily concerned, not with the operation of engines and other GFE in isolation, but with the total system." This statement, made in relationship to C-5A, while seemingly innocuous on its face, does represent a considered change from prior Air Force policy, in that engine and other GFE were originally conceived of as items that would be applicable to a myriad number of systems. The emphasis on growth potential or flexibility with regard to certain GFE items, especially engines, often resulted in a less than optimum fit with any given system; but a greater range of possible fits.

No such statement was made by the Government with regard to the SRAM missile system and it is unlikely that this was an oversight. Just as the SRAM was not to be designed specifically for the FB-111, neither was the FB-111 to be designed specifically to carry the SRAM; nor was the FB-111 avionics package designed specifically for use only on the FB-111 for use only with the SRAM missile system.

A possible approach is to divide the systems up into existing or standardized systems as opposed to developmental or future potential systems. Thus, in the case of AGE already in the inventory it may be advisable to require the contractor to design the system to utilize as much of this existing AGE as possible rather than require the introduction of new items into the inventory, unless the systems cost would thereby become prohibitive. Where such equipment already exists in inventory and will not have to be acquired specifically for the purposes of this system, GFE type action is appropriate. (This is essentially what was done on the FDL.) Where, however, large additional

increments of an item have to be procured specifically for a system, it would seem administratively simpler to have the contractor acquire the equipment on a CFE basis either directly from the equipment manufacturer or through the good offices of the Government. It may, in fact, even be less costly to go the CFE route.[1]

As the Air Force's Aeronautical Systems Division report pointed out, in this type of approach it is absolutely necessary to prepare and obtain approval of interface control documents during the pre-acquisition contract stage, especially when some of the contracts are being let in a highly competitive atmosphere and others are primarily sole source. One additional positive feature of a CFE approach is that it allows the contractor to meet systems performance in the lowest cost approach possible. That is, where he finds that one element is defective in the total systems approach he may choose either to correct that element or to upgrade the performance of another dependent element in order to achieve the overall systems mission requirements. The C-5A total responsibility clause recognizes this advantage of CFE and attempts to deal with the problem by allowing the prime contractors to separately agree (outside of the government/prime contract) as to how corrections should be made and, in that case, to inform the Government of the contract to which costs should be allocated despite the fact that they may bear little or no relationship to the actual contract upon which the costs are incurred. Once again, this is an artificial attempt to achieve, in a GFE setting, the results which arise quite naturally from a CFE procurement.

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[1] See LMI report "Cost and Effectiveness of Government and Contractors Purchasing Systems," Task 65-20, August 1966.

2. Correction of Deficiencies

Four of the firms interviewed in the course of this study stated they included a contingency in their price to cover potential deficiency corrections. This provision was thought to provide a substantial potential risk by two of these firms. As such they found it necessary to include contingencies in their prices to cover the requirement, which varied from one to three percent of the total program price. Two of the four firms including contingencies stated that virtually all this amount was removed by vigorous price competition.

The comments of prime contractors, aside from the risk exposure aspect of the clause, centered about two administrative provisions. The first was a question concerning who would pay for the transportation of already delivered items to the point directed for correction or, in the alternative, the transportation of employees to the point directed for correction. This was resolved by the insertion of a clause to make it clear that the Government would absorb these costs outside the scope of the contract.

The second point of contention related to the requirement that the contractor inform the contracting officer of potential deficiencies in supplies not yet delivered under the contract. Contractors seem to believe that this was an unwarranted intervention in the management of the contract. The Government, on the other hand, believed that to the extent that corrections of deficiencies were allowable costs under the contract, and, therefore, that the Government would be sharing in the costs of such corrections, it would rather have the options and alternatives open to it to either direct correction, partial correction,

or delivery of deficient equipment with adjustment in contract price. Such flexibility requires that the Government be informed of potential deficiencies before contract items are in fact delivered.

ASD's lessons learned report concluded that:

> . . . use of a correction of deficiencies provision in contracts for the development/acquisition of weapons system in other major equipment contracts is highly desirable. To be most meaningful, such provision should be developed and made known to contractors at the very outset--while the influences of competition are present. The provision should be structured in such a way as to afford the Government the protection it desires, while at the same time motivating the contractor to accomplish design/development/production effort in such a way as to minimize the occurrence of deficiencies in delivered products.

As stated in ASD's report, it is only reasonable to inform contractors of the provision at an early time so they may assess the potential risk to the company, and either design accordingly or include a contingency in price, or perhaps some combination of both courses of action may be pursued.

3. Changes to Specifications and Drawings

The changes clause as applied in the C-5A and SRAM programs is designed to motivate both the contractor and Government procuring agency to exercise restraint in introducing program and engineering changes.

Only one of the prime contractors interviewed expressed any real concern over the change pricing clause as contained in the C-5A and SRAM contracts. In most instances, discussion was limited to the unpriced change lower limit. In both

contracts this was $100,000. One SRAM competitor reviewed his experience on similar weapon systems to determine the number and amount of changes under $100,000, and decided to add a small factor in his price to cover the contingent cost increases (estimated to be less than 1%). The other competitor determined that the changes up and down would in all probability offset each other and did not specifically include any factor for this provision of the clause.

The clause separates changes into four major categories, dependent either on their individual or aggregate magnitude:

- Individual changes representing increases or decreases in price below a lower limit are not costed and result in no adjustment in target cost, target profit and ceiling price.

- Individual changes above the lower limit amount are costed and result in increases or decreases in 1) target cost, 2) target profit (10 percent of target cost increase), and 3) ceiling price (sum of 1 and 2 increases) until aggregate change costs, up and down, exceed 3 percent of the initial target cost.

- Individual changes which increase costs beyond the 3 percent aggregate level result in an increase in 1) target cost, 2) target profit (2 percent of target cost increases), and 3) ceiling price (sum of 1 and 2).

- Any individual change costed at more than 1 percent of the initial target cost results in an increase in 1) target cost, 2) target profit (10 percent of target cost increase), and 3) ceiling price (130 percent of target cost increases) and is not included in determining the three percent aggregate limit for category c.

Perhaps the most important part of the clause is the provision which states that the negotiated target cost adjustment shall in no case exceed the estimated cost increase or be less than the estimated cost decrease proposed by the contractor at the time of the change proposal submission. As already noted above, the underlying philosophy of this approach is to impose the initial burden of change constraint on the contractor with regard to all but the most gross change.

V. CONCLUSIONS

The conclusions concerning Total Package Procurement are based on the foregoing analysis of TPP experiences, including the prime contractor and sub-contractor sectors of industry, as well as the Government.

A. Concept

The Total Package method of procurement offers significant advantages over development-only type contracts for both the Government and industry. On balance, the advantages far outweigh the disadvantages (both cited below) and consequently LMI recommends the use of Total Package Procurement for systems procurement. The concept originally stated in brief as "Contract for as much as you can compete," we believe should be revised to be stated as, "Contract for as much as can be adequately defined and priced." Definition of elements of logistics support and for complete production quantities is essential to TPP, and, in this sense, we believe "partial" Package Procurement contracts will be more normally the case as opposed to "total" package procurement. (It may in fact be said that a "total" package procurement has not yet been made.)

One contractor suggested that the Government consider "nodal" package procurement as a variation in the TPP concept. The implication here is to buy a node worth of program; i.e., up to the first overhaul point, or 2,000 hours of aircraft performance, or some other measure of system life. In this fasion, it would be possible to avoid defining the complete life cycle logistic needs of a major system procurement. This idea is similar to the failure free warranty program recently proposed by a major defense contractor. We believe these approaches are worthy of further consideration.

Firm production commitments as opposed to priced options provide contractors with greater incentives and stimulate greater competition. The initial experiences with offering contractors options as opposed to firm commitments indicate that the option prices were the same as would have been offered for firm purchase commitments. Nevertheless, we believe that there is an unquantifiable difference in price which the contractors have confirmed. Aside from price, there is a strong psychological difference (as viewed by the contractors involved) and for this reason it appears desirable to contract on a firm commitment basis wherever possible as opposed to the use of options. The firm commitment provides a stronger motivation to invest in facilities (if required), it provides a sales backlog, and a firmer planning base. (One firm stated that they would have built a $10 million facility if they had a "real" TPP contract instead of one with priced options.)

B. Advantages

1. Cost Savings

Based upon an independent analysis of both Government and industry data it appears that Total Package Procurement can result in substantial dollar savings over conventional development, sequential production, and support procurement methods. Our initial studies have included independent cost analyses which indicate that virtually all of the savings accruing from TPP have been passed along to the Government under the strongly competitive environment, in the form of lower contract prices. Savings will also be realized due to greater efficiencies in the total acquisition process. Estimates of the savings to be realized were offered by three firms interviewed. They were all ten percent.

Efficiency is further obtained due to the earlier definition of design and the greater amount of development work conducted during the concept formulation and contract definition (proposal) periods.

2. Shorter Schedule

It is concluded that TPP will help to shorten development schedules as a result of substantially more development work being done at an earlier point in time. Three quantitative estimates were obtained--two from industrial firms and one from the Government. All were about six months in duration. It is therefore expected that TPP systems could be introduced into operational status faster than non-TPP systems.

3. Development/Production Flexibility

Total Package Procurement does provide contractors with substantial incentives to design for producibility. Our experience has shown that contractors for the most part are taking advantage of greater flexibility between the development and production portions of the program. Being able to spend additional money during development to be recouped in a more producible design provides a substantial advantage, both to the contractor and to the Government in the eventual operational product. Since TPP systems are designed with producibility as a goal, actual production time and hence operational deployment time (see above) will be decreased.

4. Planning

LMI concludes that a major advantage to TPP is the long range planning it allows. Several firms cited the long range planning for marketing, overhead allocation, facilities requirements, production scheduling, and personnel requirements

that a company can take advantage of under a Total Package program. The Government also benefits from the long run program stability and firm total program price derived from a TPP contract. Planning for facilities in particular under a Total Package Procurement could provide the inducement for firms to invest in facilities as opposed to requesting Government assistance in facilities construction. One firm interviewed made a decision to invest $40 million of company funds in facilities primarily on the basis of the planning stability of a Total Package contract.

5. Increased Competition

TPP has caused a substantial increase in design and price competition among the contractors visited. All of the programs studied contained proposals far exceeding most of the minimum performance requirements. In two cases, the technical competition was described as "severe." Since it has been fairly well established that the potential for follow-on production work is a powerful contractor motivating factor, there is every reason to believe that this incentive alone may have given rise to substantially increased competitive pricing on the contract package.

C. Disadvantages

1. Increased Bid and Proposal Expense

TPP proposals have increased bid and proposal expense due to the length of contract definition and the additional requirements for defining and pricing production and logistic support elements of TPP programs. Industry in general and the Government are concerned with the bid and proposal expenses associated with TPP programs. It must be pointed out, however, that

since so much additional development, definition, planning and programming, and contract negotiation work are being done at an early point in the normal program life cycle, it can be expected that bid and proposal and formal contract definition costs will be large for Total Package contracts. These are costs that would ordinarily be incurred during the development and production portions of conventional procurements. In this view, these necessary costs are merely shifted from the usual development and production contracts to the contract definition phase of a program. Attention should be given, however, in attempting to minimize these type costs.

2. Greater Financial Risk

TPP programs place greater financial risk upon defense contractors. To begin with, Total Package programs, if contracted for in a fixed price fashion in a price competitive environment, will in and of themselves provide greater financial risk to the contractors involved. This risk is further increased by the long-term exposure that the contractor has committed himself to as well as the sheer magnitude of the contract involved. The need for improved cost-estimating techniques is pointed out here since poor estimating alone can eliminate virtually all of a contractor's profit and potentially adversely effect capital for even the largest aerospace firms. It follows therefore that this should be taken into consideration when TPP profits are negotiated.

3. Early Program Definition

TPP causes program and design definition to be performed earlier than is the case in development-only programs.

Early system definition is brought about by the requirement to define and price in detail prior to contract many system elements which traditionally have been defined during the development program. This disadvantage is in a sense a mixed blessing insofar as we have cited it as an advantage to shortening schedule, thereby saving time and money. It has the associated disadvantage of firming up on design details, specifics of performance, and logistic support definition fairly early. We believe, in some cases, this may result in a sacrifice in technical design. When design is established early, it is extremely difficult to take advantage of later advances in the state of the art. One contractor interviewed estimated that TPP has the effect of freezing design one to one and one-half years earlier than conventional procurement methods. It appears to LMI that at least part of this "compression" of development is a result of formal contract definition and would occur regardless of the method of procurement. It was difficult for some interviewees to distinguish between the effect on early program definition of contract definition and Total Package.

4. Severity of Competition

Competition for TPP programs may be so severe as to cause contractors to reduce their commitments after contract award. Under the Total Package concept it may be that contractors involved will reduce their price to an uneconomical or unprofitable point. Under these conditions, a contractor might be unusually motivated to attempt to case off or reduce the extent of his obligations under the terms of the contract, or find ways of increasing the scope of work for potential increases in profit as well as total program volume. This gives rise to the possibility of cost

overruns attributable solely to the severity of the competition and the resultant low price. Further consequences of severe competition may be an extremely low quality, low durable design approach, or a general cheapening of the product since the contractor has a strong incentive to reduce costs and design for low cost production. This point is associated with technical innovations which will be discussed later.

D. Application

1. LMI concludes that TPP is an effective procurement technique when applied to operational systems development (or engineering development at the CD stage) type programs (using DoD Directive 3200.9 definitions); that is to say, so-called state-of-the-art programs. It is the ability to define a program technically and financially that makes it most attractive to Total Package Procurement. Programs requiring research or considerable exploratory development might force contractors to include large cost contingencies and presumably weaker contractual terms if they were required to accept Total Package Procurement. To the extent that the production and logistic support requirements can be well defined TPP contracts should include such requirements.

2. TPP should also be effective if applied to "small" programs where DoD Directive 3200.0 criteria are not applicable. We believe that substantially the same advantages will be realized for small programs as for large systems acquisition via TPP. The dollar value of a program should not be a factor in judging suitability for Total Package contracting.

3. The application of TPP should be limited by two specific criteria. First, in an area of rapidly changing technology, TPP may be too conclusive an approach unless it can be

sufficiently responsive. Since TPP "locks in" on a specific set of performance requirements for a fairly long period of time, being able to respond to a change in military need may be more of a problem in a Total Package Procurement than in conventional development/production programs. The second general area of limitation in TPP is that of a system which requires an interface application; i.e., one that is dependent upon another system or, in the case of a sub-system, which must be integrated into the weapons system. Here, if the interface is not well defined or if the parent system is subject to change, the change may be substantial enough to seriously impair and even destroy the advantages sought in the Total Package Procurement.

4. There may be situations in which Total Package Procurement should be applied where competition is not anticipated. LMI believes that there are substantial advantages to be gained by both Government and industry by applying Total Package Procurement to selective sole-source procurements. Improved procurement planning, shorter schedule, and development/production flexibility can also be realized in a sole-source environment through use of TPP.

E. Management and Control

1. There is a greater need for a DoD integrated management information system on a Total Package Procurement program than there is for a development-only program. What is needed is a system that will integrate financial, technical, and management information requirements. This is particularly needed in TPP because the production cost considerations of the program begin early in the development cycle and cannot be divorced from the technical aspects of the program. Currently proposed management information systems should insure the availability of such an integrated system.

2. The Government should disengage from the contractor as much as possible in Total Package Procurement programs. The Government should always retain visibility of the contractors' efforts so as to be constantly aware of problem areas which may necessitate redirection or program realignment. This visibility should, however, fall far short of detailed management and control. Performance specifications, output specifications, (called capability criteria in some cases) are in agreement with the TPP concept and appropriate for use in this kind of program. When and if some elements of detailed design are vital to the program requirements, they should be specified. The occasions for doing so, however, should be few and far between and carefully guarded by the project office involved. Most design approval requirements prior to first article acceptance should be removed from TPP programs and greater reliance made on performance specification requirements.

Intelligent application of the "visiblity" concept will provide top level program management information with the capability to go to lower levels only if the top level information indicated a need to do so. If the program is running smoothly, the contractor should continue managing without Government interference or direction. Where the total program seems to be in trouble, the Government can investigate the program components and functional areas to identify the problem area. At that time only do suggestions and comments become appropriate.

F. Technical Innovation

1. If TPP is applied only to operational systems development programs, then the discouragement of development innovation above and beyond the minimum performance requirements is appropriate and in fact beneficial. The contract definition

process is meant to produce performance specifications, verify technical approaches, establish program schedule and cost, and definitize the contract. The inherent assumption in this process is that the Government knows precisely what its requirements are and is satisfied that industry is technically capable of performing the work. Applying Total Package Procurement under the above circumstances has the highly beneficial effect of discouraging unnecessary development innovation after contract definition. Although technical innovation under these circumstances could improve a product so as to exceed the customer's requirements, such innovation would also most likely increase cost and prolong schedule.

2. On balance, the influential factors of cost, schedule, and system performance in the Total Package programs studied tend to support rather than constrain technical innovation. TPP contractors are "pressed" to develop design innovations in order to meet cost, schedule and performance requirements. These factors, while not exclusively characteristic of TPP, also act to constrain technological innovation. Substantial evidence and judgment does exist to indicate that contractors will be inhibited from pursuing improvement-type changes to the system under Total Package Procurement contracts. (We present this conclusion as preliminary in nature since the DIAC sub-committee formed to study this specific question has not presented a final conclusion in this matter.) It is LMI's opinion, however, that TPP contracting could create an environment which discourages system changes and growth improvements which affect technical personnel so that future innovation may be inhibited. Effort should be expended to consider the establishment of procedures and environmental inducements to guard against the potential impact of any such long term (growth) technological discouragements as currently appear to be the case.

G. TPP Contract Form

1. Total Package Procurements should be contracted for by using a firm fixed price or fixed price incentive contract form. In the case of both of these forms, incentive arrangements should be considered where the Government can satisfactorily construct and administer such incentives in an interrelated performance, schedule, and cost incentive arrangement.

2. The use of a model contract as a part of the initial RFP for Total Package Procurements will greatly aid in developing the required clauses, contract language, and incentive arrangement for the eventual Total Package contract. Special clauses will be required as a part of Total Package contracts. Clauses generally accepted as necessary are cited in Appendix D.

3. In general the terms and conditions of Total Package contracts made available to subcontractors are more stringent than the similar terms and conditions provided in the Government/prime contractor contract. In the case of the C-5A system, most of the prime contract "beneficial" clauses were not passed down to the subcontractors involved. This situation is partly indicative of the severity of competition at the subcontract level, as well as the general acceptance of greater business risks by subcontract competitiors.

H. Logistic Support

A major problem exists in the defining and pricing of elements of logistic support for TPP programs. This problem has existed in all of the TPP programs studied and has the effect of potentially limiting the usefulness of TPP and results in more partial package programs than Total Package programs. Efforts

formulation, the Government must firm up system requirements, not design details. In the case of naval ship programs, this represents a major change to the Navy insofar as more work of a different nature is necessary during concept formulation than has been done in the past.

3. The Request For Proposal document is perhaps the most crucial document in a Total Package program. It sets the stage for the amount of work required to be done during contract definition, the contract itself, and the ensuing development program. A well-planned, complete, well-written RFP is an essential prerequisite to conducting a successful contract definition and ensuing TPP program. In this connection, the need for early, but not necessarily more, project office staffing in the technical, financial, and procurement areas is essential.

J. Source Selection

The award for a Total Package Procurement should be made on the lowest life cycle cost/effectiveness basis. That is to say, cost effectiveness as a modeling tool must be used in order to assess the technical differences between proposals submitted. A major problem cited previously is that of defining and pricing elements of logistic support. In spite of the fact that the task is extremely difficult at best, the Government and industry should attempt to pursue support definition as far as possible. (Efforts currently underway have been cited above.) Since a Total Package "worth" of a system is being procured, the cost involved and the cost effectiveness relationship must be life cycle cost. RFPs and resultant contracts should be structured for the lowest life cycle cost at a given level of effectiveness or at the highest level of effectiveness for a given cost.

Once such a model is constructed and contractors' proposals evaluated with the aid of this model, it should be the basis of the contractual specification for effectiveness and cost elements. Such an approach does not preclude transfusing technical ideas from one proposal to another. It must be pointed out, however, that technical transfusion has been quite minimal on the systems studied. A substantial amount of "informal" technical transfusion did occur prior to contract definition in the programs studied and much of this transfusion manifests itself in the final RFPs that were released.

K. Total Responsibility

The concept of holding one contractor totally responsible for the performance of the system under contract is necessary in a TPP environment. The system approach, i.e., having one prime contractor and other contractors as subs to it is a more desirable management technique for assuring total systems compatibility and performance achievements at the specified levels. This should, in turn, be coupled with a minimum of Government-furnished equipment to be supplied, and complete total cost planning for inclusion in the Total Package program under contract. Difficulties can arise when it is necessary to hold a prime contractor responsible for the performance of GFE subsystems and equipment.

L. Total Package Subcontracts

Total Package Procurement is not greatly different for subcontractors than previous contract practices. In recent years, having a development program with a small production order and added production options seems to be an accepted subcontract

form. In some TPP programs, elements of support such as AGE, training, and data were included in contracts with some difficulty. Further changes occurred in these programs as a result of adding new contract clauses.

Prior to the advent of TPP, subcontractors knew they would get the production, spares, AGE, etc., in many cases, therefore Total Package Procurement offers little advantages or difference from the previous methods of contracting. In spite of a few comments of this sort, the majority of subcontractor firms were of the opinion that there was a distinct advantage to having a Total Package subcontract.

Subcontract competitors were also questioned on the similarity between Total Package Procurement and commercial contracting. Two major distinctions were made. First, commercial contracts do not require extensive reporting and documentation; second, the time period covered by commercial contracts is usually shorter than on Total Package contracts. The risk to subcontractors of rising price levels and changing market conditions, without adequate escalation provisions, is substantially greater under TPP than it is on commercial contracts.

M. TPP Ship Programs

If embarked on, the FDL program will have major effects on both the Navy and the shipbuilding industry. Shipbuilders would be involved in a new way of doing business with newly adapted skills and techniques. The FDL contract definition contractors have conducted mission analyses and trade-off studies between ship acquisition and operating costs. The most important aspect of ship design is in the preliminary, i.e., concept formulation stage, as it is for virtually all other weapons systems. More

technically competent people would consequently contribute more effectively in preliminary design rather than in the detailed "drafting-board" design stage. Greater design responsibility would be required of industry; and the Navy should develop a strong in-house systems analysis capability for ship acquisition. The use of systems analysis to establish credible performance requirements is essential to a successful Total Package Procurement.

VI. RECOMMENDATIONS

A. Concept

LMI recommends that the objective of the Total Package Procurement concept be to contract for, in a single contract, as much design, development, production and logistic support as can be adequately defined and priced at the highest level of detail sufficient for contract purposes. The purpose of Total Package Procurement should be restated as, "Contract for as much of the total system as need be defined for purposes of obtaining the aggregate prices required for the contract." Cost and design details should not be required for submission as a part of the TPP concept.

There will be cases where it may be impossible, impractical, or unnecessarily burdensome and costly to define and initially contract for all production and logistic support requirements. This includes those programs whose production quantities have not been firmly established at the time of contract definition. Most often, these cases will include programs where maintenance and support plans are so inadequately defined as to preclude even aggregate pricing of spares, AGE, data, and technical services, or where operational deployment plans are incomplete.

The above conditions should not preclude the use of Total Package Procurement even though the "package" to be contracted for is something less in completeness than a literal definition would imply, since the advantages of Total Package Procurement may still be obtained even though the "package" contracted for is something less than will ultimately be required. The production and support portions of a program may be included either as options or firm production commitments, or some combination of both.

Experience to date indicates that logistic support, and AGE and maintenance in particular, are the program elements most difficult and costly to define. Under such circumstances, it is sound to contract for a Total Package Procurement which does not initially contain undefinable elements of logistic support, such as AGE, spare parts and training equipment in the initial contract. Some procurement situations may make a life cycle cost evaluation and award a TPP program on the basis of the lowest life cycle cost/effectiveness, but not include selected elements of logistic support (such as maintenance or overhaul) in the TPP contract.

This approach would be inappropriate in the case of large missile programs, where logistic support costs are the major element of initial acquisition costs. In this instance the need for defining and pricing logistic support is essential to the success of TPP.

B. Funding Contract Definition

It is recommended that CD efforts for TPP programs be fully funded within the scope of a very carefully scrutinized work statement as opposed to cost sharing. If this policy is not implemented as the regulation requires, it is recommended that DoD Directive 3200.9 be amended. DoD Directive 3200.9 states that it is the intention of the DoD that each contractor be fully funded for his proposal work during contract definition and, further, any action that suggests cost sharing such as prior announcement of funds available should be avoided. Analysis of the C-5A and SRAM programs' contract definition efforts indicate that this policy was not adhered to. Contractors were

aware of funds available, and cost sharing was allowed. In both of these programs, competing contractors proposed and incurred substantially higher CD costs than the Government funded. Conversely, in the FDL program contractors' proposals were carefully analyzed and the scope of work reduced in three key areas in order to reduce the cost of the CD effort.

It would seem that two concrete actions can be taken in order to reduce the time and level of effort expended during contract definition. First, by reducing the scope of work required by the RFP and establishing system requirements by the end of concept formulation; and second, by reducing the Phase C effort (source selection) to a shorter period of time, thereby not requiring contractors to maintain large levels of key personnel over and above the level accepted by the Government for reasonable funding. If the Government engages in a disengagement policy and disciplines itself against including design details in the RFP as well as imposing several management information and control systems upon contractors, it is possible to reduce the level of effort and expenditures required during contract definition, as well as conventional proposal periods.

What is needed is a continuing effort to improve the formulation of RFPs in an attempt to reduce data requests, design details, and unnecessary control of contractors. This study has indicated that the increase in specification details and data requirements that appear as RFP provisions are passed down to subcontractors These requirements cause a significant portion of contract definition costs. As was pointed out above, CD costs are greatest as a percentage of total costs at the subcontractor level.

C. Contract Definition Pricing Data

It is recommended that substantially less pricing data be required for submission under Total Package programs than has been required to date; where competition is anticipated. Pricing data can also be requested of the contractor on a phased schedule so as not to necessitate high peak manpower requirements. Specifically, pricing data during contract definition should be submitted one (or perhaps even two) months later instead of concurrently with the technical proposal. In this manner, conventional proposal periods and contract definitions will appear more like a two-step formally advertised procurement.

D. Logistic Support Data

It is recommended that a major DoD effort be initiated to develop a cost data base of operating and maintenance cost information, as well as the methodology for employing this information on new TPP programs. Efforts cited above are currently underway in this area, but in our opinion greater integrated emphasis of these efforts is required. Logistic support is the most difficult area for totality in Total Package Procurement, and the key to defining logistic support is the availability of meaningful data to validate contractor proposal claims. The special Air Force Task Group which studied the C-5A program recommended that the Air Force Logistic Command (AFLC) develop the capability to accurately project depot maintenance and replenishment spares costs by weapon system. AFLC has estimated it can develop this analysis capability by January 1969.

E. Logistic Support Planning

It is further recommended that integrated logistic support requirements planning be initiated concurrently with

system requirements during concept formulation. Parametric trade-offs and cost/effectiveness studies must consider the impact of logistic support as an integral part of TPP planning. The capability for integrated logistic support planning and data analysis should be developed by all the Military Departments on a planned and coordinated basis. In addition to those current efforts mentioned above, this need has been recognized in LMI Task 66-22, Plans for Directed DoD Study of Organization and Management of Equipment Support (Long Range).

F. Total Package Ship Procurement

In recognition of the major impact TPP can have upon the Navy and the shipbuilding industry, it is recommended that:

1. The Navy initiate industrial research and development on ship construction and procurement. This is in accordance with the greater responsibility TPP will place on industry and the need for design capability which it will require on the part of the industry. The industry appears to presently lack adequate research and development capability.

2. The Navy expend greater time and personnel efforts at the concept formulation portion of ship programs in systems analysis, trade-off studies, and integrated logistic support planning, rather than in detailed design work at a later date. (This is essentially what is being done in the DX/DXG program.) Technical and scientific personnel currently used in a design capacity can be trained to provide the analysis function required at the "front end" of the program.

G. Data and Proposal Requirements

It is recommended that data for TPP programs be requested only when a clear, demonstrated need exists. As suggested

in "A Basis for Analysis of the Total Package Procurement Concept,"[1] the key to data reduction in a TPP is to be found in a distortion of an age-old adage; to wit, "Put off until tomorrow anything you don't absolutely need today." Equally important to the time phasing rationale from the point of view of data reduction is the elimination of unnecessary or "doubtful" data, and the consequent requirement for continuous updating and revision documents. No data should be requested until a certain, minimum confidence level as regard need is met.

None of the above is meant to suggest that either the Government or any prime or subcontractor should lose sight of either the long-range objectives of the program or the program data requirements. All must function on the assumption that the acquisition and operating program will in fact take its natural course and that each will play a part in the program. Early planning and definition should not be restrained, but data exchange should.

Accordingly, we recommend application of these precepts to a TPP:

(1) An RFP for Phase B proposals which would contain only: general program information, i.e., Total Package, number of production systems--including logistic support; the specific operational requirement (SOR); the Phase A source selection criteria; concept formulation studies; the preliminary systems specification, an initial cost/effectiveness model; a model of the CD contract; and a CD work statement, including a CD data requirements list. Detailed information relating to the method of accomplishing CD, the TPP contract terms, work statement, and requirements for program management plans and data would not be provided at this time.

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[1] See Appendix C.

(2) The contractor's Phase A proposal should be limited to: general information designed to demonstrate his capability to undertake CD and a development and production contract; his planned technical and management approach for CD including a preliminary system design; and a cost proposal specifically related to the CD statement of work. After the initial source selection, the RFP for the TPP (previously called Phase II) should be issued as an exhibit to the CD contract and not as an independent document.[1]

(3) The CD statement of work should require a response to the RFP and accomplishment of a specific work package resulting in a systems specification, a specified level of contract end items (CEI) definition, and systems interfaces.

(4) The TPP RFP should provide more detailed program information; TPP source selection criteria; further details of systems analysis studies and trades used to select the system for CD; and the model contract.

(5) The responsive TPP proposal should include:

a. A cost proposal covering overall system development, production and support cost to be placed on contract or on options. The contractor will initially supply cost breakdowns at lower functional levels only to the extent that they are needed. During Phase C the contractor will continue to update and refine the lower level cost breakdowns but he will be committed only to total contract and option prices. The Government

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[1]This may obviate the need for furnishing the TPP RFP to non-CD contractors who may then seek to submit TPP proposals, a situation which has not occurred in the programs studied, but is more likely to occur on smaller system procurements. Since the resulting proposals are contract requirements, the RFP might be called a "requirement for proposals" rather than a "request."

may at any time during Phase C require the contractor to provide additional cost data to show how he reached his total cost figures in order to allow the cost evaluators to investigate those areas in which they lack confidence.

b. A technical proposal which explains and supports CEI performance specifications prepared in CD. Detailed information on design and systems engineering trade-offs will not be initially provided, but the Government should have the option to request or examine such data during Phase C.

c. A systems effectiveness proposal which presents the cost/effectiveness of other probable systems and incorporates the specifics of the proposed systems performance and cost.

d. A test plan which clearly indicates how the system and CEI performance, maintainability, reliability, and supportability requirements will be demonstrated.

e. A fiscal year funding document which will be continually updated during Phase C.

In order to achieve maximum currency and allow for maximum effort during Phase B, these proposals could likewise be time phased. The technical proposal which is at the base of the other proposals could come first. The cost proposal which follows from the technical proposal could follow within four weeks or longer, and the systems effectiveness proposal which relies on the technical and cost proposals could follow up to two weeks later. This would allow both contractor personnel and Government evaluators to move from proposal to proposal in a more orderly manner.

The resultant contracts would, prior to source selection announcement, incorporate the systems and CEI specifications with a commitment to overall development, production, and support costs and such lower level cost detail as is reasonable. The fiscal year funding document as revised to date would be incorporated into the "limitations of costs" clause, and the testing plan as finally accepted by the parties would become contractually binding. The contract would provide that management, production, logistics, maintainability, reliability, and other plans would be submitted and reviewed within a reasonable period after source selection. All fundamental requirements for demonstration and test to ascertain the achievement of contractual requirements must, however, be included in the contract prior to contract award. Complete data base requirements for program management and visibility would be required only from the successful contractor in stages of successive detail as they become reasonably available.

There is considerable evidence that data requirements have themselves generated substantial additional Government and contractor work effort over and above that required to define a program, select a source, and contract for a Total Package program. Paramount to a successful data management system is an awareness of the system objectives and the time phasing of requirements. The Government must provide the contractor with program information and requirements as well as instructions relating to contract definition, definition data requirements, proposal format requirements, source selection criteria, the contract, program management and program data requirements. The contractor must provide the Government with a cost and technical proposal for contract definition, progress reports on

contract definition efforts, a CEI definition of the system, a cost proposal for the development and production of the system, plans for system test, systems support, program management, fiscal year expenditures, termination liabilities and other key program elements.

All of this information and more in all probability will be required during the acquisition phase of a program and on into its operating life. In any program, this data flow should be time-phased in order that data are made available only when needed and in order to insure data currency. This problem is particularly crucial when one considers that a TPP may initially involve over 400 prime contractors and subcontractors, of whom only one prime and perhaps ten to twenty subs will receive a TPP contract.

H. Future Studies

1. TPP Study

It is recommended that at some later date (approximately 1969), DoD initiate further analysis of the C-5A program because of the additional data and experience that will be available with respect to these initial Total Package programs and the specialized clauses involved. Specifically, it is recommended that this follow-on task expend effort in the areas of technological innovation, cost outcomes, effect of disengagement and logistic support development and pricing.

2. TPP Implementation Guidance

It is recommended that a guidance document be prepared for practitioner level personnel on the implementation

of Total Package Procurement. Our discussions with both Government and industrial personnel have confirmed the need for a document describing the decision process and procedure for implementing a TPP program from concept formulation through contract management. This guidance can also be made available through seminar sessions for both top management and field level planners and practitioners.

3. Development Contract Incentives

LMI recommends that considerable effort be directed at devising a procedure for obtaining the increased contractor motivation to design for economical production associated with TPP programs, for those programs in which a Total Package Procurement is not feasible. In the course of reviewing the Total Package concept and its implementations, we have been most impressed with the capability of the concept to motivate contractors to design initially for economical production and for reliability and simplicity of maintenance of operational hardware. This advantage of the TPP concept should be employed if possible for development-only programs.

To date, performance incentives in a development-only contract have been directed primarily toward performance characteristics; range, speed, payload, etc. More recently, incentives for reliability and maintainability have also been included in development contracts. However, we are not aware of any development contract which has included an incentive based on "cost to produce," i.e., the production cost of the system(s). It has been well established that the producibility and hence production costs of a system are primarily determined by the initial design. In our opinion a fully structured performance incentive plan for an engineering or operational system

development contract should include a "cost to produce" incentive as well as required performance incentives.

One approach to this type of performance incentive plan is to consider the contractor proposed targets for the performance incentive elements in the source selection and evaluation of the development contract proposals. Rewards and penalties within the acceptable range could be based on a "lost profit" factor. The "lost profit" factor would be based upon the estimated acquisition and operational cost to the Government as it appears in the Five Year Defense Plan, on the assumption that included within these costs is an average profit factor. Design effort which serves to reduce these acquisition and operating costs either through greater system effectiveness resulting in fewer systems to be acquired and operated, or by reduction of costs such as fuel consumption, maintenance, or spares, as well as cost to produce, would be rewarded by assigning to the contractor some multiple of the profit that would have been obtained on the life cycle cost differential. Conversely, a development effort which results in increases in such acquisition and operating costs would be penalized by some multiple of the profit factor which would have to be paid on such increased life cycle costs.

APPENDIX A

ASSISTANT SECRETARY OF DEFENSE
Washington, D. C.

Installations and Logistics DATE: 3 June 1965

TASK ORDER SD-271-25
(Task 65-31)

1. Pursuant to Paragraph C, Article 1 of Department of Defense Contract No. SD-271 with the Logistics Management Institute, the Institute is requested to undertake the following task:

A. TITLE: Evaluation of the Concepts Embodied In A "Total Package" Acquisition Plan.

B. SCOPE OF WORK: The Air Force has recently developed several advanced techniques both as regard contract award and program management. Several of these various techniques are being implemented by the Air Force under a "total package" procurement plan. This task is one of evaluating these various techniques. Its purpose is to review the various concepts encompassed within "total package" procurement by program analysis, from inception to completion, in those instances where being applied. Particular attention will be given to the procurement and management aspects of the techniques involved. This evaluation will encompass the relationship of past and present LMI studies to the "total package" procurement plan. The broader application of the techniques involved to other major programs will be considered. Particular attention will also be given to the total logistic system of a major weapon as affected by a "total package" procurement plan. This will include the interdependency and interrelationships of all elements of a major weapon's logistic system.

Observations made by LMI during the course of this evaluation will be reported in accordance with paragraph 2 of this Task Order.

2. SCHEDULE: A progress report will be submitted on 1 November 1965. Quarterly progress reports will be made thereafter. On 1 July 1966, progress under this task will be reviewed and determination will be made whether the task should continue.

/s/ Paul R. Ignatius

ACCEPTED /s/ Barry J. Shillito

DATE 3 June 1965

APPENDIX B

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D. C.

Installations and Logistics DATE: 25 August 1966

TASK ORDER SD-271-57
(Task 67-3)

1. Pursuant to Paragraph C, Article 1, 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: Total Package Procurement Concept, Synthesis of Findings

B. SCOPE OF WORK: The purpose of this task is to study contracts, other than the C-5A, which have been placed under the "Total Package" concept. At least three additional "Total Package" contracts will be analyzed. The report evaluating the concept will involve a synthesis and analysis of the three progress reports under Task 65-31, and information obtained in this study of additional contracts.

2. SCHEDULE: A final report will be submitted on 15 November 1966.

/s/ Paul R. Ignacius

ACCEPTED /s/ Barry J. Shillito

DATE 25 August 1966

APPENDIX C

RELATED STUDY EFFORTS

Since the initiation of Task 65-31 in June 1965, a number of tasks have been initiated outside of LMI to analyze various aspects of the TPP concept and to present "lessons learned" studies on early Total Package Programs, of which much has been conducted by various elements of the Air Force. In addition, several articles and papers have been published on the subject of the Total Package concept. An annotated bibliography of published studies and articles is presented below, in addition to current study efforts.

A. Defense Industry Advisory Council Subcommittee on TPP

At the 18 February 1966 meeting of the Defense Industry Advisory Council (DIAC), a subcommittee was established to "help guide the development of Total Package policy guidance application criteria." In June 1966, a group of industry and Government representatives was appointed as members, and it was decided to further divide the group and establish two areas of investigation of Total Package Procurement application problems:

1) Will the Government discipline itself to the realities of the authority-responsibility relationship inherent in Total Package contracting?

2) Will Total Package contracting stifle innovation and creative technology?

The subgroups have completed their study efforts, and will report on their findings by the next DIAC meeting in October 1967. LMI has been an observer to the DIAC subcommittee on Total Package Procurement, and has served as a working member of the DoD survey team for the subgroup on technological innovation.

B. Armed Services Procurement Regulation Subcommittee

In May 1966 an Armed Services Procurement Regulation (ASPR) subcommittee was formed in order to develop the policy and contractual language governing the application and use of Total Package Procurement. The subcommittee was instructed to work in conjunction with the above DIAC subgroups and to formulate ASPR guidance in terms of broad, general guidance as opposed to specific or restrictive terms.

C. Review of Related TPP Studies

Several studies by other organizations on the "lessons learned" theme have been made of some of the early TPP contracts. Our review of these studies is not meant to be all inclusive; rather it includes those reports that have been brought to our attention during the course of our study. These TPP studies are briefly reviewed below.

1. C-5A Source Selection and Contract Definition Experience, Special Task Group, United States Air Force, (undated), Official Use Only

In December 1965, Headquarters Air Force established a special task group to study the experiences of the Air Force in C-5A source selection and contract definition. A team of some 16 Air Force representatives was formed to conduct this study for three months. This study was conducted in response to a request from DDR&E, as amplified by ASAF-R&D and ASAF-I&L, to analyze specific aspects of systems management which were relatively unique in application to the C-5A program. In particular: (a) Total Package Procurement, (b) systems engineering procedures in accordance with AFSC manual 375-5, (c) configuration management in accordance with AFSC manual 375-1, (d) data management and particularly quantity of data requested versus quantity submitted, (e) funding levels of

prime and subcontracts during contract definition, and (f) demands placed upon subcontractors. The study memorandum requested examination of three major questions: (a) Is the Government seeking and getting more detail than is really needed to make a choice between competing contractors and to execute a definitive contract? (b) What can be done to speed up the process of selecting the winner after all the competitive proposals are in? (c) Is the Air Force using its new management techniques in a manner consistent with Total Package contracting which seeks to place greater risk and responsibility on the contractor?

2. A Basis for Analysis of the Total Package Procurement Concept, Robert H. Turtle, Department of the Air Force, May 10, 1966.

This paper on the Total Package Procurement was written at the request of the Assistant Secretary of the Air Force for Installations and Logistics. The stated purpose of the paper is to explain the philosophy and basic tenets of the Total Package Procurement concept and the rationale for decisions made in applying it to the C-5A procurement in order to provide a basis for continued analysis and imaginative adaptation. The paper preceded the completion of any of the comprehensive internal and external studies on the C-5A program and does not purport to reach any major conclusions as to the appropriate methodology of implementing a Total Package Procurement. It does explain in detail the rationale for each of the Air Force's major procurement decisions in the C-5A program.

3. C-5A Program, Lessons Learned from Contract Definition and Source Selection Evaluation, Aeronautical Systems Division (ASD), 14 February 1966 (Official Use Only).

This study was conducted by the Aeronautical Systems Division of the Air Force Systems Command. It is a comprehensive analysis of the lessons learned from that experience, prepared for the benefit of those who may be confronted with the task of applying the principles of contract definition and TPP to future programs.

The document primarily deals with the ASD experience in applying the TPP to the C-5A program, and it provides an explanation of the problem and the conclusion or solution reached for each decision point. The report acknowledges that "rather than the indicated problem solution, perhaps the most important benefit to be derived from this report is the focusing of attention to matters requiring evaluation to determine the course of action which may be appropriate in other procurement situations."

4. Lessons Learned--Source Selection and Procurement Process, Minuteman Realigned Third Stage Motor (RTS), Ballistics Systems Division (BSD), 3 October 1966, (Official Use Only)

The objective of this procurement was to develop and procure an improved third-stage that will be a part of the new Minuteman III program. This was accomplished by the placement of a single Total Package contract for the system design and development effort, a first production buy of 343 motors (with an option for an additional 407), the necessary aerospace ground equipment, and the first year's operational spares. Formal contract definition pursuant to DoD Directive 3200.9 was waived in this procurement.

5. Experiences Report on Advanced Aerial Fire Support System (AAFSS) During Contract Definition and Source Selection, Special Study Group Report, U. S. Army Material Command (For Official Use Only), Undated.

This recent report is another in the series of lessons learned studies reported by the Services in response to a request by the Director of Defense Research & Engineering. The report covers the following subject areas: adequacy of logistic planning inputs, evaluation of risk and Government/contractor interface problems, management information system requirements, contract definition procedures, source selection procedures,

incentive structuring, programming, budgeting and funding, Total Package Procurement concept, and Government furnished material.

6. Innovation and Product Quality Under the Total Package Procurement Concept, Thomas K. Glennan, Jr., The RAND Corporation, Memorandum RM-5097-PR, September 1966.

This report was prepared by the RAND Corporation in response to a request from the Air Force for specific analysis of the question of Total Package Procurement and technological innovation. The report addresses the question: What are the potential impacts of TPPC on innovation in new developments and the quality of the resulting systems? TPPC is treated as a combination of three components: the contract definition period, "bundle bidding," and a series of contractual terms and conditions designed to inhibit contract changes.

7. Defense Industry Bulletin, Department of Defense (Various Issues)

The Total Package Procurement Concept has been the subject of four Defense Industry Bulletin articles over the period of about a year. The articles are: "Effective Competition and Government Procurement," by Robert H. Charles (October 1965); "Total Package Concept," by Major General Charles H. Terhune, Jr. (February 1966); "The Total Package Procurement Concept," by Colonel Robert E. Lee (August 1966); and "Management Systems for Package Procurement," by Lt. General W. A. Davis (December 1966).

8. Can We Modernize U. S. Shipbuilding?, by Lieut. Commander Charles J. DiBona, USN, United States Naval Institute Proceedings, January 1966.

This article advocates changes in the current method by which U. S. Naval ships are designed, contracted for, constructed, and operated. The changes are to realize benefits in two categories:

First, initial construction costs; second, operating expenses. Four methods are outlined for achieving substantial benefits in ship construction: standardizing designs by building classes of ships; the use of design specifications justified on the basis of cost analyses; life cycle cost analyses; and increasing productivity by the use of modernized production facilities.

9. A Report on Contract Definition, prepared for the Office of the Director of Defense Research and Engineering, Washington, D. C., by Peat, Marwick, Livingston & Company, 2 January 1967.

The objective of this report is to provide better understanding of the intent of DoD policy in DoD Directive 3200.9, titled "Initiation of Engineering and Operational Systems Development." The report presents the rationale of the policy and some of the major problems that have occurred during the implementation of the Directive, as well as possible means of alleviating these problems. A secondary purpose is the provision of information to industrial organizations that participate in contract definition.

10. Life Cycle Costing in Equipment Procurement, Logistics Management Institute, Task 4C-5, April 1965. Also Supplemental Report, Task 66-3, February 1967.

This LMI study was devoted to investigation of the influence that changes in suppliers may have on logistic costs and how this influence might appropriately be considered in making contract awards. This study was initially limited to procurements under negotiated competition, but was later expanded to include consideration of advertised procurements as well. The objective of the study was to establish the relevant importance of equipment life cycle costs and to develop methods for measuring and forecasting these costs in evaluating bids and proposals in the process of making contract awards.

The February 1967 supplemental report presents a series of questions and answers that describes the life cycle costing technique, problems, and method of application. In addition, it presents the specifics of several of the initial test procurements, including the evaluation criteria employed, the procedures for validating logistics cost estimates and claims, and award decisions made in these test cases.

11. Wage Rate and Material Price Level Adjustment Provisions in DoD Procurement, Logistics Management Institute.

The objective of this LMI study (Task 67-4 revised) is to identify alternative ways of handling wage rate and material price level adjustments occasioned by economic fluctuations. The introduction of TPP and multi-year procurement methods, involving lengthening periods of contract performance, expose both the industry and the Government to increased pricing risks. The study currently in process will recommend preferred price adjustment provisions for long-term contracts. The anticipated completion date is fall 1967.

APPENDIX D

PROGRAMS STUDIED

Initially four Total Package programs were selected for study and analysis of TPP implementation; the C-5A, FDL, LOHAP, and SRAM. Later it was brought to our attention that the Navy A-7A Program, though initiated sometime before the formal announcement of the TPP concept, had utilized the Total Package approach. We therefore included the A-7A in our study plan. During the course of this study other TPP programs were initiated, such as the Advanced Aerial Fire Support System (AAFSS) and the Minuteman Realigned Third Stage Motor, but the major scope of our inquiry was limited to the five programs mentioned above due to time and personnel limitations. LMI did visit the Lockheed-California Company to make a brief review of the AAFSS Program.

To secure as complete an industry appraisal of Total Package Procurement as possible, most of the prime contractors involved in the contract definition and Total Package contracts studied were visited. A list of these firms appears below:

Program	Prime Contract Contractors and Competitors Visited
C-5A (Airframe)	Boeing, Douglas, Lockheed-Georgia
C-5A (Propulsion)	General Electric, Pratt and Whitney
A-7A	LTV
LOHAP	Sylvania, Collins Radio
FDL	General Dynamics, Litton Industries, Lockheed Shipbuilding & Construction, Bethlehem Steel, Kaiser Industries, Todd Shipyards
SRAM	Boeing, Martin-Orlando
AAFSS	Lockheed-California

These visits consisted of two to three man-days of detailed interviewing of from eight to twenty of a firm's key personnel. In the case of the FDL program, our visits were brief since the firms were engaged in competitive contract definition. Individuals interviewed occupied positions varying from president to individual technical, financial, manufacturing, and managerial representatives. Except in the case of the FDL program, two or more visits were made to most of the contractors involved in the programs studied. The follow-on visits were made after some period of time (more than a year in a few cases), and thus provided us an opportunity to note the development of changing situations and potential problem areas.

It was virtually impossible to study the TPP concept and the subject programs without carefully considering the contract definition periods associated with these programs. In our study and analyses, we have drawn heavily on the C-5A program and the experiences of the prime contractors, subcontractors and system program office. We have attempted to relate our findings in the C-5A program to the other systems studied in order to formulate conclusions and recommendations which apply across the spectrum of programs studied.

This chapter presents a brief description of the programs studied, so as to acquaint the reader with the pertinent details of each of the Total Package programs.

A. <u>The C-5A Program</u>

The C-5A heavy logistic support system was the first major program to formally utilize the Total Package Procurement concept. In addition, it was also the largest program to undergo

a rigorous contract definition period. The airframe and propulsion systems underwent simultaneous definition and evaluation, resulting in the analysis of essentially six different system configurations and twelve different proposals. Contract definition for the C-5A was over nine months long and involved substantial expense. (An accounting of CD costs is presented in Chapter IV.) Analysis of the contract definition effort for the C-5A program provides valuable insight into the changes required in contract definition, as well as problems arising from the utilization of TPP.

An RFP containing, among other things, a work statement and model contract for CD, and a work statement and model contract for development and acquisition of the C-5A system, was distributed on December 11, 1964 to the three airframe and two engine contractors who had participated in funded parametric studies leading up to the approval of the C-5A program. Phase A of the CD process was eliminated since the Air Force felt that no firms other than the parametric study contractors (for the airframe) could be responsive within the time allocated. In the case of the propulsion system, the two CD contractors chosen were current technical development program contractors. On December 31, 1964, the Air Force entered into a CD contract with each of five contractors. The work statement called for the identification and preparation of performance specifications for each end item required for an operational system, as well as a price proposal for development, production, and selected logistic support needs. Logistic support requirements included all required aeronautical ground equipment (AGE), training equipment, and contractor technical

services, together with spares and maintenance through the category II test period. Spares beyond category II would be added to the contract by provisioning action and would be priced in accordance with a detailed pricing exhibit contained in the contract.

Award of a contract would be made to the source whose cost and technical proposals, as evaluated by the Air Force, demonstrated the greatest overall cost/effectiveness over a ten year operating period of a system complying with all of the minimum performance requirements established in the RFP. To this end, contractors were required to prepare a ten year operating cost estimate utilizing certain given assumptions. This was to be added to the RDT&E and production costs and analyzed with the productivity of the proposed system over the ten year period. Although the initial production airframe buy was only 57 systems, a priced option was obtained on 58 more, and costs and productivity for source selection purposes was to be computed on a total of 115 operational systems.

The technical proposals were submitted on April 20, 1965, and the cost proposals on April 27, 1965. Definitive FPI contracts for RDT&E, delivery of 57 total systems, and logistic support as outlined above were negotiated and signed by each of the contractors prior to the source selection announcement on September 30, 1965.

Priced options in both the airframe and engine contracts will enable the Government to order up to 58 additional total systems, and formula options can be exercised

to order up to 85 additional systems beyond the priced quantity of 115. Each contract provides for a target profit equal to 10% of the target cost and a ceiling price equal to 130% of target cost. Priced options will be added to targets and ceiling as they are exercised, as will provisioned spares, and the final incentive fee computation will be made on the basis of up to the 115 total systems and support. The formula option for an additional 85 total systems is to be exercised in a separate fixed-price incentive contract with a 10% target profit and a 120% ceiling price.

Both the engine and airframe contracts contain an escalation clause to protect against abnormal fluctuations in the economy. Both contracts contain a clause providing for adjustments to targets and ceilings in the event of changes in the Federal laws affecting labor-associated costs, and a clause providing for limited adjustments in the option prices if actual production costs on the first 57 systems deviate substantially from the originally targeted production costs.

Both contractors proposed on the basis of three alternate cost-incentive formulas: 85/15 over target and 50/50 under, 70/30 over target and 50/50 under, and the flexible incentive[1] with an initial share of 85/15 over and under target. The target prices proposed indicated a preference for the flexible incentive. Nevertheless, since the airframe contractor was willing to accept a 70/30 overrun share and the consequently greater risk involved at a relatively small increase in target price, the Air Force chose the 50/50 - 70/30 formula for the airframe contract, while employing the

[1]A discussion of this unique clause is contained in Appendix D.

flexible incentive in the engine contract. Neither contract provides for the construction or provision of additional Government facilities beyond those presently used by the contractors.

Both contracts provide for 90% progress payments during the RDT&E and production effort until such time as payments for hardware deliveries have reduced the contractor's unrecovered costs to a stated amount, after which future progress payments will be made at 70% of total costs.

Correction of deficiencies clauses in both contracts extend the time period in which deficiencies in the total systems may be discovered, in order to include an adequate opportunity for utilization of each item of hardware in an operational environment. The costs of correcting such deficiencies are allowable costs under the terms of the incentive contract, but no adjustments are made in target price or ceiling price.

B. Fast Deployment Logistic Ship Program

The Fast Deployment Logistic (FDL) Ship was designed to improve rapid military deployment capabilities for the DoD by forward prepositioning sizeable ground forces equipments and supplies in overseas areas, and providing an over-the-beach unloading system.

The FDL program was to have been the first Navy ship program to utilize the Total Package Procurement concept. It was also to be the first Navy program to undergo a formal contract definition requiring that industry assume the responsibility for design as well as construction. This design responsibility

was to have run along total system lines rather than being directed only to the hull design. It was a planned "single contractor" program--all the ships were to have been built by one contractor. Design development, and all established production requirements for the FDL program were to have been completed at the outset, and awarded in one signle contract. The LMI analysis of the FDL contract definition had the inherent problem of isolating the effects of Total Package Procurement from the other "firsts" involved in this program. Contract definition and the industry's assumption of design responsibility would have been substantial departures from normal shipbuilding industry participation in Navy ship procurement.

LMI interviewed the three FDL contract definition contractors in an attempt to analyze their response to the new method of ship procurement, and particularly the Total Package aspects of the program. Three major shipbuilding companies who chose not to submit FDL proposals also were visited. Discussions were held with key officials of these firms in an attempt to understand the rationale of their decisions not to participate.

1. The Systems Approach

Traditional naval ship programs have normally followed a sequential path of acquisition activities beginning with preliminary design initiated after CNO approval of the system requirement. Preliminary design is solely an in-house activity, after which the Navy engages in "contract design." Contract design consists of the preparation of detail subsystem plans and specifications, and has traditionally been performed in-house, although in recent years the Navy has gone to commercial naval architect/marine engineer firms for these services.

After competition (usually on an advertised procurement basis) and award, the shipbuilder, together with a design agent, provide the required working plans to satisfy the contract design requirements.

The weapon systems approach in the FDL program would have provided the industry with the complete design responsibility through a contract definition process as has been the case for other military procurements. The shipbuilding industry would have been required to adopt the systems approach under this change.

2. Contract Definition

Contract Definition for the FDL program was scheduled to last approximately 5 months, for the total A, B, and C portions of the definition period. Phase A began April 1966 and was completed in July 1966; phase B was completed in January 1967. Phase C was scheduled for completion in July 1967. The Navy equally funded each contractor $5.275 million for the definition phase (B). In addition, $450,000 per contractor had also been established as the phase C "key personnel" funding level ceiling. This is a total of $17.175 million provided for the FDL contract definition. The three contractors competing in this program were queried as to the extent of their planned expenditures for additional IR&D and bid and proposal expenses. On the average, they responded that about $1 million would be spent over and above that funded by the Navy. This money would have been spent in two primary areas: (1) for the expense of maintaining "key personnel" during phase C, insofar as the funding ceiling established by the Navy was insufficient for the contractors'

definition of "key personnel"; and (2) for related research not in the contract definition work statement and for detailed facilities definition. One contractor stated that he would "spend as much as it takes in CD to provide confidence in estimates and prices submitted."

C. The Lightweight Observation Helicopter Avionics Package (LOHAP)

The LOHAP is a highly reliable, compact, integrated subsystem which provides communications for the Army's lightweight helicopter. The contract for the LOHAP was awarded in January 1966, some four months after receipt of proposals. The contract price is $16.1 million; a fixed-price incentive contract with approximately 117 percent ceiling, 10 percent profit, and 80/20 cost sharing ratio. The original Army procurement plan was to contract in the "traditional" fashion; that is to contract for an engineering development program via technical competition and then place the follow-on production contract on essentially a sole-source basis to the development contractor. Prior to completion of the original plan, the Army decided to change to a "single-phase" procurement plan providing for design, development, advance production engineering, quantity production, and some elements of logistics support. Without so labeling it, the Army had in fact established its first Total Package program. When queried as to why they chose to adopt a Total Package approach, the Army's first reaction was that it had entered into this sort of procurement to "overcome the problems of transition from R&D to production."

Six competitors submitted proposals for this program, with the award going to the Sylvania Electronic Systems Division of Sylvania Electric Products, Inc. In this procurement the Electronic Command contracted for all the known production requirements, some 1825 systems. They also secured an option for an additional 50 percent increase in production units in anticipation of future requirement increases. However, when the Army turned its attention to including elements of logistics support in the initial contract, it found it difficult to define these factors. The contract does have priced options for some elements of training and contractor technical services and some priced spare parts as well.

Since the program did not meet the DoD Directive 3200.9 threshold requirements, a formal contract definition was not conducted for the LOHAP. The contract was awarded on the basis of the "best overall proposal...with consideration of trade-offs, best technical approach, price, etc., rather than price alone" after a conventional competitive proposal effort.

The firms interviewed in this program thought that the Army's RFP was excellent--much better than previous RFPs issued by the same procurement agency. They had apparently "spent more time thinking it out," was one typical comment. The contractors visited confirmed the Army's thought that it was "virtually impossible" to define maintenance requirements and hence logistic support at this point in time of the program. Army Electronics Command personnel thought that they could not adequately define the maintenance philosophy which was a necessary prerequisite to the contractors' defining the maintenance needs. There was, however, substantial design

coordination and input on the part of the Army's maintenance people at an early point in the procurement process.

Both contractors stated that they started design studies at least a couple of years prior to the proposal period in order to be responsive to the Army's requirements. One of the contractors interviewed stated that when the Army changed to a Total Package contract they spent considerable time working on changes in the packaging aspect of the system in order to decrease the production costs since TPP "forced a lot more thinking on production." When questioned on the size of proposals, one of the firms stated that the proposal was about twice as large as prior proposals. The additional size was mainly in the form of greater technical details and production planning.

The contractor stated there would be differences in the method of managing the program. Specifically mentioned were: 1) three major subcontracts are on a firm-price basis for development, production, plus the 50 percent production quantity option, instead of the usual sequencing of contracts; 2) in managing the programs, production costs would be a "strong input" in the decision process; 3) they put engineering and production people together from the start of the program and later added personnel for logistic support planning; and 4) an earlier design freeze will be attempted, "but this is good because we are freezing the standard design work and concentrating on the hard parts."

D. <u>The Short Range Attack Missile (SRAM) Program</u>

The SRAM contract definition period began shortly after the C-5A source selection but prior to completion of most of the Total Package study efforts. As a result, the

SRAM initially incorporated most of the C-5A procurement philosophy. The SRAM system as originally conceived in the latter part of 1963 was to provide a short range attack missile for use on the late model B-52s and potentially on an FB-111 type bomber. During the summer of 1965, a preliminary RFP for the SRAM procurement was prepared by the Air Force. This RFP, modeled on the C-5A procurement plan, provided for a competitive CD leading to the award of a Total Package contract for design, development and production of missiles and aircraft structural and electronic modifications, and some elements of logistic support. Prior to release of the RFP, the program underwent a final DDR&E review in September 1965. At that time it was decided that the missile program should be redirected to emphasize the FB-111 as the primary carrier vehicle. Thus, the RFP as finally released provided for a competitive CD with prices to be submitted on the basis of the alternative options outlined below:

OPTION	PRODUCTION LOT-A	PRODUCTION LOT-B
(1) B-52/FB-111 missile, both carrier aircraft and electronics modifications, AGE, training equipment and contractor support through category II test.	A quantity of missiles, and B-52 carrier aircraft and electronics mod. kits, missile peculiar and peculiar B-52 AGE and training equipment.	A quantity of missiles
(2) FB-111 missile, carrier aircraft and electronics modifications, AGE, training equipment and contractor support through category II test.	Missiles and missile peculiar AGE and training equipment.	Missiles
(3) Same as (1), except only RDT&E on contract.		(No production missiles)
(4) Same as (2), except only RDT&E on contract.		(No production missiles)

The B-52/FB-111 missiles were characterized as a "compromise" configuration while the "FB-111 only" was known as the "optimum" configuration. Thus, the competitors were asked to undertake what amounted to a dual contract definition covering two missile configurations and two aircraft carrier and electronic installations. In addition, alternative bids were requested on the basis of R&D plus production options, as compared with R&D and a firm production commitment. An Air Force official indicated that this duality of the contract definition phase resulted in an approximate 40 percent increase in the scope of the work during CD, both on the part of the contractor and of the Government.

Of the contractors who submitted phase B proposals, two were awarded fixed price contract definition contracts of $2.75 million each on November 15, 1965. Technical and cost proposals for phase II were submitted on March 15, 1965, and covered the four alternatives as outlined above. For purposes of allowing the greatest flexibility to the decision maker, each proposed missile configuration was treated separately. After submission of these initial evaluation reports by the Air Force, the Government rejected the proposed configurations. The Air Force upgraded its requirements based on the technology demonstrated by the proposals. At the end of August 1965, both contractors were asked to repropose on the basis of a new missile configuration characterized as the "maximized" configuration.

The Total Package contract provides for the design, development, test and evaluation of the maximized missile configuration and of carrier aircraft and electronic modifications for both the B-52 and FB-111 aircraft. It also includes

production options which may be exercised in the alternative at a later date. The first option is for a number of maximized missiles, B-52 fleet modification kits, missile peculiar AGE, and B-52/FB-111 peculiar AGE. The second option is for a similar number of missiles, missile peculiar and FB-111 peculiar AGE. Additional priced options for production missiles in substantial quantities are provided under each of the key production alternatives, and a sliding scale of target costs is provided for potential slippages in the production option decision dates.

The initial contract for RDT&E under which any subsequent production and logistic support will be ordered, provides for a ten percent profit and a 130 percent ceiling on a target cost of $144 million. The cost incentive share is initially established at 80/20 and provides a flexible incentive plan for unilaterial upward adjustment of the cost share by the contractor. The contract also provides for all logistic support through category II testing to be provided by the contractor. The production options cover training equipment and AGE up to but not including the depot level, contractor technical services, and training needs through the squadron activation period. Spares will be provisioned under the contract and within the applicable target profit, ceiling price, and incentive provisions. Rather than attempting to establish a spare-parts pricing list, a new spare parts pricing methodology has been incorporated in the SRAM contract. Basically, this methodology calls for the pricing of spares to be provisioned during the production process at a maximum price to be determined on the basis of the total item or sub-item price less assembly and testing costs. The contract does not include schedule incentives, but does include an incentive for radar cross-section improvement.

The Air Force, as part of its disengagement procedure, is moving quickly to eliminate many approvals and controls normally imposed on contractors during the R&D and production process. Detailed design approval will not be undertaken by the Government during the contract period and, although design reviews will be held and design presentations will be made to the Government, no formal approval will be required or forthcoming. The design of the missile and carrier aircraft and electronic modifications will not be established in the contract until completion of first article testing.

E. The A-7A Program

The Navy's A-7A Attack Fighter/Bomber program began with contract award in February 1964. Although the Navy never actually called the A-7A a Total Package program, they did contract for development and four priced production options, all of which can be considered a package procurement. No provisions were made in the initial contract for logistic support requirements. The Navy has since executed all of the production options at ceiling price. The contract was preceded by a conventional design competition with the special requirement that each competitor have a comparable aircraft in being which would serve as a design departure point for the requirements of an A-7A type aircraft. There were five competitors, of whom the winning firm was the LTV Company who proposed a design which is an outgrowth of its F-8U aircraft. A-7A's primary characteristics are its simplicity, low maintainable needs, austere electronics, and subsonic bombing and close support capability.

The contract with LTV is a firm-fixed-price form with the inclusion of performance and schedule penalties only (amounting to a maximum of about $10 million). The production requirements were divided in the following option lots: Lot 1 provided for design, development, tooling and three prototype aircraft; Lot 2 provided for four production aircraft; Lot 3 provided for 35 production aircraft; Lot 4 provided for 157 production aircraft. A total of 199 aircraft have been contracted for at a price of a little more than $200 million.

The Navy is currently negotiating for a follow-on procurement (Lot 5) of some 230 aircraft. Included as a part of the A-7A program, the Navy has provided some $40 million for procurement of logistics support elements. Specific items of spares, AGE, training equipment, etc., are being procured on a supplemental agreement basis as definition occurs. The Air Force has also established a version of the A-7A to be procured on a fixed-price incentive contract.

In attempting to establish the impact of TPP upon the program, we visited the LTV Company, the Navy Project Office, the local Navy plant representative, the Navy Engineering Office, and a major subcontractor to LTV, the Texas Instrument Company, which is responsible for the radar subsystem. We attempted to identify changes in this program which are a result of TPP. Production efficiencies were realized as a result of having a priced option for production aircraft exercised at an early point in time. This allowed the contractor to have a so called "one time" release to the production group. It also resulted in having the tooling and manufacturing groups actively engaged in the design effort at an earlier time than

was usual. This had the effect of making engineers substantially more cost conscious. "With a production commitment you have a planned task--'efficient procurement'; everyone got ready for the task that they knew was coming"; was a comment indicating the extent to which the production requirement increased the efficiency of this program. "We married engineering with the purchasing department in this program"; an indication of the integration between engineering, purchasing, tooling, manufacturing. "We did more detail design work during the proposal effort than ever before--tooling and manufacturing types were around during the proposal emphasizing their role." This comment indicates the extent to which the non-engineering functions were brought into the design of the aircraft during the proposal period.

It was the consensus of all interviewees in the A-7A program that Total Package Procurement substantially promoted equipment commonality and made program participants extremely cost and schedule conscious. With respect to the Texas Instrument (TI) Company, it was difficult to identify any more cost and schedule consciousness on their part as a result of having a Total Package subcontract.

The major overriding change in the A-7A program is the firm-fixed-price contract form. In our opinion this seems to dominate virtually all considerations in this program. The contractor interprets specification requirements with very little tolerance to a greater extent than on fixed-price-incentive programs insofar as the contractual terms are involved. From the Government's point of view it appears to be a more difficult form of contract to administer because the project office cannot "get as close to the contractor" as they would like to.

APPENDIX E

THE FLEXIBLE INCENTIVE CLAUSE - DETAILS

The following limitations on this unilateral right on the part of the contractor have been incorporated into the flexible incentive clauses used in the C-5A Engine and SRAM contracts.

(1) The contractor's maximum incremental share is 50 percent.

(2) The contractor may not change his share before 25 percent or after 75 percent of the target cost has been incurred, nor more frequently than once a year.

(3) An incremental share may not be lower than half of the immediately preceding incremental share, and in no case lower than the share initially established in competition.

Thus, an initial share of 15 percent, a 50 percent restriction on incremental shares, and a prohibition against increasing the share before 25 percent of the work has been performed, limits the maximum composite cost share to 41¼ percent, computed as follows:

.15 incremental share x .25 expended	=	.0375
.50 incremental share x .75 unexpended	=	.3750
		.4125

In order to encourage the contractor voluntarily to steepen his cost share (which would represent greater risk), and to do so as soon as possible, the formula provides an increase in the target profit in the amount of 15 percent of any increase in the contractor's composite share multiplied by the amount of work remaining on the date of election. This automatically places a premium on increasing the share as soon as possible.

For example, if the maximum incremental share of 50 percent is elected when only 25 percent of the work has been performed, the contractor's actual profit will be greater until his actual cost exceeds the target cost by 11¼ percent, than if he had made no election. If the maximum share is elected when 50 percent of the work has been performed, this break-even point is reached when actual costs exceed the target by 7½ percent; and if such election occurs when 75 percent of the work has been performed, the break-even point is at 3-3/4 percent of the target cost. There is a similar reduction in target profit whenever the contractor elects to decrease his cost share.

To illustrate, if the contractor elects a 40 percent incremental share after 25 percent of the target cost has been expended, and subsequently elects a 20 percent incremental share after 50 percent of the target cost has been expended, his target profit will first be increased by 2.109375 percent, and then reduced by 0.75 percent, for a net increase of 1.35975 percent. This is computed as follows:

		Change in Target Profit
.15 incremental share x .25 expended	= .0375	
.40 incremental share x .75 unexpended	= .3000	
New composite share	= .3375	
Previous share	= .15	
Increase in composite share	= .1875	
x .15 = .028125 x .75 remaining work =		+ .02109375
.15 incremental share x .25 expended	= .0375	
.40 incremental share x .25 expended	= .1000	
.20 incremental share x .50 unexpended	= .1000	
Composite share	.2375	
.3375 previous composite share		
.2375 new composite share		
.1000 decrease in composite share x .15		
= -.015 x .50 remaining work	=	- .0075
Net Increase in Target Profit		+ .0135975

The net effect is that the contractor is permitted to earn a substantial profit, both from the increase in target profit and from a greater share in cost savings, if he is willing to go to a steeper share early in the program; but the opportunities for increased profit diminish as the program progresses and the risk decreases. The formula is thus deliberately designed to induce the contractor to try, from the beginning, to get into a position to increase his profit, both by a higher share ratio and by a higher target profit. He can get into that position only by controlling his costs as early as possible, while concurrently assuring himself that his technical performance and schedule commitments are being met.

In fact, the clause allows a built-in incentive not only to elect but to opt for as high a share as possible, and then back off if necessary. In the above example, this is what the contractor has done. Suppose, however, that after 25 percent of the work had been completed, the contractor elected an incremental share of .2667 and made no further elections. His composite share for the contract would still be .2375

.15 incremental share x .25 expended	=	.0375
.26-2/3 incremental share x .75 unexpended	=	.2000
composite share		.2375

but his target profit increase would only be .984375 percent, or .375375 percent less than he obtained by flexing high and dropping back.

.2375 new composite share		
.15 previous share		
.0875 increase in composite share x .15	=	
.013125 x .75 remaining work	=	+ .00984375

To date, neither of the contractors operating under the flexible incentive clause has reached the point where an election would be permitted, and therefore, no conclusion can be drawn from actual experience as to the motivation of contractors operating with a flexible incentive provision.

APPENDIX F

REQUIREMENTS FOR NAVAL ARCHITECTS AND MARINE ENGINEERS

The number of naval architects and marine engineers is substantially smaller than other technical disciplines, and inasmuch as there are only three major schools providing this specialized education, Total Package Procurement of ships may have an effect on the naval architecture and marine engineering professions. LMI visited these major academic sources of naval architects and marine engineers in an attempt to determine whether or not a problem exists. The schools visited were the Massachusetts Institute of Technology, the University of Michigan, and the Webb Institute of Naval Architecture. College officials were asked about current and future student enrollment, numbers of graduates, starting salaries, and demands upon the schools for their graduates. The number of undergraduate degrees awarded in recent years has been fairly stable although there has been a small increase over the past few years. During the last five academic years (1962-1966) the Webb Institute has awarded 71 undergraduate degrees, and the University of Michigan has awarded 199 graduate and undergraduate degrees. The MIT awarded 26 undergraduate degrees, 82 graduate degrees, and 122 degrees in its special naval officer graduate program. Amongst the three schools, this is approximately an average of 100 graduate and undergraduate degrees awarded per year. Only one of the schools noted that it had plans for increasing enrollment in the near future.

It was a consensus of those interviewed in industry, the Navy, and the colleges that it is entirely possible to retrain civil engineers, mechanical engineers, and other engineering disciplines in the fields of naval architecture and marine

engineering. This is, in fact, what is done. Therefore, it is possible for the actual numbers of engineers and technical personnel employed in the ship design and construction fields to far exceed the number of degree holding naval architects and marine engineers. In one Naval organization visited, one primarily engaged in naval architecture and marine engineering, only ten percent of the professional employees were actually naval architect or marine engineer graduates. The majority of professionals acquired the skills and education required by on-the-job training.

The schools contacted did note some increase in industrial recruiting for naval architects and marine engineers in the last few years. Not only were the well established major companies in these fields more interested in their graduates, but a great number of smaller new companies were also now coming to them and seeking graduates. In spite of this fact, salaries for naval architects and marine engineers have remained pretty much in line with the average salaries of other engineering disciplines.