MANAGEMENT OF INCENTIVE CONTRACT MODELS

By

MARTIN IRWIN VEINER

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TO DAVID, KENT, MARK, AND CRAIG

PREFACE

In the last five years the use of incentive contracts in government procurements has risen dramatically. The Department of Defense has stressed the superiority of incentive contracts over cost-reimbursable contracts forcing the transformation. In this case, the stake involved is very high as claimed dollar savings have run into the hundreds of millions.

During the elapsed period, much data became available for post-contract analysis. Contractors totally unfamiliar with incentive contracting techniques were rushed headlong into acceptance and compliance with Department of Defense policy. The result was surprising; multiple incentive contracts could be dysfunctional to the objectives of both parties in a contract. Therefore, potential users of incentive contracts should exercise extreme caution. Patient experimentation, testing, and evaluation of every incentive contract arrangement should precede the signing of a definitive contract. The incentive contract model is the vehicle for simulating actual experience and conducting trade-off analyses of the proscribed nature.

HYPOTHESIS: An incentive contract model which recognizes and tests interdependency between elements will tend to optimize goal congruence between the government and the contractor.

Several models have been developed but their use is limited because contracting parties do not know they exist or are ignorant with respect to potential benefits. This study investigates, analyzes, and compares different incentive contracting techniques, or models. The purpose, then, is to prove that incentive contracts structured with models are superior to those structured by traditional methods. The information presented to prove or disclaim the hypothesis should find a wide audience with government and defense contractors. Savings and greater efficiency are badly needed in government contracting.

I would like to express my gratitude to many people who gave me their assistance. My special thanks must go: to former colleagues in ETOC, the Directorate of Contractor Evaluation at Patrick AFB, who encouraged my initial research on the subject of incentive contracts; to faculty members and students at the Patrick AFB Graduate Center (of Florida State University) who have contributed helpful suggestions and ideas; to the Air Force and National Aeronautics and Space Administration students who helped locate and on occasion provided obscure research monographs; to Arthur Nolen of the Contract Management Institute who granted my attendance to several excellent contract seminars; and to Mrs. Patricia Anne Ropero, Mrs. Dianne Tersine, and Mrs. Thelma Schneider for their indefatigable support in typing the manuscript. Dr. W. V. Wilmot, Jr., has patiently supervised the completion of this project with great understanding and consideration.

In spite of the tolerance and assistance rendered by all these people, and many more too numerous to thank personally, I alone accept all responsibility for errors of fact, analysis, or judgment.

M. I. Veiner

Patrick AFB, Florida
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INTRODUCTION

Nature of the Problem

In 1961, Robert S. McNamara was appointed Secretary of Defense. During his tenure in office, from 1961 to 1968, McNamara is credited with having initiated many innovations as part of a broad "management revolution" in the Department of Defense (DOD). One of the more publicized changes insisted upon by the new Secretary in 1961 was that the military services reduce the then prevalent practice of writing cost-plus-fixed-fee (CPFF) contracts. The use of this contract form had escalated rapidly and with it came abuses and inefficiency in contract performance. In an attempt to restore economy and efficiency to the defense contracting process, government agencies and defense contractors were encouraged to substitute incentive contracts for less desirable CPFF contracts.

In the last few years, data collected from the completion of the first incentive contracts written suggest that these arrangements may have been dysfunctional. Instead of aiding the government, the incentive arrangement sometimes resulted in a procurement that cost more than it should have or perhaps lacked in performance ability. The possible unfavorable consequences of an incentive arrangement suggest the need for detailed explanation as to causes and effects. By definition, an incentive contract is one in which the contractor and the government share any savings which result from efficient management. The first assumptions with regard to incentive contracts were that contractors would automatically save dollars so that they might participate in the savings. No thought was given to an examination of each contractual element's effect on the incentive arrangement as a result of cause and effect produced by changes in other elements in the same incentive arrangement. Dysfunctional incentive contracts, or those which work in reverse, are caused by the interaction of the different elements which compose the incentive arrangement, or structure. Dysfunctional incentive contracts which might operate in reverse should be avoided by the government and the contractor.

This study is an effort to find a better way to structure incentive contracts so that dysfunctional arrangements may be avoided. The first incentive contracts were priced by negotiating each incentive element separately, thereby creating minor contract alternatives within an existing contract framework. The management decisions made separately as a result of alternatives arising during contract performance were sometimes at odds with final contract goals. Contradictory goals within the same contract were possible whenever this pricing method was employed.

The existence of contradictory alternatives would be erased by the both parties to a contract if they could be foreseen at the time of negotiation and contract agreement. However, contradictory goals are often obscured by the complexity of the incentive arrangement. A description of additional considerations which must be negotiated in the incentive contract will illustrate the complexity and its degree.

In the traditional commercial contract, the parties satisfy the usual legal conventions of: agreement, consent, consideration, and form. The traditional contract contains an offer, and acceptance, which the performing party discharges for consideration. Consideration, or payment is a single amount, which is the price. In government contracts, cost-reimbursable contracts divide the consideration into the elements of cost and profit. Although this arrangement is one step removed from the typical commercial contract which features a single price, it is not overly complicated. However, compare these simplified features to those encountered in the incentive contract.

The underlying foundation of the incentive contract is that the agreement is varying. The variations are a requirement if different cost and fees are to prevail for different performance achievements. Thus, the parties must now negotiate target cost, target fee, the share ratio, a maximum fee, a minimum fee, and a range of incentive effectiveness. These terms will be defined in greater detail in a following chapter. They convey one theme clearly: incentive arrangements are more complex because the parties must now agree on price variations, which are composed of cost <u>and</u> profit variations, all of which are tied to expected performance variations.

Prior to signing and agreement, the parties to an incentive contract must examine all cost and performance probabilities, and how imputed savings might be divided between them. Some of the prior considerations are based on fact; some are based on assumptions. The final agreement contains both objective and subjective elements. For this reason, precontract events are unlike those found in connection with conventional contracts.

The additional requirements of negotiating an incentive contract are described with one term--structuring. Structuring an incentive contract consists of selecting from the many alternatives available and combining in a final format diverse elements of cost, performance, and schedule. This process parallels that of arriving at one price in the conventional contract, except that the incentive arrangement encompasses several prices for different performance outcomes. The term structuring may be used interchangeably with the term pricing. It conveys the significance of pricing a contract which has varying schedules of compensation for varying schedules of performance.

Price in the incentive contract is a function of performance outcome, as determined by the incentive arrangement. The incentive agreement can be structured to reward or penalize the contractor. Above all, it should clearly define goals for the contractor, and require him to focus all his resources on achieving specified goals. Occasionally, goal conflicts develop with incentive arrangements due to unforeseen circumstances when incentive elements interact with one another. For example, a contractor might decide to stop all work because the additional fee he would receive from the performance and schedule incentives does not compensate him for losses on the cost incentive portion. Thus, one more term is required to describe an important phenomena of the incentive contract: the interdependency effect, or the influence of one incentive element to produce changes in another incentive element. Goal conflicts can be minimized and dysfunctional incentive contracts can be avoided by testing the interdependency effect which exists between incentive elements. The interdependency effect should be tested prior to final contract agreement during the negotiating stage by simulation with an incentive contract model.

Hypothesis

An incentive contract model which recognizes and tests interdependency between elements will tend to optimize goal congruence between the government and the contractor.

Purpose of the Study

The United States is faced with ever-increasing demands for its resources which are limited. In 1967, twenty-two of every one hundred dollars expended in this country was spent by federal, state, or local government. As recently as 1950, the ratio of government spending was as little as thirteen out of every hundred dollars.[1] The figures suggest the expansion of goods and services purchased for the public over the time period. At the federal level of spending alone, new demands grow annually out of welfare programs, poverty programs, support to education, the war in Vietnam, and other critically needed services; faster than the sources with which to finance them. They all compete for scarce dollars. Wasteful spending in one area, such as defense, can no longer be tolerated as an isolated situation. It may deprive other vital programs, causing them to either be discontinued or curtailed.

The use of incentive contracts in defense contracting can reduce waste and its undesirable side effects if incentive techniques are applied properly. The DOD has already established this concept with the mandate that incentive contracts be utilized. No governmental agency was quite as well qualified to judge the extent of waste in contracting. The defense sector of the economy inherited a tradition of excessive spending from World War II when the object of winning the war at any cost was a national goal. The DOD rationalized spending practices that supported a philosophy stating any means justified the end. The first decade of the U.S.'s participation in the race-for-space had similar overtones. Whenever an emergency or national crisis exists, spending or cost considerations become secondary, and waste in spending usually

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[1] John O'Riley, An editorial in the <u>Wall Street Journal</u>, March 25, 1968.

proliferates.

Artificial constraints must be incorporated into contracts for projects which are deemed necessary at any cost to prevent wasteful spending and exhaustion of scarce resources. The government has continuously revised its procurement regulations as one method of countering waste. Another method has been to upgrade contracting practices, such as the transition to incentives. Recognition exists on the part of both the government and defense contractors that efficiency is essential to a healthy defense industry and also to the overall health of the economy. The figures for Gross National Product, the Federal Administrative Budget, and spending for National Defense suggest the total economic involvement of defense spending. Over the last twelve years, defense spending has consumed about 60 per cent of the Federal Administrative Budget and has amounted to just under 10 per cent of this country's GNP. Table 1.1 contains this information revised and updated to include latest available estimates of spending for each category.

The magnitude of current defense spending, which is approaching an annual rate of $80 billion, is lost in the expression of a dollar figure on paper. A vastly different mental picture results when $80 billion is converted into the GNP of another country, or into goods and services that could be purchased for use in this country exclusively. For example, defense outlays in the U.S. are about double the total output of goods and services (GNP) in India. Using product purchasing

TABLE 1.1

GNP, FEDERAL ADMINISTRATIVE BUDGET, AND NATIONAL DEFENSE SPENDING FROM 1956-1968

(in Billions)

				PERCENT	
YEAR	GNP	ADMINISTRATIVE BUDGET	DEFENSE	DEFENSE/GNP	DEFENSE/ADM. BUDGET
1956	419.2	66.2	40.7	9.7	61.5
1957	441.1	68.5	43.4	9.8	62.9
1958	447.3	71.4	44.2	9.9	62.0
1959	483.7	80.3	46.5	9.6	57.9
1960	503.7	76.5	45.7	9.1	59.7
1961	520.1	81.5	47.5	9.1	58.3
1962	560.3	81.8	51.1	9.1	58.2
1963	590.5	92.6	52.8	9.0	56.9
1964	631.7	97.7	54.2	8.6	55.5
1965	681.2	96.5	50.2	7.5	52.0
1966	743.3	107.0	61.3	8.3	57.3
1967	785.0	125.7	72.0*	9.2*	57.3*
1968	845.0	137.2	80.0*	9.5*	58.2*

*Author's own estimate based on preliminary data, as of March, 1968.

Source: _Statistical Abstract of the United States_, 1967, p.25.

power, it would buy the entire annual output of the auto industry's new cars and all new private residential construction with funds to spare. Saving a small per cent of $80 billion would completely fund lesser, but nevertheless vital programs.

The DOD policy to substitute contracts with incentives for those with no incentives was admittedly adopted for expected financial savings. New weapon systems cost billions of dollars and any savings prospects are apt to be attractive, even a small percentage. However, all incentive contracting benefits are not exclusively financial; there are several non-monetary benefits. Government contract administrators are charged with the responsibility of buying the best product at the fairest price. Beyond price considerations, a plane or missile must meet performance specifications. Quality may be more essential than price. The government must use extensive control techniques to ensure required quality, and to guide the contractor towards essential areas of concentration. The contractor should rightfully recognize and emphasize the government's objectives just as he voluntarily tries to please his commercial customers. Fewer auditors and fewer inspectors are required with incentive arrangements because the burden to be efficient remains his responsibility. The contractor accepts this because his profit depends upon it.

The defense industry must learn more about the process by which incentive arrangements automatically motivate contractors in essential performance areas by offering additional rewards for additional effort. The models that were researched explain this process, but do not trace chain effects through the contractors' organization. A contractor interested in optimizing profit will, in turn, motivate his entire organization, focusing their attention on profit optimization which will automatically occur if the customer's requirements are satisfied. Knowing how the process just described functions is one matter; understanding how and why it works is another matter. Many studies similar to this one are required to develop a body of knowledge concerning incentive contracts.

In the meantime, the defense industry must use incentive contracts, and has adopted these instruments even though a complete understanding concerning their operation does not exist. For example, one needs only to look at the decline of the CPFF contract form. The use of the CPFF contract had grown rapidly in the late fifties until an all-time high of 36.8 percent of the total value of all contract procurements were of this type by 1960. Shortly after this record achievement, the DOD and McNamara instituted the incentive policy and began to reduce the number of dollars going into CPFF contracts. Incentive contracts became the preferred substitutes when firm-fixed price (FFP) contracts could not be negotiated. Table 1.2 contains dollar amounts and percentage figures for all government contract actions over $10,000. It clearly demonstrates that by 1965, CPFF contracts declined to only 9.4 percent of the total and the experience of recent years has been that a figure of less than 10 percent is being maintained. At the same time the CPFF contract was declining in

TABLE 1.2

AWARDS BY TYPE OF CONTRACT PRICING PROVISION BY FISCAL YEAR[a/]

Type of Pricing Provision	FISCAL YEAR											
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
	(Net Value $ 000)											
TOTAL b/	$13,661,308	$16,101,941	$17,997,053	$22,161,627	$22,873,335	$21,181,486	$22,857,231	$25,779,915	$26,224,582	$25,327,542	$24,330,659	$33,515,411
FIXED PRICE TYPE (SUB-TOTAL)	10,365,840	11,220,693	11,995,425	13,388,816	13,520,289	12,159,763	13,243,052	15,667,031	17,012,601	18,028,507	18,619,283	26,550,920
Firm	5,418,631	5,859,400	6,360,956	6,168,679	7,498,601	6,645,815	7,211,278	9,795,324	10,886,370	11,730,231	12,856,526	19,277,294
Redeterminable	1,715,573	1,596,461	1,548,113	1,630,271	1,070,589	1,298,138	2,403,006	1,897,663	981,440	611,885	536,435	765,555
Incentive	3,124,378	3,096,450	3,210,857	4,253,712	3,508,293	2,879,199	2,553,522	3,096,845	4,137,346	4,685,456	4,039,795	5,327,340
Escalation	107,258	668,382	875,499	1,336,154	1,442,806	1,336,611	1,075,246	877,199	1,007,445	1,000,935	1,186,527	1,180,731
COST REIMBURSEMENT TYPE (SUB-TOTAL)	3,295,468	4,681,248	6,001,628	8,772,811	9,353,046	9,021,723	9,614,179	10,112,884	9,211,981	7,299,035	5,711,406	6,964,491
No Fee	363,371	626,198	338,635	616,629	686,581	466,546	466,798	595,144	621,448	582,448	577,801	734,064
Fixed Fee	2,693,335	3,687,588	5,380,975	7,363,218	7,836,391	7,803,469	8,362,396	8,384,661	5,439,150	3,034,947	2,289,324	3,327,884
Incentive Fee	193,408	303,759	209,296	703,175	741,247	672,899	724,161	1,061,314	3,061,668	3,580,472	2,720,835	2,762,942
Time and Materials c/	45,354	63,703	72,722	89,789	88,827	78,809	60,824	71,765	89,715	101,168	123,446	139,581
	Percent											
TOTAL b/	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
FIXED PRICE TYPE (SUB-TOTAL)	75.9	69.7	66.6	60.4	59.1	57.4	57.9	60.8	64.9	71.2	76.5	79.2
Firm	39.7	36.4	35.3	27.8	32.8	31.4	31.5	38.0	41.5	46.3	52.8	57.5
Redeterminable	12.5	9.9	8.6	7.4	4.7	6.1	10.5	7.4	3.7	2.4	2.2	2.3
Incentive	22.9	19.2	17.8	19.2	15.3	13.6	11.2	12.0	15.8	18.5	16.6	15.9
Escalation	0.8	4.2	4.9	6.0	6.3	6.3	4.7	3.4	3.9	4.0	4.9	3.5
COST REIMBURSEMENT TYPE (SUB-TOTAL)	24.1	30.3	33.4	39.6	40.9	42.6	42.1	39.2	35.1	28.8	23.5	20.8
No Fee	2.7	3.9	1.9	2.8	3.0	2.2	2.0	2.3	2.4	2.3	2.4	2.2
Fixed Fee	19.7	24.1	29.9	33.2	34.3	36.8	36.6	32.5	20.7	12.0	9.4	9.9
Incentive Fee	1.4	1.9	1.2	3.2	3.2	3.2	3.2	4.1	11.7	14.1	11.2	8.3
Time and Materials c/	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.5	0.4

a/ For definitions and coverage, see Notes on Coverage. Excludes data for the Armed Services Petroleum Procurement Agency (ASPPA) from July 1954 through December 1956, but includes data for the Military Petroleum Supply Agency, the successor to ASPPA, beginning 1 January 1957. Army Procurement overseas prior to fiscal year 1958 is also excluded.
b/ Represents procurement actions of $10,000 or more excluding Intragovernmental.
c/ Includes Labor-Hour contracts.

Office of the Assistant Secretary of Defense (Installations and Logistics), Military Prime Contract Awards and Subcontract Payments or Commitments: July, 1965 - March, 1966. Washington: U. S. Department of Defense, 1966, p. 47.

usage, the fixed price contract and other incentive types experienced increased utilization.

Finally, the role of incentives in contracting must be explored. Without attempting to prove all the advantages and disadvantages of incentive contracts, their potential should be aired so that defense contractors can formulate reasonable attitudes and policies. At present, many defense contractors fear the incentive trend. There is no specific reason for this other than fear of the unexpected or unknown. They feel the incentive contract represents all stick and no carrot in the hands of a government agency. Ideas presented herein on profit under incentives should encourage these contractors to become more receptive towards incentive contracts. At the same time, they may be able to optimize profit while contributing to the strength of their country.

Scope of Work

As a prerequisite to the discussion of incentive contract models, a brief survey will cover the major contract forms presently used by the DOD. The object will be to identify the degree of incentive and risk in different contract forms. Essentially, the archtype of contracts with no incentive is the CPFF form and it will be compared with the archtype that has greatest incentive, the FFP contract. This general survey of contract forms is found in Chapter II, along with an analysis of the opportunity to optimize profit under different contract forms.

The cost-reimbursable contract is used as a norm or frame of reference in this section, only because it is so inflexible and therefore provides a sharp contrast for other contract forms. Included is a general foray into all contractual factors that might affect contractor motivation.

There are many ways to vary profit and they result in basic differences within the incentive contract classification. They are reviewed by illustrating how the contractor determines, by his performance, the final total profit as a result of decision making. Each unique technique or method for structuring an incentive contract receives special analysis in Chapter III, and examples of trade-offs, the technique used to optimize profit, are simulated.

After a discussion on the methods of structuring and pricing incentive contracts, there is a special treatment of profit, and another section that investigates the method by which incentive elements are chosen. These areas are controversial but their inclusion is an integral part of understanding contractor motivation and goal congruence. The section on models establishes the interdependency effect, and also that greater profit equals greater motivation. This study must go one step further by revealing that profit restrictions and artificial constraints against optimizing profits do exist, and to suggest that conceptual conflicts between profit constraints and incentive profits must be resolved. Particular reference is made to the Renegotiation Board and suggestions for curtailing its adverse affect on incentive contractors.

Finally, in the interest of being objective, both favorable and unfavorable aspects of incentive contracts are explored. In a separate section, delimitations are discussed to determine if the use of models can overcome some of the drawbacks assumed to automatically be part of the incentive contracting process. Another area, Appendix C, maintains perspective by covering chronic deficiencies found in defense contracting which one might expect to find regardless of whether the study's hypothesis is true and models have been applied.

Method of Research

The results of five continuous years of research effort on incentive contracting are incorporated in this study. The writer has chosen to emphasize the theoretical aspects of incentive contracts because of the need for a conceptual foundation. To some extent, a theoretical, flexible treatment is dictated because the DOD does not make completed incentive contract figures available, contract by contract. Each model is explained with simple illustrations and trade-offs. A short example is developed for each model to illustrate the method in which the parties to the contract test the interdependency effect and simulate profit outcomes for different cost/performance/schedule results.

The superiority of the incentive contract model as a management decision making tool must be judged relative to the old fashioned way of structuring the first incentive contracts, which depended upon weighting factors exclusively to obtain goal congruence. Thus, a general comparison between the older technique and the methods advocated by a particular model is presented. Although not involved with actual contract figures, this study will relate the conditions under which an incentive contract model might be appropriate, or specifically give an example of a program in which the model was applied. The extent of such reporting will depend upon information released to the public by the DOD. Generally, the discussion will center upon the theoretical foundations for structuring incentive contracts and will not involve testing validity from empirical data because of the nonavailability of data.

Source of Information

Published literature on incentive contract models is meager. Sources for incentive techniques are few by comparison with that for other subjects that exert a major impact on the economy. The literature contains no major books or articles published prior to 1960. After this date, contract specialists released some information to the public in magazine articles directed towards major defense contractors. In 1962, the Division of Research at the Harvard Business School published its first volume of the study, *The Weapons Acquisition Process*, by Peck and Scherer. In 1964, Scherer published a second volume dealing with economic incentives exclusively, which is quoted in this study. Another source has been the Alfred P. Sloan School of Management at Massachusetts Institute of Technology. M.I.T. has published numerous monographs from the "Research Program on the Management of Science and Technology." Articles have appeared at random in trade magazines, such as Aerospace Technology, formerly Missiles and Rockets, which are usually utilitarian, lack theoretical content, and only offer practical advice to contractors.

The best data on incentive contracts reside within the Pentagon in the form of completed contract records and that information is inaccessible to the average civilian. Some information, however, does find its way to the public through special studies. Various government agencies have authorized studies by Arthur D. Little, Harbridge House, Logistics Management Institute, M.I.T., Rand Corporation, Stanford Research Institute, and Booz, Allen and Hamilton, to answer specific questions regarding incentive contracts. A major coordinated research effort has never been undertaken and is still required. A large scale effort would involve greater numbers of people and dollars. These private research efforts are noted because they have influenced DOD policy and may have advocated changes similar to those found in this study. Past studies on individual contracts do not comprise a unified theory regarding the structuring and feasibility of incentive contract models to prevent dysfunctional consequences.

Finally, some of the ideas discussed were developed in the field while the author performed contract evaluation studies in 1964 and 1965. While no incentive contract model has been singled out as being preferable or superior, a pragmatic influence prevails for each model. The practical influence was extended as a result of having attended several incentive contract seminars and from making observations from comments and remarks rendered by those intimately familiar with incentive contract problems on a first-hand basis. Sources of this nature do not lend themselves to specific identification at all times but their impact should not be discounted.

Summary

There is a great need for better understanding as to how to apply incentive contracts. Their use is inescapable because the DOD has adopted the incentive philosophy with determination. A defense contractor has the option of using incentive contracts or not bidding for work.

Incentive contracts have been known to operate in reverse, having resulted in just the opposite intent of that desired by the contracting parties. In order to avoid dysfunctional consequences, and to ensure goal congruence between the parties to an incentive contract, the use of a model in structuring and pricing is recommended. The model, used properly as a contract management tool, will simulate problems before they occur, possibly preventing some problems. At the least, a model can help the parties to a contract avoid several problem areas.

Savings and greater efficiency are promised results if trade-offs, or simulations, are conducted systematically. Every justification exists to employ any tool in defense contracting that will generate savings and lead to greater efficiency in the use of scarce resources. Incentive profits can contribute to the health of the defense industry and the economy as a whole by motivating improved performance. Incentive profits depend upon varying compensation for varying performance. However, defense contractors generally fear varying profit arrangements and do not understand the incentive contract philosophy.

Providing contract managers for both sides of a contract with the theoretical tools to simulate problems will lessen fear of the unknown and remove doubt as an obstacle to the further adoption of the very practical economic concept that rewards motivate performance. Deductive processes can be used to show, then, how profits can be optimized and goal congruence will be ensured by using models that test the interdependency effect.

CHAPTER II

INCENTIVE CONTRACTING INSTRUMENTS

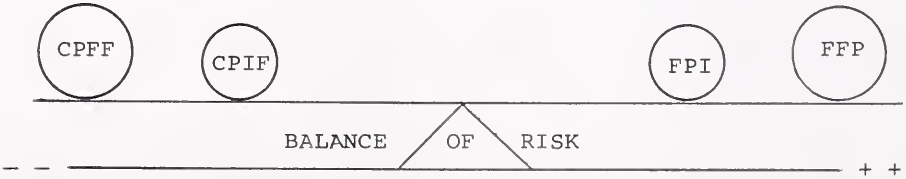
Introduction

This section will discuss general characteristics of various contract forms. One must have a knowledge of several contract instruments, both incentive and otherwise, before the relative merits and flexibility of incentive contracts may be appreciated. Following the definition and description of each contract type there will be a short reference to the environment in which that type has been used most prominently by the DOD. The descriptions will note appropriate contract usage. From this, it should become evident that a perfect contract for all procurements does not exist. Likewise, there is no best incentive structure or model. Each contract must be tailored to the situation.

Figure 2.1 shows the degree of incentive that can be incorporated into two extreme contract forms.

FIGURE 2.1

DEGREE OF RISK BY CONTRACT FORM



A contractor under a CPFF contract is subject to far less risk than a contractor on a FFP contract. To the left of the fulcrum, a contractor may be under some form of cost reimbursable contract; to the right of the fulcrum, he may have some form of fixed price contract. Under a cost reimbursable contract, costs are paid for by the government; consequently, business failure is unlikely with this contract arrangement.

To the right of the fulcrum are the various fixed price contracts. Here, for every dollar the contractor saves, he earns an additional dollar of profit. Conversely, for every dollar over the fixed target price, the contractor loses a dollar because it is his dollar that is spent. Because there are variations of both cost reimbursable and fixed price contracts, contractors and the government have learned to shift the risk by degree. It is possible to entirely rearrange the risk load and the expected profit from its normally assumed distribution. Risk shifting should not be a goal of the contract form, but it is usually a result.

Under present economic laws in our society, one assumes that the greater the risk involved in a market situation, the greater the reward or profit. If risk is slight, then profit should also be small. Statistics quoted in Chapter I indicated low percentages of profit in recent years for CPFF contractors. It was automatically assumed that contractors on a cost reimbursable contract should be forced to accept lower profits because the major risks of any contract were shifted to the government. Abrupt realization that actual cost reimbursement supported inefficient practices resulted in the development of contract variations that applied traditional risk and reward rules as they once were taught.

In defense contracting risk has unusual origins. Since risk is a major factor, its source should be carefully examined. Once a contract has been awarded, the usual source of competition as a business risk factor is eliminated. A rather common business risk, technical insolvency, is also minimized because the government makes progress payments. Even the vagaries of the business cycle have lessened impact on the defense contractor. What, then, are the major risks?

In R & D contracts, developing hardware that advances the state-of-the-art is considered a potential risk. Yet, there are relatively few contracts to which this applies. When a contractor sells nuts and bolts or a service to the government, this risk is of no concern to either party. The contractor's prime risk becomes the contract's target price or the figure for which he agrees to do the job. If the contractor has a cost reimbursable contract, even this major risk is minimized. If the contractor has a fixed price contract, the dollar amount becomes the focal point and whether he performs the work for more than, or less than the target price. Overshooting the target price represents lost money, while remaining under the target represents additional profit.

The particular type of contract instrument selected weighs heavily on the degree of risk associated with target cost. If the contractor has great confidence (high probability) in performing the contract for the target price negotiated, he will try to freeze the arrangement with a fixed price contract, having first allowed a markup for a fair profit. If however, the target is a nebulous one, and the probability of completing the contract at or near the target cost is slight, the contractor will try to protect himself with a cost reimbursable contract. Thus, the particular item and circumstances surrounding a procurement situation dictate the type of contract suitable for the parties. Other things being equal, the government will always try to shift the risk to the contractor, while the contractor will try to shift the risk back to the government, and still make a profit. Contracts have been developed which offer degrees of risk to the contractor and which use various incentives to make the contractor assume risk. The various contracts will be reviewed. The order of discussion is not related to present rank by dollar magnitude. See Table 1.2 for dollar amounts by contract type.

The process of differentiating contracts can be standardized and limited by asking two prime questions: 1.) who bears cost responsibility and, 2.) how do the parties share profit or fee dollars? Additionally, graphics are used to explain minor differences in contract arrangements, and even to build or design hybrid forms. Subsequently and reversing the usual analytic geometry of the process, we shall focus on mathematical and non-mathematical explanations of contract curves, hence the reason for "incentive contract models."

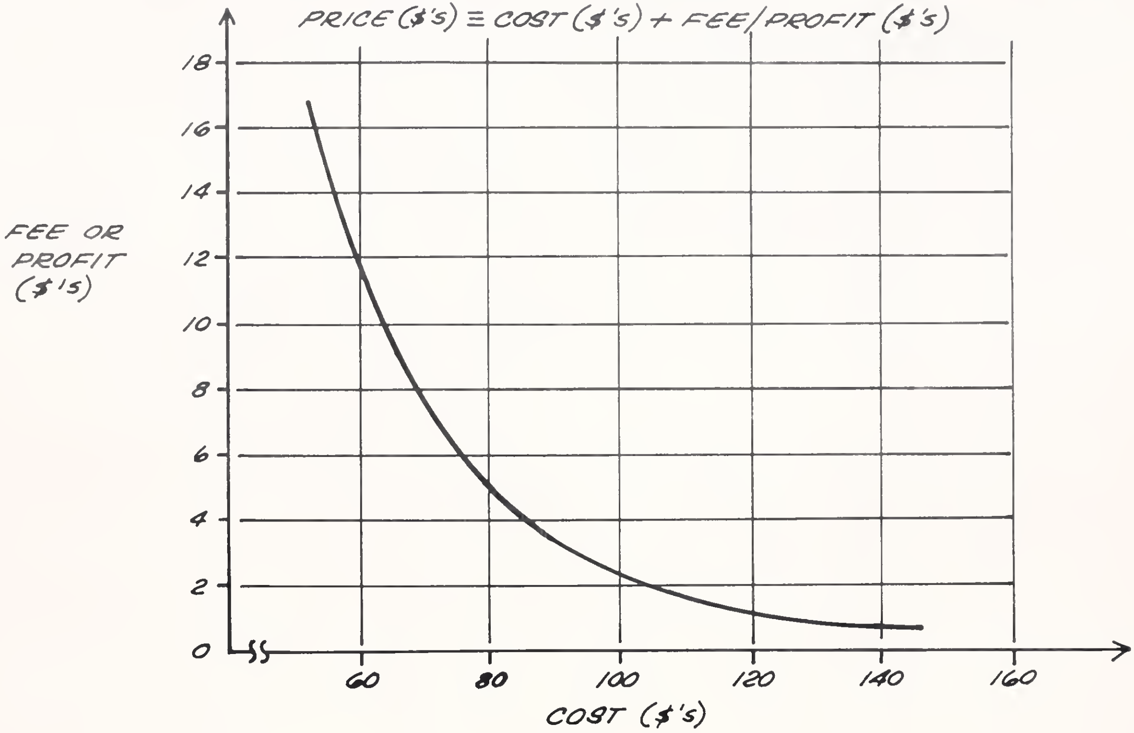
The price paid by the government for any and all services performed by its contractors is equal to the cost of performing the service plus some fee or profit for performing the service. Conventional practices have grown in which these relationships are graphed in terms of cost and profit, not price. See Figure 2.2.

Contract administrators derive great value from this graphical tool even though it does not show total price. However, total price is readily determined from the graph for any contract. The user can find price at any cost outcome by adding profit earned and cost for that level of contract cost.

The X axis (ordinate) is reserved for contract cost or target cost, while the Y axis (abscissa) shows fee or profit.

FIGURE 2.2

CONTRACT RELATIONSHIP TO BE DISPLAYED GRAPHICALLY



A line or curve describes the functional amount of profit for any cost outcome, and it is called the share line. Both cost and profit axes are scaled in dollars, not percentages. Thus, target cost and profit amounts are read directly.

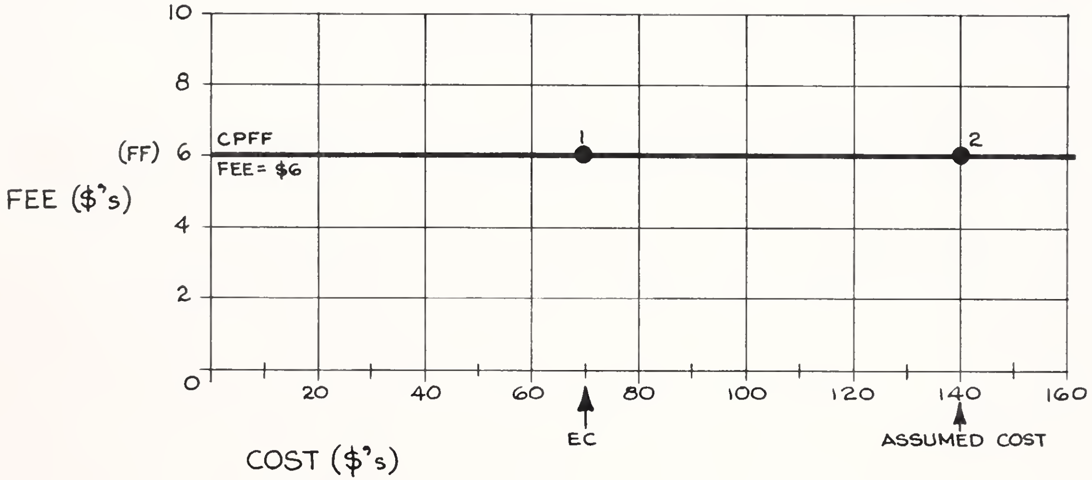
Cost-Plus-Fixed-Fee (CPFF) Contracts

The CPFF contract is not an incentive contract and contains no provisions for additional reward. However, description of the CPFF contract will permit a comparison of risk degree and incentive provided by other share arrangements in other contract forms. For example, under a CPFF contract, the government assumes total cost responsibility, and the contractor gets a flat fixed fee. If the contract overruns or underruns the target, the government still pays the total cost of the contract and the contractor still gets the same fixed fee. The government's share responsibility is 100 percent and the contractor's share responsibility is 0 percent. This is called a 100/0 share arrangement. The share arrangement or share ratio describes the government's and the contractor's portions in dividing underruns (savings) or overruns (expenses). Its graphed product is the linear or curvilinear share line.

Figure 2.3 shows a graph for a CPFF contract with an estimated cost (EC) of $70 and a fixed fee (FF) of $6. A uniform procedure is used to graph the share line whenever the

FIGURE 2.3
THE CPFF GRAPH

CPFF: EC = $70, FF = $6



SOURCE: BASIC GRAPHICS FOR INCENTIVE CONTRACTING. (CAMBRIDGE: HARBRIDGE HOUSE), 1966, PAGE 12.

profit function is linear. Two points are located at two different cost levels, and are connected with a straight line. For the first point, construct a vertical line passing through the EC of $70 and a horizontal line passing through the FF of $6. For the second point, assume the contractor had a major overrun of allowable costs which brought the contract cost up to $140, or $70 overrun. The fee at $140 would still be $6. Connecting the two points would give the share line for a CPFF contract with an estimated target cost of $70 and a FF of $6. Thus, the share line for a CPFF contract is a horizontal line. This line is parallel to the cost axis over the entire range of possible costs. All CPFF contracts have the same profile. The government will reimburse the contractor for all reasonable, allocable, and allowable costs incurred under a CPFF contract. The share ratio is 100/0, and, therefore, the government bears the entire cost of overruns and even pays the same fixed fee to the contractor whether he performs inefficiently or otherwise. Should the contractor perform for less than the EC, the government would save 100% of every dollar not spent.

Another way of expressing the sharing formula in this same situation is presented in Figure 2.4. An overrun or underrun can be stated as $X from target. The total allocation of an overrun or underrun must equal the combined

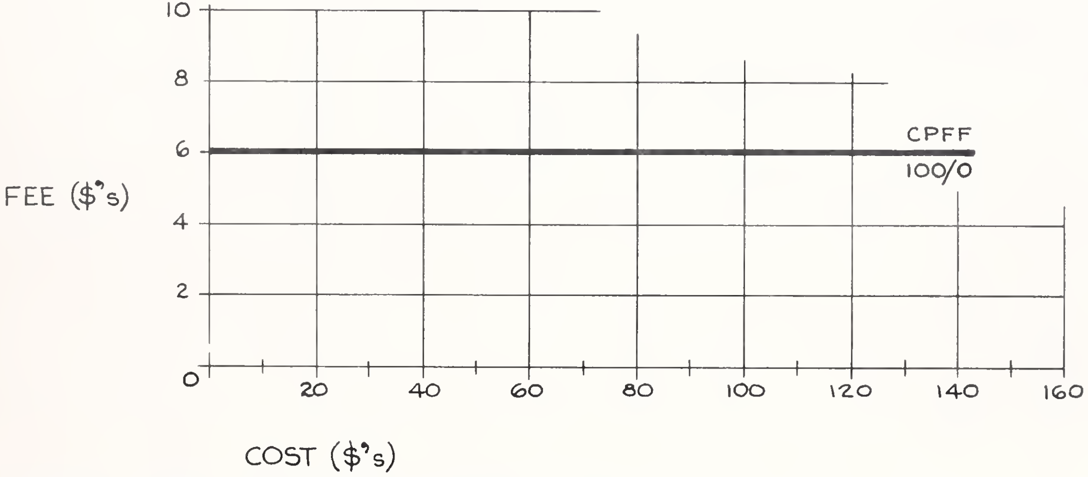
FIGURE 2.4
THE CPFF SHARE RATIO

100 = GOVERNMENT'S SHARE
0 = CONTRACTOR'S SHARE
100 = THE SUM OF THE TWO SHARE RATIOS

THE GOVERNMENT'S SHARE OF ALL OVER-OR UNDERRUN DOLLARS = 100%

THE CONTRACTOR'S SHARE OF ALL OVER-OR UNDERRUN DOLLARS = 0%

∴ THE CPFF CONTRACT SHARE RATIO IS ALWAYS EXPRESSED BY A 100/0 SHARE LINE



SOURCE: BASIC GRAPHICS, OP. CIT., PAGE 14.

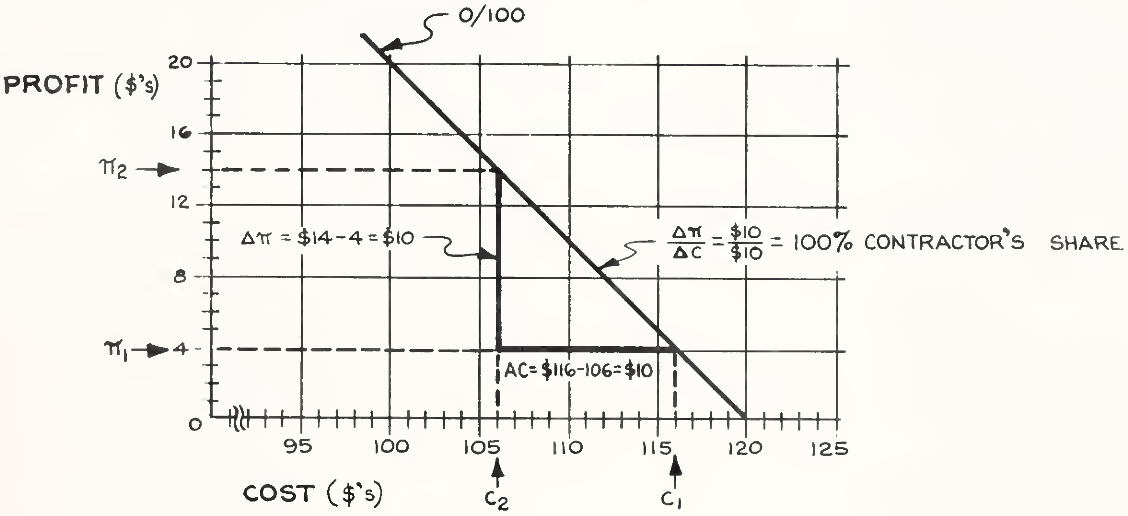
government's and contractor's shares. Thus, the sum of the numerator and denominator of the share ratio must always equal 100 percent, and the sum of the two share ratios for any sharing arrangement will show the disposition of the total overrun, or total underrun. For this reason, the share ratios are a prime feature of negotiations, as well as the dollar level of profit itself for different contract cost levels. The slope of the share line serves a similar purpose. The mathematical relationship for the slope of the share line will be developed after the same elements have been reviewed for a FFP contract.

Firm-Fixed-Price (FFP) Contracts

The FFP contract is characterized by a sharply sloping, almost vertical share line. It is the opposite of the horizontal 100/0 share line found in a CPFF contract. The FFP contractor bears all risk of cost overruns and enjoys all benefit of cost underruns, or has a 0/100 share ratio. Slope of the FFP share line is steepest for any type of contract form presented, although it is never vertical. This is shown in Figure 2.5.

Assume a negotiated FFP contract for a price of $120. The contractor will automatically receive $120 for completing the work regardless of costs incurred. If he provides the

FIGURE 2.5
THE FIRM FIXED PRICE (FFP) CONTRACT



SOURCE:
<u>BASIC GRAPHICS</u>, <u>OP. CIT.</u>, PAGE 48.

service for actual costs of \$116, his profit will be \$4 (\$120 - \$116 = \$4). If he is more successful and efficient, and performs for a cost of \$106, his profit will be \$14 (\$120 - \$106 = \$14). Regardless of cost outcome, the sum of the cost outcome and the profit must always equal the fixed price, \$120. The contractor's share for any contract is found by dividing the change in profit by the change in cost. Let $\Delta\Pi$ equal change in profit to prevent confusion with change in price, and let ΔC profit equal change in cost; and the equation becomes:

$$\frac{\Delta Y}{\Delta X} = \frac{\Delta\Pi}{\Delta C} = \frac{(\$14 - \$4)}{(\$116 - \$106)} = \frac{\$10}{\$10} = 1 = 100\%$$

Therefore, the share ratio is 0/100 for an FFP contract, the exact opposite of the 100/0 for a CPFF contract. The FFP share line can not be vertical in Figure 2.6 because ΔC is always an absolute figure.

Since the contractor makes \$1 in profit for every \$1 he saves on cost, or loses it in the reverse situation, the Armed Services Procurement Regulation (ASPR) states it is the most preferred contract type.[1] The FFP contract gives the contractor maximum incentive to achieve cost reduction and satisfy DOD goals because: 1) the government is able to assume complete cost responsibility under this form of contract, and 2) management is motivated to take positive steps

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[1] Armed Service Procurement Regulation (ASPR), U.S. Department of Defense, 3-402 (b)(1), 1963.

to avoid costs[2]. If both parties are equally competent in contract negotiation, the FFP contract can satisfy both parties. The objective and best interest of the government is to get the procured item at the least cost and on schedule, provided the item is of good quality and meets specifications. The objective and best interest of the contractor is to make a fair profit at a reasonable price while satisfying the customer. Pricing complexity is avoided because the share formula is simply 0/100. The contractor is rewarded proportionally to his efficiency and he bears the burden of resolving all problems. The government prefers to use this contract whenever possible. However, lack of certainty with respect to future costs, or unknown costs, may cause a contractor to hesitate in accepting the binding arrangement of an FFP contract. Under its terms both parties are bound by the negotiated prices for the life of the contract and no price adjustment is possible. Latest figures available (Table 1.2) indicate that FFP contracts account for 58 percent of total procurements, having reached this level along with the drive to incorporate incentive contracts for DOD work.

The contractor's profit with FFP contracts stems from his ability to control costs and he must manage efficiently since all savings below target cost are retained as profit.

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[2] Incentive Contracting Guide, Office of the Assistant Secretary of Defense, (Installation and Logistics) DOD, AFP 70-1-5 1965. p. 29.

Benefits to the government are both direct and indirect in nature. In the direct area, cost reductions on FFP contracts suggest the most efficient production methods for future follow-on contracts and also the most advantageous prices. In the indirect areas, savings accrue because of the small expense and workload involved in administering this contract since there are no advisory audits and but one negotiation. By contrast, CPFF contracts require constant supervision and heavy audit attention.

The rigid contractual features of the FFP contract demand fairly exact pricing information for success. Required _a priori_ knowledge of positive target cost restricts the use of FFP contracts in most R & D work and _service_ procurements where this exact information is not available. In the latter, for example, the work requirement may be stretched over a long period of time and be non-definitive; or the work may be non-repetitive even though the same service contract is negotiated two years in a row. The FFP contract is not suitable in these situations. It is most functional where products, not services, are the procurement object. During World War II and the post war era, the government bought large numbers of identical planes from the same manufacturer. Despite this fact, FFP contracts were not popular and not used.[3] The FFP contract

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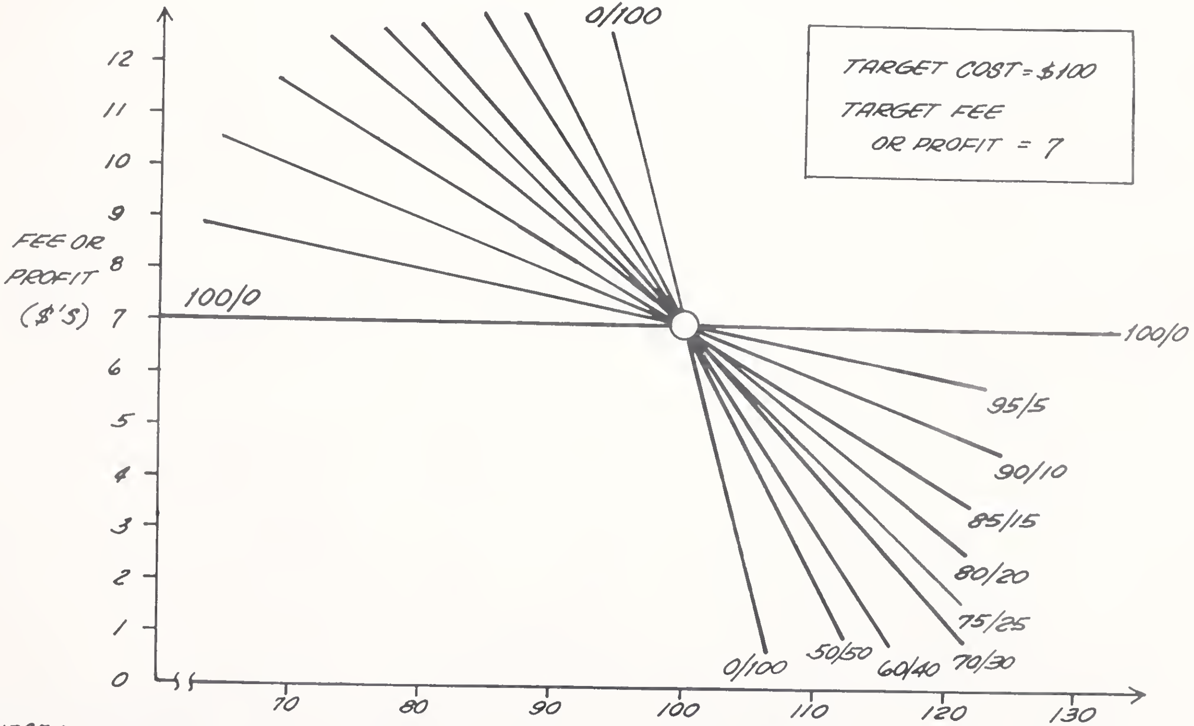
[3] Miguel Angel Reguero, _An Economic Study of the Military Airframe Industry_, Department of the Air Force, 1957, p. 169.

is most suitable and is used for purchasing "off-the-shelf" items, where reasonably close cost projections can be made at minimal cost. Even though it is not always appropriate the FFP contract is a standard against which all other contracts may be evaluated.

In the two graphic situations presented, Figure 2.3 for the CPFF contract and Figure 2.5 for the FFP contract, no slope equaled no incentive and most slope equaled most incentive. These extremes are the parameters of any incentive structuring problem. Therefore, all salient features of the share line have a bearing on this topic.

In Figure 2.6, a number of share ratios and their associated share lines are plotted for a contract with a target cost of $100. All the share lines pass through the target fee of $7 (7 percent) and the target cost of $100. As the contractor's share ratio increases from 0 to 100 percent, the share line becomes steeper and steeper and the contractor absorbs or shares more and more heavily in any cost overruns or underruns. Under actual contract conditions only <u>one</u> share ratio would be applicable for any <u>one</u> contract cost outcome. Thus a contractor would have negotiated either a 90/10 <u>or</u> a 75/25 share line with the government at target cost. Complex contract forms which have varying share ratios, either due to a stepped or curvilinear share line, will be introduced later.

FIGURE 2.6
SHARE RATIOS



SOURCE : BASIC GRAPHICS, OP. CIT., PAGE 16.

A basic understanding of share line construction is a prerequisite for incentive contract comprehension. The first step in constructing a share line has already been covered; it consists of locating the intersection of target cost and target fee. It is one point of determination for the linear share line. For the other, a second point must be selected for an assumed cost outcome. If the parties negotiate an 80/20 share line and a TC of $100, should the contractor perform the work for $80, he will have succeeded in saving $20. How is this $20 underrun divided and what is the associated fee? The contractor's share of all cost underruns, or overruns, is 20 percent. For finding the associated fee connected with an underrun of $20, one must increase fee equal to the magnitude of the underrun multiplied by the contractor's share. Since $20 x .20 equals $4, this is the contractor's share with an 80/20 share line arrangement. The $4 is a reward, and it is added to the target fee of $7, resulting in a total fee of $11 paid to the contractor for performing the service for a cost of $80. The second point is marked by coordinates for $80 of cost and $11 of fee.

Once two points have been found, the share line is completely defined by connecting the two points and extending the line. The sample 80/20 share line was completed by connecting two points with a solid line extended in both increasing and decreasing fee directions. Therefore, the second point defining the share line could have been constructed by assuming a cost overrun rather than a cost underrun. Any point would have been sufficient provided that it was other than at target cost and target fee. The share line described is pictured in Figure 2.7.

A fee can be computed for any incentive arrangement without graphic illustration as long as the share ratio is known. Graphics assist critical negotiation of an incentive contract, although fee can be figured independently, using a share line equation. The contractor's fee is increased by adding incentive fee to target fee as a result of a cost underrun. The cost underrun times the contractor's share is added to target fee to get total fee.

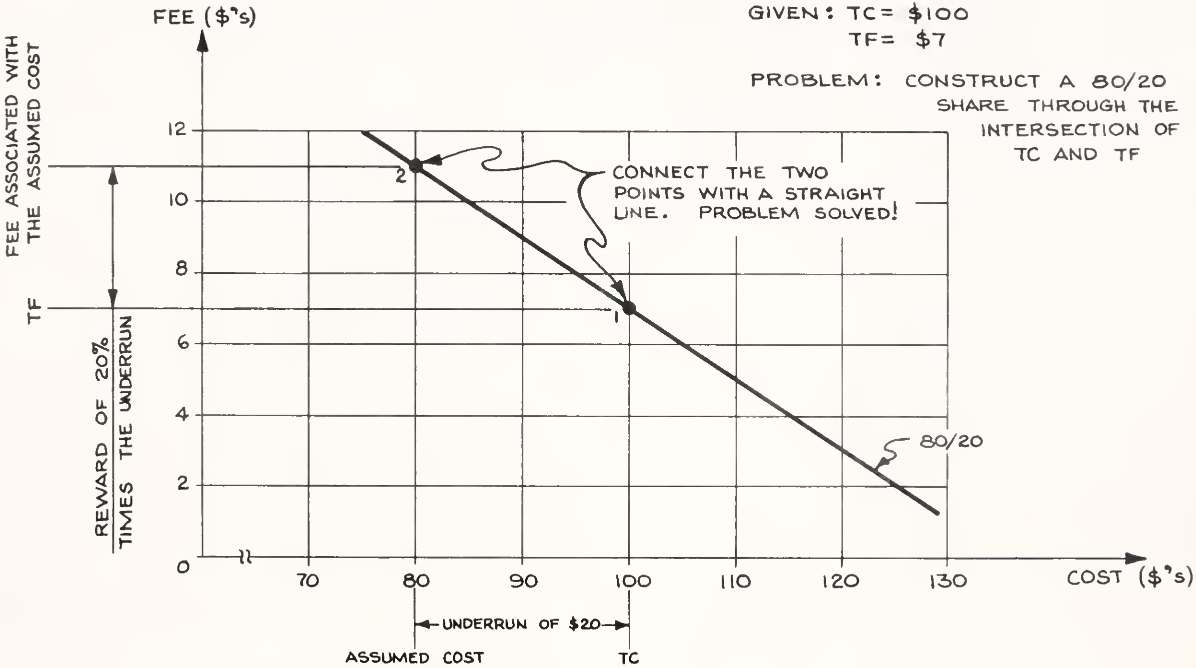
$+ \Delta F = - \Delta C$ x contractor's share, or

$\frac{\Delta Y}{\Delta X} = \frac{\Delta F}{\Delta C}$ and

$\frac{\Delta F}{\Delta C}$ = the contractor's share; and the slope of the share line.

The share line equation may be used for constructing the share line if it is not known, or also for solving for fee at any given cost outcome at variance with target cost and target fee. This can be proved by taking the same information from the example used in Figure 2.7. Assume the share line had not been labeled 80/20. By reading the cost and fee

FIGURE 2.7
CONSTRUCTING A SHARE LINE



GIVEN: TC = $100
TF = $7

PROBLEM: CONSTRUCT A 80/20 SHARE THROUGH THE INTERSECTION OF TC AND TF

CONNECT THE TWO POINTS WITH A STRAIGHT LINE. PROBLEM SOLVED!

SOURCE: <u>BASIC GRAPHICS</u>, <u>OP.CIT.</u>, PAGE 22.

information of the coordinates for \$100 and \$80 where they intersected the share line, the reader would be able to determine ΔF and ΔC thus:

$$\Delta F = (\$11 - \$7) = \$4$$

$$\Delta C = (\$100 - \$80) = \$20$$

$$\frac{\Delta F}{\Delta C} = \frac{4}{20} = \frac{1}{5} = 20\%;\ \text{the contractor's share}$$

In Figure 2.8, the government's share is automatically 80 percent because (100% - 20% contractor's share) equals 80 percent. The two share ratios (80/20) must always equal 100 percent by definition.

This information can be used to determine fee over any cost range as follows:

Example I:
Target Cost \$90
Target Fee \$7
Share Ratio 70/30

What will be the contractor's fee if he accomplishes the work for \$80? This is a \$10 underrun since,

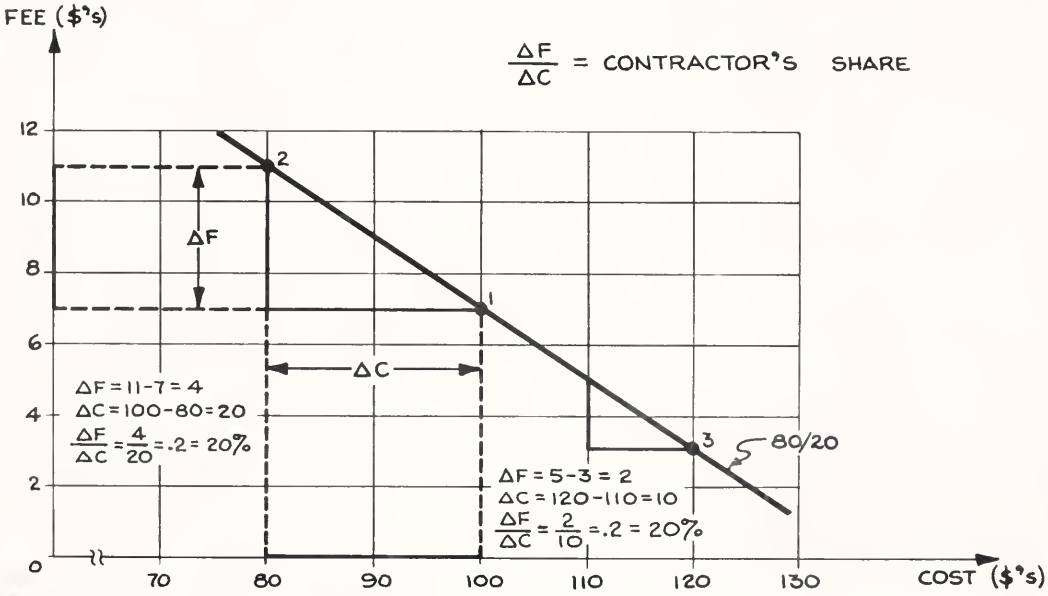
$$\frac{\Delta F}{\Delta C} = 30\%$$

$$\frac{\Delta F}{(90-80)} = \frac{\Delta F}{10} \times \frac{.30}{1} \text{ and}$$

$$\Delta F = \$3.00 \text{ and}$$

Total Fee = Target Fee (\$7.00) + Delta Fee (\$3.00) or \$10.00

FIGURE 2.8
SHARE LINE EQUATION



SOURCE: BASIC GRAPHICS, OP. CIT., PAGE 24.

Example II:
Target Cost $90
Target Fee $7
Share Ratio 70/30

What will be the contractor's fee if he does the work and it costs $110? This is a $20 overrun.

Since $\frac{\Delta F}{\Delta C} = 30\%$

and $\frac{\Delta F}{(90-110)} = \frac{\Delta F}{-20} \times \frac{.30}{1}$ and

$\Delta F = -6.00$

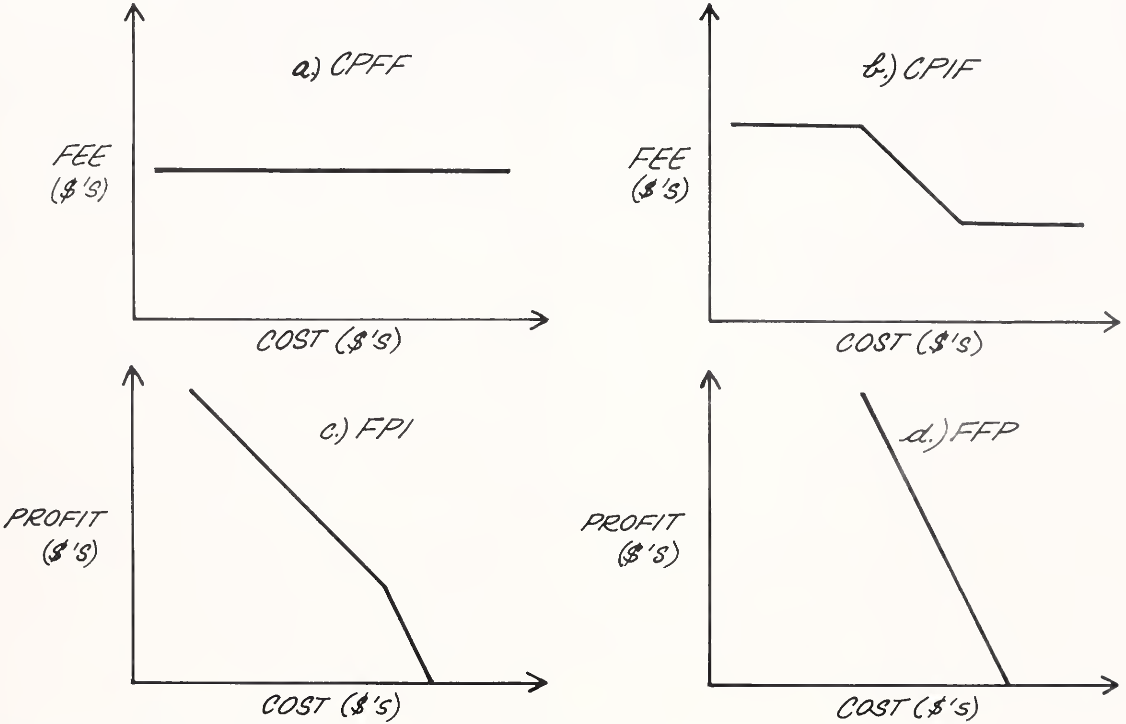
Total Fee = Target Fee (7.00) + Delta Fee (-6.00) or $1.00

Note that the government saved $7.00 ($10 x 70%) in Example I and lost $14 (20 x 70%) in Example II. While the government had the lion's share, the contractor was forced to be cautious and would ordinarily have preferred the first situation over the second one.

This completes the basic indoctrination for share ratio and share line understanding. This indoctrination was necessary because share lines are incorporated into every contract. By analyzing the share line, it is possible to identify and partially analyze every contract. Proof of this statement can be found in the illustrations of basic contract types in Figure 2.9.

The CPFF and FFP contract graphs have already been explained. Their share lines were compared to show how opposite

FIGURE 2.9
BASIC CONTRACT TYPES



SOURCE: BASIC GRAPHICS, OP. CIT., PAGE 6.

they appeared to be. Even the contract environments were compared. The CPFF contract is used where target cost is actually an unlikely estimate (low probability) while the FFP contract attaches great weight to the target cost estimate (high probability). These two contract forms in Figure 2.9, illustrations a. and d., have opposite share lines.

The essential element of the FFP contract is price. It is ideal for formal competitive procurements. Since the contractor agrees to provide the work or service at a specified price, he, and he alone, is responsible for profit. He has complete cost control and is responsible for allocating factors in their best mix. If he is more efficient than his competitors, his profits will be higher than theirs. The real incentive to avoid waste and devise better production methods results in $1 of additional profit for each $1 saved.

The essential elements of the CPFF contract are: 1) estimated cost, and 2) the fixed fee. Estimated cost, or the cost the government will pay the contractor on this cost reimbursable form are for those costs that are true and allowable. Frequently, the Administrative Contracting Officer (ACO) and his supplier are in disagreement as to whether a cost is allowable and should be repaid by the government. Therefore, this contract requires close audit supervision and special accounting treatment by the contractor. Even with close supervision, there is greater opportunity for the parties to not have a meeting of the minds with the CPFF contract.

Section 15 of ASPR contains a statement of cost principles now used as a basis for determining costs under cost-reimbursement contracts and they are often incorporated into contracts by reference. There still remains the possibility that legitimate contractor costs may be disallowed or excessive costs may be erroneously approved by the government's auditor or the ACO. At the same time, Chapter I pointed to the problem of low fees with CPFF contracts. Under the circumstances a contractor usually tries to get every penny he can out of the government as an allowable cost. This tendency causes massive overruns with cost reimbursable contracts relative to estimated target cost.

The CPFF contract allows no incentive for cost reduction. Nor can the contractor promise to hold the line on costs if the government will give him an extra fee. Under the provisions of 10 U.S.C. 2306(d), the maximum permissible fee on CPFF contracts is limited to 10 percent of estimated cost of the contract, exclusive of fees, on most types of work.[4]

Returning to Figure 2.9, the share line in b., Cost-Plus-Incentive-Fee (CPIF) and c., Fixed-Price-Incentive (FPI), contracts offer compromises over the extremes afforded by the share ratios under CPF (a) and FFP (d) contracts. These are

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[4] Government Contracts AFM 110-9, Extension Course Institute, Air University, DAF-DOD, 1964, p. 7-5. The limit is fifteen percent on R & D work.

major contract forms in use today. Table 1.2 shows the relative importance of CPIF and FPI contracts in dollars and percentages. Table 1.3 shows impressive growth since 1960.

Cost-Plus-Incentive Fee (CPIF) Contracts

The essential elements of the CPIF contract are: target cost, target fee, maximum fee, minimum fee, and the share ratio.

The contractor's total fee on a CPIF contract is limited to the range of fees defined by the maximum and minimum fee provisions of the contract. The maximum and minimum fees are limits, and the share line in these regions is a constant (horizontal). Therefore, the first step in constructing a CPIF graph is to insert the horizontal share lines that represent these two extremes of possible fee outcome. The maximum and minimum fees are not derived algebraically: they are the result of negotiation by the parties to a CPIF contract. For example, given:

Target cost	$100
Target fee	7
Maximum fee	12
Minimum fee	2
Share line	80/20

Clearly, fee cannot exceed $12, nor can it fall below $2. Once either extreme has been reached, due to either a cost underrun or a cost overrun, fee ceases to change as further underrun or overrun is incurred. The possible numeric range of fee variance is:

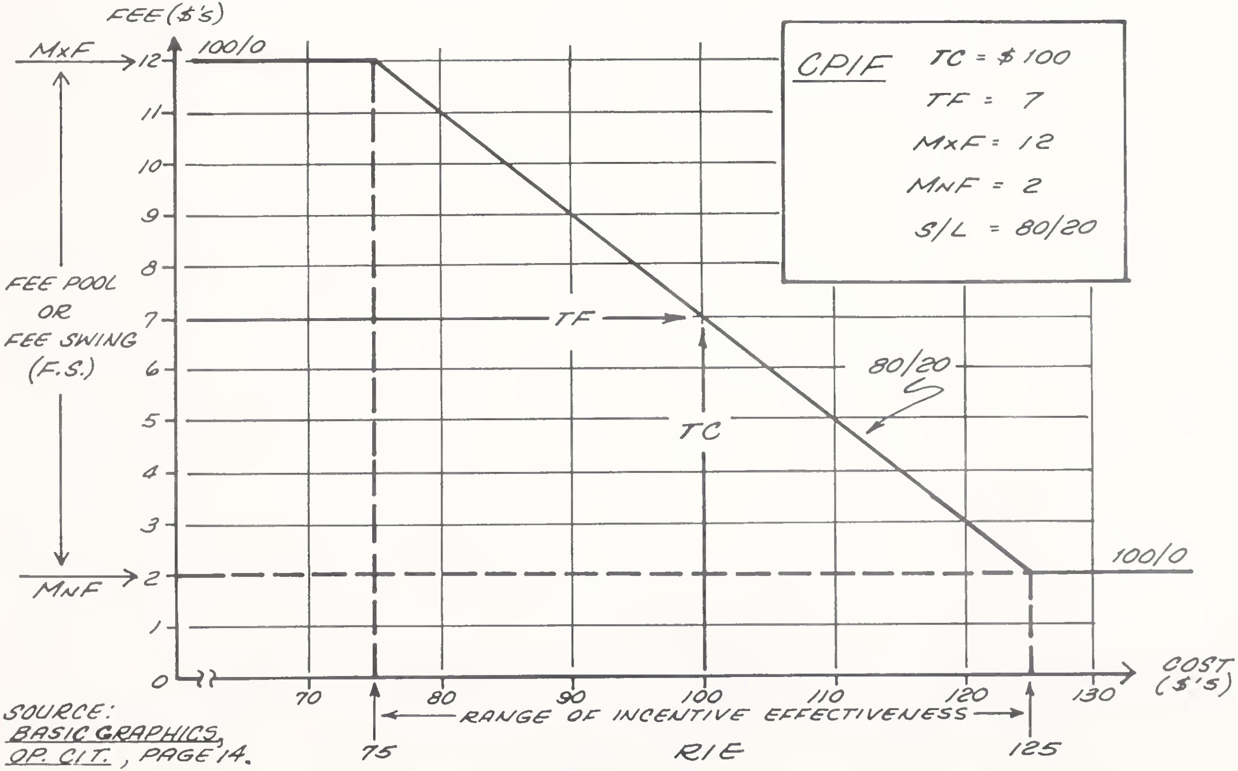
	Maximum	Target	Minimum
Actual Cost	$75	$100	$125
Target Cost	100	100	100
Underrun	25	0	
Overrun		0	25
Target Fee	7	7	7
Reward	+5	0	-5
Total Fee	$12	$7	$2

The contractor will probably perform for some cost within the target area, so we will concentrate on this probable outcome for the moment. For the construction example, the next step after inserting the maximum and minimum fee lines or plateaus, is to locate coordinates for target cost and target fee ($100 and $7). Another point is necessary to define the 80/20 share line, therefore one other cost outcome other than target cost is selected. Assume a cost of $90, then total fee would be $9, because target fee ($7) and incentive reward ($2) combine to make up the total.

The share line is constructed once these two points of reference are located. It is extended until it intersects the maximum ($12) and minimum ($2) fee lines. The construction of the CPIF contract is now completed. See Figure 2.10.

The parameters shown in Figure 2.10 suggest a contractor

FIGURE 2.10
THE COMPLETED CPIF CONTRACT



SOURCE:
BASIC GRAPHICS,
OP. CIT., PAGE 14.

would attempt to perform the contract for a cost of \$75, because lowering the cost to this outcome, his total fee continues to rise. Once performance for \$75 is reached, fee goes no higher and the contractor no longer has additional incentive to cut costs. In the regions where maximum and minimum fees are applicable, and the share line is a constant or horizontal, the contract switches from a CPIF form to a CPFF form. The profit ceiling, maximum fee, and the profit floor, minimum fee, convert the incentive contract to a fixed fee contract and this may defeat the intentions of both parties. In the early 1960's, when the parties to incentive procurements were extremely cautious, many CPIF contracts had share lines which were plateaus in the region of most probable outcome. Plateaus are self-defeating and were quickly abandoned by sophisticated contract negotiators as soon as experience was gained with incentive contract pitfalls.

Since the share line must have slope, $\frac{\Delta Y}{\Delta X}$, over the cost region for the contractor to make additional fee through rewards, the cost range becomes very significant. In the contract illustrated, the operative cost range of the 80/20 share line is defined as the range of incentive effectiveness (RIE). The lower limit of the RIE is a cost of \$75, and the upper limit of the RIE is a cost of \$125. At these cost outcomes, fee has reached its maximum and minimum levels respectively. Furthermore, the variance between maximum and minimum fee can be defined as fee swing (FS), or fee pool. In Figure 2.10, the FS is $10 (12-2), and the RIE is $50 (125-75).

In the CPIF contract, the general share line equation $\frac{\Delta Y}{\Delta X}$ for the contractor's share, is replaced by the specific equation when the share line is a straight line, or:

$$\frac{FS}{RIE} = \frac{\$10}{\$50} = \frac{1}{5} = 20\% \text{ (the Contractor's Share)}$$

The difference between general and specific equations is more apparent than real. The fee pool, FS, is nothing more than the entire change in fee (ΔF) between maximum and minimum for a specific CPIF contract with a constant contractor share line. At the same time, RIE is nothing more than the entire range in cost (ΔC) over which the share line operates. The general equation is used to find the contractor's share ratio for any cost outcome, while the specific equation is used with a CPIF contract when the share line is a straight line.[5] Regardless of which equation is selected, whenever two CPIF contract elements are known, the third element can take on only one value. Thus, as long as two of the variables are specified: FS, RIE, or Contractor's Share, the third value can be derived.

In the CPIF contract illustration, the variables were simplified for clarity. In practice, actual incentive contract

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[5] Basic Graphics for Incentive Contracting, Boston: Harbridge House Incorporated, 1965, p. 45.

arrangements are often more complex. Through hard and determined negotiations, the parties might agree to a broken share line, or a series of separate share lines with different slopes and different share ratios. For example, the government might agree to split reward, 70/30, on the underrun side of target cost, while taking more of the loss, 90/10, on the overrun side. Contractors will frequently maneuver in order that they may share profits to a greater extent and losses to a lesser extent.

Our typical example has a positive maximum and minimum fee. It is quite possible to make the fee floor a zero fee, or perhaps even a negative or minus fee. The intent, of course, is to permit a contractor to make a small profit even if he has done badly by incurring a major cost overrun, thus a minimum fee will ordinarily be used to prevent a contractor from experiencing an out-of-pocket loss[6]. However, to remind the government and the contractor that incentive rewards are a two-way street, ASPR states that: "Whenever this type of contract, with or without the inclusion of performance incentives, is negotiated to provide incentive up to a high maximum fee, the contract also shall provide for a low minimum fee, which may even be a 'zero' fee, or, in rare cases, a 'negative' fee."[7] The minimum fee may be eliminated altogether

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[6] U. S. Air Force, Department of Defense Incentive Contracting Guide, Pamphlet 70-1-5, (Washington, D. C.: Office of the Assistant Secretary of Defense-Installations and Logistics) 1965, p. 5.

[7] ASPR, op. cit., 3-405.4.

and the sharing formula continued indefinitely on the overrun side of target cost, whereby, the contract becomes "cost sharing." A contractor faced with this alternative, would be strongly motivated to stop excessive spending. While such arrangements work favorably to the government's advantage, they are admittedly difficult to negotiate with any contractor.

Finally the FS and range of costs over which the incentive provision operates, (RIE), are completely non-standardized. There is no one best incentive arrangement. Each time a new contract is negotiated, the FS, RIE, and share ratios must be worked out to the satisfaction of both parties based on the degree of confidence they have in the target cost estimate. Incentive contract models are valuable to parties looking for alternatives at this vital negotiating stage.

The share line in Figure 2.10 is completely symmetrical between FS and target fee; and between RIE and target cost. In practice, the share line determined by multiple incentive will not be symmetrical. There will be a skewed effect on both FS and RIE targets. The Figure 2.10 example was symmetrical because FS was ± $5 from the target fee of $7; and because RIE was ± $25 from target cost of $100. They might have been skewed by having unequal positive and negative FS's in terms of dollar variance possible; or, the dollar difference between target cost and the lower limit of the cost RIE could vary from the dollar difference between target cost and the upper cost limit of the cost RIE. In any case, a contract which has different dollar amounts ±TC is a skewed model and is therefor called an asymmetric model. A majority of today's multiple incentive contracts are asymmetrical models. Nevertheless, the rules for structuring the symmetrical incentive contract model apply equally for the asymmetrical model and the analytical processes are identical.

Why has this information been pursued in great detail? The reason will manifest itself as more complex arrangements of the CPIF and FPI are presented. The rules for determining fee will not change as complexity increases. A contractor is always interested in the total fee, which is based on both target fee and marginal incentive fee. Fee determination is complicated when it depends not only on cost, but also on performance and schedule as well. The contractor must manage by making trade-off decisions that allocate his factors in a mix designed to produce the highest total fee possible. He can only solve the allocation problem based on a knowledge of the total reward. The key to incentive performance lies in making the reward or total fee, in actual dollars, visible to the contractor at every moment. The problems created by combining several incentives into one contract will be discussed in detail later. Management must have knowledge of their impact on FS and RIE before a decision-theory is possible.

Fixed-Price-Incentive (FPI) Contract

Contract form c, the fourth type illustrated in Figure 2.9 is an FPI contract. The essential elements structuring an FPI contract are, 1) target cost, 2) target profit, 3) ceiling price, and 4) the share ratio.

The FPI contract is somewhat of a hybrid variety between the CPIF contract and the FFP contract. It is also a relative of the older redeterminable contract used by the DOD. Essentially, it provides for a flexible dollar amount of profit based on a predetermined fixed profit pattern. Target cost is a highly realistic prior estimate of actual cost of performance as agreed to by contractor and buyer. Target profit is the expected profit the contractor will receive if his actual cost of performance equals target cost. The profit formula has a provision for decreasing the contractor's profit as actual cost exceeds target cost, and of increasing profit as actual cost is reduced below target cost. The ceiling price (CP) is the maximum dollar amount the government will pay on an FPI contract. Therefore, if the contractor's actual cost equals the ceiling price, he just breaks even and earns no profit. This *is* the contractor's break-even point. If actual cost exceeds the CP, he must pay or absorb costs out of his own pocket, and suffer losses accordingly.

The ideal situation for using the FPI contract would specify a high degree of confidence in the maximum target cost estimate, while involving substantial future opportunity for cost reduction. It would be appropriate, for example, in a production procurement which involved large quantities over an extended period of time. This situation would possibly involve an improvement factor, or a learning-curve effect. An FPI contract is not recommended for industry or government unless costs can be estimated with enough accuracy to assure realistic targets and profits because a contractor can receive a reward for overestimating his costs with an FPI arrangement.

The FPI contract may take two forms; one has a firm initial target and the other has a series of firm targets. The latter form is known as a fixed-price-incentive contract with successive targets (FPIS). The FPI with a firm target is used when contractor and government knowledge of probable cost is indefinite though substantial, so that fair, firm targets cannot be established at the outset. Resetting the target with the FPIS must become possible at some early point in the future performance of the contract, such as just prior to delivery or shop completion of the first item. The FPI contract can only be used after a written determination and finding is made setting forth that 1) this method of contracting is likely to be less costly than other methods, or 2) it is impractical to secure supplies or services of the kind or quantity required without the use of such a contract[8].

The FPI contract can be explained numerically or graphically. As with the CPIF example, by starting with the numerical explanation and graphing the result both approaches can be demonstrated simultaneously.

Given an FPI contract with: target cost (TC) equal to \$109; target profit ($T\pi$) equal to \$11; ceiling price (CP) equal to \$129; and a share line of 60/40, then:

LINE (L)		GREATER ←PROFIT		TARGET PROFIT	MINIMUM PROFIT	NO PROFIT
1	ACTUAL COST	89	99	109	119	124
2	TARGET COST (TC)	109	109	109	109	109
3	TAR-ACT (L2-L1)	20	10	0	-10	-15
4	TARGET PROFIT ($T\pi$)	11	11	11	11	11
5	REWARD/PENALTY (40% of Δ ,L3)	8	4	0	-4	-6
6	TOTAL PROFIT (L4+L5)	19	15	11	7	5
7	PRICE (L1+L6)	108	114	109	126	129(CP)

The FPI differs from the CPIF in two very important respects. First, there is no maximum fee limitation on the FPI contractor. Therefore, with respect to cost underruns, each time the contractor saves an additional \$10 in cost, marginal profit increases by \$4 with a 60/40 share line. The govern-

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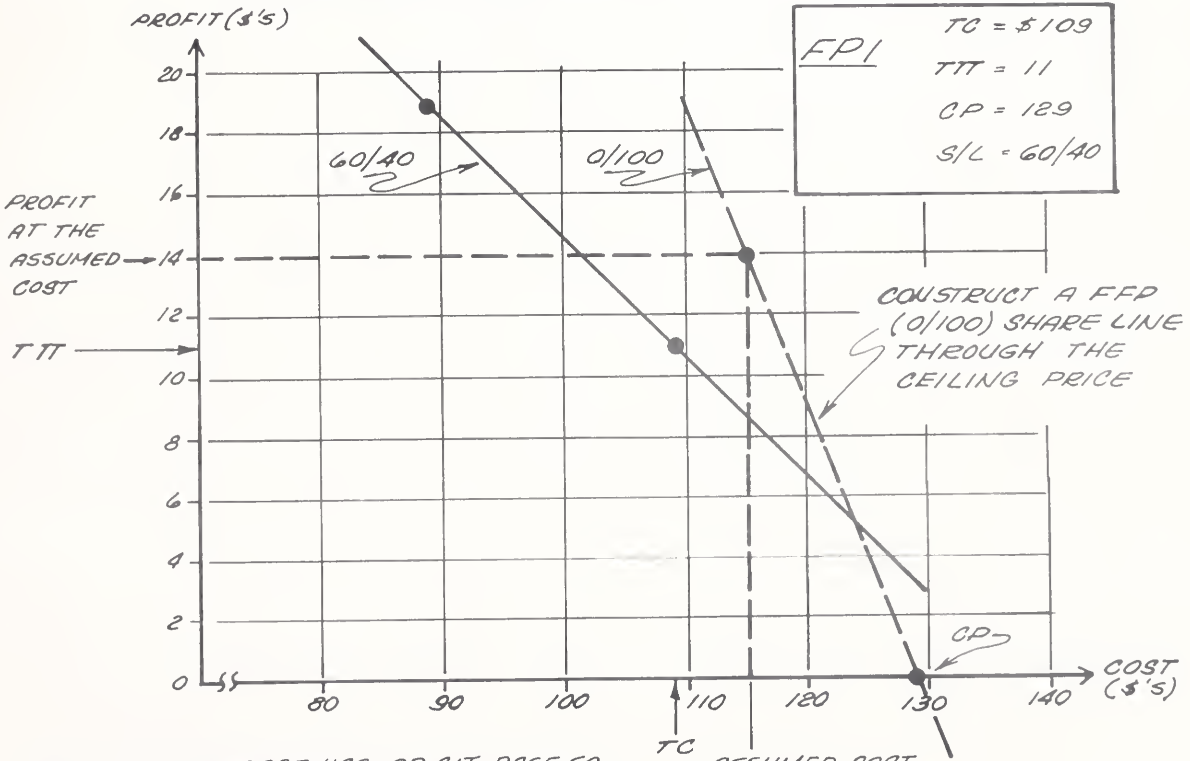
[8] *Government Contracts*, *op*. *cit*. p. 7-3. Cited from 10 U.S.C. 2306 (c).

ment saves \$6 or the remainder of the \$10 saved by the contractor. The second distinction of the FPI is the ceiling price representing a dollar limit the government will pay to the contractor. When actual cost reaches the contractually stated ceiling price, the sharing ratio of 60/40 ceases to apply. With respect to cost overruns, as the contractor expends an additional \$10, profit is decreased by \$4. The application of the 60/40 share line to additional expenditures ceases once a cost outcome of \$124 is reached because it would result in a price paid that was greater than the \$129 ceiling price. Contract definition and agreement prohibit payment over \$129. Graphic analysis of the FPI will support the CP position.

Figure 2.11 starts with the FPI assumptions just given. The FPI must be structured in two distinct steps. First, a point for locating a 60/40 share line is plotted for TC (\$109) and Tπ (\$11). Locating a second point for the 60/40 share line is based on some assumed cost outcome and determining the profit associated with that assumed cost. For example, if TC is \$89, a contractor would get a total profit of \$11, plus 40 percent of the \$20 underrun, +\$8, or \$19 (\$11+\$8), thus, the two sets of coordinates locate the 60/40 share line and it is plotted.

There is a distinct break point in the share line due to the impact of the ceiling price on the FPI contract. This

FIGURE 2.11
CONSTRUCTING THE FPI CONTRACT



SOURCE : BASIC GRAPHICS, OP. CIT., PAGE 60.

is the point at which, because of the contractual maximum limit, CP, the contractor must absorb overrun costs himself. Therefore, the contract goes from one with a 60/40 share line, to one with a 0/100 share line. By definition, the contract switches from an FPI to an FFP where the 0/100 share line becomes operational. The contractor has an internal cost ceiling which he should try to avoid and it is equally important because opportunity cost or foregone profit results before the external ceiling price is reached. The point at which the share line becomes kinked and the share ratio changes to 0/100 is called the point of total assumption (PTA).[9] In Figure 2.11, the intersection of the solid share line with the broken share line originating at the CP marks the PTA.

Finding the PTA geometrically, and constructing the 0/100 broken share line is an added problem of the FPI contract. Two points will again serve the purpose. The first is at the CP on the X axis. Its coordinates are 0 and 129. The second point is found by assuming a cost outcome of $115 and the profit associated with that cost, assuming the CP of $129 to be the price of an FFP contract in which the price equals $129. The assumed cost $115 is subtracted from $129 resulting in a profit of $14. These two figures are the

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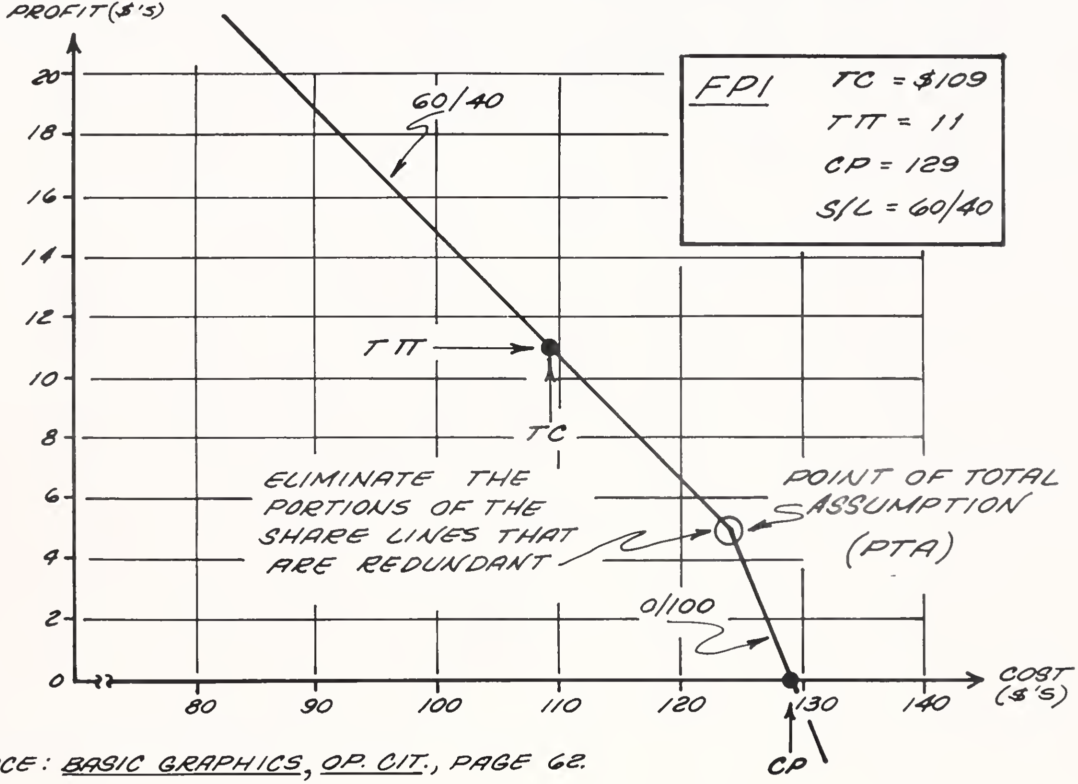
[9] Basic Graphics, op. cit., pp. 60-65. This is a handy term and is more useful than the cost ceiling phrase found in the DOD Guide.

coordinates for the second point. The contractor with a 0/100 share line would make $14 on a $129 FFP contract if he managed to perform the work for a cost of $115.

The final result, once the redundant portions of the 60/40 and 0/100 share lines have been eliminated, is given in Figure 2.12. The completed FPI is characterized by a PTA located at the point of intersection of both share lines. Both numeric and graphic presentations make the CP and PTA (no Π) vividly clear. As a contractor expends cost dollars, profit is reduced by the contractor cost share until suddenly at the PTA cost point and beyond further expenditures will be penalized at the rate of $1 of profit lost for each $1 of cost expended. In the specific example, the 60/40 share line determines the relationship between cost and profit until the 60/40 share line is intersected by the 0/100 share line extended from the CP. There is strong motivation to avoid spending additional cost dollars to complete a job once the contractor's share has changed from 40 percent to 100 percent on the overrun side at the PTA. Needless to say, spending beyond the CP is even less desirable and should be avoided.

The point of total assumption is very significant to the contractor. In the graphic example, the PTA was found geometrically. It may also be precisely determined algebraically, substituting in the following formula:

FIGURE 2.12
FINAL CONSTRUCTED FPI CONTRACT



SOURCE: BASIC GRAPHICS, OP. CIT., PAGE 62.

$$PTA = \frac{\text{Ceiling Price} - \overset{(TC + T\Pi)}{\text{Target Price}}}{\text{Government's Share}} + \text{Target Cost} \qquad \text{or,}$$

$$= \frac{CP - TP}{GS} + TC$$

$$= \frac{(129 - 120)}{.6} + 109$$

PTA = $124

FPI contract data state either explicitly or implicitly four contractual elements and incentive provisions. The CP, TC, TΠ, and share ratios are stated explicitly. Target price is implicitly understood and is simply the sum of TC and TΠ at any cost outcome. The PTA cost point is implied although the contractor devotes utmost attention to it for previously stated reasons.

Finally, attention is drawn to the much steeper share lines and share ratios in the FPI contract. The share ratio is a response to "tight" or "loose" targets. Both parties must ordinarily consider that target cost is reasonable. Under certain circumstances, there may be little confidence in the initial target. One party or the other will conclude that target cost is too high or too low. At this point, they will tailor the incentive contract to meet existing conditions. In other words, to match the RIE, a loose target cost should be accompanied by a low target profit objective and a tight target cost should have greater associated target profit as a reward.[10] Since the terms of applicability stated for the FPI called for a high degree of confidence in the estimate of target cost, one must assume that the RIE is rather narrow and because of this would create a steep share line effect.

Cost-Plus-Award Fee (CPAF) Contracts

Concluding this primer on incentive contracting instruments, one finds a final form which is unlike the FFP, CPIF, or FPI contracts. The CPAF contract has only emerged as a useful contracting tool within the last few years. However, its popularity with NASA, has drawn the attention of the DOD. Both the Navy and the Air Force are presently experimenting with CPAF contracts on a limited basis.

The subjective nature of the CPAF contract distinguishes it from the traditional objective features of the incentive contract. Yet there are attributes common to both types. The CPAF contract is a marriage of the objective, before-the-fact evaluation of conventional incentive agreements and the subjective, after-the-fact performance evaluation of merit systems for final profit determination.[11] The CPAF contract, in contrast to the other incentive forms is most often a "rewards only" agreement. A CPAF contractor's final profit is determined by a board or panel after all work has been completed.

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[10] DOD Incentive Contracting Guide, op. cit., p. 26.

[11] Ibid., p. 94.

A favorable decision by the board results in the award of additional profit to the contractor over the usual target profit.

A general description of the CPAF contract will have to suffice. Examples of a numeric, geometric or even graphic illustration do not exist because each contract is tailored to an individual situation and total profit is based on subjective after-the-fact evaluation. With a CPAF contract, the contractor can increase his profit above a base fee, providing the customer's subjective evaluation of his performance under the contract is favorable.[12] Trade-offs in the usual sense are not stressed. Therefore, the CPAF contract is also a combination of the CPFF and CPIF contracts. At the outset of the contract, a CPFF contract base and minimum fee is established. In practice, the CPAF is managed like the CPFF contract because fee does not prompt decisions. Marginal profit is a bonus or reward-only fee added to base fee.

The mechanics of the CPAF evaluation must be clearly defined in the contract. Evaluation is performed on a quarterly basis, and ratings are compared with standard criteria incorporated in the contract itself. The subjective rating is particularly effective for non-personal service contracts

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[12] *Ibid.*, p. 93

relative to the difficulties raised by CPFF and CPIF contracts for service procurements. Historically, level-of-effort work has been purchased with straight cost reimbursable contracts which give contractors no incentive to be efficient. The CPAF contract introduces the possibility of making more than a base fee, even if it is determined unilaterally by the buyer. While the previous statement overemphasizes the subjectiveness of the CPAF contract, in practice, both parties have given it enthusiastic endorsement. If there is some analogy with a human being's performance, psychologists have proved the superiority of rewards versus the use of penalties.[13] The carrot works better than the stick for some animals, and for some of the humans.

In a later chapter (VI), some of the potential problems raised by incentive contracts are discussed in detail. Where price estimates are little more than guesses, involving an incentive structure may be futile. If a contract has many changes and modifications, which is often the case with service contracts, the incentive arrangement may lose its meaning from dilution and also become burdensome in the process. For these reasons the combined objective conventional incentive and the subjective evaluation techniques make the CPAF contract more suitable to contract problems where straight

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[13] Neal E. Miller and John Dollard, Social Learning and Imitation. (New Haven: Yale University Press), 1941. p. 2, et passim.

incentive forms are unlikely to succeed. The NASA Guide states unequivocally that, "formula type incentives cannot be applied to nonpersonal services contracts because of the difficulty of defining work to be performed precisely, and -- as a result -- accurate cost estimating."[14]

The essential elements of the CPAF contract are: target cost, base fee, maximum fee, and criteria for evaluating performance which results in additional fee paid to the contractor. Additionally, the contract must specify the methods and techniques to be used for assessing the contractor's performance before beginning work.[15] These specifications are usually supplements to the contract and are not in the main contract itself. With these elements as a foundation, the NASA Guide exhibits a structuring technique for a CPAF contract in steps similar to those used for structuring and pricing a straight incentive contract.

The work statement spelling out the work to be performed has heretofore been neglected. It is assumed that for each contract situation, the work is always clearly defined. While not always possible, it is definitely desirable for any incentive contract, and even the CPAF contract. Major areas of contractor effort should be set forth in a format

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[14] NASA Incentive Contracting Guide, NPC 403, National Aeronautics and Space Administration, 1965, p. 701.

[15] Ibid., p. 702.

that corresponds to the organizational structure intended for use by the contractor. Objectives within each area should be clearly stated in terms of end results desired. Performance standards should be precisely stated and related to profit. Specific performance demands enable the contractor to manage his resources and make decisions based upon a knowledge of the interaction taking place between cost, performance, and his profit target.

The evaluation criteria, the most important feature in shaping a CPAF contract, should be selected with extreme caution. Every effort must be taken to select criteria which stress areas of prime importance to the government and cause contractor management to focus on critical areas. Evaluation criteria should be organized to conform both with the work statement, and with the organization intending to perform the work itself.

Controlling cost should continue to be a major evaluation area of the CPAF contract. This is very important and when possible, the use of conventional incentives for cost portions is recommended.[16] Since both parties can predict, with some accuracy, the number of man-hours the contractor will require from the statement of work, a major segment of the cost estimate should be valid.

Therefore, it is feasible to use a CPIF formula on the cost portion, while applying CPAF subjective evaluation techniques to the performance areas.

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[16] _Ibid_., p.712.

A meaningful share line for cost only may be developed which encourages the contractor to sacrifice cost and performance alternately (trade-offs). NASA's preference for incentive contracts is based on objective standards.[17] Only indefinite portions of the CPAF contract should be evaluated by subjective techniques.

The NASA Guide continuously compares the CPAF and CPIF contracts and finds them equally valuable. In Chapter III, this writer takes exception and disagrees when using analytical techniques. It is not possible to maximize profit through managerial control and decision making if the exact fee pool is unknown. In the CPAF contract, fee is inexact and ill-defined. Conceptual similarities exist because every CPAF contract has an RIE, from minimum acceptable performance to outstanding performance like that found in the CPIF and FPI contracts. However, the application of incentive evaluation techniques to the CPAF's RIE and its measurement are impossible. Neither exact measurement nor absolute quantification is used. Indeed, the major problem with the CPAF contract is the need for government representatives to judge the contractor fairly and consistently in a situation which usually lacks objective, quantifiable data.[18]

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[17] Ibid.

[18] Ibid., p. 703.

Measurement problems raised by lack of quantification can and have been overcome. The existence of the measurement problems should not be ignored when designing evaluation criteria which are subjective. NASA believes that CPAF evaluation criteria do create an RIE, and that a contractor's performance under CPAF receives "objective" evaluation. Sample evaluation criteria used by NASA are given in Appendix A. Its inclusion, with comments from the NASA Incentive Contracting Guide is designed to show that even though quantification is achieved in certain vital areas, the calculation of a ratio does not guarantee concrete definition of the RIE or objective measurement. The CPAF contractor is promised a profit if his nebulous evaluation after-the-fact is favorable.

SUMMARY

This section has reviewed several contracts currently employed in the defense acquisition process. Major distinctions between the various contracts were emphasized, moving from the CPFF contract with no incentive to the FFP contract which offers maximum incentive. The basic elements of each contract form are compared in Table 2.1.

The rationale for introducing incentive contracts was presented in Chapter I. Excessive dependence on CPFF contracts caused the pendulum to swing in the other direction

TABLE 2.1

ELEMENTS OF BASIC CONTRACT FORMS

CPFF	FFP	CPIF	FPI	CPAF
1. Estimated Cost	1. Price	1. Target Cost	1. Target Cost	1. Target Cost
2. Fixed Fee		2. Target Fee	2. Target Profit	2. Base Fee
		3. Maximum Fee	3. Ceiling Price	3. Maximum Fee
		4. Minimum Fee	4. Share Ratio	4. Evaluation Criteria
		5. Share Ratio		

to avoid the mistakes of the past. There is an individual procurement cycle for hardware and services, and the preferable contract form is apt to change with time and/or the level of confidence in the estimate of cost. The FFP contract remains the best form of contract for most situations because of its competitive aspects. At the same time, defense contractors are not prone to accept excessive risk. Thus, there exists a need for a variety of contract forms.

The illustrations for pricing and structuring these various contracts were purposely simplified for ease of explanation. Total profit was determined by share ratios over the RIE, and depended on one variable, cost. The next chapter will deal with the real problems of structuring multiple incentive contracts based on a variety of factors, such as, cost, performance and schedule. The nonstructured variety of problems caused by multiple incentives, and some of the techniques which have been developed for their solution, offer challenges to the disciplines of decision-making theory, operations research, mathematics, statistics, micro-economics, and even "Yankee ingenuity."

CHAPTER III

STRUCTURING MULTIPLE INCENTIVE CONTRACTS - THE MODELS

Introduction

This section discusses several methods of structuring and evaluating incentive contracts. Unlike Chapter II, it deals with specific incentive contracts which have multiple incentive elements.

A basic comparison of structuring techniques is possible by reviewing the mechanics of fee determination under different methods. Each contract structure technique, or model, possesses unique characteristics. Continuity between models is provided by common parts and terminology they share: TC, TP, FS, RIE, and share ratio. However, greater concentration will stress the differences that exist between models. Model appropriateness will be judged by the reader from background information; this study compares and contrasts models only.

Defense procurement history is replete with changes in attitudes towards several contract forms. At one time, the industry, taken to include both government and contractors, was in favor of the CPFF contract. Real flaws concerning the CPFF did not manifest themselves until experience and historical data had accumulated. A prediction for the future of multiple incentive contracts is premature. The present will become history. The incentive contract might yield in the future to a far superior arrangement. Techniques must evolve or even the sacred idol of today will become the shibboleth of tomorrow. Those who do not learn the lesson of history are doomed to repeat its mistakes. CPFF contract abuses hastened the demise of this form. Likewise, the future of the incentive contract depends upon a better understanding of the cost/performance/profit relationship. Models offer a means to this end.

Within the last two years, a specific phenomenon of the first multiple incentive contracts was discovered. The first contracts were structured with what may be described as traditional techniques. Lacking any foresight for specific problems, early contracts were structured by individually appraising cost, performance, and schedule areas separately. Possible consequences were ignored by unwitting incentive contract proponents. Results under a contract so designed typically led to goal conflict. Contractors used trade-off analysis to achieve highest total profit at the expense of government objectives. In essence, functional relationships of multiple incentive features, all of which are weighted in the overall determination of profit, were ignored and were assumed to be <u>independent</u>. The opposite is true. In the multiple incentive contract, total fee determination makes all elements <u>interdependent</u>.

The government gradually recognized the pitfalls of separately negotiated incentive elements as results of the first multiple incentive contracting experiences became available. Research on the problem began in public and private sectors. New theoretical structuring models were suggested from various quarters. The common feature of these is the interdependency relation. The most frequent expression for a "better way" to test interdependency lies in an interdisciplinary approach which considers not only previously mentioned physical sciences but also economic and behaviorial theory. NASA, the DOD, and AEC, and even the National Security Industrial Association are funding intensive research to provide practical answers to the problems of utilizing incentives. Understanding and applying models is one facet of incentive contracts. Extra-contractual and interpersonal relations are another. The scope of this study is confined narrowly to the problem of suggesting most appropriate contract structuring techniques.

The models and their order of discussion are (1) the traditional approach; (2) the formula approach, Coleman and Dellinger model; (3) tabular models - matrix forms; (4) Planned Interdependency Incentive Method (PIIM); (5) Trade-off Curves Analysis, using constant fee; (6) Systematic Techniques of Incentive Contracting (STOIC); and (7) the Logmill System. Trade-off decisions are simulated for each of the seven structuring techniques to demonstrate the interdependency effect between incentive variables.

Furthermore, as in Chapter II, the models chosen have no special advantage for hardware or service contracts. One characteristic of service contracts and the application of incentive methods to them is their numerous subdivisions on the performance and schedule portions. For this reason, service contracts are poor examples for illustrative purposes. By using contract examples of airplane and missile procurements, the number of performance and schedule incentive variables are minimized permitting explanation flexibility.

The Traditional Approach

The example discussed is a CPIF contract,although it might just as easily have been an FPI contract. The contract objective is successful performance which consists of completing a satisfactory end item or service at a reasonable cost and within certain time limits.[1] The incentive arrangement is structured so that it motivates the contractor to achieve outstanding results in every performance area, in addition to the cost area. The incentive format must encourage the contractor to seek desirable alternatives in the maximizing process. The contractor should be compelled into decisions between cost, performance and schedule that are in consonance with the overall procurement objectives of the government.[2] The traditional method depends upon (1) RIE and the profit pool, and (2) relative weights assigned to each incentive, for goal achievement.

Preliminary work must precede the structuring of the contract. Work to be performed must be carefully defined. The contractor's proposal and trade-off studies must be

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[1] DOD Incentive Contracting Guide, op. cit., p. 47

[2] Ibid.

analyzed. Both parties must agree to a norm for the performance incentive portion. With service contracts, historical data and records often provide missing links essential for contracting. Once records are complete, performance incentive parameters can be selected and defined, and a norm chosen. Target cost and performance are tied to the norm. Target cost can be negotiated and delivery milestones set up for a schedule incentive element. PERT and critical path techniques are often utilized for the schedule section of the contract.

Assume that the previous considerations had been executed and the parties have a "meeting of the minds" for a new aircraft with these targets:

Target Speed	1000 MPH
Performance Range	950 - 1050 MPH
Target Delivery	29 months
Delivery Range	27 to 33 months
Target Cost	$100 million
Cost Range	$80 to $130 million

The more effort devoted to precontract planning and definition, the greater confidence both parties have in targets. To promote careful and often costly precontract studies the government pays for Program and Project Definition. Assume this has already been applied to the range of estimates above so that targets selected are fairly valid. The work has been precisely defined and priced, and cost outcome rests on the contractor's ability to control cost while designing a plane with a top speed of 1050 MPH. The performance target should become the most important goal of the contract. The contractor will manage so as to reach the highest performance target level and possibly do so at the lowest cost level possible.

The contractor should not be allowed the opportunity to pick his own performance range. Nor when deciding between minimum performance and maximum performance, should the contractor have to provide additional or different services. Performance incentive parameters should coincide with the item the government ordered. Considering all these factors, and additional ones such as overlap and trade-off which will be defined, the parties must agree on target fee and the fee pool.

Maximum fee, it is assumed, will be awarded if the best cost, performance and delivery schedule are attained by the contractor. Thus, he should get the greatest profit the government is willing to pay if he produces a 1050 MPH plane, in 27 months, at a cost of only $80 million. Minimum fee will, likewise, be a function of the highest cost, the slowest performance and the latest delivered date. Minimum fee would occur if the plane cost $130 million, flew only 950 MPH, and took the contractor as long as 33 months for delivery. Maximum fee and minimum fee can be looked upon as a reward or penalty alternatively, thus for:

Incentive Element	Outcome of Maximum Reward	Outcome of Maximum Penalty
Cost	$80 million	$130 million
Performance	1050 MPH	950 MPH
Schedule	27 months	33 months

These conditions determine the range of profit or the fee swing (FS) or fee pool. Terminology is non-standardized, but any phrase that denotes amount of fee available will suffice.

However, fee pool is not the most important relationship. The relative emphasis between incentive objectives has not been established. Weighting the various incentives is supposed to guarantee desirable results between cost, performance and schedule. For this reason, the DOD Guide wants the customer, i.e., the government to retain complete discretion in the weighing of various incentive elements. Many individual contract factors must be considered for relative weighing between incentives, such as, the state of the art, confidence in targets, undetermined risk factors, etc. Once relative weights have been discussed and tested by the parties, specific weights must be negotiated. Herein lies a major problem of the multiple incentive contract.

Via traditional, i.e., non-quantitative methods of structuring multiple incentive contracts, the real impact of weighing is not felt by parties concentrating on targets. Distinct break points in the share line are inputed into the contract by nonoperational segments, the point where a performance incentive ceases to motivate. A contractor sets his long range objectives on maximum profit but operates in the short run on a basis designed to gain the highest profit from the set of alternatives facing him. "The break-even point between decisions to commit or not to commit further time and money will be determined by the weights assigned the three incentive areas."[3]

Just how specific is the incentive arrangement under this traditional pricing method? Your author concludes that while incentives continue to operate, they are indeterminate over the entire range of cost and profit outcomes. To force this point, that the parties do not know with any degree of exactness how weighing will cause them to operate in the short run situation, look at all possible tradeoffs shown in Table 3.1. It shows the possibility of combining cost, performance, and schedule (2.069×10^{15}) different ways. The only difference between the hypothetical CPIF contract situation described and that used to make up the table is that the performance incentive is subdivided into four categories instead of one. Complex service contracts may subdivide performance incentive into fifteen smaller "cost centers".

Assume the negotiating parties ended up with an arrangement permitting maximum fee of $18 million (18%), minimum fee of $2 million (2%), and weighed as follows:

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[3] *Ibid.*, p. 50.

TABLE 3.1

NUMBER OF ALTERNATIVE REWARD AND PENALTY TRADEOFFS TO BE CONSIDERED IN NEGOTIATIONS

TYPE OF INCENTIVE	INCENTIVE ELEMENTS	NO. OF TARGETS*	NO. OF INCENTIVE FORMULAS*	NO. OF BREAKPOINTS	TOTAL NO. OF COMBINATIONS
Cost	Total	4	4	6	96
Schedule	Interim	4	4	6	96
	Final	6	6	8	288
Performance	Range	4	6	6	144
	Reliability	4	6	6	144
	Accuracy	4	6	6	144
	Speed	4	6	6	144
	Total Number of Possible Tradeoffs = 2,069,000,000,000,000				

*The number of targets, incentive formulas, and breakpoints was selected arbitrarily for purposes of illustration.

Source: J. Sterling Livingston, "Trends in Incentive Contracting" Reprint from, "The Southwestern Legal Foundation, Current Trends - 1964 Institute on Government Contracts," (Chicago: Commerce Clearing House, Inc.) 1963.

	WEIGHT	MINIMUM FEE	TARGET FEE	MAXIMUM FEE	FEE SWING
COST	50	$1.0	$5.0	$9.0	±
PERFORMANCE	25	.5	2.5	4.5	±
SCHEDULE	25	.5	2.5	4.5	±
TOTALS	100	$2.0	$10.0	$18.0	

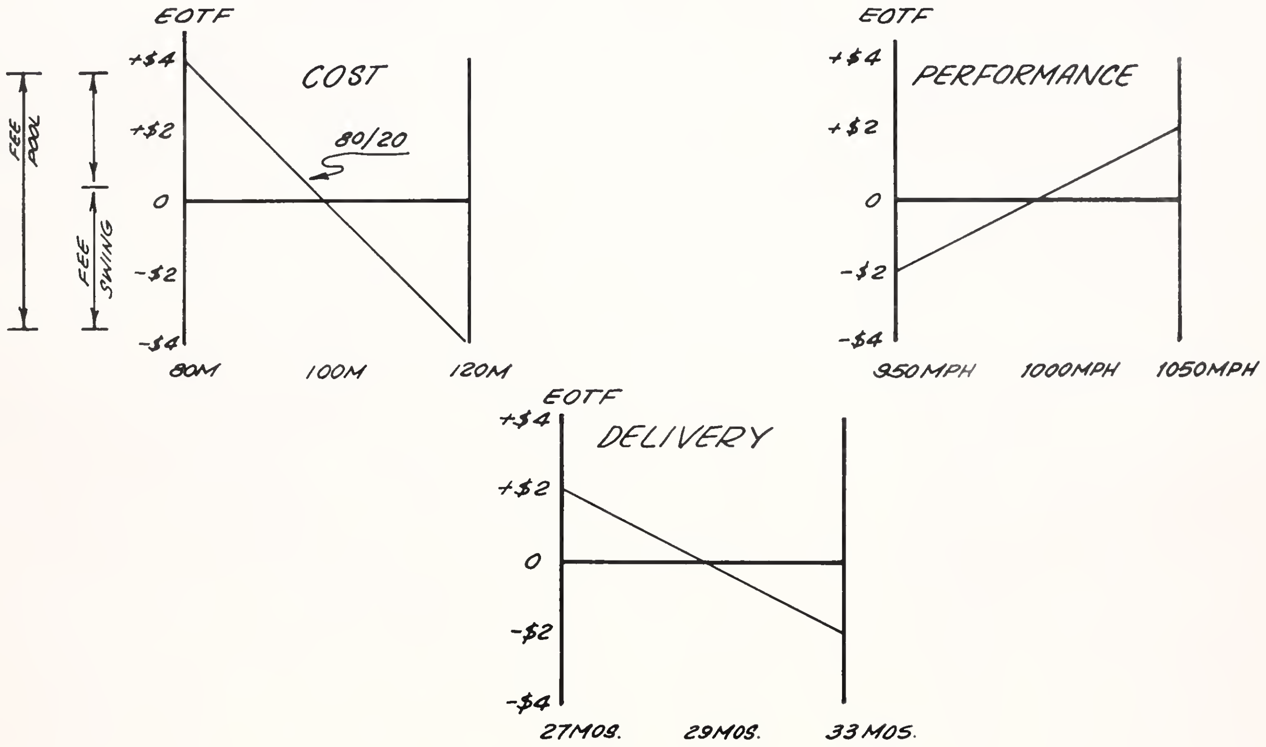
Only one set of conditions applies to yield the maximum fee (reward) and only one set of conditions applies to yield the minimum fee (penalty). In the vernacular of contract administrators, this contract is "compartmentalized." There is a linear relationship for each incentive and it remains constant throughout the range of cost/profit outcomes. Most incentive contracts are constructed in this manner, although occasionally and possibly on purpose, the design may include an overlap.

Resorting to graphics, we now have an opportunity to construct figures which would translate directly the effect on total fee (ETOF) for any incentive element. The arrangement is described as goalposting, because the graph used, in the form of an H, resembles a football goalpost. The X axis has the RIE for the particular incentive, while the Y axis reads ETOF directly. Vertical ETOF axes are erected at both the lower and upper extrems of the RIE for each incentive element, and the horizontal cross member is extended between the two ETOF axes. This line is actually the target fee line for the weighted individual incentives. However, the ETOF is 0 when all incentives have target outcomes. Thus, the 0 ETOF point actually represents a fee of $5.0 million for goalposted cost; $2.5 million for goalposted performance; and $2.5 million for goalposted schedule. See Figure 3.1.

The goalposts show that +$4 million FS for cost is earned only if the cost outcome at the end of the development equals $80 million. Should outcome be $100 million, the contractor's fee will neither be increased nor decreased because of cost performance. If, for some reason, the cost outcome equals $140 million, the entire negative FS of -$4 million will be operative. The -$2 million fee for performance is applied if, at the end of the development, the plane flies only 950 MPH. Should performance outcome equal 1000 MPH, the contractor's fee will be neither increased nor decreased because of performance. Should performance equal 1050 MPH at the end of the development, all of the +$2 million FS for performance is earned. Delivery at 29 months has no effect on fee. Early delivery at 27 months would put the entire schedule incentive, +$2 million, into effect. Late delivery, for example 33 months, would subtract $2 million.

The contractor's final fee is determined at the end of the development by adding the sum of the three separate ETOF's to TS. An infinite number of possible fees could be earned, but only two fee outcomes are unique. Maximum fee depends on coincidental satisfaction of the three goals hardest to achieve, while minimum fee depends on lowest

FIGURE 3.1
GOALPOSTED MULTIPLE INCENTIVE CPIF CONTRACT



possible achievement. The final graphic solution would look like the CPIF graph, Figure 2.10, illustrated in Chapter II.

The almost infinite number of possibilities raised in Table 3.1 for a multiple incentive arrangement can now be reexamined. In view of particular trade-off decisions created by the contract, the contractor must evaluate each step he intends to make. Hopefully, the relative weights assigned will insure the government that the contractor will manage his firm so that the desired objectives of both parties will be met. If there is a divergence of objectives, improper weighting is usually the fault. Tests should be made by checking what happens when discrete changes are made in individual incentives.

What is the value of greater speed? For example, suppose the contractor expends $80 million, finishes testing the aircraft in 27 months and records a maximum speed of 975 MPH. He now estimates he can boost speed +25 MPH for a cost of $10 million and three months additional work. Should he do it?

At first glance, it looks as though the contractor would pick up an extra $1 million by increasing speed from 975 MPH to 1000 MPH. However, he would lose $2 million additionally on the schedule incentive. His preferred course of action would be to deliver the plane and get final acceptance immediately.

There are several incentive contracting aids that can be utilized with the conventional or traditional model. For instance, it is possible to have a computer print out all possible outcomes for a specific incentive matrix to have alternatives available for making trade-off decisions. This operation should not be confused with a computer program that actually simulates and makes decisions for optimum achievements.

A simple T-Chart may be constructed to clarify incentive element relationships. NASA has pioneered with an approach called Value Statement Analysis.[4] This approach calls for weighing savings that accrue if a contractor achieves maximum rather than minimum acceptable on-target performance. Any time cost and performance changes are tied together and affect one another, they are analyzed in detail. The T-Chart approach may be as simple as this.

	Δ element	Δ fee		Δ element	Δ fee
Performance	+50 mph	+ $2 million	Delivery	- 2	+ $2 million
Cost	$10 million	- $2 million	Cost	+$10 million	- $2 million
	50 mph	= $10 million		2 months	= $10 million

T-Chart value statements are admittedly crude and do not work with skewed share lines and many elements. In practice, contracts have curvilinear instead of linear share

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[4] *NASA Incentive Contracting Guide*, *Op. Cit.*, p. 506.

lines and too much complexity for decision-making with this crude tool.

ISO-FEE CHARTS

A step advance over a matrix, table, or T-Chart is the approach developed for more advanced models, but sometimes used independently for value statements with conventional contracts. The iso-fee charts are related indirectly to indifference analysis in economics. An iso-fee chart is prepared by graphing sets of outcomes in cost and performance (or schedule) that result in the same fee (iso-fee) earned for each pair of outcomes in the set.

The procedure for finding and graphing pairs is illustrated below using cost and performance from our CPIF model, but simplified by exclusion of the schedule portion. Assume delivery is on target at 29 months and will therefore have no effect on FS. One slight additional change from previous assumption is also necessary. Change the cost RIE from $80 120 million to make it symmetrical. Asymmetrical elements contain breakpoints and thus require curvilinear solutions, an unnecessary complication at this point. The same procedure is applicable when breakpoints exist.

Table 3.2 is based on an 80/20 share line. (The CPIF model presented would have had a $\frac{FS}{RIE}$; $\frac{16}{50}$ or 68/32 share line, with a breakpoint because it was asymmetrical.) The problem consists of finding three pairs of cost and performance outcomes that will result in a fee outcome of $10 million. Step 1, recognizes that a cost outcome of $100 million represents a total change in fee equal to 0 on the $10 million target fee. Step 2, assumes a performance outcome of 950 MPH. Step 3, requires finding the ΔF associated with that performance outcome, - $2 million. Step 4, requires finding the ΔF for cost that when added to the ΔF for performance would result in no change in Δ Fee Total. (For a net effect of $0, a + $2 million reward must be added to the - $2 million penalty.) Step 5, requires finding the Δ cost that would result in a + $2 million reward. Since the contractor is on an 80/20 share line, cost savings of $10 million would result in + $2 million of profit. Step 6, is to add the Δ cost (- $10 million) to the TC ($100 million), which results in a cost outcome of $90 million. The first pair of cost and performance outcomes leading to a fee of $10 million are $90 million and 950 MPH; the next is $100 million and 1000 MPH; and the third pair is $110 million and 1050 MPH. The procedure is repeated exactly for a $12 million fee.

Once a series of hypothetical cost and performance combinations leading to the same fee have been found, pairs of constant fee (iso-fee) can be plotted on a graph and a connecting line drawn through the points. The connecting line is an iso-fee or equal fee line, as constructed in Figure 3.2.

TABLE 3.2

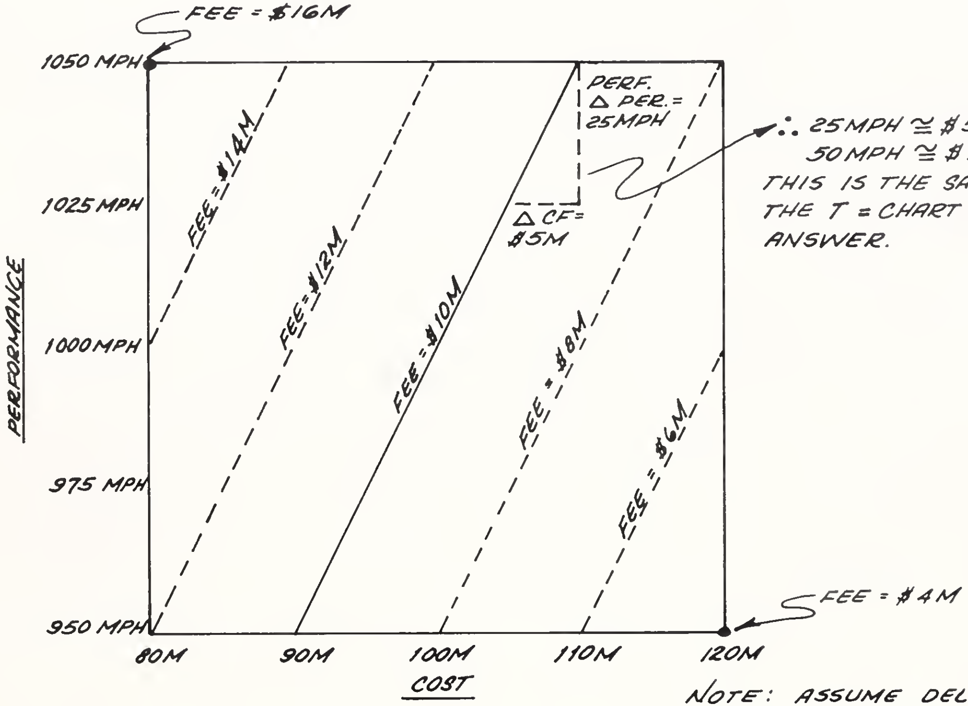
ISO-FEE POINTS

	FEE = $10 Million			FEE = $12 Million		
2. Performance MPH	950	1000	1050	950	1000	1050
3. Δ Fee Perf	$-\$2\overline{M}$	0	$+\$2\overline{M}$	$-\$2\overline{M}$	0	$+\$2\overline{M}$
1. Δ Fee Total	0	0	0	$+\$2\overline{M}$	$+\$2\overline{M}$	$+\$2\overline{M}$
4. Δ Fee Cost	$+\$2\overline{M}$	0	$-\$2\overline{M}$	$+\$4\overline{M}$	$+\$2\overline{M}$	0
5. Δ Cost	$-\$10\overline{M}$	0	$+\$10\overline{M}$	$-\$20\overline{M}$	$-\$10\overline{M}$	0
6. Cost	$\$90\overline{M}$	$\$100\overline{M}$	+$110M	$\$80\overline{M}$	$\$90\overline{M}$	$\$100\overline{M}$

The iso-fee chart employs the RIE cost incentive on its horizontal axis, and the RIE performance incentive on its vertical axis. The solid line representing fee equal to $10 million shown on the chart was plotted by connecting the three cost/performance outcome pairs determined in Table 3.2. Since these are linear because the restated cost and performance incentives were symmetrical, two points would have been sufficient to find the $10 million iso-fee line. As a rule, as long as cost and performance RIE's are symmetrical the iso-fee lines on the iso-fee chart will be linear and parallel.

Once one straight iso-fee line has been located, because others are parallel, they can be found by inspection and

FIGURE 3.2
ISO-FEE CHART VALUE STATEMENT ANALYSIS



∴ 25MPH ≅ $5M
50MPH ≅ $10M
THIS IS THE SAME AS
THE T = CHART ANALYSIS
ANSWER.

NOTE: ASSUME DELIVERY
IS GOING TO BE ON TARGET.

substitution. For example, by holding performance constant at 1000 MPH (target), and assuming a cost increase to $110 million, a $10 million overrun, fee will decrease by $2 million (.20 x $10 million). The performance outcome of 1000 MPH, in combination with the cost outcome of $110 million, must therefore, lie on the $8 million iso-fee line because ($10 million - $2 million = $8 million). Using one point as a reference, cost/performance coordinates of $110 million and 1000 MPH, the $8 million iso-fee line is then drawn parallel to the $10 million iso-fee line.

The slope of the iso-fee line establishes value equivalents and is, therefore, the same as the value statement.[5] One pair of outcomes that lead to $10 million in fee is: cost equal to $105 million and performance equal to 1025 MPH. A contractor can make rapid decisions having this information at his disposal. For instance, he might need to know how much performance would have to increase to protect his $10 million fee, if cost should jump by $5 million, to $110 million. Using the iso-fee chart, he can determine with a glance that performance would have to go up by 25 MPH. If 25 MPH approximately equals $5 million, then 50 MPH approximately equals $10 million.

Concluding with iso-fee charts, contractors may find it beneficial to make up several charts, holding cost,

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[5] Basic Graphics, op. cit., p. 91.

performance, and schedule constant, one at a time. Thus, letting two variables fluctuate, you would have iso-cost, iso-performance or even iso-schedule lines. Special iso-charts are not themselves overly informative. However, when combined into a single three-dimensional model by a computer program, they are capable of solving major problems with incentive contracts. The two-dimensional model will suffice for the present.

Finally, before leaving non-quantitative traditional techniques for structuring contracts, a word on evaluation. No excessive attempt is being made to be critical of traditional structuring techniques. Just the opposite point should be made. The value of the incentive to motivate is proportional to the understanding a contractor has of the arrangement. Simple techniques are preferred, and are entirely suitable for incentive contracts that are "compartmented," that have no overlap, that are linear, symmetrical, and not very complex. However, non-quantitative techniques are worthless as share lines become exponential curves. Keeping the incentive formula basic has several advantages because the contract is easier to negotiate and price.

Figure 3.3 is another standardized contracting tool used for estimating cost and profit relationships when they are symmetrical. By extending the approximate share line, the RIE and FS can be experimented with and analyzed. This chart also has lines indicating percent of profit. Profit dollars as a percent of cost dollars can also be drawn with

FIGURE 3.3
GRAPHIC ANALYSIS STRUCTURING TOOL

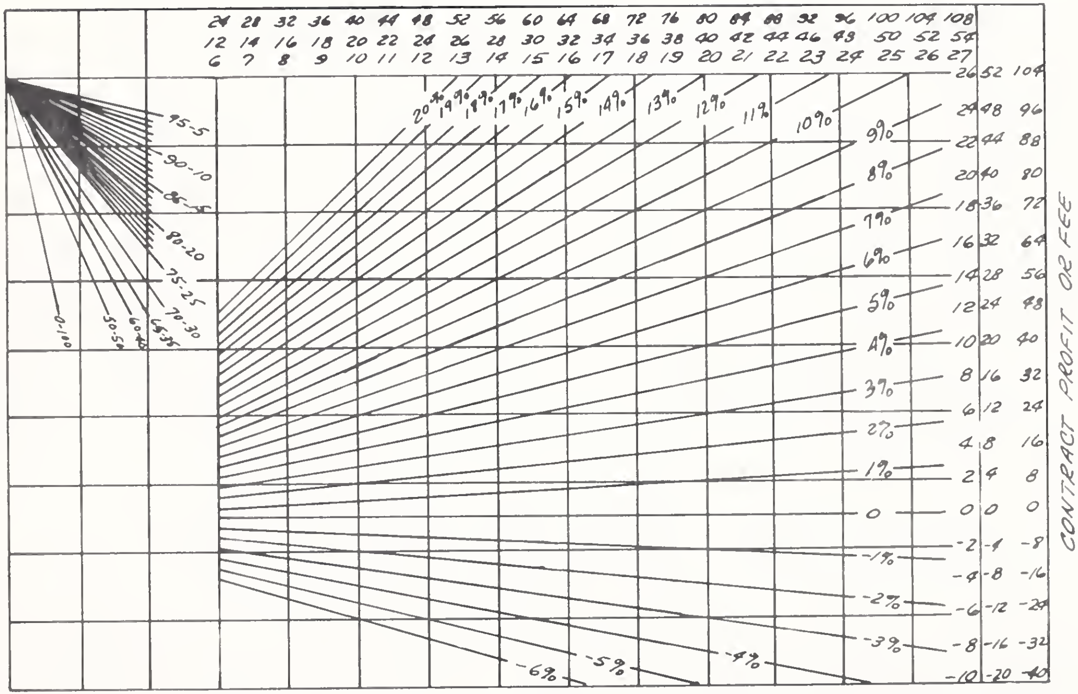
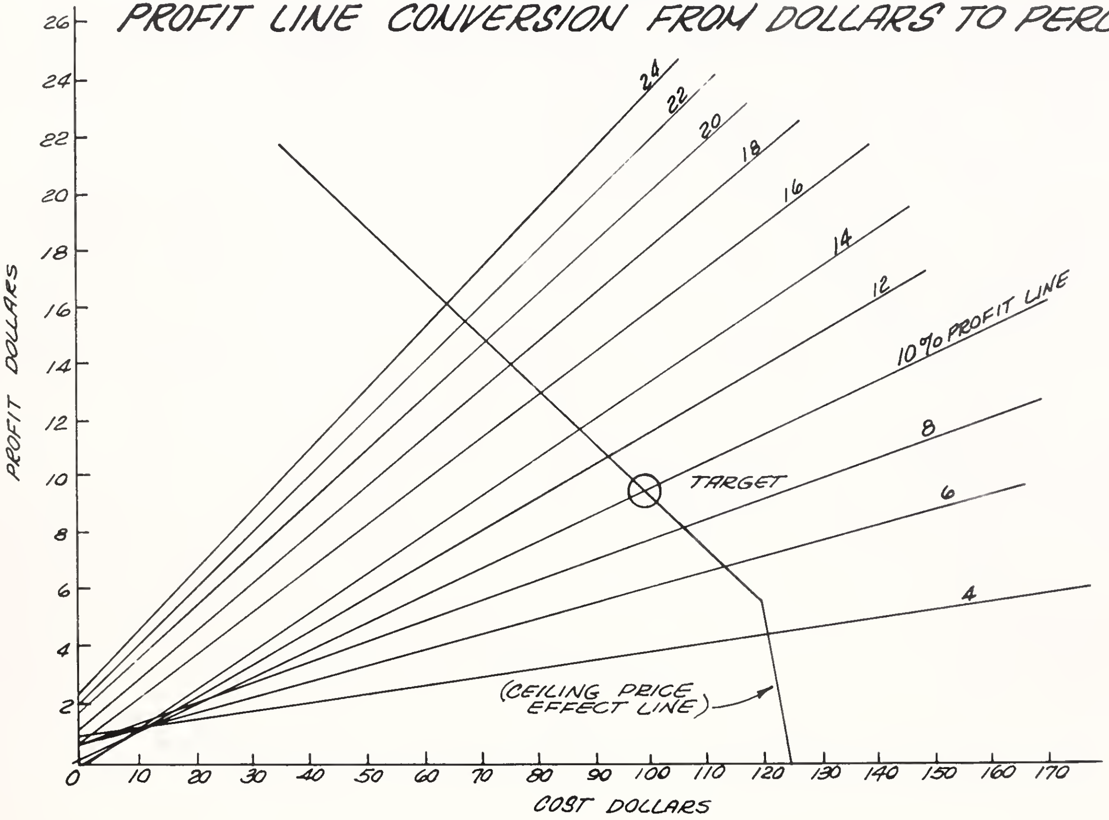


FIGURE 3.4
PROFIT LINE CONVERSION FROM DOLLARS TO PERCENT



one specific contract, starting with a point at the lower left hand corner and extending through a combination of points. Figure 3.4 is a profit line chart of this nature for one contract. Numerous aids have been developed for quick analysis that are similar including a profit wheel (the equivalent of a circular slide rule) and a slide rule which permits direct interpretation of cost/profit relationships.

The Formula Approach - Coleman and Dellinger Model[6]

Structuring the multiple incentive matrix so that a contractor's most profitable trade-off decision coincides with desired objectives of the government is, at best, a difficult task. The formula approach applied to the curve-fitting process enables negotiators to avoid damaging arrangements, even though complete interdependency does not exist.

The formula example assumes a CPIF contract with the following:

Target Cost	$100 Million
Target Delivery	24 months after contract award
Target Performance	1000 MPH
Target Fee	$7 Million (7%)
Fee Swing	±$8 Million

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[6] Col. Jack W. Coleman and Maj. David C. Dellinger, "Incentive Contracting," Air University Review. USAF, Vol XVI, No 1, Nov - Dec. 1964, pp 31-41. The formula example was developed by these two men at the Air Force Institute of Technology (AFIT).

The ranges of incentive effectiveness given:

INCENTIVE	MAXIMUM REWARD	TARGET	MAXIMUM PENALTY
Cost	$70 M̄	$100 M̄	$130 M̄
Performance	1050 MPH	1000 MPH	950 MPH
Schedule	21 months	24 months	27 months

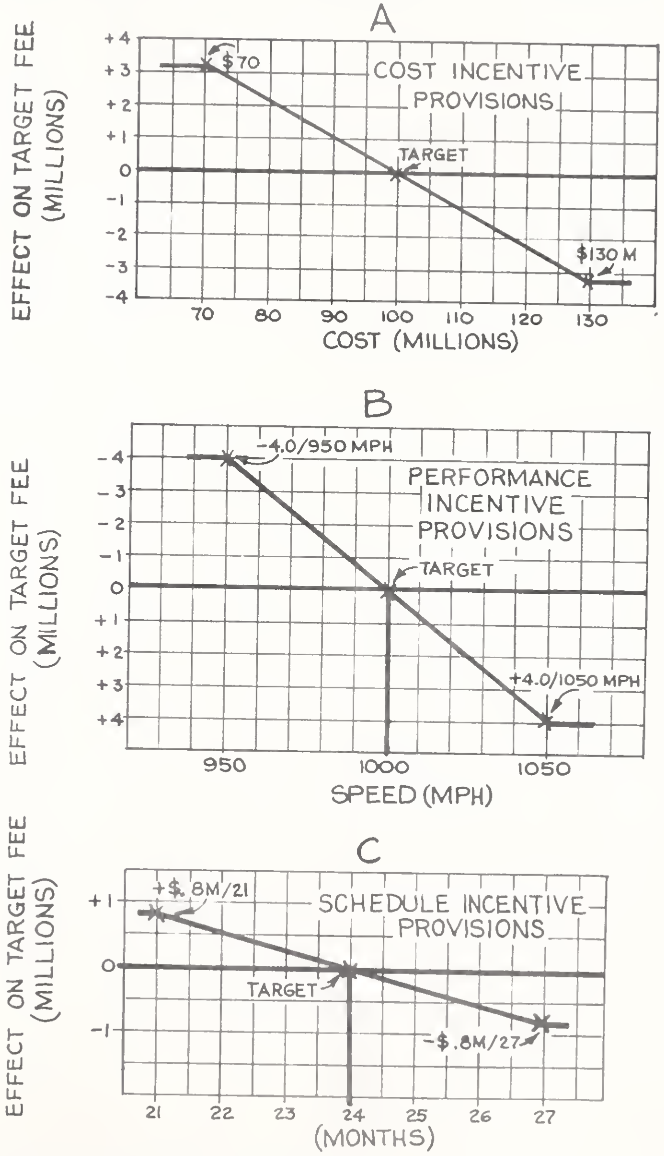
The given weighting, and the structure of the example is purposely simplified so that graphic analysis only depicts linear (constant) relationships. Preliminary trade-off decisions were considered by negotiators for both parties. The contractor suggested the following weights for the incentive elements: cost 40% (± $3.2 million); performance 50% (± $4.0 million); and schedule 10% (± $0.8 million). Figure 3.5 illustrates the incentive elements, their RIE and effect on FS.

By taking the general equation for a straight line and substituting values for the incentive elements, exact changes in the profit structure can be tested and manipulated. The formula permits precise profit determination for any contractor outcome whose values may be substituted. Initial calculations require finding coefficients for each incentive. The mechanics and technique are as follows:

Let X = miles per hour that actual performance exceeds the minimum acceptable (least likely) speed, 950 MPH.

FIGURE 3.5

GOALPOSTED MULTIPLE INCENTIVES FOR FORMULA MODEL



SOURCE: DOD GUIDE, PAGE 99.

Let Y = Millions of dollars that actual cost exceeds the best possible cost outcome. The lowest cost is $70 million.

Let Z = Number of months that actual schedule exceeds the shortest possible schedule. The lowest figure for the schedule RIE is 21 months.

Let F_T = Total fee which consists of target fee and ± incentive reward or penalty, in dollars,

and the general equation becomes:

$F_T = \$X - \$Y - \$Z + \text{Scale Factor.}$[7] The variables in this formula must have values within the RIE, thus X has to be between 0 and 100 MPH; Y is between $0 and $60 million; and Z is between 0 and 6 months. Once the weighting and range of values is known, coefficients can be calculated.

The coefficient for X is $.08 and it represents the change in fee for each mile per hour change in performance. It was derived by:

$$\frac{(50\%)\ (\$8\ \overline{M})}{50} = \$.08$$

The coefficient for Y is $.10666 and it represents the change in fee for each one ($1) million dollar change in cost, or

$$\frac{(40\%)\ (\$8\ \overline{M})}{30} = \$.10666$$

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[7] The scale factor is not explained by its authors. It is presumably, a displacement factor necessitated by the three-dimension model; it equals target fee.

The coefficient for Z is $.26666 and it represents the change in fee for each additional month of schedule slippage, or,

$$\frac{(10\%)\ (\$8\ \overline{M})}{3} = \$.26666$$

The final coefficients for this contract and the specific equation for total fee are:

$$F_T = \$.08\ x - \$.10666Y - \$.26666Z + \$7\overline{M}$$

It is proved by substituting real values. For instance, if all incentive elements are completed on target as they were negotiated with: performance (X) at 1000 MPH; cost (Y) at $100 million, and schedule (Z) of 24 months, then:

$F_T = (\$.08)\ (50\ \text{MPH}) - (\$.10666)\ (+\$30\ \overline{M}) - \$.26666\ (3\ \text{Months}) + 7$

and

$F_T = \$4.00 - \$3.20 - \$.80 + \$7\overline{M}$

and

$F_T = \$7$ million (Target Fee)

The formula model has great practical value. It is used for making trade-off decisions when the contractor is faced with several alternatives. The contractor can use linear programming solutions, simplex tableaux, or exhaustive search techniques to maximize his profit. The following given illustration shows how a three-way trade-off can be approximated in mathematical form, with these cost performance possibilities:

COST	PERFORMANCE	SCHEDULE
\$ 70 M	950	21
	975	24
	1000	27
\$100 M	975	21
	1000	24
	1025	27
\$130 M	1000	21
	1025	24
	1050	27

The trade-off formula is:

$$1.2X - Y - 10Z \leq 0$$

based on the weighting between performance (40%), cost (50%), and schedule (10%). The contractor now plans his activities in such a way as to maximize profit.

Figure 3.6 graphs the trade-off function for each variable in terms of the cost of two other variables.

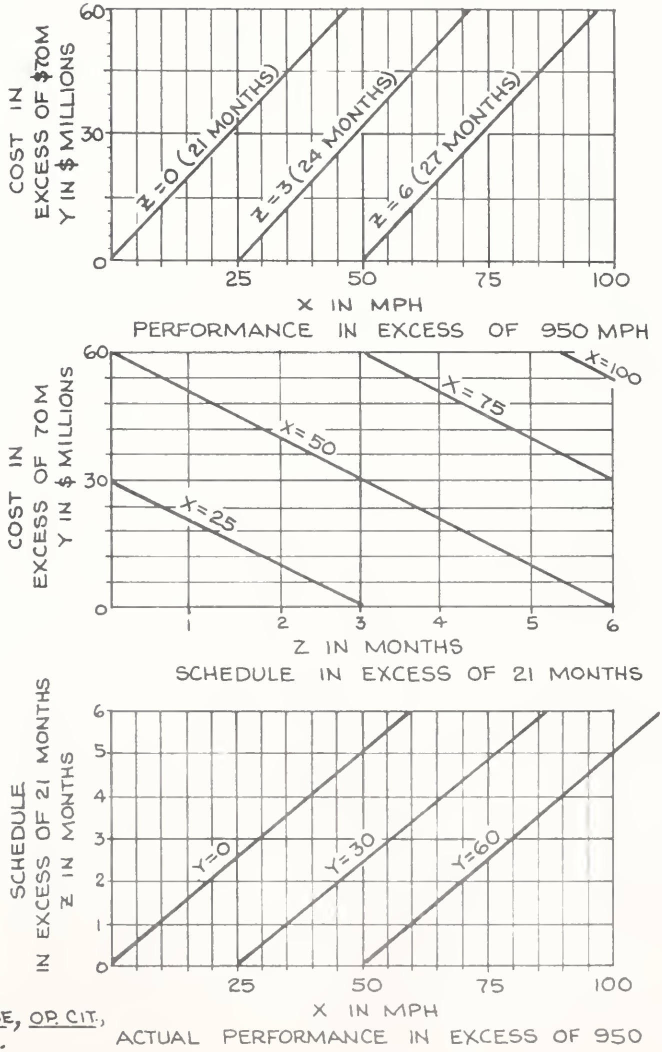
Maximum fee will come from the combined values of X, Y, and Z feasible at the time and point of management decisions. Armed with the information, the contractor tries to optimize in his decision-making. Optimization would occur when: $X = 50$ MPH; $Y = \$0\ \overline{M}$; and $Z = 6$ Months, and was solved by linear programming. Therefore, substituting in the original formula the optimal values:

$$F_T = (\$.08)(50\text{ MPH}) - (\$.10666)(\$0\overline{M}) - (\$.26666)(6\text{ Mos.}) + \$7\overline{M}$$

$$F_T = \$9.4\ \overline{M}$$

FIGURE 3.6

GRAPHIC PORTRAYALS OF TRADE-OFF FUNCTION 1.2X−Y−10Z=0 IN THREE PLANES



SOURCE:
DOD GUIDE, OP. CIT.,
PAGE 101.

The authors note that even though a contractor had a TF of $7 million with a FS of ± $8 million, he would probably never attain a fee of $15 million. The maximum hoped for fee based on the realities of trade-off possibilities is $9.4 million.

The composite weighting of incentive elements did not produce the incentive desired by the government. The government wanted performance incentive versus cost incentive of 50 and 40 percent respectively. The contractor, judging from the trade-off formula, might not be expected to do the job for the optimum situation. He would not exceed target on performance, and he would underrun cost by $30 million, or just the opposite intent of the weighting. In other words, the contractor's optimum combination was entirely different from that desired by the government. This information would suggest a change of weighting factors.

It is also possible to show the effect of discrete changes on decision-making. The contractor might ask whether it was worthwhile to produce a plane that could go +25 MPH faster (1025) if it cost him +$30 $\overline{M}$ ($130 $\overline{M}$). By solving for $X = 75$, $Y = 30$ and $Z = 6$, F_T would be $8.2 million. Clearly, this decision, while beneficial to the government, would nevertheless hurt total profit structure for the contractor. F_T would decrease some $1.2 million as a result of the action to build the faster plane, at the higher cost involving more time.

Tabular Models

The designation of a "tabular model" for the structuring problem does not exist. Contracting parties have used the term loosely so that at various times it is a synonym for: 1) tables prepared by exhaustive search techniques; 2) tables of optimum trade-offs for formula approaches; 3) a unique matrix form for a single contract; 4) the computer results of one of the other models described herein; or 5) a method which determines baselines of performance and adjusts all other outcomes through a series of multipliers. The definition and description are illustrated for the last type of incentive contract structure, although other trained observers in the contracting field opt to use the term differently.

Care should be exercised in terminology but the lexicon for incentive contracts is in an evolving state. It would be equally improper to describe "a computer model." Computer programs and flow charts for the generation of curves and tables exist for all of the models reviewed. These programs, in Algol or Fortran, produce curves and tables. However, one cannot call any approach utilizing a computer, "a computer program," with any greater exactness than referring to, "a tabular model," because it makes use of tables. A title should be more specific than either of these phrases.

The computer is used with incentive contract models to produce large masses of data on probable outcomes. Computer applications of this nature are not new. They free man from tedious, boring labor by making rapid simulations of thousands of trade-off possibilities. Computer substitution for manual effort has led to a custom of designing complex incentive contracts in a way which was never possible before their advent. Early incentive contracts had straight share lines, while the typical incentive contract today has greater sophistication. Share lines are curvilinear. For example, there are parabolic and dynamic shapes which require solving and plotting exponential equations. Administrative personnel in contracts do not, as a rule, have the mathematical dexterity necessary to cope with equations manually. The computer has eliminated this problem.

Larger computer installations have expensive plotters which graphically present trade-off information of the sample type. Incentive contract analytical techniques require a combination of mathematical and graphic solutions. Contract administrators stress the need for visual impact and graphic portrayal. In order for incentives to operate, they must be visible and translatable into impact dollars on fee. Each major decision must show up as a reward or penalty on target fee.

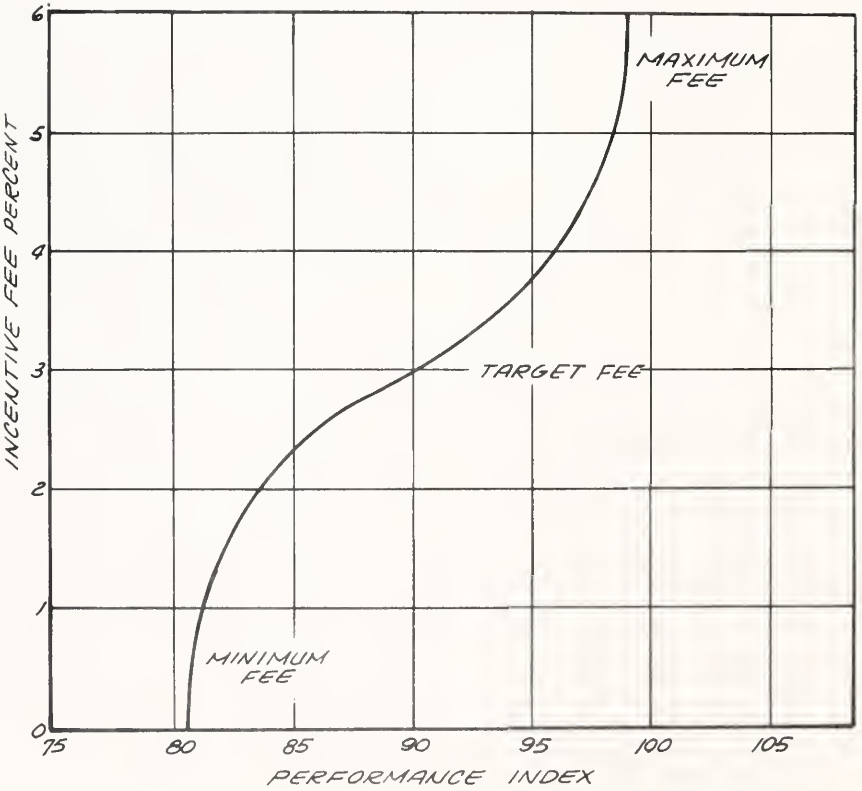
One major CPIF contract for services at Patrick Air Force Base, Florida, had numerous performance subdivisions which were used to calculate a performance index, which, in turn, was linked to fee. This contract contained features associated with tabular models. Figure 3.7 is the graphic illustration of this CPIF contract. The tabular contract form requires the intermediate step of developing an index by which current performance can be compared to base-year performance. The final payoff effect on fee looks like a french-curve, and complicates the calculation of profit. Negotiators for this contract used a computer to tabularize sample outcomes. The data were interpreted directly from computer tabulations for profit effect or could be solved by substitution in a logarithmic equation.

Firms with computers and operation research analysts have valuable tools when it comes to testing trade-off decisions for any incentive contract. A particular trait of tabular examples is that they require large amounts of data analysis as a preliminary to contract negotiations. None of the tabular contracts surveyed could be condensed for entire inclusion. For this reason, your author chose and included an existing contract from the DOD Incentive Contracting Guide which uses multipliers in a manner that satisfies the definition of a tabular form.

LMI Tab Model

A particular approach described as a principle and not as a well defined technique in the DOD Guide is that developed

FIGURE 3.7
PAA CPIF CONTRACT PERFORMANCE INCENTIVE



by the Logistics Management Institute (LMI).[8] It is a simplified approach which converts performance into achievement levels determined by the parties through negotiations. Each level has a multiplier assigned to it, based on the degree of difficulty associated with the achievement and on the degree of desirableness. The achievement levels can be correlated to government objectives, thereby causing the contractor to stress performance in specific areas. The multiplier for a specific achievement level is used to adjust target profit, so that target fee times the multiplier equals total fee.

The LMI model was developed expressly for multiple incentive contracts which cannot treat incentive elements independently. It attempts to balance objectives, using rewards, or multipliers greater than one; or penalties, multipliers lower than one. The primary function of this model is to provide discipline for, 1) compelling effective planning and analysis of the total range of contracting objectives, 2) improving techniques of communicating to contractors the priorities of trade-offs and procurement objectives, and 3) rewarding the contractor in ratio to his success in complying with the government's order of priorities.[9] The tabular model interrelates the elements, and permits shifting relative

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[8] DOD Guide, op. cit., p. 73. Reader is referred also to Logistics Management Institute Task 5B-3, 22 July 1963.

[9] Ibid., p. 74.

importance within the trade-off matrix. Therefore, it is a desirable structuring technique because the test of interdependency is satisfied.

The salient features of this model over the traditional approach are that it, 1) breaks ranges of incentive effectiveness into achievement grade, and, 2) assigns a multiplier for each grade. The grade levels are usually numbered, although each element may not have the same number of subdivisions nor is it even necessary to subdivide every element. The suggested multiplier is usually within a range of 0.5 to 1.5. The principle involved for assigning multipliers to achievement levels is: a multiplier is assigned to the achievement grade realized on an element and is used to adjust (multiply) the basic (unadjusted) incentive fee earned on other elements.[10]

A short example will illustrate this principle. Given a performance RIE divided into eight achievement grades. Actual performance achieved results in contractor making grade 5, which has an assigned multiplier of 1.10. This multiplier is then used to multiply and adjust the basic incentive fee earned on the cost and schedule elements. No rule can be stated as to the necessity of having multipliers for each incentive element other than if all three incentive elements have multipliers, the contract should specify how

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[10] Ibid., p. 75.

two multipliers applied to a single element will be resolved into one. Thus, each contract has a separate multiplier rule (see sample tabular model from DOD Guide in Appendix B). One set of multiplier rules applies to situations above target (rewards) while another set of rules applies below target (penalties). Either changing the mix of weights between cost, performance, and schedule assigned to the unadjusted incentive package, and/or changing the number of grade levels and assigned multipliers, is used to design a final incentive contract that suits objectives of both parties.

A step-by-step outline for preparing a tabular model would have the following requirements. Step 1, decide which incentive elements require multipliers and how they should be applied. Step 2, develop a way to grade achievement for each incentive element. Step 3, assign multipliers to the achievement grades and adopt the basic incentive arrangement pattern to fit desired total effect. Step 4, state a specific rule for multiplier usage, including instructions for resolving two multipliers into one with unadjusted fee. Make up different multiplier rules for penalties and rewards because they cannot apply to the same elements. Step 5, calculate the basic, unadjusted incentive profit or fee for each element. Step 6, select contractor's realized grade outcome for each incentive element and identify multiplier. Step 7, apply assigned multiplier to unadjusted profits or fees in accordance with rule established in Step four. Two multipliers applied to the same profit or fee should be resolved into a single multiplier. Step 8, multiply each incentive profit element by its proper multiplier. Sum products and combine with minimum profit to arrive at final profit.[11] The sample tabular form contract in Appendix B was structured using the same mechanical rules.

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[11] _Ibid_, pp. 92-93.

Planned Interdependency Incentive Method (PIIM)

PIIM is a computer model developed by Prof. J. Sterling Livingston (Harvard) and Management Systems Corporation for NASA's specific use on the Gemini Spacecraft incentive contract.[12] It is an entirely new computer model for firms with large-scale digital computers. Because of inherent complexity, its only application now is the Apollo Program. The following discussion on PIIM will explain its basic concepts, its applications, and its capabilities.

PIIM was developed because conventional incentive contracting techniques were unable to bring together incentive parameters for cost, performance, and schedule that would satisfy government objectives. At the time, there was a need for an incentive structuring system that would describe detailed, combined trade-off functions. The government specified requirements for the Gemini Spacecraft in terms of budgetary dollars, performance objectives, and program timetable, and then assigned value priorities to these. The traditional two-dimensional chart which showed the amounts of fee paid for cost or performance *separately*, could not set fees for combined outcomes that were unequal to the sum of individual fees earned separately for each parameter. The technique of using iso-fee lines with two dimensional elements

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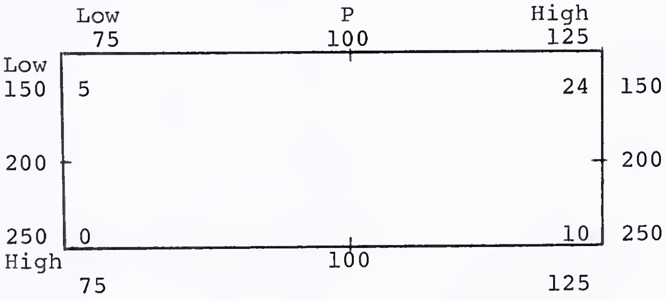
[12] *Planned Interdependency Incentive Method*, final report to NASA under contract NAS 9-3466, 30 January 1965.

has already been illustrated, but the fee under these circumstances is always the product of a balanced output between cost and performance. The government needed a technique to deal with varying emphasis between the elements. PIIM uses a technique to shift incentive emphasis between parameters for different program outcomes.

The basic concepts of PIIM are described in the following example.[13] Assume the government has a value statement which reflected fee amounts related to cost and performance as follows:

FEE	COST	PERFORMANCE
$24 Million	$150 Million	125 Points
$10 Million	$250 Million	125 Points
$ 5 Million	$150 Million	75 Points
$ 0 Million	$250 Million	75 Points

this could be diagrammed as:



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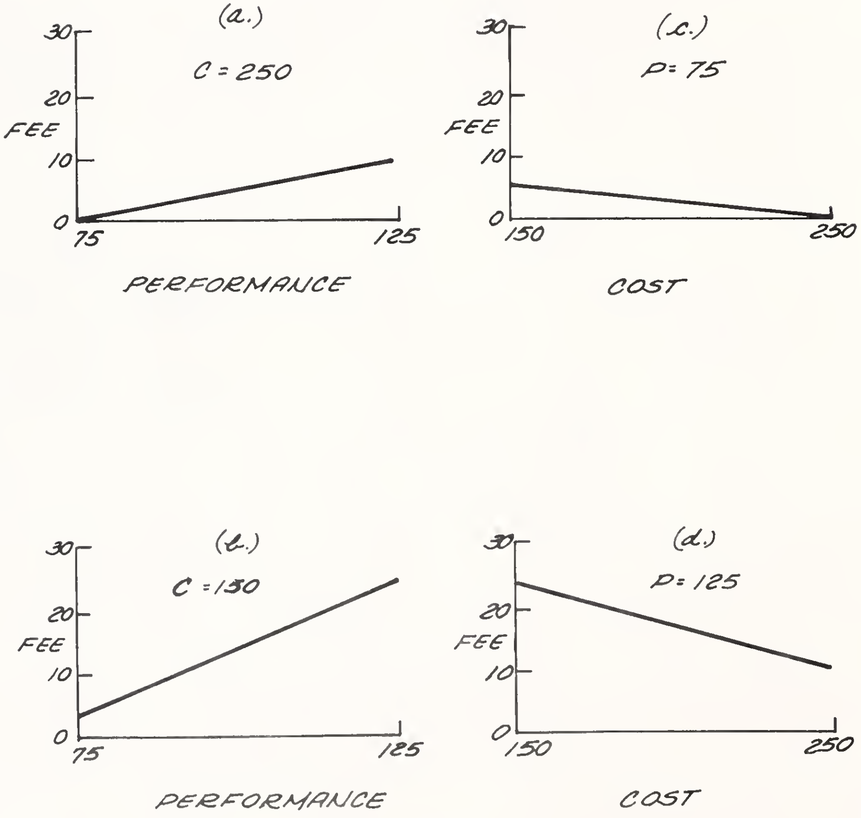
[13] Ibid., p. 75.

The diagram shows that cost can be low and performance low, or, cost can be high and performance high, or a mixture of the two. The importance to the government of these combinations is the impact of the incentive at <u>that</u> moment. For instance, if performance is high and cost is low, the incentive arrangement should motivate the contractor to maintain both cost and performance levels. On the other hand, if performance is low and cost is high, the contract should be structured to motivate the contractor to improve on both of these elements. At the same time, the necessity of shifting emphasis comes when both cost and performance are low because the government wants a contractor to improve performance while deemphasizing cost. Thus, the fee combinations show low or no fee, or high and greatest fee when the cost/performance outcome is matched to the government's value objectives.

Figure 3.8 shows share lines for the various parameter combinations described, in a conventional two dimension format. In Figure 3.8a, if the cost outcome were $250 million, the incentive plan for performance would start at 0 fee for 75 points, and rise to maximum fee of $10 million for 125 points. In Figure 3.8b, assuming a cost of $150 million, incentive fee would increase from $5 million at 75 points up to $24 million for maximum performance of 125 points. Reversing the constant in Figure 3.8c, if performance were 75, fee would decrease from $5 million at a cost of $150 million, down to 0 incentive fee if cost were to climb to

FIGURE 3.8
SHARE LINE COMBINATIONS



SOURCE: PIIM MANUAL, OP. CIT., PAGES 12-13.

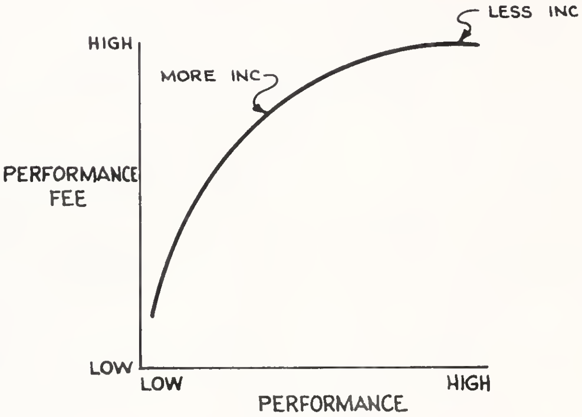
$250 million. In Figure 3.8d, if performance is at a maximum with minimum cost, the contractor would get maximum incentive fee of $24 million, and $10 million if the cost were $250 million.

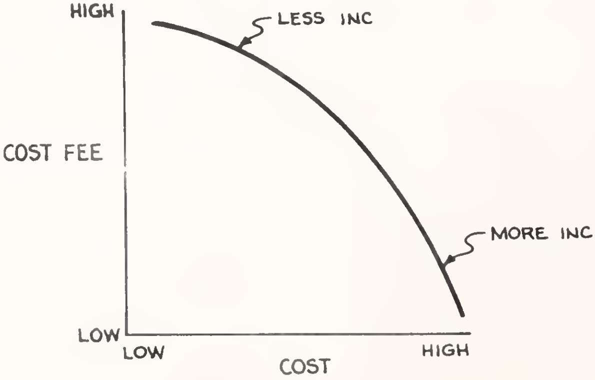
The government procurement agency decides as a result of analysis that this format does not stress proper relative emphasis between cost and performance. As it now exists, in linear form, incentive to effect changes is constant at all output levels. By changing from straight to curved parameter/fee lines, it is possible to improve the emphasis on government objectives. This is done by letting the slope of the fee line vary with the objective for a particular outcome; slope then becomes synonomous with the <u>rate</u> of incentive fee payment. The contractor can be stimulated to perform better over a particular region by making the slope steeper, i.e., earn a higher rate of incentive fee, or by making the slope flatter, i.e., earn a lesser rate of incentive fee.

In Figure 3.9, with performance at a high level, more emphasis is given to the possibility of its decreasing, thus the slope is greater in the midrange. The changing slope pursuades a contractor not to go overboard trying to hit maximum performance, because he earns performance incentive fee at a decreasing rate near the maximum performance rating. On the other hand, the government wants more emphasis on cost as it increases in an attempt to force a contractor to restrain costs. Thus, there would be greater slope to the incentive fee line in the high cost region. So far, the construction

FIGURE 3.9

RATE OF INCENTIVE CHANGE DEMONSTRATED





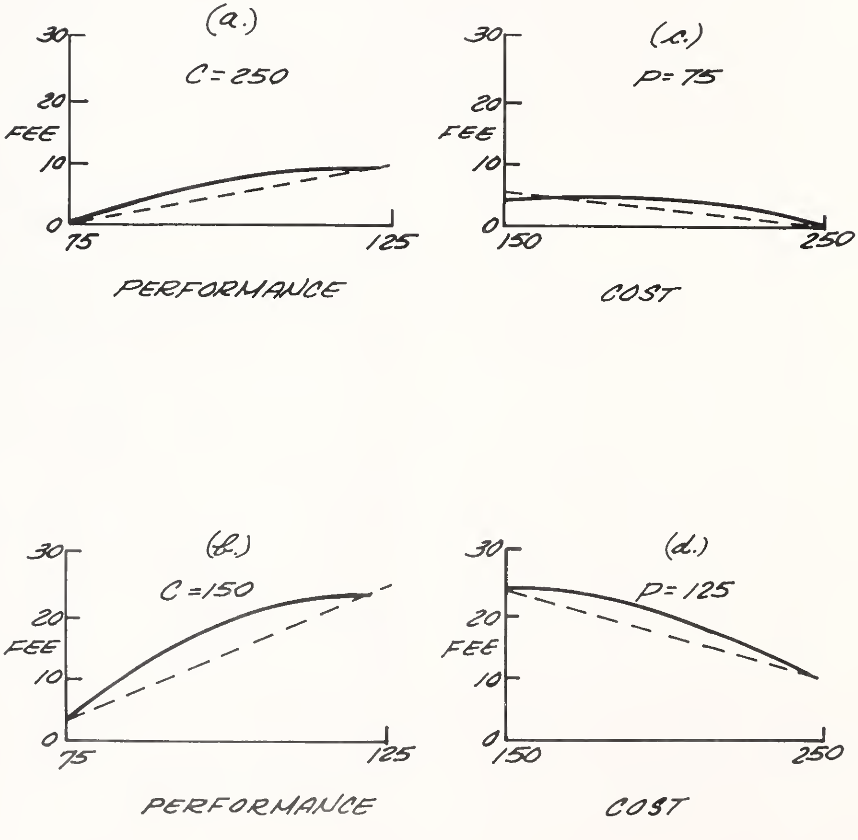
SOURCE: <u>PIIM</u> <u>MANUAL</u>, <u>OP.</u> <u>CIT.</u>, pp. 14+15.

example has dealt with each incentive individually. Now comes the more difficult task of combining the varying share ratios for each of the four possible cost/performance outcomes.

Applying the relationships desired by the government in Figure 3.9 would result in the transformation of the linear share lines from Figure 3.8, into the curved share lines in Figure 3.10.

By changing the slope of the share line, in the high cost region, $250 million, incentive emphasis is less when coupled with high performance. Note the gradual slope. Cost and performance have been balanced overall by a shallow share line in Figure 3.10a. In Figure 3.10b, at a low cost of $150 million, greatest incentive is placed on low performance and lower incentive on high performance. This encourages the contractor to improve his performance in the low end of the performance range, yet will not result in an over-reward for performance if he doesn't check climbing cost. Thus, performance and cost are balanced out near the high end of the performance parameter. Slope in that range is fairly shallow. In Figure 3.10c, when performance is at a minimum, there is again a balance between cost and performance as shown by the shallow share line over the range of cost outcomes. However, in Figure 3.10d, when performance is high, 125 points, there is relatively strong incentive at high cost levels, around the $250 million cost range. This is the area of greatest slope, while the area of lower cost near $150 million contains a more shallow share line.

FIGURE 3.10
SHARE LINE TRANSITION



SOURCE: PIIM MANUAL, PAGES 15 & 16.

In summary, the four curves in Figure 3.10 represent the extremes of the incentive plan. The two curves for cost match the extremes of the performance range. The two curves for performance match the extremes for the cost range. The contractor's total fee will now be determined by some combination of the variables just reviewed.

With PIIM, fee is determined from a three-dimensional surface drawn smoothly across the four boundaries illustrated in Figure 3.11. Any cost and performance outcome can be located on this surface, and the resulting fee is determined by the height of the surface at the point of cost and performance outcomes.

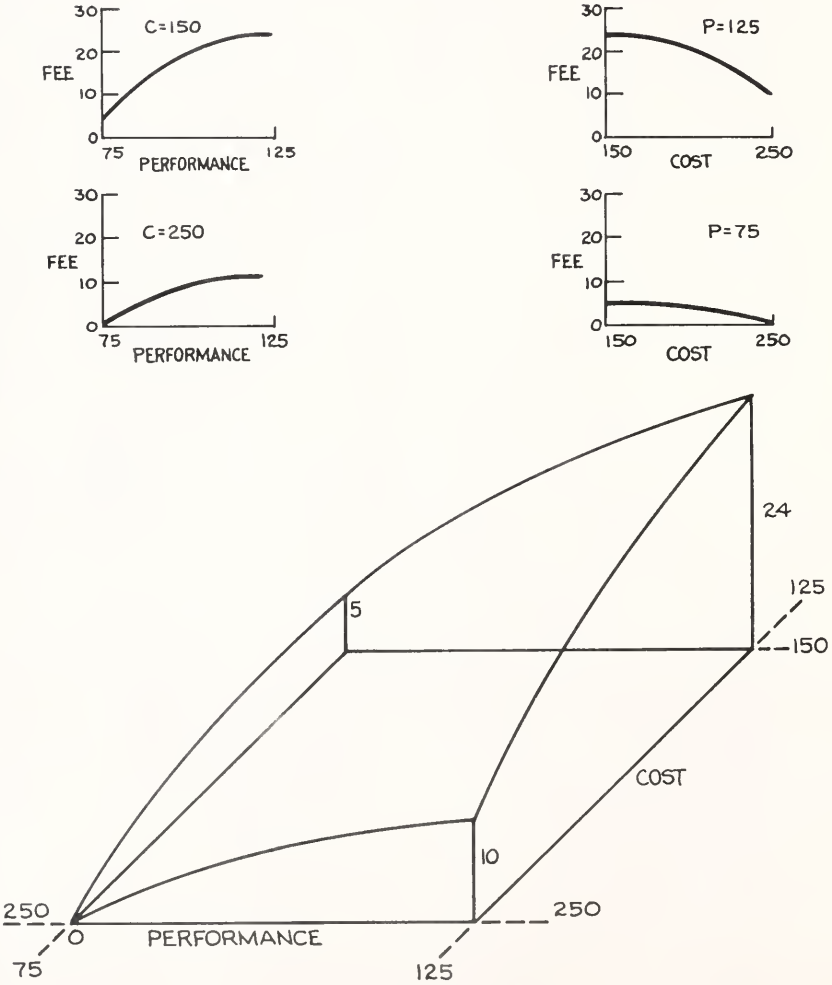
Figure 3.11 illustrates the PIIM Incentive Fee Surface applied to the boundaries of the incentive arrangement used.

Iso-fee or constant fee lines can also be used with the three-dimension model. These are the lines connecting all points of equal height on the fee surface. The iso-fee lines for the value structure used as a sample are presented in Figure 3.12.

The $5 million iso-fee line connects the $150 cost and 75 point performance combination in the upper left-hand corner and varies until it approximates a $250 cost, 100 point performance outcome in the middle foreground. It is difficult to describe points without lettering all the intersections on the fee surface. Yet, it is possible to adjust the height of the PIIM surface to reflect a change in values. This creates a shift which changes the slope of the fee curves and also

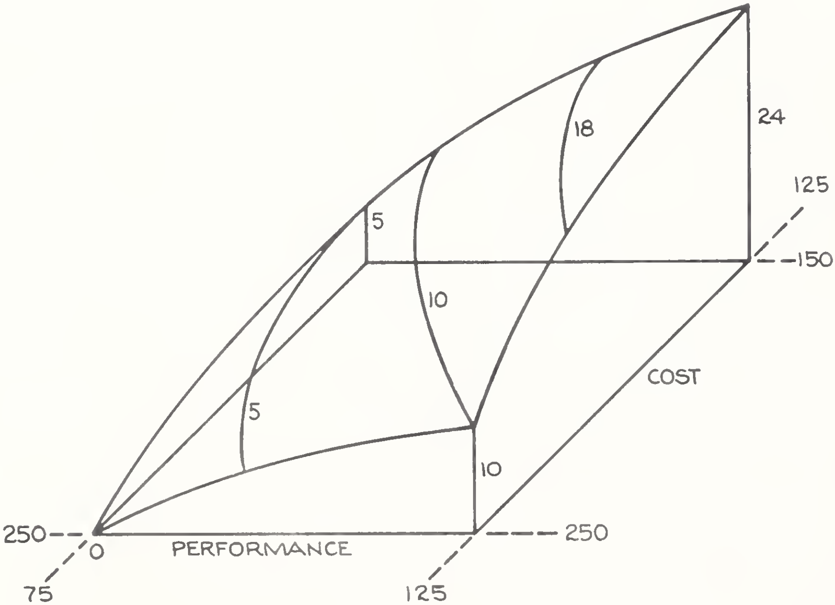
FIGURE 3.11

PIIM INCENTIVE FEE SURFACE



SOURCE: PIIM MANUAL, OP. CIT., PAGE 18.

FIGURE 3.12
ISO-FEE LINES ON PIIM SURFACE



SOURCE: PIIM MANUAL, OP. CIT., PAGE 21.

changes the emphasis between incentives. See Figure 3.13,

In Figure 3.13, one sees a good example of how the incentive plan can be altered. Assume the government team structuring this contract decided that high performance, even at the sacrifice of high cost, was of prime importance. They could raise the fee from $10 to $15 million at maximum performance, 125 points and highest cost, $250 million. By raising the fee values near the high performance/cost region, the whole iso-fee structure is increased to place more emphasis on the performance incentive. The uniqueness of PIIM is that changes can be achieved by varying one or all of the four corners that make up the PIIM surface. Since the four corners support the value structure desired by the government, by raising, lowering, or tilting the PIIM surface emphasis can be shifted. Figure 3.14 shows what might occur if the government had chosen to increase fee in the low cost/low performance region while decreasing fee in the high cost/high performance region. This would have the effect of forcing the contractor to watch his costs more closely.

Another example was given to show the flexibility of the PIIM model.[14] Given the grid below, after balancing cost and performance extremes the government feels it must have greater emphasis in the high cost area.

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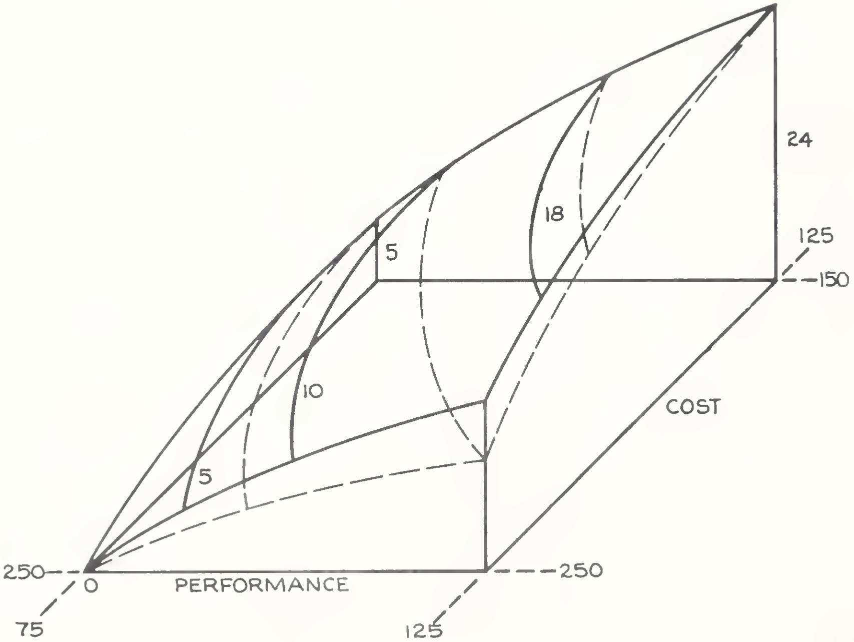
[14] <u>Ibid.</u>

FIGURE 3.13

ALTERATION OF PIIM SURFACE TO CHANGE INCENTIVE RAISED FEE AT MAXIMUM PERFORMANCE AND COST



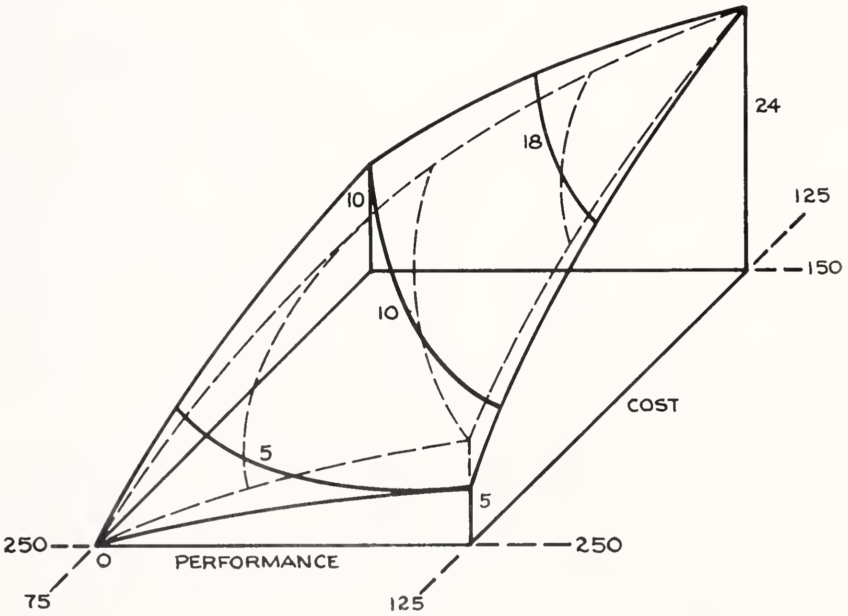
SOURCE: PIIM MANUAL, OP. CIT., PAGE 22.

FIGURE 3.14

ALTERATION OF PIIM SURFACE TO CHANGE INCENTIVE

DECREASED FEE AT MAXIMUM PERFORMANCE AND COST

INCREASED FEE AT MINIMUM PERFORMANCE AND COST



SOURCE: PIIM MANUAL, OP. CIT., PAGE 23.

Low Perf. High

Cost

Perf.	Bal.
Bal.	Cost More emphasis needed.

High

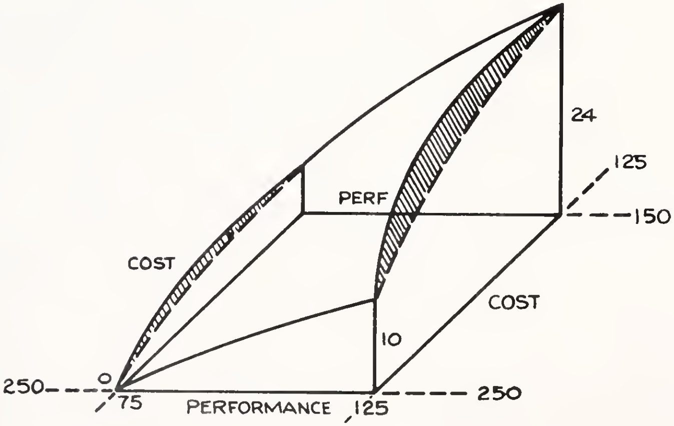
By changing the slope of the curve that bounds the surface of the cost area, a new fee surface is generated and it provides for greater fee between the extremities of the cost range.

Figure 3.15 shows that a bulge was created in the surface along the plane that touches the performance range of 125 and is in the high cost region. (Cost value = $250 million; performance value = 125 points.) The slope is much steeper around the cost of $250 million, while it is more gradual at the cost of $150 million than it was previously. The contractor should have greater motivation to watch his spending when operating in the high cost region. The shaded area describes the change.

At the same time the surface was altered in the high cost/high performance area, the fee surface was disturbed along the opposite edge in the low performance area. The lesser shaded area reflects the change. Since this is a three-dimension model, the changes shown in the extremities spread out over the <u>entire</u> surface, from one edge to another.

FIGURE 3.15

ALTERATION OF PIIM INCENTIVE OVER COST RANGE



SOURCE: PIIM MANUAL, OP. CIT., PAGE 25.

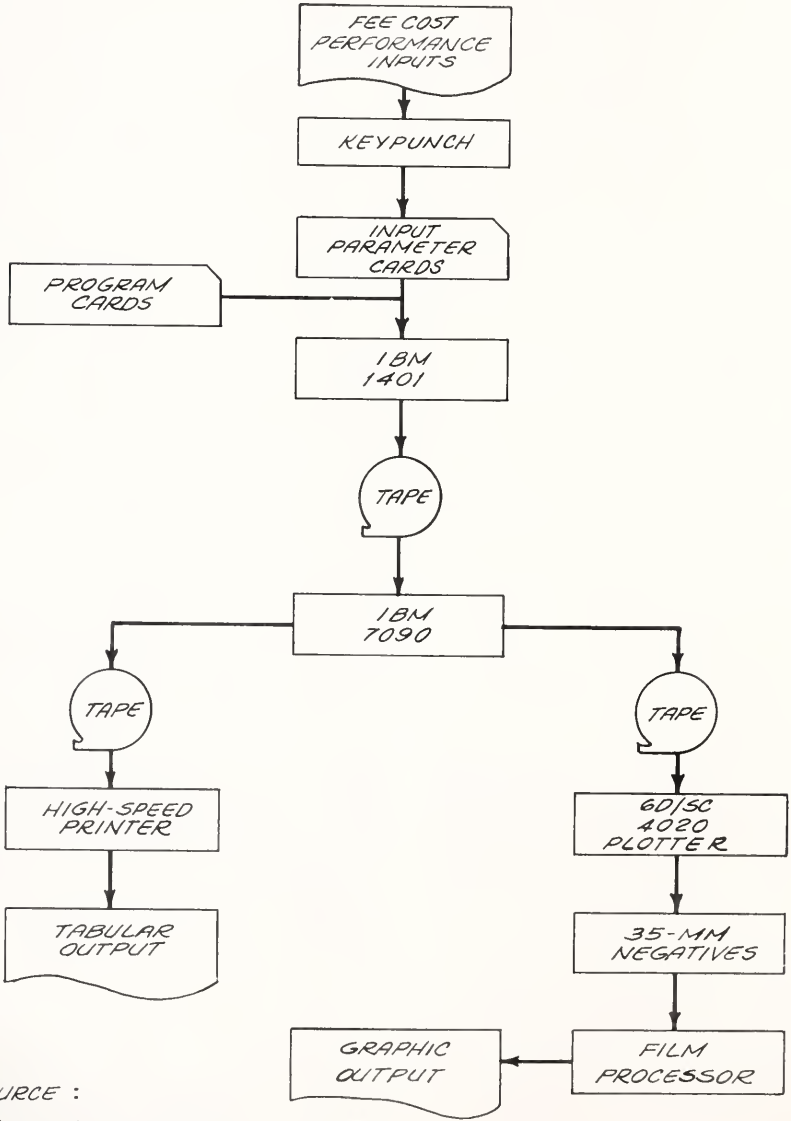
Changes of this type can be used to stress performance, cost reduction, reliability, tight scheduling, etc.

The PIIM fee surface is flexible because incentive fee can be altered to meet value conditions by either varying the fee heights at the four corners of the surface, or by altering the slope at the extremes of the curves that bound any surface. The examples used simplified reality because they depicted two separate changes and their effects. In a true contract environment, the parties negotiating the contract would experiment by _simultaneously_ changing the fee heights at the corners and varying slopes at the extremes. This would enable the government to get in one contract a model that would, a) pay more fee whenever performance increased for the same cost, b) pay more fee whenever cost is reduced and there is no attenuation of performance, and c) balance cost/performance incentives throughout the range of outcomes.

Under actual contract conditions, a contractor would optimize profit by making tradeoffs, using PIIM with a computer that provides output charts and tabulations. The flow of data and machines used can be determined from Figure 3.16. Inputs from incentive parameters are processed through an IBM 1401, and then the taped outputs are processed by an IBM 7090. Data reduction and output can take two forms. One is tabular produced on a high-speed printer. The other is graphic processed on a plotter. This flow and the list of suggested equipment was prepared before firms began accepting

FIGURE 3.16

TYPICAL HARDWARE USED WITH PIIM MODEL



SOURCE :

PIIM MANUAL OP. CIT., PAGE 28.

delivery of third generation computers. Even at that, the PIIM format using sophisticated hardware consumes little actual running time. Speed is generally not of great importance.

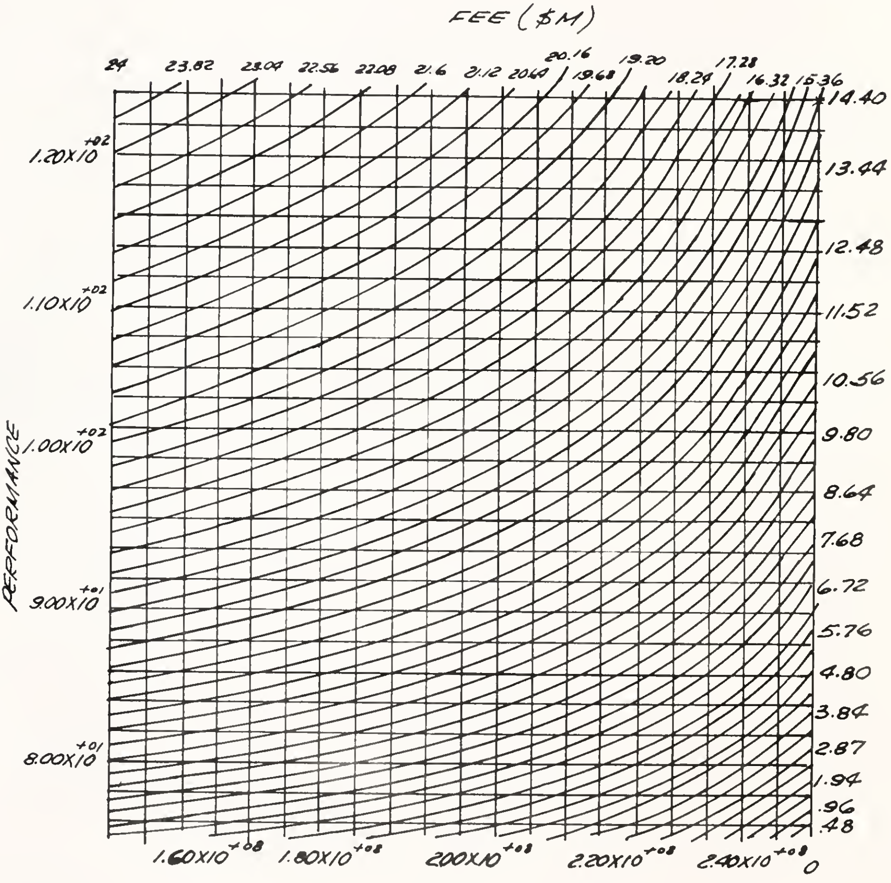
The graphic outputs with a PIIM format are more advanced than any other model covered in this study. Graphic choice and variety provide quick information for decision-making. There are six graphic outputs which are shown in Figures 3.17 - 3.22. The same data are also produced in tabular form. The six graphs are: Lines of Constant Fee (3.17); Lines of Constant Cost (3.18); Lines of Constant Performance (3.19); the Cost Share Ratio (3.20); the Fee/Performance Ratio (3.21); and the Cost Equivalent Ratio (3.22).

Each of these graphs deserves an explanation as to how it is applied by the contractor.

Lines of Constant Fee (3.17) have already been discussed. The lines show points on the PIIM surface where height is the same for any two incentive combinations. Thus, the contractor will make the same total fee for any one of the combinations whose coordinates are on that line on the same surface.

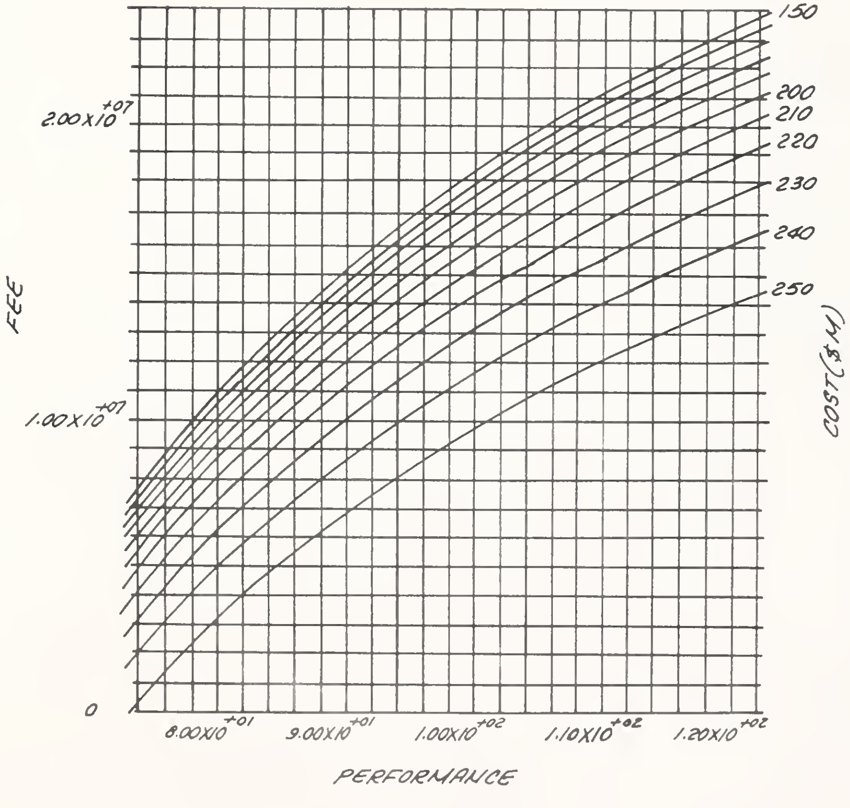
Lines of Constant Cost (3.18) express in two dimensions the fee that will be paid for varying performance along a line of constant cost. Thus, by slicing a segment of the $250 million cost plane that intersects the PIIM model, the contractor can examine fee as performance changes in that plane. The illustration in Figure 3.23 shows the plane which

FIGURE 3.17
LINES OF CONSTANT FEE



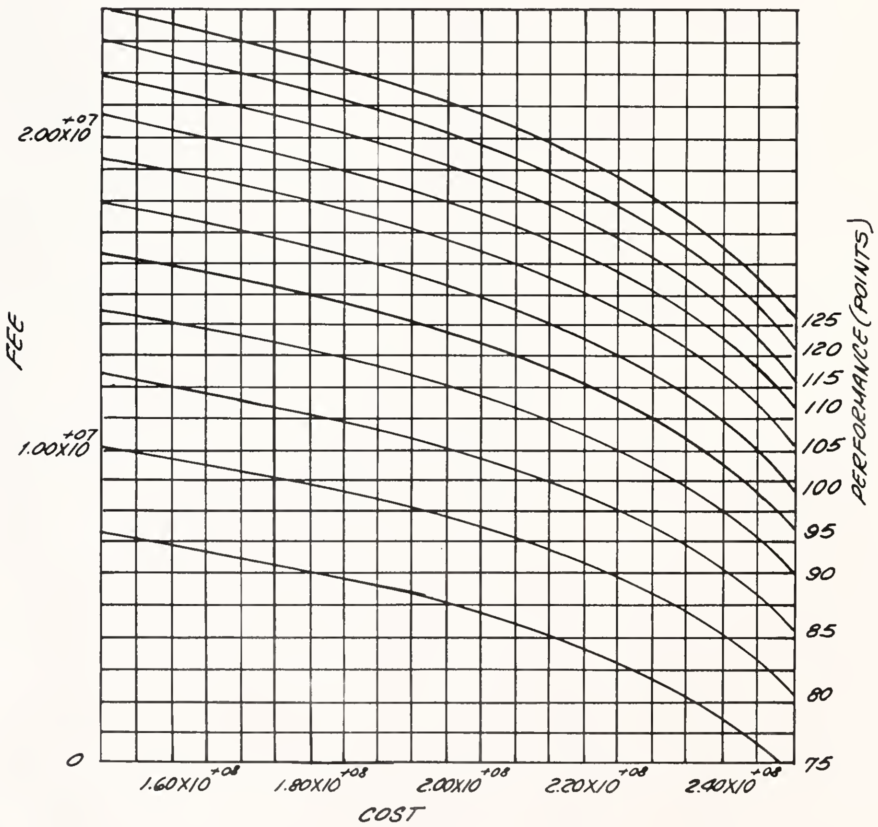
SOURCE: PIIM MANUAL, PAGE 31.

FIGURE 3.18
LINES OF CONSTANT COST



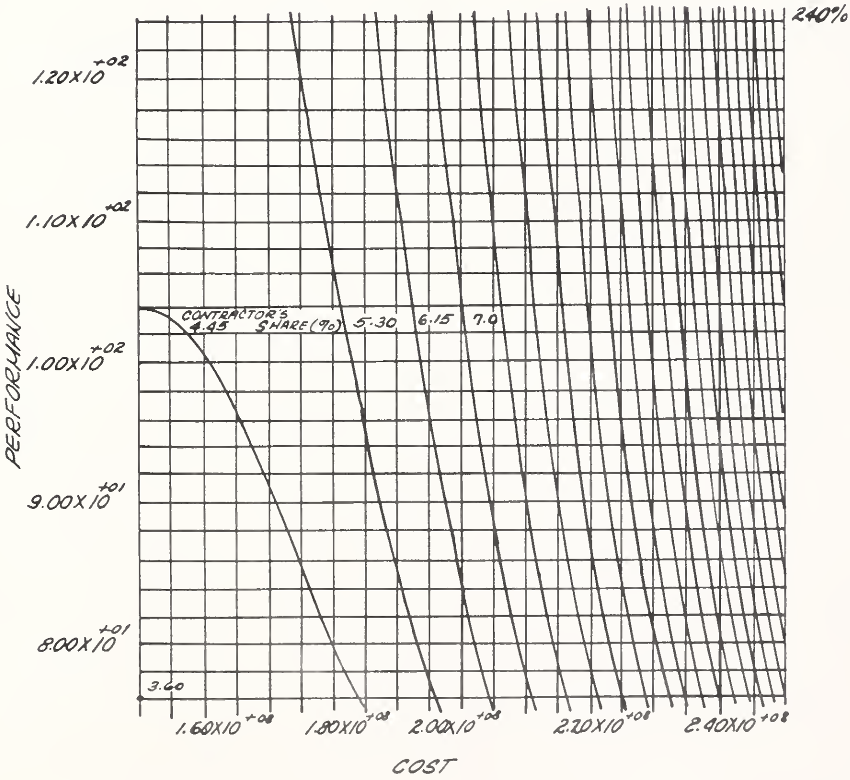
SOURCE: PIIM MANUAL, PAGE 33

FIGURE 3.19
LINES OF CONSTANT PERFORMANCE



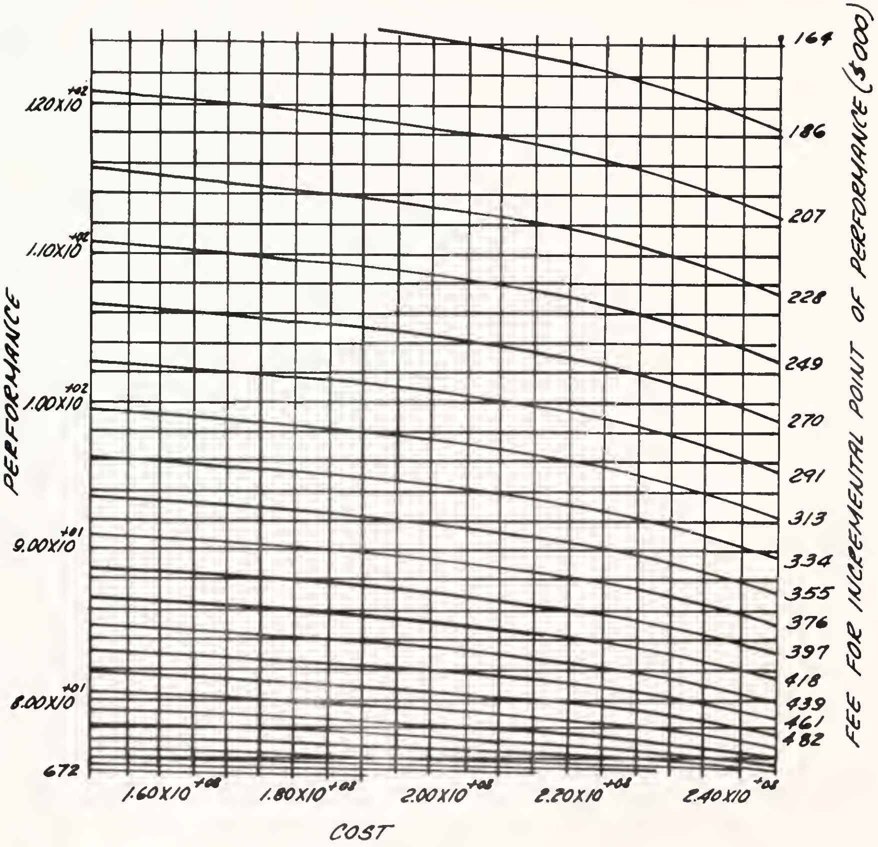
SOURCE: PIIM MANUAL, PAGE 35.

FIGURE 3.20
LINES OF CONSTANT SHARE RATIO($\partial F/\partial C$)



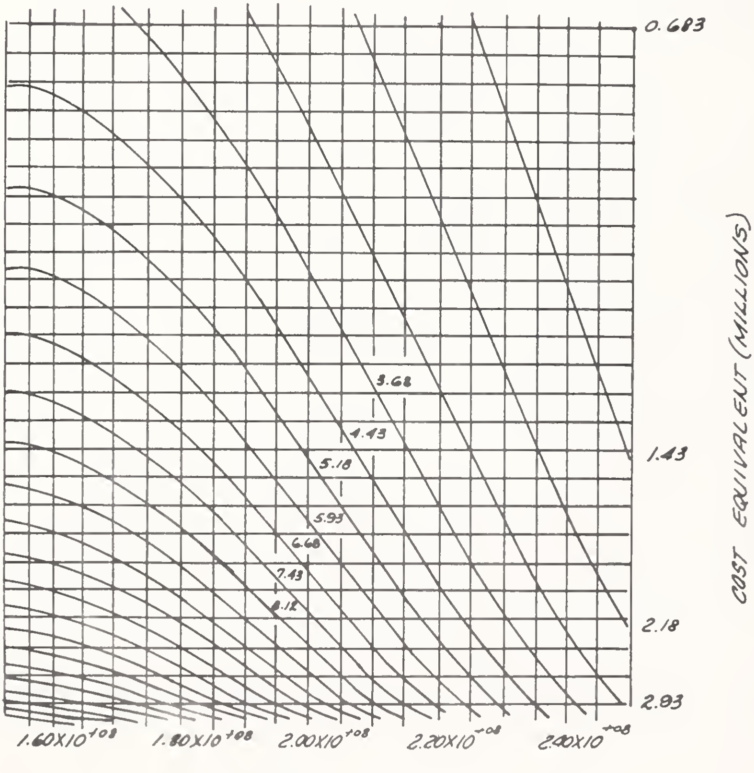
SOURCE: PIIM MANUAL, PAGE 37.

FIGURE 3.21
LINES OF CONSTANT $\partial F/\partial P$



SOURCE: PIIM MANUAL, PAGE 39.

FIGURE 3.22
LINES OF CONSTANT COST EQUIVALENT($\partial C/\partial P$)



SOURCE: PIIM MANUAL, PAGE 40.

FIGURE 3.23

PLANE FOR LINES OF CONSTANT COST

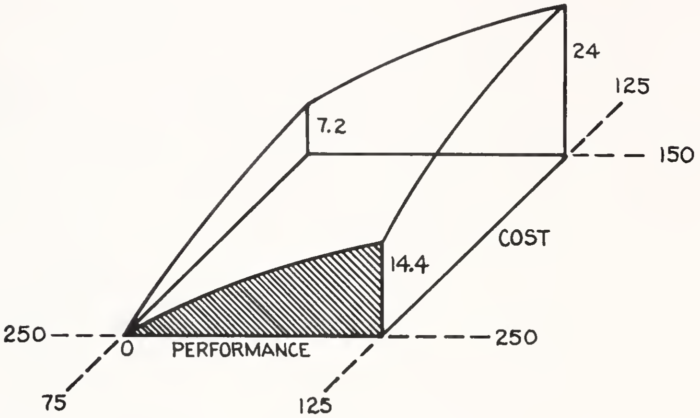
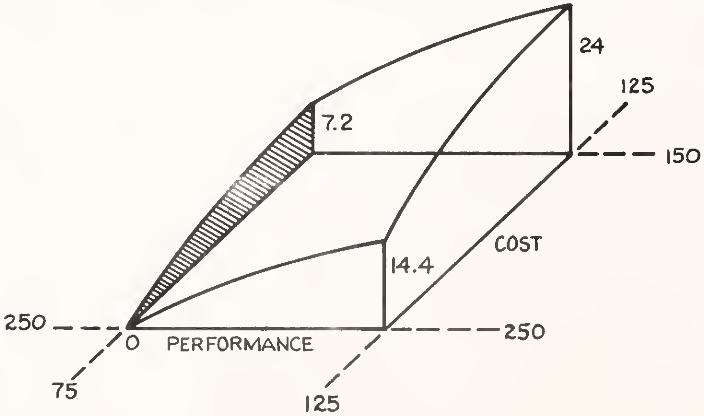


FIGURE 3.24

PLANE FOR LINES OF CONSTANT PERFORMANCE



SOURCE: PIIM MANUAL, OP. CIT., PAGES 32 & 34.

describes the line of constant cost for $250 million.

Lines of Constant Performance (3.19) describe fee changes that occur by varying cost while holding performance constant. Again this is a two-dimension output as the plane intersects the PIIM model. Figure 3.24 shows the segment affected which is for constant performance of 75 points.

The Cost Share Ratio (3.20) shows the rate of change of fee with respect to cost. The graph of this ratio, $\partial F/\partial C$, is used by the contractor to find his share of cost for any combination of program outcomes. He is motivated by high share ratios at high cost levels which increase rapidly in that region, thereby encouraging cost savings. The reason is that each additional dollar spent in the high cost region sacrifices more fee for the contractor.

The Fee/Performance Ratio (3.21) shows the rate of change in fee with respect to performance improvements. The ratio, $\partial F/\partial P$, shows that at low performance levels, e.g., 75 to 95 points, the lines are close together and the contractor is motivated to climb to a higher fee by moving up the performance scale. At the higher end of the performance scale, e.g., 110 to 120 points, there is greater distance between the lines and the contractor earns less fee per point of improvement in performance. The government presumably wanted this incentive structure to insure at least minimal performance.

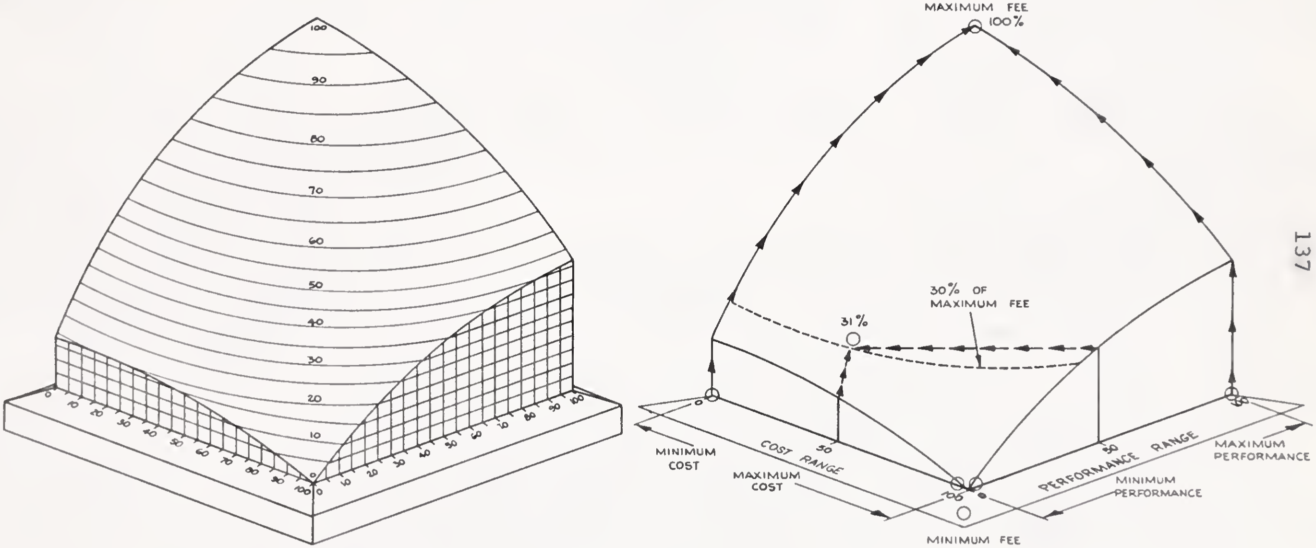
Cost Equivalent Lines (3.22) depict the rate of change in cost with respect to performance. The ratio, $\partial C/\partial P$, produces lines of constant cost equivalent. The contractor uses this for trade-offs between cost and performance, for the ratio determines how much additional cost he can incur in the process of improving performance point by point, without any loss of fee. For example, if he was spending \$190 million for 106 points of performance, what should the contractor's maximum cost be to achieve one additional point of performance? Moving up the constant cost line in Figure 3.22, performance of 107 should not cost more than \$4.43 million as this is the trade-off of $\partial C/\partial P$.

The actual three-dimension PIIM model used by NASA for the incentive contract with McDonnell Aircraft Corporation (now McDonnell-Douglas Corporation) for the Gemini Spacecraft is presented in Figure 3.25. The peak of the model, dubbed "Happiness Hill," represents the maximum possible fee that McDonnell could earn with maximum hardware performance and minimum cost as spelled out in the contract. The accompanying illustration shows fee outcome at 31 percent of maximum fee if McDonnell achieved 50 percent scores in performance and cost. This contract employed all the theoretical tools described and was an outstanding success.

This review of PIIM has been very basic. For greater detail on structuring and application, one must refer to works on the mathematical formulations and computer program that are inseparable from the PIIM model. The scope of this study is limited to a description of the models so that several alternatives may be compared.

FIGURE 3.25

PIIM GEMINI SPACECRAFT MODEL AND 50 PERCENT OUTCOME



SOURCE: SCHOOL OF SYSTEMS AND LOGISTICS, AIR FORCE INSTITUTE OF TECHNOLOGY, AIR UNIVERSITY, CLASS 67-A (176), JULY 1966. UNPUBLISHED.

Trade-Off Curves Analysis

Trade-off curves embody many features found in PIIM; however, the technique was developed separately as a research project by the Mathematics Department faculty at the United States Air Force Academy. The most definitive reference on trade-off curves analysis is, The Evaluation and Structuring Techniques of Multiple Incentive Contracts. Unfortunately, this document, published in 1966 by the Air Force Academy, is marked, "For Official Use Only." The stamp restricts the information contained within to those who, "have a need to know." Furthermore, material taken from a document with this stamp requires clearance which usually entails red tape and delays. For this reason, discussion of trade-off curves analysis is somewhat sketchy.

Air Force Academy research developed two approaches to the structuring problem. The first method is the more sophisticated of the two, and is called System Analysis Technique. It requires close coordination of project, technical, Systems Analysis, and pricing personnel to develop all data necessary. The second method is simply called the Curve Fitting Technique. It relies on three standard sets of trade-off curves, selecting one set--or region--as the most appropriate for any given procurement. It also requires the close coordination of many different specialists. Both methods satisfy the test of interdependency, as individual weighting of each performance parameter, as well as the inter-relationship of the various performance parameters, can be checked.

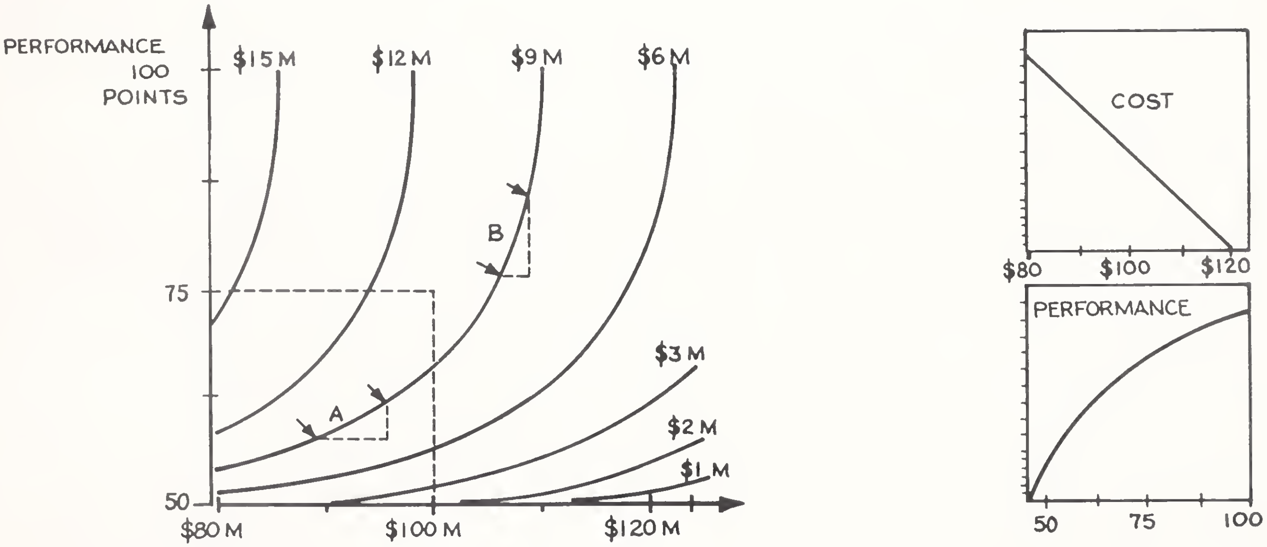
Incentive parameter inputs are arranged to take advantage of the computer. The programs generate curves, tables and formulae for structuring and altering multiple incentives. Furthermore, by providing evaluation and analysis, programs help shape curves that communicate the government's interest. Object values are emphasized by the determination of relative values for different incentive element combinations.

For the above stated reasons, the two methods cannot be reproduced. As a beneficial alternative, the underlying philosophy of these techniques will be described.

Figure 3.26 illustrates a form of trade-off curve analysis which fundamentally depends upon iso-fee or constant fee lines. In the example given, target cost is $100 million, with a symmetrical share arrangement over the RIE of $80 million to $120 million. Target performance is 75 points with a curved share line over the RIE of 50 to 100 points. The curves generated by the computer show any combination of cost dollars and performance points that will yield the contractor the same corresponding constant fee over the entire range of possible outcomes.

The coordinates of target cost, $100 million, and target performance, 75 points, are shown on the iso-fee chart as broken lines. Area A in the graph occurs below the targets for cost and performance. It shows that a contractor can trade-off a greater amount of cost to receive a smaller increase in performance for the same amount of fee. Thus, due to the slope of the fee curve in that region, there is greater emphasis on improving performance. In area B, however, which lies above target cost and target performance, it takes greater performance increases, with smaller cost increases, to maintain the same fee position. Thus, the contractor is motivated to control spending accordingly as he tries to earn more incentive fee by boosting performance.

FIGURE 3.26
TRADE-OFF CURVES ANALYSIS



Systematic Technique of Incentive Contracting (STOIC)

Perhaps the completed solution presented for the problem of structuring incentive contracts is one developed by W. A. Hagan and the Executive Staff at NASA's George C. Marshall Space Flight Center (MSFC). The totality of their approach is impressive because it relies on interdisciplinary exchange felt to be so essential by your author. In the course of its description, note elements drawn from psychology, economics, mathematics and management. The system enlists tools developed by both the physical and the social sciences.

MSFC's Mr. Hagan first explores the field of motivation research. The reason for this is explicitly stated. Any contract, incentive or otherwise, between the government and a contractor must supplant and substitute for the lack of competition. Under a CPIF contract, for instance, the contractor's financial risk is shifted to the government. Once a contract is signed between a contractor and the government, a bilateral monopoly (_sic_) is formed for the life of the program.[15] The element of competition normally provided for by the market mechanism must be instilled into the contract synthetically. An incentive arrangement may do this through "pre-directed motivation."[16]

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[15] W. A. Hagan, _STOIC_, NASA. George C. Marshall Space Flight Center, Huntsville. 1966. Two monographs of unnumbered pages. Author's note: This is monopsony.

[16] _Ibid._

The STOIC approach to incentive contracting is based upon motivation research linked to contract objectives. Hagan explains how the STOIC acronym was selected to convey a dual meaning:[17]

> During the 300's B.C. a philosopher named Zeno of Citium taught in the city of Athens. He was called 'the STOIC philosopher' because he did his teaching at the STOA POIKILE (painted porch or corridor) on the north side of the market place. One of the basics of his philosophy was indifference to pleasure or pain. It might be stated: 'Mentally shielding himself from both pleasure and pain man should control that which is controllable and leave the rest to the Divine.' The principles of control and indifference are fundamental to our STOIC system.

At the same time, there is a veiled contract clause in every contract which operates even though it is unwritten and is therefore uncontrollable. It is that the government encourages the contractor to expend as much as, but not more, than, X resources to accomplish Y objective. If the contractor expends less than X resources to accomplish Y objective, his profit will automatically be increased; or alternatively, for the converse his profit will be diminished. No incentive formula devised can fully predict the choice of alternatives open to the contractor, nor the course of action he will take. This is the realm of the uncontrollable, or the Divine! However, by designing an incentive contract that captures major incentive events, the contractor will have to comply with the desires of the government. STOIC attempts to do just this.

STOIC creates relationships of indifference. In

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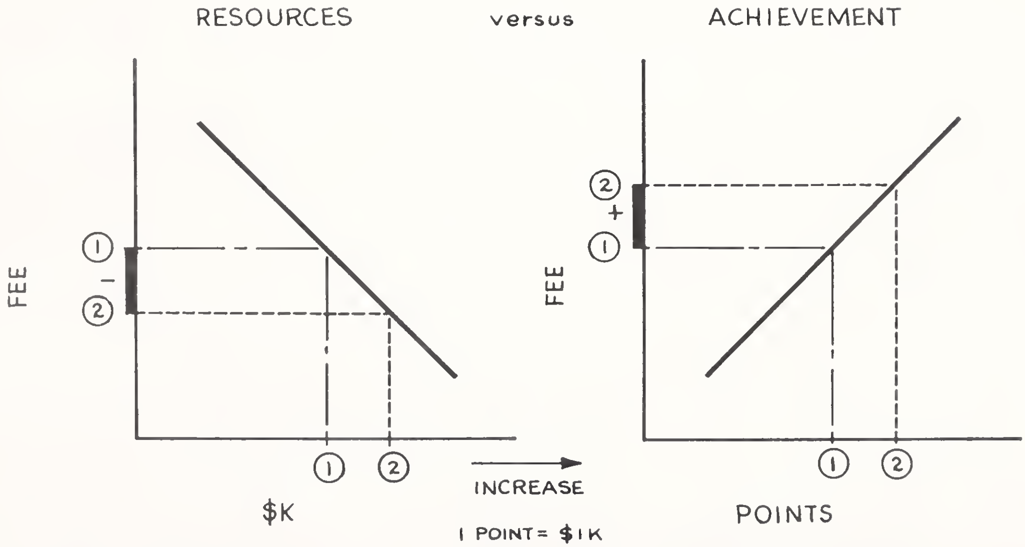
[17] Ibid.

other systems reviewed, the contractor and the government were always perplexed to find, as of any one moment, what the trade-off costs in fee were between the incentive elements. With STOIC, the contract is structured to provide motivation to spend cost dollars to attain target conditions. If the contractor exceeds target achievement levels he must curtail spending or face the loss of fee. The system is simplified in that cost, performance, and schedule are redefined into Resources versus Achievement, not specific trade-offs. See Figure 3.27.

FIGURE 3.27
FUNDAMENTAL STOIC



SOURCE: STOIC MANUAL.

In Figure 3.27, some of the graphic prerequisites to structuring a STOIC are described. In the Resources versus Achievement graphs, the slopes of the respective sharelines are equal, but opposite. Resources are defined in units of $1,000 dollars. Achievement is defined in points. Letting the X axis intervals be equal for both graphs, then: one point equals $1,000 of cost. The Y ordinate intervals are also equal in fee dollars.

Since the scales for both graphs are identical, changes in Resources can be compared to Achievement changes. Thus if Achievement points advance to position Z, there is a corresponding increase on the ordinate for plus fee. Additional Achievement was accomplished through the expenditure of Resources, as it went from position 1 to position 2, and there is a penalty in fee because of the added spending. In Figure 3.27, increased Resources equal increased Achievement, thus there is a STOIC -- a point of indifference -- and the contractor makes no additional fee.[18] The government obtained something extra for additional cost dollars but the contractor received no additional fee for his effort, because of the Resource increase.

The STOIC, relationships of indifference, thus requires a) cost to be expressed in some form of linear trade-off arrangement for achievement, b) achievement to be

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[18] Idem. Hagan uses one concept of indifference. In economics, similar calculations for elasticity may be shown three different ways.

expressed in cost dollar equivalents, and c) slope homogeneity between cost and points of Resources versus Achievement. As long as the constant equivalent, 1 point = $1,000, exists, there is slope homogeneity. This should not be considered a restraint on sensitivity. Sensitivity is reflected in the Incentive Event Value Tableaux or the Achievement itself.[19]

In Figure 3.28, the two lower graphs below those for Resources and Achievements depict Incentive Event Value Tableaux or Achievement. Their X axes contain non-additive values, as with one for performance points and schedule days. However, both have points which are additive, on the Y ordinate. A construction rule in STOIC states that: "A summation of all ordinate points on all Tableaux becomes the limits for the abscissa of Achievement."[20] From the figure, the plus values on the ordinates are: (+4) + (+3) = (7) and (-2) + (-6) = (-8). These correspond to the range of X values on the abscissa for Achievement. How this is used will now be shown.

If the contractor in the lower right hand Tableau finds himself over target and in a position of losing -6 points, (see black arrow), he must ask himself whether it is wise to make a trade-off between reaching the target and sacrificing the cost. He checks the Achievement graph and

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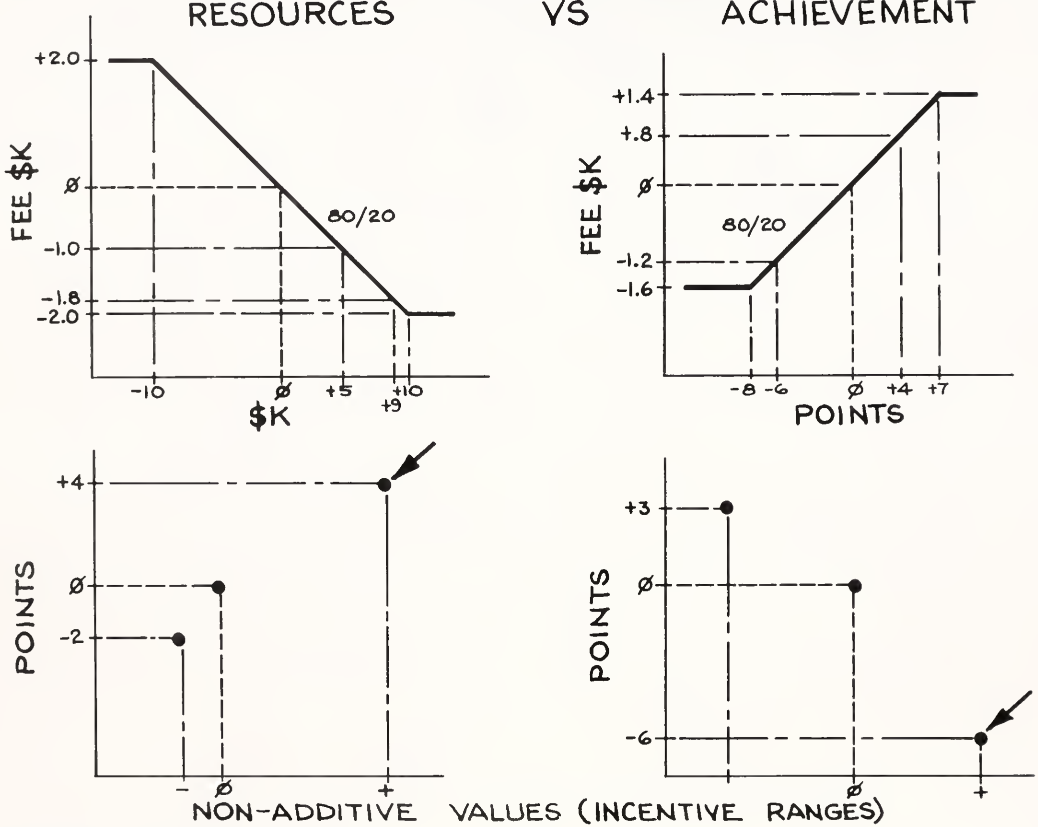
[19] Ibid.

[20] Ibid.

FIGURE 3.28



SOURCE: STOIC MANUAL.

finds that -6 points on the abscissa is worth a fee/penalty of $1,200. At the same time he estimates that making up the -6 points will cost him $5,000. On the Resources graph, $5,000 cost a fee penalty or sacrifice of $1,000. Since $1,200 - $1,000 = $200, he should make the trade-off because the cost fee penalty is not as great as the Achievement fee reward.

Consider the contractor in the Incentive Event Value Tableau in the lower left graph. He must decide whether to spend $9,000 to get an additional 4 points (black arrow). In terms of the top graphs, the Resources graph would cost him -$1,800 in fee sacrifice for a +$9,000 outlay in cost, and the Achievement graph shows he would only net +$800 for the additional 4 points. The trade-off is not favorable so the contractor will not expend Resources for the sake of higher Achievement.

These examples have illustrated the STOIC philosophy. In each case, the specific fee gain or loss was measured. For example, $200 increase in fee in the first trade-off versus a $1,000 loss in fee with the second trade-off. It was unnecessary to be specific. The STOIC relationship of indifference established the course of action without the specifics of mathematics or graphics. Since the Resources versus Achievement constant values of 1 point = $1,000 cost had been predetermined, the contractor could note that:

Trade-off #1 = 6 points = \$6,000
Since: Cost \$5,000 $<$ \$6,000
$\therefore$ He should do it.

Trade-off #2 = 4 points = \$4,000
Since: Cost \$9,000 $>$ \$4,000
$\therefore$ He should not do it.

The path between defined points of the lower graphs in Figure 3.28 is unspecified. There is total freedom to use straight lines, stepped lines, or even curvilinear formations. NASA has wisely avoided undue complexity but the STOIC manual concedes the necessity, on occasion, for sophistication, when government administrators are forced, "to get the contractor's attention."[21] Here lies a good justification for using advanced structuring techniques, and STOIC has the required flexibility.

STOIC's flexibility permits the inclusion of value factors. Consider, for the moment, the buyer. The more of something the buyer has, the fewer additional units he desires because of its decreasing marginal utility. Thus, a buyer will ordinarily pay less per unit for additional units. In Figure 3.29, the hypothetical marginal utility of peanuts versus an allowance is illustrated. One might willingly pay 10 cents for 50 peanuts, or 0.2 cent per peanut. The same person would probably not pay 20 cents for 100 peanuts; he would more than likely offer less than twice the amount, nor would he pay 10 times the original purchase price for 500 peanuts. Due to diminishing marginal utility for the buyer of peanuts, or performance, the per unit price of additional units should be lower, and total price will not be linear. Marginal utility implies

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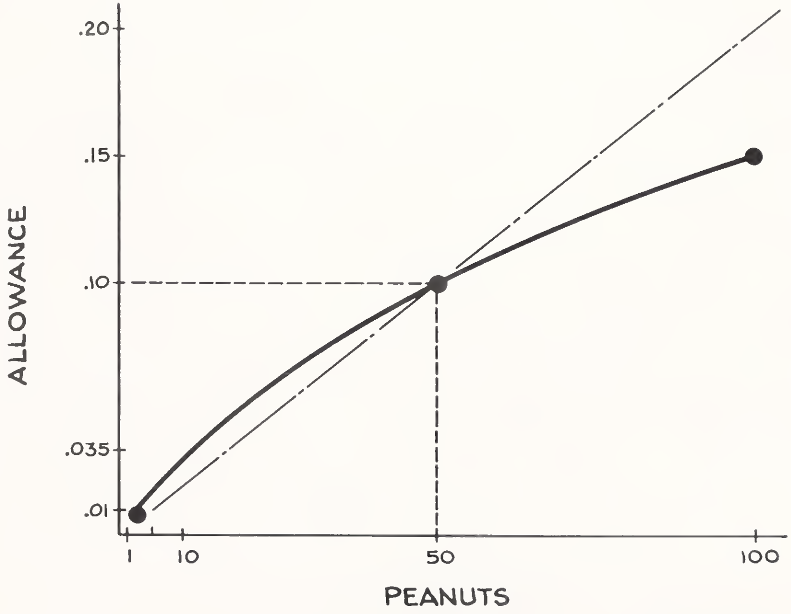
[21] *Ibid.*

FIGURE 3.29
MARGINAL UTILITY



SOURCE: STOIC MANUAL.

a parabolic structure, and the same format is recommended for an incentive parameter, such as performance.

The formula for solving for fee with a parabola:

$$\text{Fee} = ax^2 + bx$$

is used where a and b are constants and x equals points or non-additive values. Furthermore, the first derivative of the equation:

$$m = 2ax + b$$

is the slope of the share line at any particular point. "Parabolic structuring of an Incentive Event Value Tableau forces the contractor's attention upon a marginal trade-off."[22] Decision making becomes more sensitive because the contractor carefully weighs any increase in performance or schedule which is at the expense of dollars; and the trade-off is marginal.

Enough of the essentials have been developed to go through an outline of a STOIC structure. Some remaining new features uncommon to any other system will also be described in the process.

Step 1. Begin by establishing all performance and schedule Incentive Event Value Tableau as previously described. Define the constant equivalent between $1 of cost and 1 point of performance.

Step 2. Total all points into an Achievement. The

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[22] Ibid.

sum of all ordinate points on the tableaux becomes the limits for the abscissa.

Step 3. Establish initial position on cost. As with a conventional incentive arrangement, set target, minimum, and maximum cost. The RIE applies to target Achievement.

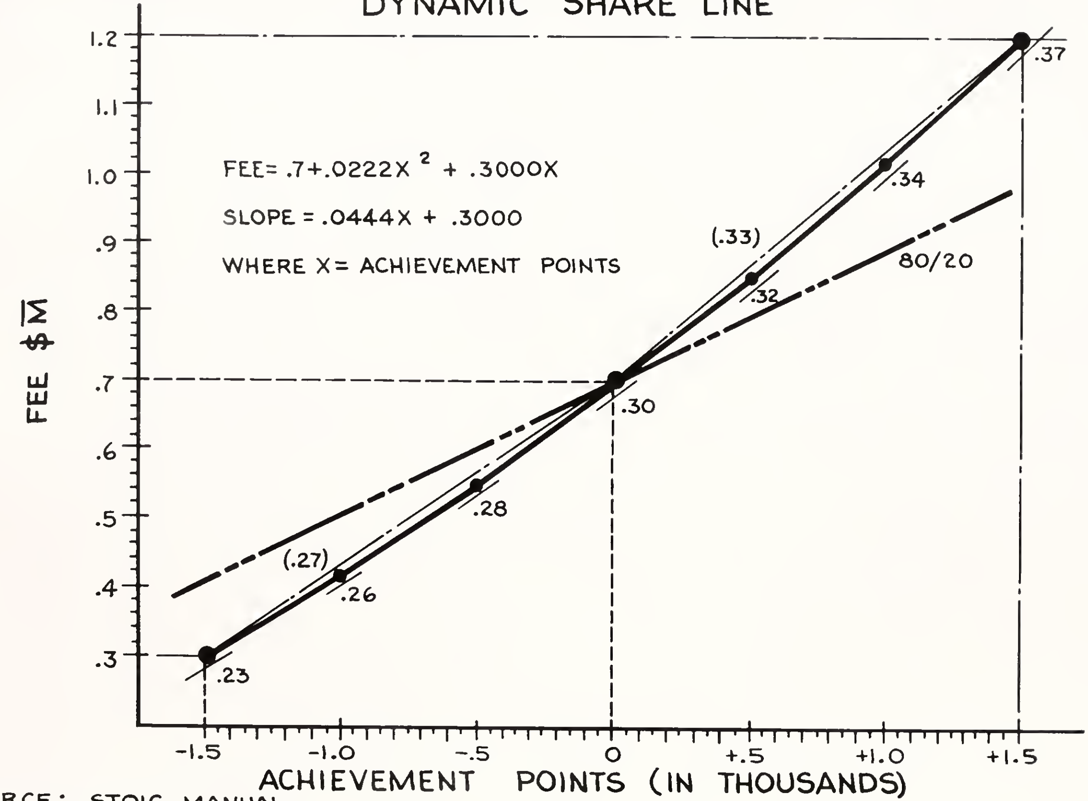
Step 4. Establish initial arrangement limits. These may be compartmentized, or they may overlap. Overlap is defined as extensions made to the cost base to maintain cost effectiveness in the event of large overruns.

Step 5. Select initial point position. This is the target to which plus points will be added for maximum fee and minus points will be subtracted for minimum fee. This is a very important step since STOIC is also referred to as a "Total Point System." The contractor's only measured Achievement is total points.

Step 6. Select target fee. The fee swing will be composed of maximum and minimum fee. Alternatively, these points may be the contractor's major interest or concern.

Step 7. Negotiate an initial sharing arrangement. Again the Total Point System allows development of any desired share line arrangement. It may be linear, stepped, or non-linear. The preferred share line is the simplest linear arrangement. However, due to confidence in the targets, one of the parties may want to widen the FS, narrow the point range, or make the sharing arrangement progressive. A progressive arrangement would offer varying share ratios. This is called a dynamic share line. See Figure 3.30.

FIGURE 3.30
DYNAMIC SHARE LINE



SOURCE: STOIC MANUAL.

In Figure 3.30, the dynamic share line is compared with the straight 80/20 share line. The parabola provides for minimum sharing of 77/23 at the least desirable position. It increases up to 70/30 at target and then attains a maximum of 63/37 at the top of the fee swing. The parties could have even used a cubic parabola which has convex and concave segments. In a motivational sense, this might have a high sharing ratio in the underrun area, somewhat of a plateau or lesser sharing arrangement in the target area, and finally a very high sharing arrangement at maximum fee and achievement.

Step 8. Set up a tracking system which will provide visibility to top management and every party concerned as the contract progresses. The objective is to create a system which permits rapid evaluation at a glance without requiring in depth study and penetration of the contract. One of the major disadvantages with other contract models was that visibility was impaired by complexity. Only a select few experts on a particular contract could predetermine fee at any outcome. The STOIC system overcomes this objection by utilizing nomography.

A management nomatic is drawn using the principles of nomography.[23] The rules of construction governing the addition of three numbers by nomograph are merely adapted

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[23] NOMATIC, Nomographic Aid to Incentive Contracting, Executive Staff, NASA, MSFC, March 1967, pp. 3-5.

to the three variables, cost, performance, and schedule. The basic arrangement begins with four considerations. See Figure 3.31. In order: a) spacing the five lines according to the rules for addition of three numbers, b) constructing a horizontal target base line, c) constructing the line lengths using a uniform scale reflecting point ranges, and d) converting the point ranges into desired values of cost, schedule, and performance.[24]

The scales for the nomatic lines of cost, fee, schedule, and performance take their values off the plus or minus delta target point values from Figure 3.28. The lower graphs presented delta point values from target, but the entire FS in points and the RIE for the incentive was unmarked. Assume this is done as was described previously.

Recalling the constant equivalency relationship of before, the value statements or trade-off for performance and schedule are constant over the range of possibilities. Now, select any uniform scale (Figure 3.32) to measure cost, schedule, and performance lines. The scale used to measure the fee line can only be one-third of the scale used for the other incentive lines because three points on the fee scale equal the length of one point on the cost, schedule, or performance line. The resulting NOMATIC should look like Figure 3.33.

The final step requires scale conversion. The lines

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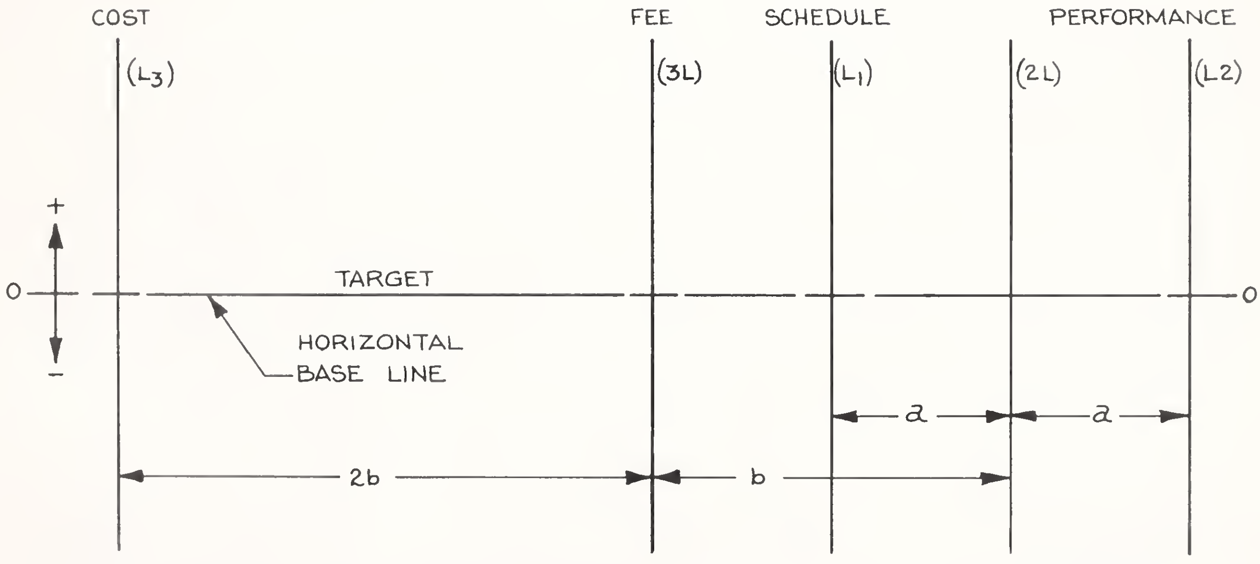
[24] Ibid., pp. 8-10.

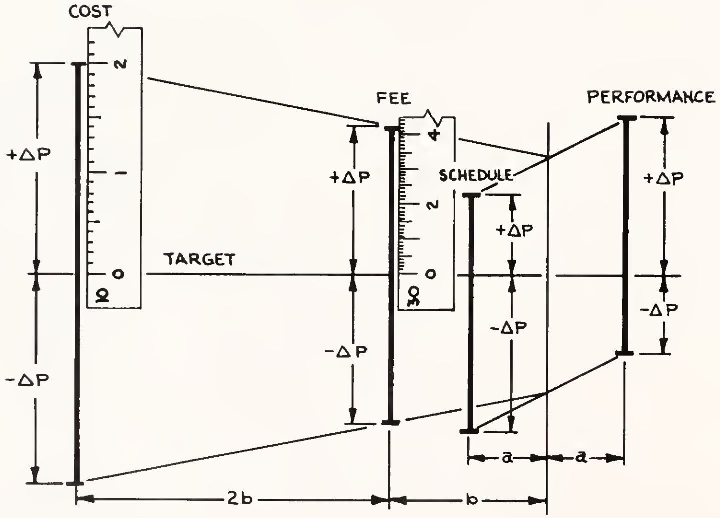
FIGURE 3.31
NOMATIC FOR INCENTIVE ELEMENTS



SOURCE: NOMATIC, PAGE 9.

FIGURE 3.32

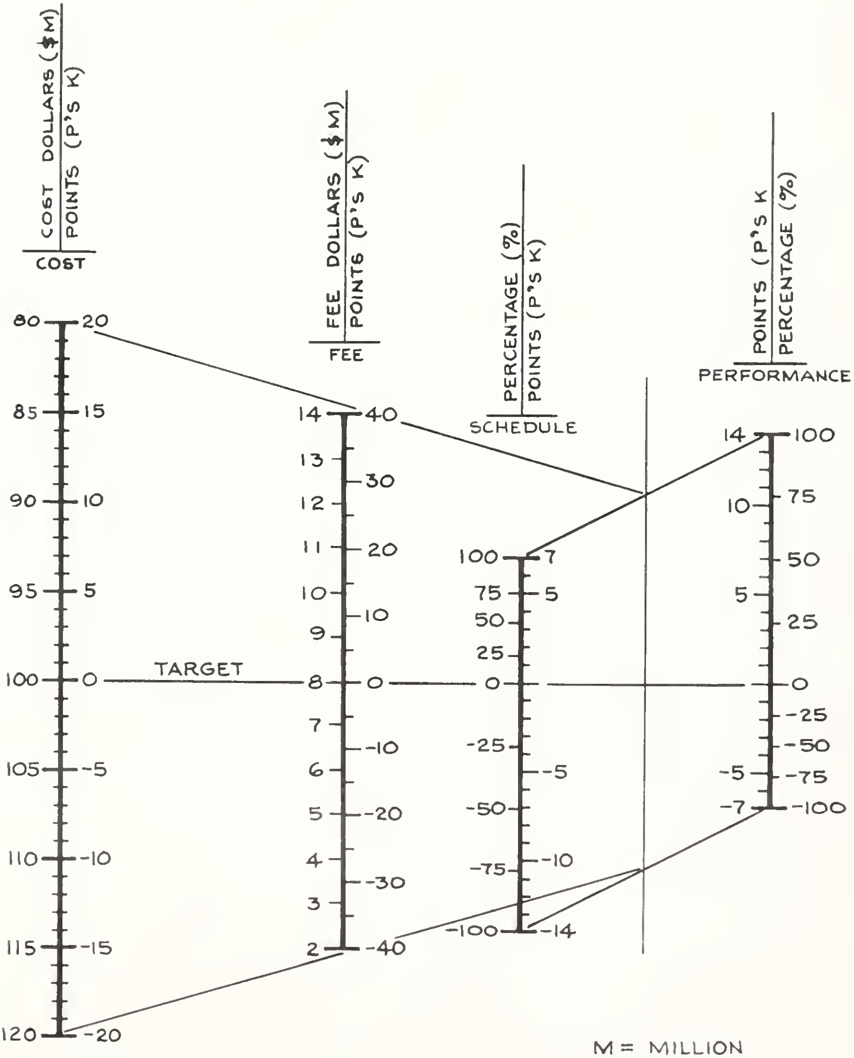
SCALING THE INCENTIVE NOMATIC



SOURCE: NOMATIC, PAGE 11.

FIGURE 3.33

CONSTRUCTING THE NOMATIC



SOURCE: NOMATIC, PAGE 12.

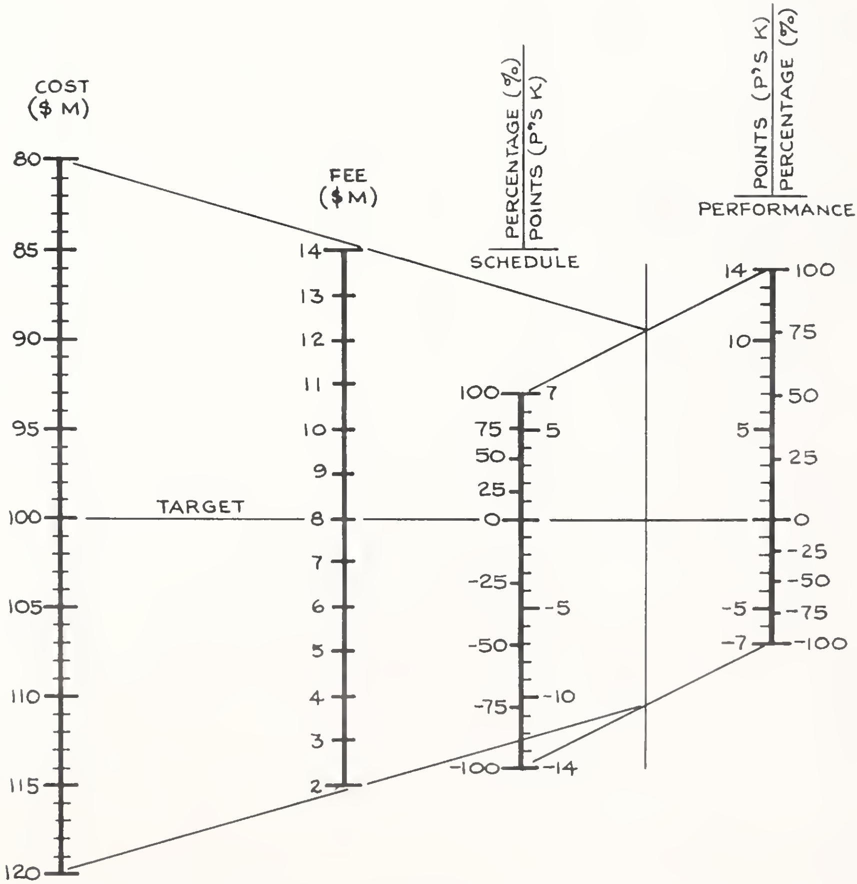
M = MILLION
K = THOUSAND

were laid out by rule using point values. They now have to be converted to corresponding values of cost, fee, schedule, and performance. The schedule and performance lines are converted to percentages (±100%); the cost line and fee line take on cost and fee dollar values. This is done by adding 1,000 cost dollars per point to target cost at the horizontal base for overruns and subtracting in a similar manner for cost underruns. The fee line is not directly converted. Fee and point values must be determined separately, either graphically or by formula solution. The result is the final NOMATIC in Figure 3.34. By the simple process of connecting performance and schedule outcomes and then connecting the reference line to the cost outcome, fee is automatically calculated at the point of crossing. Tracking the contract is an easy reality.

This concludes the basic description of STOIC. It too went through a process of simplification that was performed for the sake of clarity. Many fine points escaped this discussion which was primarily designed to show how the model functions.

FIGURE 3.34

THE COMPLETED NOMATIC



SOURCE: <u>NOMATIC</u>, PAGE 14.

The CMI Logmill System

The Logmill System was developed by Arthur J. Nolan, a Director and principal instructor of the Contract Management Institute. Much of his work was performed under NASA contract while engaged in conducting seminars and lectures on pricing and negotiating incentive contracts for NASA employees.

Mr. Nolan observed the complexity of other models, and noted they required analytic geometry, calculus, algebra or computer programming experience in order to be fully comprehended. At the same time, from his field experience in training price analysts and negotiators, he knew the majority lacked the formal education or prerequisites to deal with sophisticated mathematical models. He searched for a model that incorporated the flexibility of advanced models, yet would require no advanced training or applications of formidable mathematics. The Logmill System represents the successful answer to his research probing. Here are the essentials of that system, as Mr. Nolan describes them.[25]

The required tools are some graph paper, both arithmetic and logarithmic, and a pair of clear plastic triangles. A detailed step by step construction example explaining their usage will be deferred for the moment while a most prominent feature of Logmill System is examined.

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[25] Arthur J. Nolan, CMI Logmill System For Structuring Incentive Contracts. Contract Management Institute. Washington, D. C., 1966. Washington: Contract Management Institute, 1966. An unpublished monograph.

The system takes its name from the single cycle semilogarithmic graph paper that is constructed into an iso-fee graph. Iso-fee graphs have already been illustrated and explained in previous models. In each case, they were on arithmetic grids, and if trade-offs were anything but linear, the computations for solution required exponential equations. Plotting is more difficult than plotting straight lines, and price analysts often lack the requisite skills. However, the Logmill iso-fee lines appear as straight lines. They are simply determined by locating two points, and connecting them. At the same time, the lines represent varying ratios because they are the equivalent of curves on an arithmetic grid. The reason for this is that a straight line on a semilog graph is a curve when converted to an arithmetic graph, and vice-versa.

The discussion of PIIM and STOIC touched upon the principle of incentive progression implicit in the Logmill System. A curvilinear equation can be used to increase the cost versus performance trade-off as it exceeds target and reaches a maximum. This prevents the contractor from overstressing performance and neglecting cost. It is a desirable feature that complicates structuring share lines because it requires curves. The Logmill System eliminates curves and curve fitting but retains desirable effects with linear expressions. Inventor Nolan says this may possibly be a constraint of the Logmill System in that the iso-fee line is automatically a parabolic function.[26] However, in most incentive contracts a curve most accurately describes the objectives of the buyer.

The X axis of this graph is composed of a cost factor, while the Y axis has a total performance factor in points. The iso-fee line which shows the change in Y with respect to changes in X is in millifee units. Its value is dependent upon two things: the level of the cost outcome for some performance rating, and the sharing arrangement. In order to explain the complete interdependence of these variables, they must be carefully defined. Nolan created an exact terminology for them.

The cost axis does not have absolute dollars. It is stated instead in millicosts plus or minus target. One millicost (MC) is equal to 1/1000th of contract cost.[27] If target cost is $1,000,000, a MC is $1,000; if target cost is $5,500,000, a MC is $5,500. Thus the value of a MC is easily found by moving the decimal point three places to the left of target cost. In Figure 3.35, the primary iso-fee lines are constructed at intervals of 100 MC.

The Y axis is composed of points taken from a trade-off analysis. The point scale conversion is shown in a separate section, Figure 3.36. Again, the incentive parameters have a target and fluctuate ± to that target.

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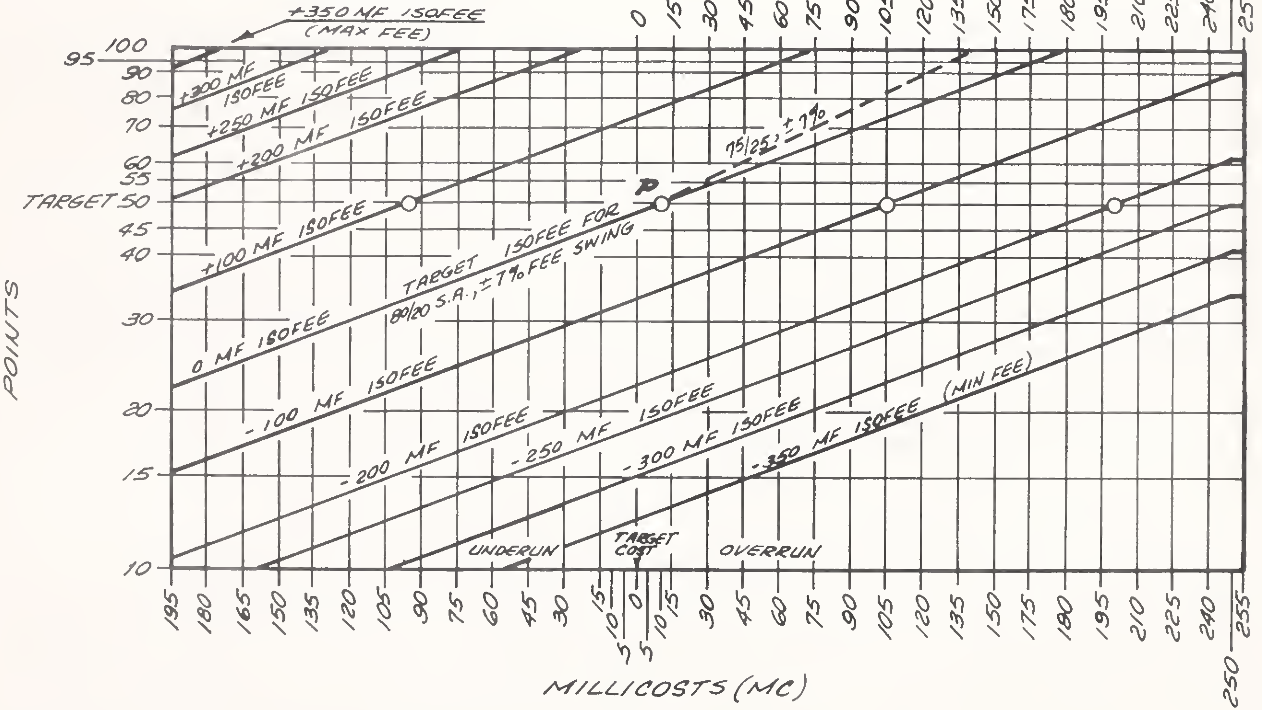
[26] Ibid., p. 2.

[27] Ibid., p. 1.

FIGURE 3.35
MF ISOFEE CHART

CMI LOGMILL SYSTEM



SOURCE: ARTHUR J. NOLAN, 1966.

FIGURE 3.36

TRADE-OFF CHART FOR PERFORMANCE

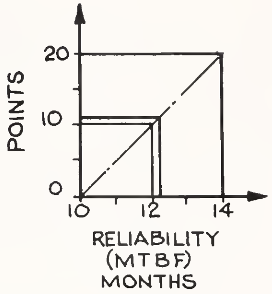
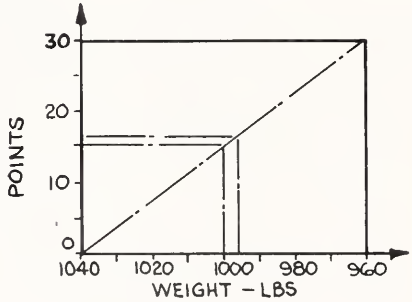
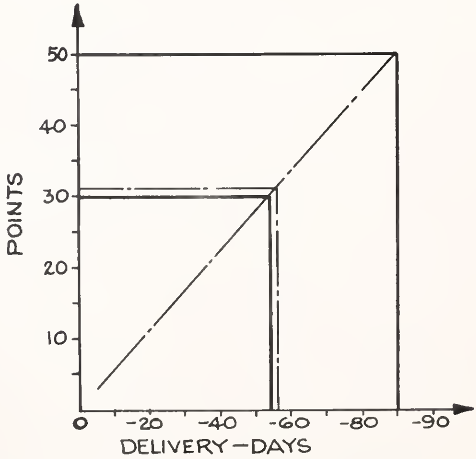


ILLUSTRATION: 50% DELIVERY, 30% WEIGHT, RELIABILITY FOR ALTERNATIVE WEIGHTING, ALTER SLOPES OF SLANTED LINES. POINT FOR DELIVERY, + POINT FOR WEIGHT + POINTS FOR RELIABILITY = 100 POINTS





SOURCE: ARTHUR J. NOLAN, 1966.

The performance trade-off for multiple incentives requires trial weightings and then conversion to performance points. Points available for each incentive may not exceed weighting factors, and must therefore equal 100. For example, the weights in the CMI illustration, Figure 3.36 are: 50% for delivery, 30% for weight, and 20% for reliability. The performance equivalent in points can be shifted by rotating a triangle over the origin, thereby testing different trade-offs. No mathematical substitutions are required. Only the knowledge that a fee pool of 50 points for delivery, 30 points for weight and 20 points for reliability exists.

The iso-fee line is stated in millifee units. There is another constant equivalency assumption as one millifee is earned for one millicost, adjusted for the share ratio. For example, if the contractor had a 75/25 sharing arrangement, a $1,000 change in MC would be worth a MF of 250. If the same arrangement pertained to a MC of $6,000, each MF would be worth $1,500. Thus, a formula can be written indicating the value of a MF as:

$$MF = (MC)(CS)$$

where CS is the contractor's share.

Even though the terms on the MF iso-fee graph, Figure 3.35, have now been defined, the method of constructing and applying this tool has not been developed. Its originator has somewhat understated the task by overstressing simplicity.[28]

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[28] *Ibid*., p. 3.

The method of developing a Logmill graph of a contract can be approached in a similar fashion used for other models, starting with some figures and building step by step.

Step 1. Beginning with TC and target profit, determine FS, and also select a share ratio.

Step 2. Prepare a table of critical MC numbers. The critical MC number is defined as one-half the MC range.[29] For example, if the MC range is 350, the critical MC number is 175. The reverse also applies in that doubling the critical MC number yields the MC range. The critical MC number must be found in order to locate a second point for constructing the target iso-fee line. Thus, Nolan suggests that a table of critical MC numbers be prepared for different FS and sharing arrangements. Table 3.3 shows these critical MC numbers for several different FS and share ratios. Stated differently, the critical MC number equals the number of MF's to be paid to the contractor if he improves performance to maximum above target performance. Using Table 3.3 as a reference, with an 80/20 share arrangement and a FS of ±7%, the contractor would be rewarded 175 MF's of additional fee if his performance goes to the maximum over target. This statement must be qualified by whatever trade-off's have already been made and iso-fee line on which the contractor is operating.

Step 3. Taking the contract condition of a 75/25

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[29] _Ibid._, p. 5.

TABLE 3.3

CRITICAL MC NUMBERS

FEE SWING + & - %	SHARING ARRANGEMENT								
	90/10	85/15	80/20	75/25	70/30	65/35	60/40	55/45	50/50
9	450	300	225	180	150	129	125	100	90
8	400	267	200	160	133	114	100	88	80
7	350	238	175	140	117	100	88	78	70
6	300	200	150	120	100	86	75	67	60
5	250	167	125	100	83	71	63	56	50
4	200	133	100	80	67	57	50	44	40
3	150	100	75	60	50	43	38	33	30

Source: Arthur J. Nolan, CMI LOGMILL SYSTEM FOR STRUCTURING INCENTIVE CONTRACTS. Washington: Contract Management Institute, 1966, p. 6. An unpublished monograph.

share line and a ±7 percent FS, the critical MC number is 140 in Table 3.3. The X axis is labelled in MC's, based on the RIE for MC. If the RIE is ±25 percent, the RIE becomes: 1,000 x .25 or ±250 MC's. Label the top axis, A'A", to correspond with the base. Select target fee points, P, at the coordinates for performance target of 50 points, and target cost of zero MC's. The critical MC number on the A'A" axis, when connected with P, gives the iso-fee line at target, which is also at zero MF. By using a triangle, several share lines may be tested. For example, the critical MC for a 75/25, ±7% FS is 140; for an 80/20, it is 175. Any two points, P at target, and a critical MC number, yield an iso-fee line.

Step 4. To locate other iso-fee lines, circle points at increments of 100 MC's parallel to base axis. Then add additional iso-fee lines by passing lines through circled points parallel to target iso-fee line. Do this until maximum and minimum MF levels have been reached. Doubling the critical MC number automatically gives the maximum and minimum MF. The new MF iso-fee lines correspond ± to changes in MC, thus there is a +100 MF iso-fee line, etc.

Step 5. Construction thus far requires testing for reasonableness to see that proper FS and share ratios were chosen. A triangle rotated on point P can check for MC equivalency. This is defined as the trade-off of an increment of improved performance equal to one MC of improved cost.[30] The contractor will look at the trade-off cost between an increment of improved performance; perhaps it takes 3 MC's versus an increment of one performance point. The iso-fee slope is reasonable when MC (and MF) equivalents are about the same for 5 points of performance improvement. For example, if there were excessive performance or cost bias when the contractor improved from 50 to 55, versus from 95-100, an alternative iso-fee slope might be selected.

Step 6. Make up performance point equivalent charts (not shown). Relate performance increments with MC equivalencies at or around target by using the logmill chart.

Step 7. Convert MC and MF back to contract dollars. This only requires the mental arithmetic of multiplying by 1000 for MC, and this times the CS for the MF, to get fee answer in dollars. For each MC or MC equivalency, there is a MF. If contract dollars represent odd amounts, the author suggests making up a set of conversion charts (not shown).

The final structure selected may have as much sophistication as the most complicated model presented in this paper. The claimed advantage of the CMI Logmill System is that this model can be developed manually without the use of a computer, nomographs, curves, fittings, solutions of simultaneous equations, or a computer plotter.[31] Only the simple tools listed at the outset, i.e., the ability to

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[30] Idem.

[31] Ibid., p. 2.

rotate triangles, and familiarity with semi-logarithmic scales are necessary. A majority of price analysts possess these criteria, thus no expensive additional training should be required. The Nolan model is too new to have been adopted by any major contract as of the present, but its apparent advantages may make it popular in the future after contracting parties familiarize themselves with the system.

Summary

This concludes the discussion of structuring models. The intent of this section has been to contrast model development. Interdependency models or structuring techniques represent advances over traditional methods. The use of a model when structuring an incentive contract can bring about the flexibility necessary for any procurement situation, whether for hardware or services.

Only the rudiments of each model were explored. No amount of mathematical expertise can substitute for experience with incentive contracts in negotiation. Negotiation experience with incentive contracts is generally meager because we are still in the infancy of this subject. Time will lead to the discovery of flaws in present model philosophy and in the words of W. S. Davis, MSFC Assistant Director for Procurement and Contracting:[32]

> We're going to have a very extensive increase in incentive contracting, especially for our larger contracts. . . . We think incentive contracting is much better than the worn out cost plus fixed fee form but we also think

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[32] *STOIC*, *op*. *cit*., Ref. 0-1.

> there may be something even better. . . . We feel there are people elsewhere with ideas on this subject that would be very useful and we would welcome them.

Work continues that will eventually lead to more sophistication. MSFC officials have already applied other advanced management concepts to the structuring problem, such as, critical path programming, learning curve effects, probabilistic considerations, stochastic techniques, Monte Carlo theory, etc., to help quantify the imponderables and otherwise unquantifiable relations of the past. They have already selected acronyms for advanced model development: SYNOTIC, for Synthetic Optimization of Incentive Contracting, and, ESOTERIC, for Executive Simulation of Total Environment and Resources for Incentive Contracting. The future looks promising as improvements emanate from present research on contracting techniques.

There should be no naivete over the progress rate in adopting incentive contracts. Their utilization has not been delayed because of the lack of quantitative or objective models thus far. There have been other constraints on the use of incentive contracts. The models are designed to overcome <u>inflexibleness</u>. The other constraints, some of which are entirely external to the contract instrument, still remain. The remainder of this study will examine some of those aspects in an attempt to understand better how one should implement an incentive contract.

omy. If a firm plans to earn a profit, such as the explicit amount stated as a percent of a contract's face amount, it is no longer earning a pure profit. Instead, the planned return is a factor cost. The firm's net profit now has element's of the economist's gross profit. Included are the economic payments for several different factors, with perhaps a mixture of rent, interest, wages, and pure profit. The profit or fee pool available on an incentive contract is a variety of economic gross profit. Since profit originates by matching contract revenue and expenses, and since the accountant cannot deduct for some factor costs which must be imputed, contract profit is certainly not pure profit. Another consideration under government cost-reimbursable contracting is that profit is allowed compensation, which can vary depending on expenses allowed.

Contract profits as used in the incentive models are income earned as a result of receiving government payments in excess of cost. This definition and use coincides with traditional profit descriptions for all industries. Although discrepancy exists between profit definitions, role is equal.

Defense Industry Traditional Profit Patterns

Peck and Scherer considered the role of profit in the defense industry, while admitting to a problem of identifying a defense industry. Their study was hampered because the DOD purchases items from several industries. No one industry typifies the "defense industry;" it is rather, a collection of firms in several industry classifications as used by agencies;

CHAPTER IV

PROFIT UNDER INCENTIVE CONTRACTS

Introduction

Profit plays a special role in defense contracting and under incentive contracting in particular. The significance of profit in motivating the contractor was established at the onset. NASA research efforts on incentive contract models are primarily directed towards the study of motivation, using a definition which is synonomous with self-initiation. What is the role of profit in motivating performance? How does profit cause the contractor to initiate actions which will satisfy the customer's objectives, hence, ensuring goal congruence?

The operation of incentive models depends upon a flexible profit policy on the part of a government agency because each incentive contract relies on profit, both in the positive and negative sense, to automatically motivate performance. Therefore, the negotiating parties must reach some common basis of agreement on profit percentages and amounts.

Profit Defined

Economists tend to think of profit in a narrow sense. Pure profit is chance or unexpected return over which the firm has no control. Profit is risk income which cannot be related to other factor costs. Therefore, profits are considered unearned income because they happen and are not automatic.

Industrial profits are normally overstated in our econ-

Securities and Exchange Commission, Department of Commerce, etc. There are subtle dangers in trying to find a "defense industry," because one would find that out of the top 100 largest industrial corporations, many have substantial contracts with the DOD. To prove this, one study compared the overlap between the 100 largest defense contractors and the 100 largest industrial corporations for different time periods such as: World War II, Post 1945 era, Korean War era, and the Missile Age.[1] The duplication in the listings was always high, and suggests that today 40 out of the 100 firms would appear on both lists. Separating defense profits from commercial profits for these firms would not be productive.

However, Peck & Scherer did isolate and compare three industries which might be representative of a "defense industry." They compared rate of return on net worth for these firms with all manufacturing firms, the duplication notwithstanding. For the early years, 1956 and 1957, one finds that these firms showed a higher return than all manufacturing firms combined. By the end of the period, 1959 and 1960, when CPFF contracts were so strongly in vogue, rate of return had dropped. In the aircraft industry alone, rate of return on net worth slipped from 20.2

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[1] Peck & Scherer, op. cit., p. 120.

per cent in the second quarter of 1956 to 7.2 per cent in the first quarter of 1960. See Table 4.1.

Renegotiation Board figures correlated these findings and explained them for 1959. Net profit or realized profit as a percentage of sales was 11.5 per cent for various fixed price contracts, but only 4.9 per cent for

TABLE 4.1

RATE OF RETURN ON STOCKHOLDER'S EQUITY
FOR THREE DEFENSE ORIENTED INDUSTRIES
AND ALL MANUFACTURING CORPORATIONS 1956-1960

YEAR*	ALL MANUFACTURING CORP.	AIRCRAFT & PARTS	ELECTRICAL EQUIPMENT/ SUPPLIES	INSTRUMENTS & RELATED PRODUCTS
1956	12.3	14.4	11.4	12.4
1957	10.9	17.7	12.6	12.0
1958	8.6	13.1	10.2	10.6
1959	10.4	8.2	12.5	13.0
1960 (1st Qtr. Only)	9.8	7.2	10.5	11.6
AVERAGE	10.5	13.8	11.6	12.0

Source: Federal Trade Commission - Securities and Exchange Commission, Quarterly Financial Report for Manufacturing Corporations, 1957-1960. Taken from Peck & Scherer, *op. cit.*, p. 207.

*Quarterly data were condensed by averaging to yield single figure for annual rate of return after taxes.

various types of reimbursable contracts.[2] The shift from 11.5 to 4.9 per cent was caused not only by the change in contract instruments used, but also because of such factors as the shift from production to R&D procurement, more competitive negotiating techniques, and many more details too numerous to mention. Profit levels had drifted dangerously lower in a segment of the economy that typically had enjoyed better-than-average profits. Furthermore, the missile age introduced annual greater turnover in the top 100 largest defense contractor's list to attest somewhat that profits were not stimulating proper competition.

In 1960, a special committee set up by President Kennedy studied the current status of the defense establishment. The Bell Committee Report called attention to trends caused by CPFF contracting. Among other things, the cost reimbursable contract was referred to as a blank check, and the Committee called for an immediate cessation of reliance upon it. Profits, as a per cent of sales, or net worth, might have seemed slimmer, but dollar amounts expended for the total defense contract outlay continued to grow with massive overruns. In other words, the price the government was paying for cost and profit together was higher, and the contractor was enjoying it less because profits were lower.

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[2] *Ibid.*, p. 208. For 25 Contracts with Highest Refunds.

Common Guides to Defense Contract Profit

A Columbia University study conducted by Professor Wilson looked at the pricing and negotiating process for any clues on the level and amount of profit. As a generalization, this study found that whatever a contractor received as profit the last time he worked for the government, he subsequently would receive the same percentage the next time around.[3] If this were true, the contractor could probably be expected to perform no better or worse than he did for the last contract. It must be assumed that profit motivates, and no change in the percentage of profit must be tantamount to no change in motivation.

A Cleveland attorney, Herbert Bass, believes and affirms that contractors negotiating for profits do so under their own rules of the game.[4] Even though ASPR prohibits the now illegal cost-plus-a-percentage-of-cost (CPPC) contract, many contractors made their proposals as if they were CPPC contracts. Bass has had extensive experience representing contractors before the General Accounting Office and the Armed Services Board of Contract Appeals. His specialization and the experience he gathered on the line, plus his first

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[3] Seminar conducted by Dr. John Kennedy at the Ramada Inn, Cocoa Beach, Florida, on April 6, 1967.

[4] CMI seminar at Cocoa Beach, Florida, on January 26, 1967. Mr. Bass feels the practice is in wide spread use today.

hand knowledge of the contracting process only serve to enhance his testimony. CPPC techniques were being used with CPFF contracts and contractors succeeded in making some percentage they deemed reasonable via contract changes. Bass further feels that contractor negotiators are always more capably advised for negotiating contracts than are their respective government counterparts.[5] There, Bass feels that contractors were setting and getting the profits they desired.

Notice the extremes of the positions just presented. First, contractors had a blank check for profit. Second, they received about the same profit percentage on each contract. Finally, the last position was that contractors made, in the final analysis, the profit they felt they deserved, although the devious techniques used to do this were omitted.

None of these positions relates to the reason for profit's existence. In classical economics, true profits are a residue remaining after the factors of production have been rewarded. In the closer context of business reality, profit is a payment for risk-bearing or even the market rate of interest for some investment used. Regardless of which definition of profit is chosen, it cannot be related to profit objectives determined by the three studies presented above. Profit justification must revert to a payment for risk taking, yet the basic unescapable fact remains that risk

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[5] *Ibid.*

taking under a government contract is minimized and that under a cost-reimbursable contract there is no risk.

The DOD never intended to confuse the contracting public with vagueness on the profit issue. Section 3-808.1 of ASPR states:

> It is the policy of the Department of Defense to utilize profit to stimulate efficient contract performance. Profit generally is the basic motive of business enterprise. The government and defense contractors should be concerned with harnessing this motive to work for more effective and economical contract performance. Negotiation of very low profits, the use of historical averages, or the automatic application of a predetermined percentage to the total estimated cost of a product, does not provide the motivation to accomplish such performance. Furthermore, low average profit rates on defense contracts overall are detrimental to the public interest. Effective national defense in a free enterprise economy requires that the best industrial capabilities be attracted to defense contracts. These capabilities will be driven away from the defense market if defense contracts are characterized by low profit opportunities. Consequently, negotiations aimed merely at reducing prices by reducing profits, with no realization of the function of profit cannot be condoned. For each contract in which profit is negotiated as a separate element of the contract price, the aim of negotiation should be to employ the profit motive so as to impel effective contract performance by which overall costs are economically controlled. To this end, the profit objective must be fitted to the circumstances of the particular procurement, giving due weight to each of the performance, risk, and other factors set forth in this 3-808. This will result in a wider range of profit which, in many cases, will be significantly higher than previous norms.

During World War I, CPPC contracts were used extensively with a popular fee being ten per cent. Under CPPC contracts, contractors made profits which we should judge to be extremely excessive by today's standards. By the year 1964, profits on government contracts had slipped to 2.8 per cent of sales on $39 billion worth of procurements.[6] The profit motive was not functioning as ASPR intended, thus the adoption in November, 1963 of the above statement.

The DOD early in 1962 asked the Logistics Management Institute (LMI), a non-profit organization established to review DOD procurement and logistics, to study the practice of how profits were negotiated. DOD wanted LMI to examine each Department's practice separately, and produce a new approach which would include uniform recommendations on negotiation and determination of profit or fee. LMI developed an entirely new approach to profit determination within the existing ASPR statutory limitations, i.e., maximum profit percentage limited to ten per cent on manufacturing contracts and fifteen per cent on research and development work. This approach was called the "Weighted Guidelines Method".

LMI Weighted Guidelines Method

On January 1, 1964, the Weighted Guidelines Method was made mandatory for negotiated procurements where a cost analysis is performed.[7] This LMI developed tool is now used

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[6] Edwin P. James, "Weighted Guidelines Profit on Defense Contracts," Management Accounting, December, 1965, p. 3.

[7] ASPR Revision 3-808.2, November, 1963.

Table 4.2

Weight Ranges of Profit Factors

Weighted Profit Guidelines

Profit Factors	Weight Ranges
Contractor's input to total performance:	
Direct materials	
Purchased parts	1 to 4%
Subcontracted items	1 to 5%
Other materials	1 to 4%
Engineering labor	9 to 15%
Engineering overhead	6 to 9%
Manufacturing labor	5 to 9%
Manufacturing overhead	4 to 7%
General and administrative expenses	6 to 8%
Contractor's assumption of contract cost risk	0 to 7%
Record of contractor's performance	-2 to +2%
Selected factors	-2 to +2%
Special profit consideration	1 to 4%

Source: Edwin P. James, *op. cit.*, p. 4.

by the contracting officer to compute a profit percentage which represents his prenegotiation evaluation. Target profit for the contract is the result of weighting several factors.

From Table 4.2, one can see that the material provided in a contract may have a profit range of from one to four percent, while engineering labor can result in a profit reward from nine to fifteen percent. In other words, separate percentages are used for the contractor's inputs to total performance. The composite weight of these inputs is a measure of how much the contractor himself is expected to contribute to the overall effort. Additional percentages are paid for special Risk (0-7%) based upon cost responsibility assumed by the contractor and the type of contract used; and Performance which is judged upon past major work performed for the DOD; and finally Selected Factors which involve the extent to which the contractor requires government facilities or financing. Table 4.3 shows a FFP contract whose profit objective was determined using the Weighted Profit Guidelines.

For the first time, if the estimate for profit between two parties differs drastically, the contractor proves his profit position.[8] The adoption of the Weighted Guide-

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[8] Paul M. Trueger, "Profit Guidelines on Defense Contracts," _Journal of Accounting_, 117 (January 1964), p. 47.

Table 4.3

Weighted Profit Guidelines Example

FFP Contract for Contractor-developed Military Item

Profit Factors	Estimated	Assigned	Profit
Contractor's Input to Total Performance	Costs	Weight	Dollars
Direct Materials			
Purchased parts	$ 750,000	3.0%	$ 22,500
Subcontracted items	750,000	4.0	30,000
Other materials	500,000	3.0	15,000
Engineering labor	50,000	11.3	5,650
Engineering overhead	25,000	7.6	1,900
Manufacturing labor	1,100,000	6.4	70,400
Manufacturing overhead	1,325,000	6.4	84,800
General and administrative expenses	500,000	7.55	37,750
Totals	$5,000,000		$268,000
Composite weight - (Profit dollars ÷ Estimated costs)		5.36%	
Risk		7.00%	
Performance		2.00%	
Selected Factors		2.00%	
Totals using Weighted Guidelines Method	$5,000,000	16.36%	$818,000
Special Consideration		3.00%	150,000
Profit objective		19,36%	$968,000

Source: Edwin P. James, *op. cit.*, p. 5.

lines Method should narrow the broad subjective area that faced both parties and should substantially lessen four persistent problem areas by:[9]

1) Providing assurance that additional profit earned under incentive is not taken away by the Renegotiation Board.

2) Developing meaningful targets against which performance may be measured to arrive at fair profits.

3) Relaxing profit limitations to provide a wider range of returns for more meaningful incentives to industry.

4) Establishing more precise ground rules in arriving at profit factors.

The Renegotiation Board

Renegotiation proceedings represent a major threat to contractors who make large profits on incentive contracts. Your author feels hesitant to even broach the subject which offers substantial material for a separate paper. Yet it must be introduced at this time because of the fundamental dichotomy between ASPR and the Renegotiation Act of 1951. Contractors have, in effect, been given two separate sets of rules concerning profit. The act created the Renegotiation Board, which is an independent agency under the Executive Branch of Government.

The Board's task is to eliminate excessive profit from government contracts. Yet the Act provides no measure or standards for ascertaining excessiveness, and it

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[9] Idem.

remains that excessive profit is judged by the Renegotiation authorities themselves. No precedents or records exist to let a contractor know what price and fee are excessive.[10] It is used in its subjective sense, and has even allowed the accountant to justify exorbitant prices. Nevertheless, the Renegotiation Board can force a contractor to give back some of the money earned on government business if it considers him to have made excessive profits. The Board does not give any consideration to the form of contract used, and may demand that profits earned under an incentive contract be forfeited. It did just this in 1962 when it demanded that the Boeing Company give up $13,000,000 in profit which had been earned largely on incentive contract(s).[11]

The Renegotiation Board is not bound by DOD profit equations, but they are accepted as valid guidelines for justifying profits.[12] However, there is an ironic feature of the renegotiation process which is out of phase with American jurisprudence. Usually, those charged with an

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[10] Barron K. Grier, "Renegotiation Act of 1951," Business Lawyer, 18 (January 1963), p. 442.

[11] Boeing Airplane Co. v. Renegotiation Board, 37 T.C. No. 64, January 1962.

[12] William Beller, "Incentives Marked by Profit Formulas," Missiles & Rockets, 14 (January 20, 1964), p. 24.

offense against society are presumed innocent until proven guilty. In renegotiation hearings, the reverse is true. The contractor charged with making an excessive profit has the burden of proof on him to prove through his accounting mechanism that he didn't make excessive profits. The Board does not have a fixed, reasonable maximum profit rate; rather, it applies its test of reasonableness to aggregate defense business, applying different values or weights to fixed factors on the overall basis of renegotiable business during each fiscal year. It is highly subjective.

For example, one of the most troublesome statutory provisions directs the Board's negotiators to take into consideration "reasonableness of costs and profits," with regard to value of products, normal earnings, and a comparison of war and peacetime products.[13] They use no definitive measure, although the Board examines net profit rate as a percentage of sales, and net profit rate on tangible net worth. Contractors are being judged with a rubber yardstick as long as adjectives apply in place of absolute quantities.

Under the present renegotiation process, a contractor must use accounting to justify and answer these questions for the Renegotiation Board: 1) what is the significance of costs and profits of the contractor and his

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[13] Sumner Marcus, "Need for Standards in Renegotiation and other Determinations of Defense Profits," George Washington Law Review, 32 (October 1963), p. 35.

industry in previous years on production not subject to renegotiation; 2) what is the significance of costs and profits of other contracts; and 3) to what extent is the contractor entitled to increased profits by virtue of an increase in volume of products resulting from defense contracts?[14] These are entirely irrelevant possibilities. A contractor cannot reasonably avoid excessive profits if the assumptions used to determine the condition are unstated. Public utility regulatory agencies behave with greater uniformity, and they state rate standards explicitly. This is far more equitable. Furthermore, these agencies act with consistency on the question of profit determination and its reasonableness.

Profit as a percent of sales, or cost, in a government contract, is a meaningless identity. It fails to recognize the amount of capital required to produce those sales. The reasonableness of the percentage of cost must always be related to the investment required to produce that profit. The Weighted Profit Guidelines and the new ASPR philosophy recognize this fundamental fact. The Renegotiation Board does not. There is no written disagreement between the Board and the DOD on the desirability of incentive contracting. Equally apparent, however, is the Board's intent *not* to permit the retention of profits they

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[14] Sumner Marcus, *op. cit.*, p. 35.

consider excessive simply because they were earned under an incentive arrangement.

This raises a potential problem. For one thing, it definitely lessens contractor motivation towards achieving maximum fee on an incentive contract due to doubt that he will be permitted to keep the reward of high profits. For another, it may result in higher costs for the taxpayer in the long run if it discourages the greater risk of a rewards/penalty mechanism. Consider this example for identical work:

	Contractor A	Contractor B
Work Specifications	Identical	Identical
Contract Type	CPFF	CPFF
Risk - Share Ratio	100/0	67/33
Contract Final Cost	$100	$70
Fee	8	18
Fee/Cost (Percent)	8%	26%
Final Price	$108	$88

Assume Contractor A and Contractor B submit identical bids on some government project. In this hypothetical case, Contractor A would complete the work for $108, including the $8 (8%) fee. However, if Contractor B were picked, and he completed the work for $70 due to major innovations, he could net an additional $10 ($30 x 1/3) in fee. His final profit would amount to 26 percent of his final cost. The taxpayer would benefit from a highly motivated contractor such as

B working on an incentive contract, yet the Renegotiation Board might very well bring proceedings against this contractor because of his comparably higher fee. Thus, high share ratios and wide FS's are inconsistent with the double standard created by the renegotiation threat.

At the same time one must ask how real is the threat of loss of increased profits under an incentive contract? In all fairness to the Board, recovery proceedings in recent years have been light compared to the heavy claims stemming from Korean War procurements. Indeed, exact Board influence is not measured by dollars of profit forfeited. The Board can and has caused three distinct actions, each of which must be construed to have caused a contractor accounting liability. It can seek a price reduction from the contractor; it can seek a voluntary refund; or it can have a determination of excessive profit leading to rebate. The magnitude of these actions is suggested by the following figures from a recent *Annual Report*: "Determinations of excessive profits during Fiscal Year 1964 aggregated $24,160,028, bringing the total since 1951 to $895,795,058 before adjustment for Federal income and excess profit tax credits."[15] To this must be added

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[15] U.S. Renegotiation Board. *Ninth Annual Report of The Renegotiation Board*. Fiscal Year Ended June 30, 1964.

voluntary refunds and price reductions reported in connection with renegotiation proceedings, of $41,097,044, and the total reported savings since creation of the present Board which is claimed to be $1,230,151,174.[16]

Many defense industry authorities feel the Renegotiation Board should be abolished and that its responsibilities should be transferred to a Controller of Departments and/or the General Accounting Office. There is sufficient redundancy within existing audit agencies and one more is unnecessary. Eliminating the Board, or at least excluding incentive contracts from their jurisdiction would represent progress for the cause of incentive profit policy.

The discussion has investigated the impact and consequences of high profit on an incentive arrangement. Indirectly, it was suggested that profit motivates, and therefore, high profits must create greater motivation. In reality, some additional observations are warranted.

The Weighted Guidelines method struck a very responsive note in the defense industry which had learned to expect low profit as a routine matter on government contracts. Coupled with incentive contracts, contractors can now expect a drastic change in the profit picture. For the time being, profit levels have changed only slightly. New incentive profit policies will eventually raise profit levels. Even under incentives, profit earned has been up slightly.

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[16] _Ibid._

NASA Study Results on Incentive Profits

The most intensive study of incentive contracting practices at NASA covering fifteen major contracts with a value of $1.5 billion has just been completed.[17] It proved without a doubt that negotiated profit rates are up, but not to the levels of general expectation. In one sample, the average earned fee on six incentive contracts was compared with the average actual fee in a sample of 34 CPFF contracts for similar work. The incentive contract sample average earned fee was 6.34 percent based on final actual cost, while the comparable average fee on the CPFF contracts was 4.84 percent. "For the purpose of comparison, therefore, it can be assumed that the difference in fee of 1.5 percent represents the premium paid by NASA for use of incentive contracts."[18] Air Force contract studies produced similar results.

The NASA study on this question concluded that presumably the 1.5 percent greater cost of an incentive contract must be viewed in context with the additional benefits received under such an arrangement. It was not possible to prove by statistical evidence that incentive contracts delivered more than 1.5 percent in improved cost effectiveness. However, based on evaluation of tangible fact, it

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[17] Booz, Allen & Hamilton, Study of the Effectiveness of NASA Incentive Contracts, (Vol. I; Washington: NASA), August, 1966.

[18] Ibid., p. 58.

appeared that the return to NASA in terms of improved cost effectiveness had been significantly greater than the differential in final fee paid to contractors under incentive contracts.[19] This comparison was not made in the scientific tradition as work on different contracts was not identical.

The answer to the question raised previously is that somewhat greater fees are paid under incentive contracts, but that the differentials are of small magnitude. Smaller fees have resulted because the first incentive contracts had shallow share lines, i.e., the contractor's share was as low as 10 percent of savings. Another false assumption held by government representatives concerns underruns. Up to the present, even though major contracts have had a wide range of incentive effectiveness, experience suggests that massive underruns are unlikely to occur. The best performance outcomes have been no less than 90 percent of target cost. Even though an incentive contract may offer unlimited opportunity to reduce cost below the target figure, the evidence pointing to outcomes of 60 or 70 percent of cost makes these cases most unlikely. A specific exception to this statement is NASA's Gemini Program which was expected to have a 20 percent cost underrun at approximately 98 percent completion. This represented outstanding achievement comparable to near

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[19] Ibid.

perfection.[20]

Potential Impact of Low Profit on Incentive

Low fees may undermine the incentive goal if the contractor can make more of a gain on overhead charges than he would expect to make in additional fee. This quirk arises because of different accounting treatment for costs and profit by government and business. For instance, the government accounts for each contract as a separate transaction on which overhead expenses and general, and administrative expenses, are calculated as a fixed percentage of direct labor and direct material cost. Profit is figured as a percent after the above items are totalled. The government also uses absorption costing instead of direct costing methods. The contractor is reimbursed for overhead costs at a rate, not on the basis of actual distribution of audited overhead. The contractor, however, may be using direct or variable costing on an incentive contract, and finds advantages in losing money on the cost incentive as the following example demonstrates.[21]

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[20] Remarks by James E. Cravens, Office of Industry Affairs, NASA Headquarters, made on February 15, 1967, in Phoenix, Arizona.

[21] Bruce Backe, "Low Fees May Undermine Incentive Goal," Aviation Week & Space Technology, January 11, 1965, pp. 69-72.

Assume a contractor managing several other government contracts simultaneously signs a CPIF contract with TC equal to \$50,000; TF equal to \$3,500 (7%); Maximum Fee equal to \$5,500; Minimum Fee equal to \$1,500; and a Share Ratio of 80/20. Cost analysis of this contract shows:

Engineering Labor	$ 5,000
Engineering Overhead @150%	7,500
Manufacturing Labor	10,000
Manufacturing Overhead @200%	20,000
Materials	2,955
Sub-Total	$ 45,455
General and Administrative @10%	4,545
Total Cost	$ 50,000
Target Fee - 7%	3,500
Target Price	$ 53,500

The incentive arrangement looks quite normal on the surface. If the contractor reduces his costs by \$10,000, he can just make the \$5,500 maximum fee [3500 + (10,000 x 0.20]). Success in this region of performance would yield a profit equivalent of 13.75 per cent because: $\frac{5,500}{40,000}$ equals 13.75%. On the overrun side, he would still make his minimum fee of \$1,500 if costs hit \$60,000 because: [3500 - (10,000 x 0.20)] equals minimum fee. That would be a profit equivalent of: 60,000 or only 2.5 per cent.

It is always better for the government if maximum fee is made at minimum cost and would appear so from the contractor's viewpoint based on the profit percentages illustrated. However, Backe stresses the fact that all too frequently the high cost option is more favorable to the contractor because he is concerned with profit on over-all business for the period rather than for profit on one specific job.[22] Taking the exact situation just described, it is possible for the contractor to make $16,000 more by spending an additional $7,181 when conditions so favor this; namely, having other in-house government work. Table 4.4 has figures for the combined work and the CPIF contract. It also shows the maximum profit he can make, $105,500, for all work combined if performance/cost is at the minimum cost level ($40,000).

The way in which overhead is recovered now enters the picture. The contractor in the situation described in Table 4.4 would hold the line on overhead and spend no additional money for indirect expenses. However, he would increase the direct cost of work on the incentive contract. He could accomplish this by failing to lay off personnel in over-staffed areas, by making work in striving for unnecessary tolerances or reliability; or even by permitting material costs to increase by failing to operate efficiently in this area. These practices would cause increases in the direct expense areas of engineering labor, manufacturing labor,

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[22] Ibid., p. 69.

TABLE 4.4

CPIF CONTRACT AT MINIMUM AND OTHER CONTRACT BUSINESS

	CPIF CONTRACT	OTHER CONTRACTOR BUSINESS	CONTRACTOR'S TOTAL BUSINESS
Engineering Labor	$ 3,000	$ 100,000	$ 103,000
Engineering Overhead @150%	4,500	150,000	154,500
Manufacturing Labor	8,000	200,000	208,000
Manufacturing Overhead @200%	16,000	400,000	416,000
Materials	4,864	100,000	104,864
Sub-Total	$36,364	$ 950,000	$ 986,364
G. & A. @ 10%	3,636	95,000	98,636
TOTAL COST	$40,000	$1,045,000	$1,085,000
Profit	5,500	100,000	105,000
SALES PRICE	$45,500	$1,145,000	$1,190,500

TABLE 4.5

CPIF CONTRACT AT MAXIMUM AND OTHER CONTRACT BUSINESS

	CPIF CONTRACT	OTHER CONTRACTOR BUSINESS	CONTRACTOR'S TOTAL BUSINESS
Engineering Labor	$ 5,000	$ 100,000	$ 105,000
Engineering Overhead @ 150%	7,500	147,000	154,500
Manufacturing Labor	12,000	200,000	212,000
Manufacturing Overhead @ 200%	24,000	392,000	416,000
Materials	6,045	100,000	106,045
Sub-Total	$54,545	$ 939,000	$ 993,545
G. & A. @ 10%	5,455	93,181	98,636
TOTAL COST	$60,000	$1,032,181	$1,092,181
Profit	1,500	112,819	114,319
SALES PRICE	$61,500	$1,145,000	$1,206,500

Source: Bruce Backe, *op. cit.*, p. 70.

and also in material. The government would reimburse the contractor for overhead on these new higher direct costs, even though the actual dollars had not been spent. The contract would increase until it simulated the conditions in Table 4.5.

The contractor could receive an additional $12,819 in allowable overhead on the CPIF contract. It would be extremely difficult for the government to determine that these costs were actually unnecessary. At the same time, the contractor will have reduced the overhead to be recovered on his <u>other</u> business by an equal amount. The net result after these manipulations to direct cost and overhead will be that <u>overall profit</u> on all government business will increase by $8,819 because ($114,319 - $105,500 equals $8,819). The government, instead of paying the minimum incentive price, i.e., $45,500, or even the target price, i.e., $53,500, now will pay $61,500, or $8,000 more than the target price.

At the same time, it may be said that when actual distribution of overhead is determined by audit at the close of the year, the extra charges for overhead would be returned to the government if <u>all</u> of the contractor's business were on a cost reimbursable basis. Even then, the final determination would not change matters to any great extent. The final settlement would produce these overhead rates, which come from the total business column in Table 4.5:

Engineering Overhead $\frac{154,500}{105,000} = 147\%$

Manufacturing Overhead $\frac{416,000}{212,000} = 196\%$

General & Administrative $\frac{98,636}{993,545} = 9.9\%$

These rates would then be applied to the subject CPIF contract:

Engineering Labor	$ 5,000
Engineering Overhead @ 14%	7,350
Manufacturing Labor	12,000
Manufacturing Overhead @ 196%	23,520
Materials	6,045
Subtotal	$53,915
General & Administrative @ 9.9%	5,338
TOTAL COST	$59,253

Ironically, it results in a reduction of $747, from the $60,000 maximum cost. The contractor will have made a wise trade-off in that he made $8,819 - $747 = $8,072 in additional profit by <u>losing</u> all of his incentive fee and most of the normal fee. Again, the villain, if there is one, is absorption costing. If direct costing has been used, the overcharge on one contract would not have been possible.

As long as absorption costing continues to be used where one contractor works on several government contracts simultaneously, great caution must be exercised in structuring a new incentive contract. Specific care must be given to the share arrangement. Fee swing and share ratio must be great enough so that incentive fees will exert motivation. The government must be prepared to pay incentive profits that are greater than the additional recovery of overhead made possible when the contractor foregoes fees and increases direct costs. In fact, whenever a contractor is operating at less than 100 percent of capacity, the government should anticipate attempts to increase costs.

Using the same example from Tables 4.4 and 4.5, it will be shown that reverse incentives can be eliminated by increasing the contractor's share of the saving to an amount greater than he would receive in overhead reimbursement. The initial proposal called for:

Engineering Overhead	$ 7,500
Manufacturing Overhead	20,000
General & Administrative	4,545
TOTAL	$32,045

Another way of viewing these indirect expenses is that they represent approximately 64 percent of the total cost calculation, assuming that engineering labor, manufacturing labor, and materials remain at the estimated cost level. The final figures when the contract is completed are never the same. Nevertheless, even with flux, for all practical purposes the contractor must get at least 64 percent of savings from target, and must absorb 64 percent of all costs over target if incentive is to remain positive. The example now requires a 36/64 share ratio. This would produce a fee line, with

TABLE 4.6

CONSTANT OVERALL PROFIT WITH HIGH 36/64 SHARE RATIO

	CPIF CONTRACT	REMAINDER OF CONTRACTOR'S BUSINESS	TOTAL BUSINESS
Cost (Minimum)	40,000	1,045,000	1,085,000
Profit	9,919	100,000	109,919
Selling Price	49,919	1,145,000	1,194,919
Cost (Target)	50,000	1,038,581	1,088,581
Profit	3,500	106,419	109,919
Selling Price	53,500	1,145,000	1,198,500
Cost	55,000	1,035,081	1,090,081
Profit	0	109,919	109,919
Selling Price	55,000	1,145,000	1,200,000
Cost (Maximum)	60,000	1,032,181	1,092,181
Profit	(2,900)	112,819	109,919
Selling Price	57,100	1,145,000	1,202,100

Source: Bruce Backe, _op_. _cit_., p. 72.

the target fee over the same RIE, that makes the contractor the same profit _on his total_ business regardless of performance on the one CPIF contract. A steeper share ratio would give him _more overall profit_ for lower than target cost on the CPIF contract, while a shallow share ratio would give him _more overall profit_ for higher direct costs on the CPIF contract.

Table 4.6 has been prepared with the 36/64 share ratio to show that total _overall profit_ is the same for various levels of performance. The government still saves money when the contractor reduces costs, and has incentive to save money for the government over the incentive range, because overall profit remains the same. The only drawback to this particular approach is that the government may pay more fee than is necessary. This might occur if actual overhead proved to be much lower, hence it could have been "covered" by a shallower share line. Some compromise in the share ratio is probably desirable. Notice, the incorporation of a negative incentive, i.e., a loss of $2,900, can be used to keep the positive side of FS from extending as high as it might otherwise without this feature.

A Mini Case on Fee

As helpful as the Weighted Guidelines are, and in the present context of ASPR maximums and Renegotiation Board proceedings, profit levels are still a problem. Yet it has been demonstrated that profit is the prime lever in an incentive contract. Its role must not be hampered by false restrictions. The FS and share ratio must serve the joint objectives of both parties. For the most part, government buyers, members of Congress, and the public have exaggerated misconceptions about inflated defense profits. Public pronouncements on this always deal with the final profit made as a percent of total cost or sales. Nothing could be so misleading as to ignore the capital investment required or the net value of the procurement to the government. The following miniature case is based on the pricing and profit policy of one of this country's largest corporate conglomerates. It has been included because it illustrates that profit as a percent of cost (sales) is meaningless.

The XYZ Corporation bids and successfully wins a service contract for the operation and maintenance of highly technical electronic equipment at a missile test site. A statement of facts reveals that the contract type is a cost-plus-fixed-fee (CPFF); that all equipment and facilities are government furnished (GFE); that XYZ Corporation will not have to contribute any fixed assets or make any capital investments; that only working capital need be invested and this will be at a minimum since the government will make progress payments on monthly billings, including fee.

The problem consists of finding out whether the government contract just received produces a profit which exceeds the company's cut-off rate of return. The procedure could be reversed so that the price bid actually insures the target profit. The specifics of this contract are:

Total Cost	$2,250
Fixed Fee (6%)	135
Total Price	$2,385
Work Schedule	13 Months

Given this information, what is the rate of return on assets for this CPFF contract with a 6 percent profit target?

The XYZ corporation does not spend a great deal of time or effort indoctrinating its project management with the details of capital budgeting procedures. Indeed, its approach is simple and does not use the preferred time adjusted methods. However, it does want to make a fair profit and in the interest of making management decisions wisely, and based on equal assumptions for all departments, it circulates the company's procedure to be used in bidding. See Exhibit 4.1.

Exhibits 4.2 and 4.3 duplicate the analysis used by XYZ for a recently awarded CPFF contract. Although the XYZ Corporation does not use sophisticated methods, its procedures prove to be adequate in terms of results. Management is happy to learn that even though the fixed fee was 6 percent of sales, the company should make a 20.3 percent return on the assets employed to produce those sales. This is well above the cut—off rate for new investments!

EXHIBIT 4.1

METHOD OF CALCULATING RETURN ON ASSETS

I. Calculate Asset Base

Calculation of Asset Base - Set up Columns

Column 1: Cash Outlays for Billable Costs - Cash Outlays should be phased by month from inception to completion of contract. Cash Outlays include all costs, direct as well as overhead, G&A, and other charges such as 1% for Research. (Capital assets and Inventories are not to be included in this column except as part of billable costs).

Column 2: Fee - Fee should be phased on a monthly basis in line with the cash outlays above. Impact on receivables can be determined.

Column 3: Sales - Sales are calculated monthly by adding columns 1 and 2.

Column 4: Cash Receipts - Represents monthly payments received from the customer until final payment.

Column 5: Receivables - Column 3 less Column 4.

Column 6: Inventories - Average Inventory level on hand at end of month.

Column 7: Capital Equipment - Capital Equipment less depreciation at end of month.

Column 8: Assets - This is figured by adding Columns 5, 6, and 7 together. This asset base should then be added for each month and divided by the total months for an average monthly asset base.

Column 9: Imputed Interest - Calculated at .005 of Column 8, by month and totaled.

This imputed interest cost and return on assets will be considered as follows:

EXHIBIT 4.1
(Cont'd)

II. Calculate Net Income After Taxes Annualized

Find Gross Income (Per Proposal)
Subtract Imputed Interest
Result is Adjusted Gross Income
Less: Income Taxes
Produces: Net Income After Taxes

Imputed Interest

Gross Income (Per Proposal)
Less Imputed Interest

Adjusted Gross Income
Less Income Taxes

Net Income After Taxes

III. Figure Return on Assets

Divide Net Income After Taxes Annualized by
Average Monthly Asset Base (Column 8)
Result is Percent Return on Assets
Take Net Income After Taxes and Divide by
Total Months of Assets (Column 8 ÷ Months)
Times 12. Produces Return on Assets

Return on Assets

$$\frac{\text{Net Income After Taxes (Annualized) (1)}}{\text{Average Monthly Asset Base (Column 8)}} = \% \ \text{Return on Assets}$$

Annualized Net Income

$$\frac{\text{Net Income After Taxes}}{\text{Total Monthly Assets (Column 8} \div \text{Months)}} \times 12 \text{ Months} = \text{Return on Investment}$$

EXHIBIT 4.2

EVALUATION OF CPFF CONTRACT
CALCULATION OF RETURN ON ASSETS

	1	+ 2	= 3	4	5	+ 6	+ 7	= 8	
MO.	CASH OUTLAYS	FEE	TOTAL SALES	CASH RECEIPTS	RECEIVABLES	INV'TRY	MISC. CAPITAL ASSETS	TOTAL ASSET BASE	IMPUTED INTEREST @ .005
1	100	6	106		106	-	100	206	1.0
2	100	6	106	106	106	-	99	205	1.0
3	150	9	159	106	159	-	98	257	1.3
4	150	9	159	159	159	-	97	256	1.3
5	200	21	212	159	212	-	96	308	1.5
6	200	12	212	212	212	-	95	307	1.5
7	250	15	265	212	265	-	94	359	1.8
8	300	18	318	265	318	-	93	411	2.1
9	250	15	265	318	265	-	92	357	1.8
10	200	12	212	265	212	-	91	303	1.5
11	150	9	159	212	159	-	90	249	1.2
12	100	6	106	159	106	-	89	195	1.0
13	100	6	106	106	106	-	88	194	1.0
TOTAL:	2250	135	2385	2385				3607	18.0

AVERAGE MONTHLY ASSETS: $\frac{\text{Total Asset Base}}{\text{Total Months Required}} = \frac{3607}{13} = 227.5$

EXHIBIT 4.3

CALCULATION OF ADJUSTED RETURN ON ASSETS

Provision for Imputed Interest

	Amount
Gross Income (Per Proposal)	135.0
Less Imputed Interest - (Total of Col. 9)	18.0
Adjusted Gross Income	117.0
Less Income Tax	56.2
Net Income after Taxes	60.8

Return on Assets

$$\frac{\text{Net Income after Taxes Annualized}}{\text{Asset Base (Column 8 Averaged)}} = \text{\% Return on Assets}$$

60.8 Net Income ÷ 13 Months (Asset Base) =
4.68 x 12 Months =
56.2 Annualized Profit

$$\frac{\text{56.2 (Annualized Profit)}}{\text{277.5 (Average Assets)}} = \text{20.3\% Return on Assets}$$

Summary

Profit plays a major role in motivating contractor behavior under incentives. The profit amount is allowed profit by government standards which differs slightly from the usual profit result of all industrial/commercial firms. It is impossible to segregate profits of defense firms exclusive of profits from all manufacturing firms because there is an overlapping of firms which are actively engaged in both defense and commercial markets.

Assorted references suggested that, in reality, the method used by defense contractors for arriving at profit during contract negotiation was unrelated to any officially recommended techniques. Contractors tried to get the same percentage on a recurring basis, or negotiated profit amount as a percentage of cost even though it is illegal. Written guides exist in the form of *ASPR* recommendations and the LMI Weighted Profit Guidelines which may be used by negotiating parties as a reference to profit percentage and amount. In general, these guides are too restrictive for incentive contracts and lack an understanding of incentive philosophy and spirit.

Table 4.7 returns to the same industries which appeared in Table 4.1, but for the latest available data. Rate of return has improved in the last few years. The reasons

TABLE 4.7

NET INCOME OF THREE DEFENSE ORIENTED INDUSTRIES COMPARED WITH ALL INDUSTRIAL GROUPS

		1964	1965	1966
ELECTRICAL EQUIPMENT & ELECTRONICS	% Sales	3.9	4.7	4.9
	% Net Worth	11.1	14.6	16.5
AIRCRAFT & SPACE	% Sales	2.7	3.3	3.0
	% Net Worth	13.1	15.5	15.5
INSTRUMENTS & RELATED PRODUCTS	% Sales	8.1	9.0	9.9
	% Net Worth	16.6	19.7	21.7
ALL INDUSTRIAL GROUPS	% Sales	6.2	6.7	6.4
	% Net Worth	10.3	11.1	11.2

Source: MONTHLY ECONOMIC LETTER, First National City Bank, New York, April, 1966 and 1967.

for this are not examined, although the trend occurred during the period in which the CPFF contract declined, while the use of incentive contracts expanded. The NASA study was not critical of profit amounts and suggested that incentive profits were only marginally higher and worth the additional cost.

Profit restrictions and constraints only hinder incentive model application and reverse the automatically desired result of incentive contracts. The Renegotiation Board is a good example of a force countering the wider use of incentive contracts. Since it prohibits defense contractors from seriously trying to optimize profit, the Board should be abolished or excluded from the incentive picture.

No rule, guide, or specific figure should exist in <u>ASPR</u> for profit levels under incentive models. The futility of setting maximum rates without considering the investment used to perform on a contract is obvious. For example, six percent of cost may be abysmally low or outrageously high for the same contract depending on the amount of invested assets committed by the contractor. Low profit target amounts on incentive contracts can result in a dysfunctional contract, as contractors might try to optimize profit via the overhead account. Thus, low profit equals low motivation and should be avoided.

Government personnel must adopt a more liberal profit policy if the use of incentive contracts is to progress. This means they must not be squeamish about negotiating incentive contracts with maximum profit potentials of 30 or 40 percent of cost. Some progress has already been made with the adoption of Value Engineering Incentive Clauses, which are excluded from fee limitation provisions. The Value Engineering Clause is unusual in that it offers very high profit potential to the contractor that initiates a major cost reduction achievement. The law provides that a contractor shall retain a predetermined share of all cost savings resulting from the adoption of change proposals submitted by him, and that under an incentive contract his share of the savings may be as high as 50 percent.[23] Prior to this regulation, a contractor might not have suggested a change if the lower contract value from savings eliminated his work and reduced his fee, and there were no rewards paid for the effort. This is just one area where thoughtful planning has improved incentive contracting technique.

Incentive profits should give the government a wider choice of firms to deal with and result in the selection of firms with greater proven efficiency. Incentive profits can be used to induce strong competition; advocates of very low profit amounts for defense contracts must be made aware of a paradox of thrift, and that low profits reduce incentive.

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[23] DOD Incentive Contracting Guide, op. cit., pp. 62-63.

CHAPTER V

SELECTION CRITERIA FOR INCENTIVE PARAMETERS

Introduction

This section is devoted to a discussion of the factors which must be considered by both parties negotiating an incentive contract and the method by which contract considerations become elements in the model. The parties may elect to include few elements in the model and incentivize only major contract variables, permitting these to affect fee. The Value Statement approach aligns itself with incentivizing few elements and yet it achieves interdependency.

An opposite approach would suggest taking all contract performance requirements from the work and relating them to fee in the model. This is obviously not practical as the model would contain too many variables. A compromise is necessary; elements should be carefully selected from major areas of cost, performance, and schedule. A systems approach to the question of the elements which should be selected for the incentive contract model integrates such extra-contractual information as overall cost effectiveness and the procurement's life cycle. The integrated approach demands on occasion that many contract variables be included.

Examples given in this section will demonstrate the basic differences in each approach. Namely, the elements selected for the Value Statement force the buyer (government) to identify the value, or marginal utility, of every increment of performance purchased. At the same time, it requires the contractor to carefully weigh (trade-off) extra cost and extra performance, and their effect on his total fee. The integrated (systems) approach requires similar information for element selection, but leans in the direction of evaluating long range factors over short run considerations. The result is that no firm rule can apply to the structuring of models. Each situation deserves individual attention.

General Goal Preferences

The government wants a product for a reasonable price. The contractor wants to maximize his profit. The ideally structured incentive contract would select enough elements so that both of these objectives are satisfied. Since a model containing dozens of elements is too complex, compromise is necessary when choosing elements. Only critical goals should be emphasized. In one contract it may be performance; in another it may be cost. The parties themselves have to agree on object priority beforehand. A sensible attitude must recognize that every contract needs automatic as well as structured incentives. A good example of an automatic incentive is one that exerts pressure on the contractor to perform well without any immediate monetary reward. For example, now that past performance is used in justifying profit amount with Weighted Guidelines, the contractor is obliged to do well if he wants additional attention and profit on the <u>next</u>

contract he negotiates. Structured incentives are designed for specific outcomes, whereas automatic incentives work for general improvement.

Real issues may be buried in a welter of elements. A selection format for elements minimizes disagreement and brings the parties to a signed contract faster. The format must possess essential qualities. It must indicate which items of cost, performance, and schedule are of a major nature. It should develop a rational basis for assigning relative weights between the incentive parameters, and give recognition to the interdependency effect. The flaw of structuring compartmentized contracts, i. e., treating cost and performance separately when they are really interdependent, has already been mentioned. Finally, the format should ensure desirable trade-offs, even if one or more parameters has reached its limit. Because requirements are this demanding, no single approach has universal applicability. One suggestion might work well in a research and development contract, and fail in a production or service contract. For this reason, several approaches are explored.

It is interesting to compare contract models with economic models. Neoclassical economists have demonstrated tendencies with short run, intermediate, and long run models. Contract situations do differ from the firm, where an expanation of behavior must consider perpetual existence. Most contracts have shortened life, seldom beyond a few years. Greater emphasis must be given to the short run in contracts.

The Value Statement Concept[1]

The use of a value statement was briefly introduced in Chapter II. At this time, it will be scrutinized again for answers to the problems just raised. The NASA position is that a majority of the problems with incentive contracts exists because of a predominant deficiency. That is, the customer, usually the government, fails to convey its requirements to prospective vendors and thus consistently places them in a position where they cannot respond intelligently.

The ingrown custom exists whereby the government asks for explicit information on the Requests for Proposals (RFP's) This forces the contractor, not the government, into supplying the weighted incentive parameters. At the same time, there has always been an assumption on the part of government procurement officials that if relative weights and performance parameters were provided, then prospective vendors would meet procurement objectives in the process of submitting competitive proposals. Evidence presented in Chapter IV refutes this assumption. The contractor can find the right incentives weighted improperly or tied to an impractical share ratio so that something called "negative incentive" is actually created.

In order to prevent a reverse incentive effect, and to correct the false assumption that the competitive bidding process will automatically result in the adoption of the

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[1] Structuring, Analyzing, and Evaluating Multiple Incentive Contracts (SAMIC), NASA, Langley Research Center, Hampton, Virginia. June 10, 1966.

right incentive parameters, weighted properly, the customer must tell the vendor of what value performance increments are to himself. Reverting to the terminology used earlier, the customer must express the marginal utility or worth of any increases in performance. The device used to do this is called a value statement. It is defined as the breakeven point for trade-off decisions between cost, performance, and schedule where the net effect on fee or profit is zero.[2] Since these are equivalents in cost, performance, and schedule, they are also the customer's expression of equal marginal utility.

The value statement is not only necessary with regard to selecting parameters; it is a necessity when one realizes the problem involved in selecting the best bid from several contractors who have each submitted bids with different relative weights between incentive parameters, and have different share ratios. It makes comparative analysis feasible when the mere figure submitted by the low bidder, i.e., the lowest price, is invalid as a selection factor on an incentive contract award. Unlike the specific instructions set forth for the FFP or CPFF contractor, the incentive forms, such as the FPI and CPIF, establish goals, parameters, targets, and minimum and maximum fees.[3] Selecting the winning bidder and the best contract structure without pre-established

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[2] Ibid., p. 2.

[3] Arthur J. Nolan, Incentive Contracting in the Aerospace Industry, op. cit., p. 100.

guides would be difficult at best. By making the customer define his needs, the contractor is better able to estimate requirements. Therefore, the value statement serves several useful ends. It forces the contractor to focus on the buyer's needs. It permits the buyer to make a meaningful comparison between different proposals. Finally, since the value statement places a cost on each incentive, the contractor visualizes a share line. In short, if the government includes a value statement with the RFP, contractors can build an incentive matrix into their bids.

The surprising fact is that neither ASPR nor the DOD Incentive Contracting Guide now require a value statement. The Guide still proclaims that relative weighting is the prime determinant of importance to the government for the various incentive elements comprising the incentive matrix. No conflict exists between these two managerial controls if the advantages of and application of the value statement are understood. The advantage of the value statement over an expression of relative weighting is that while the latter represents merely an order of priority, the former additionally attaches a determinable dollar amount which dictates explicitly the order and degree of priority in terms of a trade-off matrix.[4]

The first step in writing performance and delivery incentives into a contract is the selection of goals which

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[4] SAMIC, op. cit., p. 5.

are to be used as targets.[5] The buyer's requirements with regard to incentive elements have no meaning if these goals are not included in the RFP. The vendor needs specific information necessary to meet the procurement's requirements and also to place each competitor on an equal footing. If each contractor does not know the buyer's goal priority, he may return with proposals based on different incentive matrices. Only the buyer knows the exact intent and priority of his goals. These should be expressed in the value statement. If the buyer omits essential incentive factors, such as cost equivalents, he places prospective offerers into a position whereby they can be neither truly competitive nor completely responsive even though they have all been supplied with the same information on goals. Up to the present time, the government has relied on relative weighting of incentive elements, and hoped for the best.

Relative weighting of incentive elements alone does not guarantee that trade-offs will be made in the government's best interest. It does not permit the government to evaluate several bids because bids received do not have a common basis for comparison. It therefore lessens the competitive aspect between bids received. Only bids expressing incentive increments in terms of cost are truly comparable. The value statement establishes the cost relationship necessary for making a meaningful, structured, incentive matrix. The

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[5] Ralph C. Nash, Incentive Contracting, Government Contracts Monograph No. 7, (Washington, D.C.: George Washington University) 1963, p. 41.

onus for development of the value statement must rest with the government, for only it is in a position to know the "worth" of the various increments of performance and schedule required to meet its objectives.

At the same time, the value statement gives the contractor more freedom to structure a contract that is more competitive while being more suitable for the government. Just how this operates and the simplicity of the value statement were illustrated with this example from SAMIC.[6]

A typical RFP for a sophisticated spacecraft is given in Exhibit 5.1. The procurement itself is for a complex item, but the incentive contract model has been purposely simplified, in that there is only one performance element and a single value statement. Had there been several performance parameters, it would have resulted in several performance/cost curves and several value statements applicable over different ranges of cost and performance. The single value statement illustrates a prime rule of SAMIC, that the performance/cost relationship should always be expressed in the form of a percentage of target cost to permit maximum freedom in building a matrix.

The exact method by which the government arrived at the final value statement for the IEP satellite in Exhibit 5.1 is not given. However, it is possible to reconstruct some of the movements from available data. For example, for each share ratio that might be chosen ultimately, it is

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[6] SAMIC, *op. cit.*, pp. 7-18.

EXHIBIT 5.1

RFP SEGMENT FOR Instrumented Experimental Payload Satellite

It is anticipated that this procurement will be consummated on a cost-plus-incentive-fee basis with incentives on cost and performance. Incentive matrices submitted in response hereto shall be limited to a performance incentive on spacecraft weight meeting the value statement and performance levels set forth below:

Value Statement

±1# = ±0.9% of Target Cost

Performance Levels

Maximum Fee @ 50#
Target Fee @ 75#
Minimum Fee @ 100#

Notwithstanding any other fee provisions of the contract, if spacecraft weight exceeds 100#, the total fee payable under this contract shall be the minimum contractual fee. To determine the incentive fee for performance, spacecraft weight will be determined in accordance with the procedures set forth in the Statement of Work.

The cost incentive must operate over a range of costs above and below target commensurate with a multiple-incentive contract. In any event, any resultant contract will contain cost overlap provisions.

Source: SAMIC, op. cit., p. 7.

EXHIBIT 5.2

PREDICTABILITY CHART USED TO DERIVE VALUE STATEMENT

Contractor's Share	Performance Fee Swing %	Cost Range with Total Fee Swing of:						
		±5.0%	±5.5%	±6.0%	±6.5%	±7.0%	±7.5%	±8.0%
10	2.25	27.5	32.5	37.5	42.5	47.5	52.5	57.5
11	2.475	22.95	27.5	32.04	36.59	41.13	45.68	50.23
12	2.70	19.17	23.33	27.5	31.67	35.83	40.0	44.17
13	2.925	15.96	19.81	23.65	27.5	31.35	35.19	39.04
14	3.15	13.21	16.78	20.36	23.93	27.5	31.07	34.64
15	3.375	10.8	14.17	17.5	20.83	24.2	27.5	30.8
16	3.60	8.75	11.88	15.0	18.13	21.25	24.38	27.5
17	3.825	6.91	9.85	12.79	15.73	18.68	21.62	24.56
18	4.05	5.27	8.05	10.83	13.61	16.39	19.17	21.94
19	4.275	3.82	6.45	9.08	11.71	14.34	16.97	19.6
20	4.50	2.5	5.0	7.5	10.0	12.5	15.0	17.5
21	4.725	1.3	3.69	6.07	8.45	10.83	13.21	15.6
22	4.95	0.22	2.5	4.77	7.05	9.3	11.59	13.86
23	5.175	(0.76)	1.41	3.59	5.76	7.93	10.11	12.28
24	5.40	(1.67)	0.42	2.5	4.58	6.67	8.75	10.83
25	5.625	(2.5)	(0.50)	1.5	3.5	5.5	7.5	9.5

Source: SAMIC, *op. cit.*, p. 21.

possible to predict probable outcome, in percentages, irrespective of estimated target costs.[7]

A predictability chart similar to Exhibit 5.2 must be compiled for each procurement prior to final determination of the value statement percentage selected for the RFP. Exhibit 5.2 depicts possible outcomes for the IEP satellite procurement, with several share ratios from 90/10 up to 75/25. It indicates that as the performance incentive, FS, increases, with a greater contractor share, the cost incentive FS diminishes.

The value statement chosen for the IEP satellite, plus or minus one pound equal to plus or minus 0.9 percent of target cost, was not determined on the basis of predictability alone. Exhibit 5.2 was used only as a guide. The originator of this approach cautions acceptance without substitution and testing. The mere identification of cost for an increment of performance, and its expression as a percentage of the customer's estimated target cost does not automatically establish a reasonable value statement percentage. Therefore, it is both desirable and necessary to test a complete incentive matrix for selected share lines to determine beforehand the value statement percentage most likely to engender acceptable incentive offers from industry.[8] The suggested method for testing a likely value statement percentage

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[7] The hypotheses or confidence levels used to derive the 0.9 percent were not given.

[8] Ibid., p. 8.

consists of substituting figures, by trial and error, for the following formula: value statement percentage = fee dollars per increment of performance ÷ selected share lines ÷ target cost. The end product of this process should convey the compromised best interests of both parties to the contract.

The government received six offers in response to the RFP. They are shown in Exhibit 5.3. The contracting officer must evaluate these bids to determine whether the incentive matrix submitted by each satisfies the value statement, and he must eventually rank the bids. The benefit of the value statement approach in competitive ranking is that it permits quantification of different target costs, fees, and share lines. Each contractor structured his incentive matrix on the government's value statement, while trying to maximize profit and still be competitive. The three different objectives are not mutually exclusive, but they do require a compromise. From the beginning it should be obvious that the lowest bid for target cost, $2.5 million, cannot be used as a selection factor by itself. The contracting officer must perform several intermediate steps which relate the three objectives just mentioned before ranking of bids is possible. Then only will he have a basis of ranking the proposals and selecting one to receive the award.

The most important link in the value statement chain is the calculation of a PRICE factor. The PRICE factor makes it possible for the contracting officer to relate different

EXHIBIT 5.3

SIX PROPOSALS FOR THE IEP SATELLITE

CONTRACTOR	A	B	C	D	E	F
Target Cost	$3.0M	$2.8M	$3.4M	$2.7M	$3.8M	$2.5M
Maximum Fee	14%	15%	15%	15%	14%	15%
Target Fee	8%	7.5%	8%	8.5%	8%	10%
Minimum Fee	2%	0%	1%	2%	2%	5%
Fee Swing	± 6%	± 7.5%	± 7%	± 6.5%	± 6%	±5%
Performance Incentive Range - Weight						
Maximum Fee @	50#	50#	50#	50#	50#	50#
Target Fee @	75#	75#	75#	75#	75#	75#
Minimum Fee @	100#	100#	100#	100#	100#	100#
Value Statement - (±1# = ±0.9% of Target Cost)						
	$27,000	$25,200	$30,600	$24,300	$34,200	$22,500
Share Ratio	86/14	79/21	75/25	82/18	88/12	90/10
Relative Weighting						
Performance	52.5%	63%	80.4%	62.3%	45%	45%
Cost	47.5%	37%	19.6%	37.7%	55%	55%
Cost Incentive Range						
	± 20.4%	± 13.2%	± 5.5%	± 13.6%	± 27.5%	± 27.5%

Source: SAMIC, *op. cit.*, p. 9.

bids with a common denominator. The PRICE factor for each offer is based upon several internal forces which the government has decided to review; and it is an acronym for these:[9]

(a)	Position	Relative technical position in the state of the art.
(b)	Risk	The myriad of factors reflected in the potential fee dollars to be earned or lost compared to the costs related to each increment change in performance.
(c)	Incentive	The motivating factors of either contractual or economic considerations.
(d)	Cost	The target cost and range of cost over which the incentive operates.
(e)	Effectiveness	The proficiency of management in its employment of resources.

The PRICE factor defines the offerers' incentive matrices and makes comparison between the various target costs, fee structures, value statements and different ranges of incentive effectiveness possible.

Taking contractor B's proposal as an example (from Exhibit 5.3), the way in which the PRICE factor is derived from the value statement can be shown. In Exhibit 5.4, the value statement is first related to the *particular* offerer's target cost and target fee. Since the government specified that one pound of weight would be equal to 0.9 percent of target cost, B's value statement is worth:

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[9] *Ibid.*, p. 10.

EXHIBIT 5.4

DERIVATION OF PRICE FACTOR AND ITS APPLICATION

OFFEROR B

a. Target Cost - $2,800,000

b. Fee Structure - Maximum - 15%
- Target - 7.5%
- Minimum - 0%

c. Value Statement - ±1# = ±$25,200 (0.9% X $2,800,000)

d. PRICE Factor - 21% X $25,200 = $5,292
$5,292 x 25# = $132,300

e. Share Line - 79/21

f. Fee Swing - $132,300 $2,800,000 = ±4.725% (Performance)

Total Fee Swing - 7.5%
Less Perf. Reward Fee - 4.725%
Cost Reward Fee - 2.775%

Total Fee Swing - 7.5%
Less Perf. Penalty Fee - 4.725%
Cost Penalty Fee - 2.775%

g. Relative Weighting - 4.725% ÷ 7.5% = 63% Performance Wt.
2.775% ÷ 7.5% = 37% Cost Wt.

h. Range of Cost Incentive - 2.775% ÷ 21% = ±13.2%

i. Reward/Penalty - +1# = $5,292)
) ±1# = $5,292 Fee = ±$25,200 Cost
±1# = $25,200)

Source: SAMIC, op. cit., p. 11.

$\pm 1\# = \pm \$25,200$

because this is (0.9% x $2,800,000).

Taking B's share of any cost savings from target cost, or share of expenses over target cost, which is 21 percent, and applying it to the value of one pound, the $25,200 results in a PRICE factor of $5,292 for one pound. For 25 pounds, the PRICE factor is (25 x $5,292), $132,300.

The fee swing for performance variance alone, therefore, is not the total ±7.5% given in the bid, but rather the performance price factor amount of:

$$\frac{\text{Performance FS}}{\text{Target Cost}} = \frac{\$\ \ 132,300}{\$2,800,000} = \pm 4.725\%$$

Since the total FS was plus or minus 7.5 percent, if plus or minus 4.725 percent of this was dependent upon the performance incentive, the difference, plus or minus 2.775 percent must be related to the cost incentive. The minus 2.775 percent in fee is a cost penalty; the plus 2.775 percent in fee is a cost reward for savings. Therefore, the value statement did in fact supersede the requirement for relative weighting between the incentives and provided the matrix because:

$$\begin{array}{lll} 4.725\% & = 63.0 & \text{Weight of Performance} \\ \underline{2.775\%} & = \underline{\ 37.0} & \text{Weight of Cost} \\ 7.500\% & \ \ 100.0 & \end{array}$$

Going back to the value statement definition of fee equivalents for performance and cost, the reward or penalty for offerer B's matrix is: one pound of performance equals $5,292 of fee or one pound of performance is worth $25,200 or 0.9 percent of target cost. Therefore: $\pm 1\# = \pm \$5,292$ FEE $= \pm \$25,200$ COST.

Having determined the value statement cost and the PRICE factor (or share line) for one contractor, it is only a matter of repeating the process for each offerer. After this has been done for each matrix, the contracting officer can begin to analyze and evaluate on a comparable basis. The share line is derived from the value statement. The steeper the share line, the more acceptable the incentive arrangement to the contractor. In other words, the government may use the slope of the share line to indicate the degree of confidence the contractor has in reaching performance levels.

Now, to rank each offerer explicitly, "it must be borne in mind that the PRICE factor, which defines the share line and assigns fee dollars to both performance and cost, is inseparably interrelated to the value statement, a derivation of target cost, which determines the cost value of an increment of performance, which in turn determines the range of cost effectiveness by relating to target cost the cost fee swing."[10] Any meaningful evaluation process must consider all this and still evolve a ranking system which attributes the highest score to the offerer with the lowest value statement cost and steepest share line, tempered by the cost fee swing and target fee. The architects of the value statement approach have also solved the ranking problem with a scoring system, but do not suggest it is the ultimate one.[11]

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[10] *Ibid.*, p. 16.

[11] NASA employees Frank V. Moore and Wayne R. Glenny, although no credits are given in *SAMIC*.

The scoring system assigns a percentage figure to each value statement cost on the basis of its relationship to the lowest value statement cost proposed, and then summing:

(a) Value Statement Cost Percentage

(b) PRICE Factor (Contractor's Share)

(c) Cost Fee Swing Percentage

SUB-TOTAL

Less:
(d) Percentage of Target Fee

FINAL SCORE

The offerer with the highest score receives preference. In Exhibit 5.5, each of the original contractor's proposals has been ranked using this high point scoring system. Since contractor F had the lowest value statement cost, $22,500, all other value statement costs are adjusted downward. To this is added the price factor and the cost fee swing. The final high score, after deducting target fee percentages belongs to contractor B; thus he is ranked number one. This method appears to be entirely objective for evaluating each offerer's incentive matrix, but does not purport to eliminate the need for limited subjective analysis and good judgment.[12]

In the overall context of this chapter's discussion, the value statement approach does not require the government to hand the contractor a list of items to be incentivized and the relative weights attached thereto. Rather, it allows the contractor complete latitude in proposing any type of incentive matrix he desires, constrained only by the priorities

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[12] *Ibid.*, p. 18.

EXHIBIT 5.5

SIX BIDS RANKED ACCORDING TO HIGHEST SCORE

	A	B	C	D	E	F
Target Cost	$3.0M	$2.8M	$3.4M	$2.7M	$3.8M	$2.5M
Value Statement Cost	$27,000	$25,200	$30,600	$24,300	$34,200	$22,500
ADD:						
% Relationship to "F"	83.3	89.3	73.5	92.6	65.8	100
Price Factor % (Contractor's Share)	14	21	25	18	12	10
Cost Fee Swing %	2.85	2.775	1.475	2.45	3.3	2.75
SUBTOTAL:	100.15	113.075	99.975	113.05	81.1	112.75
DEDUCT:						
Target Fee %	8.0	7.5	8.0	8.5	8.0	10.0
Final Score	92.15	105.575	91.975	104.55	78.1	102.75
Ranking	4	1	5	2	6	3

Source: SAMIC, p. 18.

of the value statement, which tells him exactly what the government wants and not how he should go about the task of production.

An Integrated Approach

Although the object of this section has been to answer the problem concerned with "what" incentive parameters go into the incentive matrix, it is difficult to avoid the broader question of structure and fee discussed in the two previous chapters. This will become more apparent with the present topic in that it deals with the selection problem in a general manner. The contracting parties should be less concerned with the specific mechanics of incentive contracts and concentrate more on achievement. The evolution of improved incentive contracting techniques points to a general approach which is, in fact, an integration of several developments in procurement management.

One of these is called the Total Package Procurement Concept. It approaches the problem of interdependency of cost and performance parameters in a straight-forward manner: the contractor is not only responsible for the development of the system, but he is also responsible for the procurement and maintenance costs of the system.[13] The Total Package Procurement Concept increases the risk involved for the contractor, but it also includes provision for increasing or decreasing cost sharing as the contract progresses. It is being used for the Air Force's C-5A program with Lockheed, giving that contractor an extremely large contract for an extended period of time with high profit potential. Whether or not

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[13] James N. Daniel, "Trends In Incentive Contracting", The Management of Aerospace Programs. 12(Washington, D.C.: American Astronautical Society). 1967. p. 174.

this procurement technique works cannot be stated at this time. Further evaluation depends upon additional experience. Perhaps a fair comparison will never be possible since the contractor assumes greater responsibility, thereby relieving the government of personnel. Controversy exists over who is most efficient. The money the government saves will not appear as an asset with the Total Package Procurement Concept; nevertheless, it should be considered.

Another development of the systems analysis philosophy in the DOD is cost effectiveness. Here, the ultimate procurement decision for a program depends on the system cost effectiveness determined while in the development phase. The contractor would have additional incentive in that he would receive more profit for a higher measure of cost effectiveness.

The DOD Incentive Contracting Guide is very specific about procurement objectives with regard to cost effectiveness. For one thing, it recommends that a contractor <u>always</u> receive more fee for increased weapon system effectiveness and/or decreased total system cost. If this definition is satisfied, the contract has a desirable monotonic fee relationship.[14] For another matter, measured incentive variables should be related to cost effectiveness to produce the desired effect on fee.

The cost effectiveness concept is not an absolutely identifiable quantity. It requires assumptions about the

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[14] <u>DOD Incentive Contracting Guide</u>. p. 102.

long run. When the long run is considered, the government must not only consider development cost, but also operational effectiveness and the item's life cycle cost. Life cycle cost involves development, procurement, operation, maintenance, and even time of utilization. Effectiveness value must justify its cost. Often cardinal measurement cannot be used to show utility to the government, and then relative measurement must be relied upon. The subject of cost effectiveness is a digression at this point. It has been included because incentive parameters can and should be selected to produce cost effectiveness objectives.

The cost effectiveness approach stresses the interdependency of incentive variables. Cost and system effectiveness can also be simulated with models that manipulate variables. Any incentive plan that treats these variables independently, as with a weighted average summed, ignores the functional relationship. A cost effectiveness model relates the incentive variables to cost and effectiveness, and from there they may be adopted for contractual purposes by letting them determine fee.[15] The diagram in Figure 5.1 explains the process non-quantitatively.

A preferable method of solving the incentive selection problem would consider the advantages of the Total Package Procurement Concept, the item's life cycle cost, the cost effectiveness advantages and even the systems effectiveness

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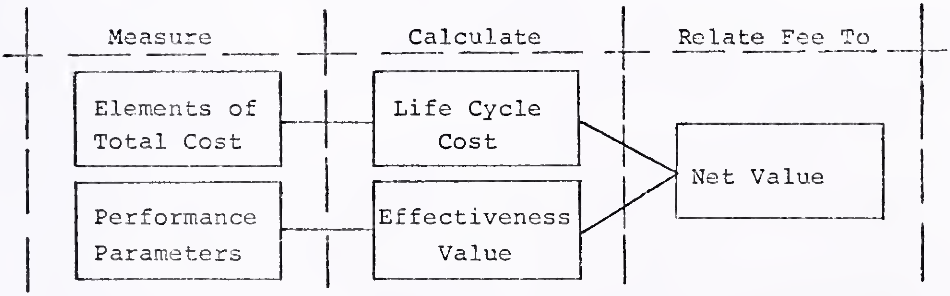
[15] For an excellent reference on how overall effectiveness and fee can be related the reader is referred to the DOD Guide. pp. 106-110.

variables that were studied initially. Specialists have developed simulation models which can be used to solve problems from system origination on through operation and maintenance activity. The procurement cost is just one phase of a contract's life cycle. The incentive contract should be in phase with all development activity prior to procurement, and also forward looking to application and cost effectiveness after procurement. In short, the totality of a procured item or service should not be ignored in the contracting process. Therefore, an integrated approach which incorporates all the items related to a procurement's development and usage should be applied to the task of selecting incentive parameters and structuring the incentive contract, so that fee result coincides with overall value objectives.

FIGURE 5.1

INCENTIVE FEE CALCULATION
BASED UPON COST EFFECTIVENESS



Source: DOD Incentive Contracting Guide, *op. cit.*, p. 108.

Figure 5.2 is a diagram of the elements that might be considered for the integrated, total approach. It has both objective and subjective features. This should not deter anyone from recognizing its advantages. For instance, if an incentive contract is used to procure a missile and technical specialists insist on a high degree of reliability, the cost of extra reliability would not be ignored, relative to the time needed for more development, and the expected service time in a deployed ready state. All too frequently in the past, the extra reliability was purchased, as for instance, in the Minuteman missile where a resistor normally costing 10 cents might cost the government $50.[16] Often hardware was purchased on specifications designed to last a lifetime, only to be replaced ten years later by an improved version. Examples of this can be found in government surplus stocks of first generation Minuteman, Atlas, and Titan missiles.

A primary requirement of any incentive structure which should automatically occur if the integrated approach is used is that the resulting incentive model will always express the government's preference. The models of total life-cycle cost and system effectiveness would allow the development of incentive provisions that would always pay more fee for greater value, regardless of how this level of value might be achieved.[17] The incentive plan might measure and include these variables in the performance area: reliability; accuracy; mean-time-

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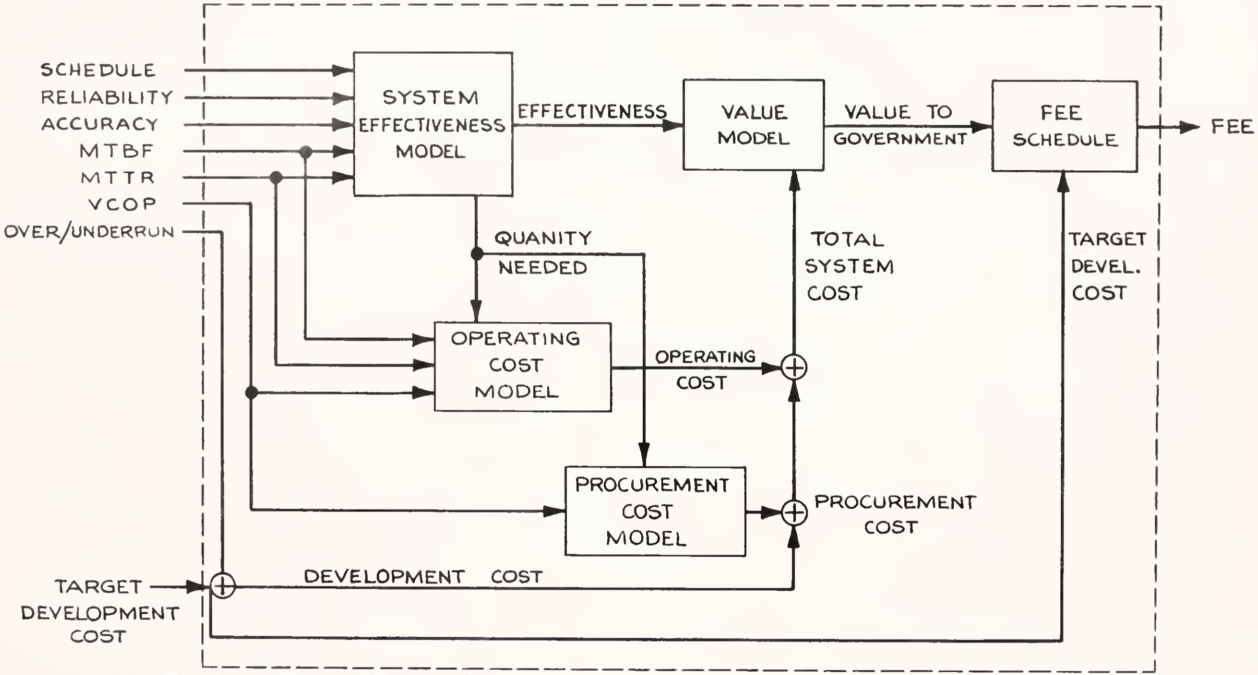
[16] Daniel. op. cit., p. 172.

[17] Ibid., p. 175.

FIGURE 5.2
ELEMENTS OF INCENTIVE MODEL



SOURCE: DANIEL, OP. CIT., PAGE 175.

between-failures; mean-time-to-repair; unit cost of production; and development cost. Then the projected incentive fee is related to these parameters through a series of models, i.e., systems effectiveness model; procurement model; operating cost model; value model; and fee schedule.[18]

The value model, which has not been discussed before, relates the total system effectiveness and the life-cycle cost to the value for the government. This, in turn, must be tied to the incentive fee schedule. The PIIM fee surface essentially does this. The value model is concerned with the government's desires, while the fee schedule is concerned with the contractor's desires and motivates performance by relating fee to value. No incentive plan can be validly structured without identifying the interdependence of the incentive variables, value to the government, and fee schedule. How this might be accomplished in a series of tasks was described by Daniel in the following sequential order.[19] Figure 5.3 illustrates these tasks one would expect to apply in the incentive contract development process.

Task 1

The buyer reviews preliminary system effectiveness and cost models during the conceptual stage to see how they might interface with an incentive contract structure. Particular emphasis is given to the degree of effectiveness to be derived and to performance characteristics that might be appropriate

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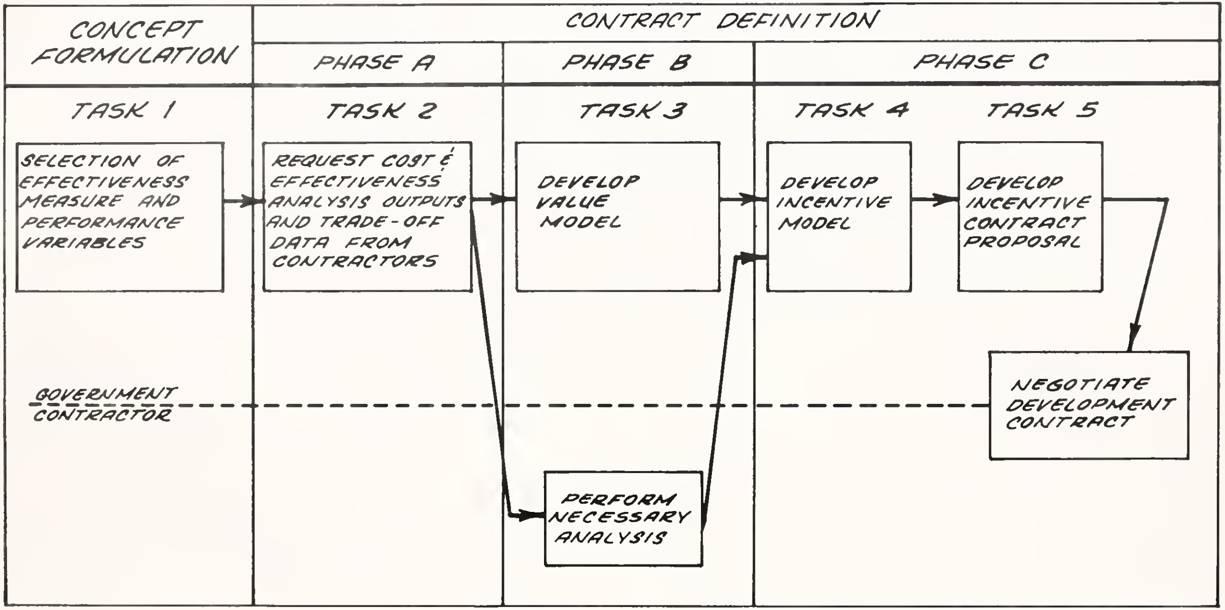
[18] Ibid., p. 176.

[19] Ibid., pp. 177-180.

FIGURE 5.3
INCENTIVE CONTRACT DEVELOPMENT PROCESS



SOURCE: DANIEL, OP. CIT., PAGE 177.

as incentive contract parameters.

Task 2

The government takes the results of the analysis in Task 1 and requests additional information from the contractors studying the problem in the Contract Definition stage. They would be asked to provide effectiveness and cost analysis outputs; a system effectiveness model; a procurement cost model; and even an operating cost model. At this point the government might also request performance and development cost trade-off data.

Task 3

During the same period, the government builds its value model. Decisions have to be made, for a preliminary, if the contract will encompass: variable effectiveness only; variable cost only; both cost and effectiveness variables; and whether procurement quantity will be fixed or variable. The government's relative preference for various combinations of cost and effectiveness are expressed in the value model, which is developed from the opinions of military and technical planning personnel. The actual model itself can take a tabular, matrix, or mathematical form.

Task 4

The government builds an incentive model based on the relationships between: system effectiveness, procurement cost, operating cost, and value. This incentive model is altered by performance and cost trade-off data from Task 2. The specific variables of this incentive contract will depend upon: the sensitivity of system effectiveness and cost to each variable; the degree of control the contractor has over the variable; whether the variable was included in the technical specifications as a threshold value; and whether the variable can be accurately measured or estimated in the development phase. The final product of Task 4 is an incentive model whose parameters represent limiting specifications for each variable. This model computes relative value for any combination of selected parameters.

Task 5

The government writes the incentive contract proposal from the incentive model that was just developed. Translating the incentive model requires adaptation into a suitable form for inclusion in the development contract. The contractor must receive the incentive form tailored to fit his decision making process. The incentive model may have chosen parameters that are additive over ranges, as are most typical multiple incentive contracts. Some incentive models cannot be approximated with additive parameters. The contract might be served better by a tabular model or by an analytical formula. At this time, the incentive contract proposal is normalized, and fee weights are established minus dollar amounts which are added after negotiation.

Task 6

The incentive contract is negotiated, using the relative weights established by the incentive model and relating the fee thereto. The relative weights themselves are not subject to negotiation or change.

The benefits of the integrated approach to incentive contracting are that: the incentive plan is under explicit consideration from the beginning of the program leading to better understanding of incentive objectives; the incentive parameters are based on the same criteria that were used in the decision to proceed with the development of the system; the incentive structure reflects the non-linearities and interdependencies of the product; fee is monotonic and moves desirably with value changes to the government. Both parties can avoid trade-off surprises and undesirable incentive effects.

Other Approaches

Whether or not the final profit matrix is based on weighting incentive parameters for the contractor is immaterial. The Value Statement achieves a desirable effect without attaching specific weights directly. The integrated approach relies on specific weighting of incentives. What is far more important is the definition of a profit formula related to cost and performance variables before the contractor begins work for the government. In order for the incentive matrix to work, the contractor must have certain definite knowledge beforehand.

He has to know what total fee pool is available. He cannot exercise a decision-making theory if the opportunity to optimize profit does not exist. This suggests the application of marginal analysis, or incremental analysis to trade-off decisions. Knowledge alone of more or less profit cannot exert the same degree of incentive control on a contractor as an exact knowledge of profit change. Thus, an explicit incentive matrix that definitizes profit relations resulting from trade-off decisions is decidedly preferable.

There are critics to this theory. Scherer is the strongest opposition. In the conclusion of his extensive work on economic incentives he justifies the application of after-the-fact evaluation of the contractor.[20] This type of system is based on ordinal ranking of performance of principal contractors executing large advanced weapon systems. It would attempt to relate overall performance to efficiency, just as present incentive structures do. However, it could extend beyond a single measure for performance versus cost of the contractor. It might include past performance considerations, or any other number of subjective factors whose inclusion in before-the-fact incentive matrices creates objections.

Some of the advantages claimed for after-the-fact evaluation are not realistic. Scherer makes the point that the movement for after-the-fact evaluation started about the same time that incentive contracts began receiving special emphasis from the DOD. However, unlike the experience with incentive contracts, after-the-fact evaluation did not catch

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[20] Frederic M. Scherer, The Weapons Acquisition Process: Economic Incentives (Boston: Harvard University, 1964), Chapter 12.

the imagination of America's defense contractors. Consequently, no data exist to prove or refute Scherer's reasoning. Nevertheless, the claimed advantages are worthy of being examined.

Two basic incentive systems employing after-the-fact evaluation have been proposed. One correlates profit with efficiency; the other with sales or some variable related to overall performance. A major claimed advantage of these systems is that profit can be directly related to performance and is not subject to bargaining. After-the-fact evaluation alters profit in accordance with performance, and discourages "padding" the government's bill. An auxiliary benefit would result in that the contractor and the government would be less suspicious of one another and would therefore negotiate important issues with greater faith. It would supposedly reduce contract administration and audit costs. Fairness and equity would be restored; the government could reward high profits to those who performed well, and low profits or losses to inefficient firms.

Unfortunately, desirable laws to govern human behavior and human motivation do not exist and work automatically in the will of man. After-the-fact evaluation sounds logical and can be defended on theoretical grounds; however, when one views the discrepancies that arise from contractual differences every day, in the legal sense, i.e., contractors invoking dispute clauses and cases before the Armed Services Board of Contract Appeals, little doubt remains. After-the-fact evaluation would require a degree of cooperation between the contracting parties that simply does not exist today in practice, unless it is in the minds of men. Subjectivity would still be a major problem.

At the time Scherer formalized his ideas on after-the-fact evaluation, which he does not claim to have originated, the DOD was beginning a new Contractor Performance Evaluation Program. One cannot help feeling that Scherer was taken in by its promise. If, indeed, the data collected were going to be as useful as promised, past performance evaluation would become a major force to be reckoned with when bidding for new government business. At present, many of the objectives of the Performance Evaluation Program remain unfulfilled.

Another critic of the traditional incentive contract structure is Thomas. His thesis is that all incentive contracts are subjective and the government might just as well profit by using more cost-plus-award-fee (CPAF) contracts.[21] The traditional incentive arrangement is merely subjective before-the-fact, while the CPAF contract is totally subjective after-the-fact. Thomas makes a strong case for using the CPAF contract for service procurements. In as much as the CPIF and FPI contracts demand objective evaluations with regard to targets, these are difficult to establish with ser-

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[21] John E. Thomas, Procurement of Services Under Cost-Plus-Award-Fee Contracts. An unpublished thesis submitted to Florida State University, 1965. Mr. Thomas is a NASA contracting officer.

vice contracts. However, the issue is not whether one contract type is superior to another, as every contract may have a preferred situation where it is ideal. Rather, it is a matter of the degree of subjectivity that exists. The models that were described may have subjective elements, but it was possible, through the application of mathematics, to reduce this to a minimum. By contrast, the CPAF contract is entirely subjective. A contractor displeased by a subjective evaluation which he considered unfair has been known to force the government to change its rating, and hence, to alter profit. This occurred recently with a NASA contractor at the Kennedy Space Center.

As long as men are acquisitive and some suffer from greed, subjective contracts depending on after-the-fact evaluation used by the two techniqes just described will not be a final solution to the problem of rewarding contractual motivation. Subjective contracts may be an acceptable substitute where the cost and benefits from objective contracts are not economically feasible. The NASA study on incentive contracts found this same result. They took a small sample of five CPAF contracts. In four of these, the incentives generated tangible motivations and responses from the contractors.[22] The basic benefits produced by the CPAF contracts were not the same as those trade-offs sought by the incentive models. The CPAF concept resulted in better communication and review

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[22] Booz, Allen & Hamilton, *op. cit.*

techniques, a by-product of systematic monitoring and evaluation. Improved performance was not so much the result of trying to achieve greater profits.

Summary

A carefully structured incentive matrix can motivate the contractor towards common goals and the elements selected for that matrix should correspond with major contract goals. The preferable incentive model will use incentive variables related to overall system effectiveness, requiring the buyer to carefully weigh the value of additional performance against cost. Several methods were described which successfully pursue this objective, but two guides, the Value Statement concept and the Integrated Approach, were considered especially useful.

Maximum impact or motivation can only be exerted if incentive variables in the contract orient the contractor before work begins. For this reason, after-the-fact evaluation systems are rejected. They do not ensure later contract trade-offs in the best interest of the customer.

Incentive parameters in a model make the payment of profit automatic and objective. This approach is consistent with one school of management thought called decision-making. All contract decisions should be made on the basis of choosing the most favorable economic alternatives available.

CHAPTER VI

DELIMITATIONS OF INCENTIVE CONTRACTS

Introduction

To declare patently all virtues and no vices for incentive contracts would distort fact. The purpose of this section will be to raise objections, and then offer solutions to incentive structuring problems. Objections from critics take two forms; they usually pertain to either structural problems, or administrative problems. Structural problems concern mechanics of incentive models, while administrative problems result from daily operations. Another way of classifying problems might be according to their phase of occurrence, such as precontract, during negotiation, or during performance. The discussion overlaps any rigid classification.

Structural and Administrative Problems

Operational incentive contracts are confronted with major negotiating problems when contract modifications, sometimes called changes, revisions, or supplemental agreements, are excessive. The terminology used to describe changes varies from one government agency to another. Two basic change forms occur: those which are minor and only require the contractor to alter his routine for no additional payment; and those which are outside the scope of the original agreement, or simply stated, new work. New work requires additional payment for recognition of additional performance. The former class of change presents no real difficulty. However, any time the government requires new work or changes leading to new funding on an incentive contract, the original incentive matrix is altered. The most desirable outcome possible is to disturb the original agreement as little as possible assuming both parties were satisfied with the incentive arrangement.

Negotiating an equitable adjustment under these circumstances requires strict adherence to the following rule: the change should not provide either party with an opportunity to reprice the unchanged portion of the work. The basic terms of the initial agreement should not be disturbed. In fact, since modifications will automatically occur on a long development contract, the initial instrument should state explicitly the method by which these changes, which are not supposed to interface with the original incentive, will be handled. There are two extreme methods which represent opposite approaches to the changes problem. These will be explained with the aid of an example illustrated in the DOD Incentive Contracting Guide.[1] Alternative methods are some variation of one or the other and will not be discussed at length.

For purposes of illustration a simplified example is used. The contract is a CPIF rather than a FPI contract;

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[1] DOD Incentive Contracting Guide, op. cit., pp 57-71.

the change is additive as are most changes, rather than deductive. Deductive changes might be applied using the same processes in reverse order. Also, the changes will concentrate on cost-incentive provisions only. The complexity of changes under multiple-incentives complicates illustration. However, the principles developed for application in the cost-incentive-only situation are equally apropos. The problem of preventing alteration of the incentive matrix becomes more severe.

Given an existing CPIF contract with these basic provisions:

Target Cost	$100	
Target Fee	$ 6	(6%)
Maximum Fee	$ 14	(14%)
Minimum Fee	- $ 2	(-2%)
Share Ratio	90/10 ± 10% of TC	
	65/35 over ± 10% (± $10) of TC	

Therefore, the fee swing (FS) is plus or minus $8 (±8%) and the range of incentive effectiveness (RIE) is from $70 to $130 (±30% x $100 target cost).

The government decides on a contract modification and the contractor negotiates a cost of $10 for the additive work, plus a fee of $1 (10%) based on Weighted Guidelines (See Chapter IV). A first approximation would show that the new TC was now $110, ($100 + $10) and that the new TF $7, ($6 + $1). The question both parties have to resolve is how to incorporate the change for the contract modification into existing incentive provisions?

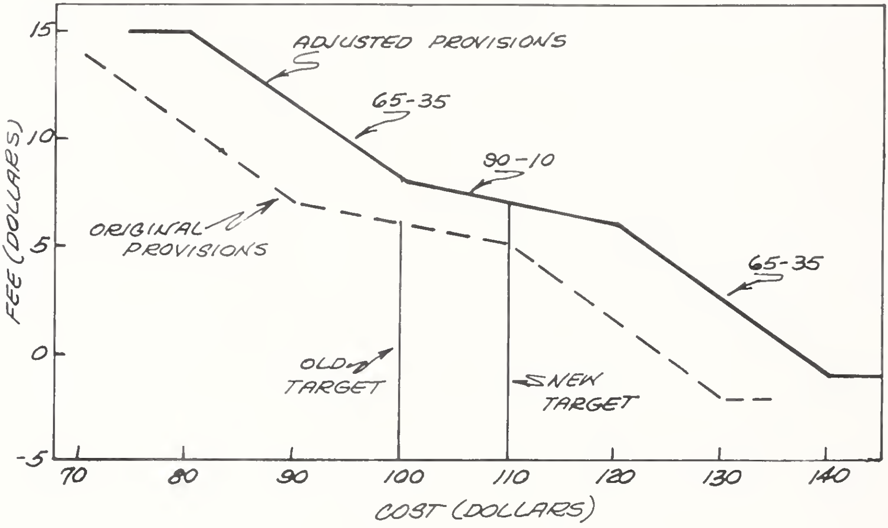
The first method possible would be to keep the dollar relationship expressed in the original contract constant. See Figure 6.1(a). TC is increased by the exact cost of the change, and minimum and maximum fees are adjusted upward by the same amount as fee added to TF as a result of the negotiated change. The share line is shifted in Figure 6.1(a); but it is the same with regard to dollar variation from the new TC. Thus the constant-dollar method of incorporating the change does not spoil or alter the sharing arrangement; the share line is simply shifted to the right to correspond to the dollar amount of the change. The RIE is exactly the same as before, plus or minus $30 from TC, and the FS is also the same, plus or minus $8, [7 - (-1)]. When these dollar changes are completed, the contract target percentages are entirely different. Now, with new figures:

Target Cost	$110	
Target Fee	$ 7	(6.36%)
Maximum Fee	$ 15	(13.64%)
Minimum Fee	- $ 1	(-0.91%)
Share Ratio	90/10 within ± 9.09% (± $10) of TC	
	65/35 over ± 9.09% (± $10) of TC	

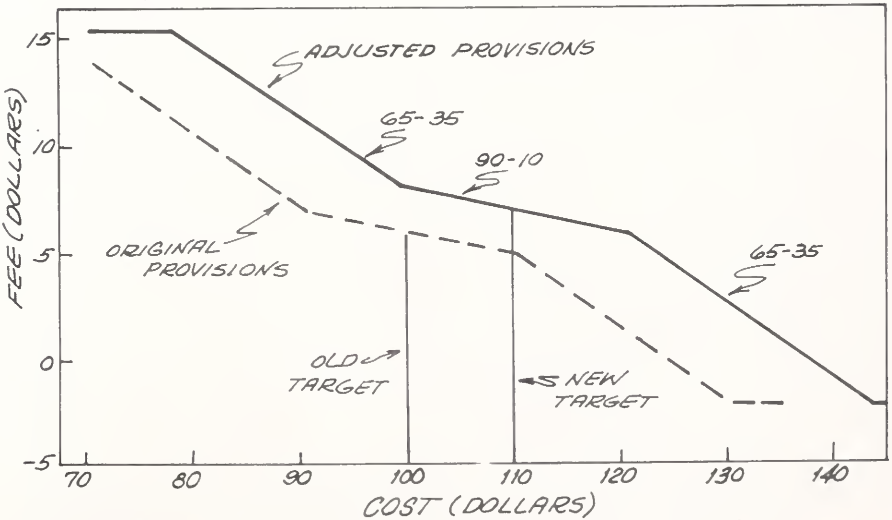
The second method that could be used to adjust the existing incentive arrangement is called the <u>constant-percentage method</u>. It disregards dollar relationships of the original agreement and seeks to preserve percentage relationships instead. For instance, the new work would still cost +$10 but the profit incentive would be derived from the original contract and:

FIGURE 6.1
CPIF CHANGE: DOLLAR VS PERCENTAGE ADJUSTMENTS

(a.) CPIF CHANGE: DOLLAR ADJUSTMENTS



(b.) CPIF CHANGE: PERCENTAGE ADJUSTMENTS



SOURCE: DOD INCENTIVE CONTRACTING GUIDE, PAGE 59.

Target Cost	$110	
Target Fee	$ 7	(6.36%)
Maximum Fee	$ 15.4	(14%)
Minimum Fee	- $ 2.2	(-2%)
Share Ratio	90/10 within ± 10% (± $11) of TC 65/35 over ± 10% (± $11) of TC	

This technique retains the same maximum and minimum fee percentage. However, in the process of so doing, the FS becomes plus $8.4 and minus $9.2. In addition, the RIE is changed to a minus $31.8 from TC, and a plus $34.1 from TC. This is illustrated in Figure 6.1(b).

An overall comparison of the constant-dollar and constant-percentage methods emphasizes their similarity in the TC and TF region. Differences do not occur until one gets to the extremes of possible cost outcome. For example, in the 90/10 incentive region, outcomes were identical. Even in the 65/35 region the differences are only one quarter of one percent. This can be verified by making a superimposition of Figure 6.1(a) on 6.1(b). There is also the consideration of uncertainty at the extreme cost outcomes. The constant-dollar method ignores uncertainty, as a figure with 100 percent confidence is added to a target which had a plus or minus 30 percent uncertainty. The constant-percentage method is extreme to the opposite degree; it assumes the same uncertainty for the change work by applying constant-percentages even though there may be 100 percent certainty regarding the modification.

The constant-dollar method has the advantage of retaining the share line; of being simple to administer; and of not extending overrun or underrun protection or opportunity. The constant-percentage method has the advantage of not disturbing the original percentage objectives of the contractor, thus goal tracking may be easier. Between the two alternatives, it must be said that the constant-dollar method is usually preferable. Constant-percentage alters the incentive matrix drastically when multiple incentives are involved. Since this is not desirable, dollar adjustments are preferable.

A compromise between the constant-dollar and constant-percentage method is called the equitable-adjustment method. This approach consists of negotiating a change for any item in the original incentive arrangement which might be affected by the additive work, hence a new TC, TF, maximum and minimum fee and even a sharing arrangement might result. The parties must remain objective to avoid repricing.

Finally, contract modifications may be negotiated as separate baby contracts. While this permits the parties to use any kind of pricing arrangement, i.e., FFP or CPFF, and completely isolates the basic incentive arrangement from disturbances, it is not especially desirable. The parties must assume to have exact knowledge of the change amounts for this to work. This is a possibility in level-of-effort contracts, but seldom occurs in research and development work. The incentive arrangement should be extended to include all work both old and additive performed by the contractor.

Evidence and fact gathered to date from experience suggests other constraints created by incentive contracts, but none assume the importance of changes. One of the frequently heard objections is that the entire foundation of the incentive matrix is usually built upon supposition. TC and TF are based on estimates which are built on *a priori* reasoning. Even though the DOD may spend millions in project definition, critics are always concerned with the possibility that the incentive matrix will produce large intentional overruns because final targets were set loosely.

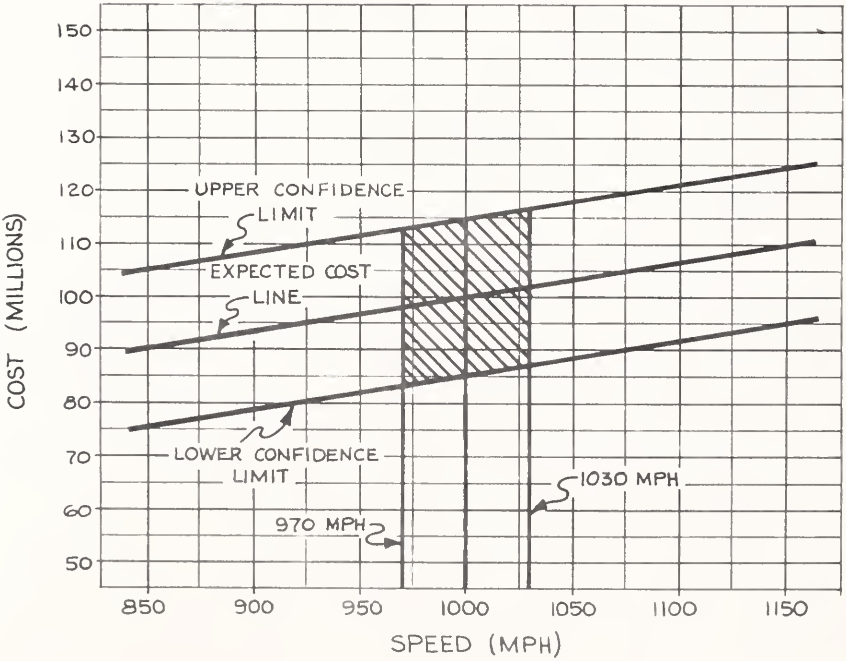
There are several safeguards available to the government which could prevent massive overruns, or, more particularly, might also insure that the contractor does not achieve lowest cost/highest fee with loose goals.

Figure 6.2 illustrates the cost/performance development curve for a hypothetical airplane contract. Assume the parties had a great deal of confidence in the cost estimates they had agreed upon. Negotiation would continue, based on the narrow confidence limits illustrated. TC of $100M̄ would have a narrow RIE from $85M̄ to $115M̄, and the performance incentive similarly would operate over a narrow RIE, from 970 to 1030 MPH.

If the government does not agree with the contractor's precontract figures, and does not have the capability of submitting additional ones as substitutes, less confidence can be placed in the estimates. Figure 6.3 represents the same procurement situation only the RIE has been extended

FIGURE 6.2

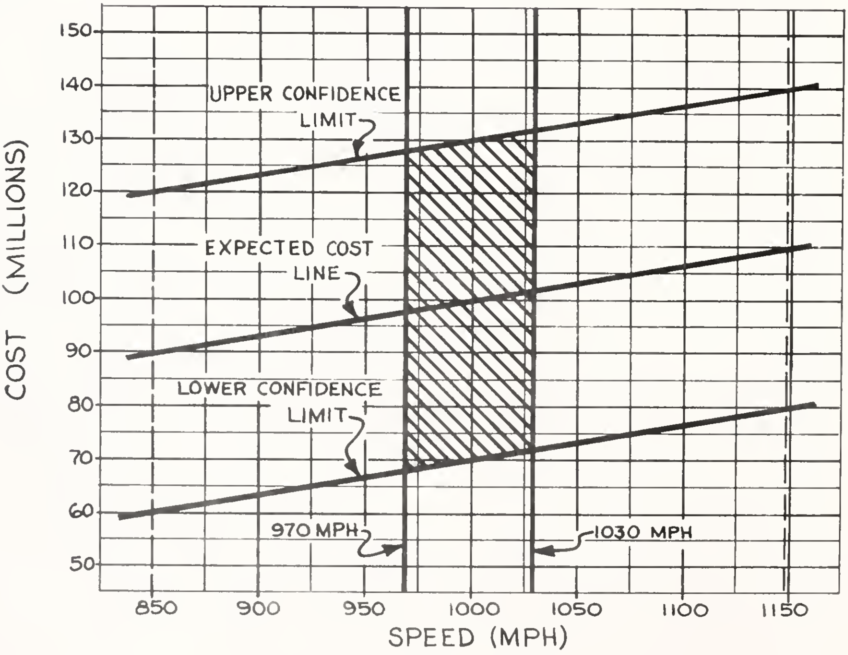
COST/PERFORMANCE CURVE WITH NARROW CONFIDENCE LIMITS



SOURCE: DOD INCENTIVE CONTRACTING GUIDE, PAGE 7.

FIGURE 6.3

COST/PERFORMANCE CURVE WITH BROAD CONFIDENCE LIMITS



SOURCE: DOD INCENTIVE CONTRACTING GUIDE, PAGE 73.

because of possible variation in the target estimates. Now with a TC of $100M, the cost RIE extends from $70M to $130M, while the performance RIE is unchanged. The government still wants the same plane but now there is less certainty regarding its final cost. By extending the RIE over a greater range, with the same share ratio, the contractor's opportunity to earn maximum fee was lessened, as was the probability of a massive overrun.

The use of probability theory to select targets is not restricted to incentive contracts alone. Confidence intervals can be used when negotiating any kind of contract. However, the other contract forms have but one figure of major significance. With the CPIF or FPI contracts, there is a range of major significance and the actual outcome has a much better chance of falling within this range. Making the incentive operable over this range seems like a logical solution. Furthermore, the possibility of a major overrun that might cost the government many additional millions, or of a lopsided underrun that might give the contractor added millions in profits, exists with the conventional FFP or CPFF contracts also. These shortcomings do not exist to any greater degree with incentive contracts. Careful estimating using probability theory can counteract these threats.

No other contract form provides for intentional overruns that increase performance levels as does the incentive contract. True, once the contractor exceeds the upper confidence limit of minimum fee, if he still doesn't have an acceptable product, the government must resort to other control techniques. With no incentive left, the CPIF contract becomes a CPFF contract. This is unfortunate, but it also indicates the government must manage the contractor while he is operating within the RIE, to ensure that increases in cost always obtain additional performance. Overrunning a target on cost is not detrimental in itself; overrunning without getting additive performance is wasteful and represents poor management.

The Scherer Thesis

Scherer's study examined the relationship between the tightness of cost targets on FFP and FPI contracts and came up with some interesting conclusions.[2] In practice, the contractor's behavior is markedly affected by whether or not he thinks the target is fair, or is tight. Under both of these contract forms, the profit-cost correlation persists, so that for every dollar saved under target cost, the contractor earns one additional dollar of profit. The monetary incentive for marginal cost reduction is a constant. This is the reward theory which was described earlier. It is an unwritten clause in every contract form: decreases of cost are recognized as/with increments of profit.

Another theory is necessary to explain the reactions by contractors to the "tightness" or "looseness" of targets. This is extremely significant if the contract was negotiated

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[2] Scherer, op. cit., pp. 230-234.

using a confidence interval. The second theory considers the contractor's behavior from the standpoint of risk and the tight target. Studies repeatedly showed that contractors exhibited risk aversion to the extent of negotiating lower share ratios in the overrun portion if they had to expose themselves. Scherer believes this propensity extends into the negotiation of all incentive areas. Contractor behavior is prompted by several factors, one of which is the cardinal rule: never take a loss. The American corporate executive is obsessed with a fear of losses; small or insufficient profit is tolerable but losses are a symbol of managerial failure.

The two theories undoubtedly describe a joint function. The reward theory explains economic behavior and the drive for the profit maximization goal. The pressure theory explains valid psychological phenomena and identifies the risk aversion goal. Incentive contracts may create a situation where the contractor's behavior is motivated by <u>both</u> sources. For instance, if the profit-performance correlation is expected to occur in such a range as to pose a serious possibility of loss because the government negotiated a very tight target cost, the contractor will use risk-aversion techniques.

Scherer's studies of incentive contracts found that the distribution of actual cost outcomes from cost targets had a standard deviation of roughly ten percent.[3] Taking this

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[3] *Ibid.*, p. 232.

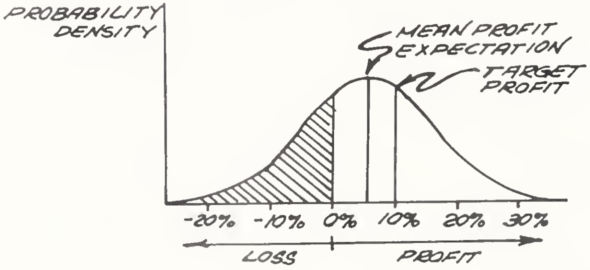
figure as a standard, and rejecting other causes of uncertainty, contractors may develop a relationship between negotiated target costs and expected actual costs, so that even though the <u>possibility</u> of a loss is foreseen, the <u>probability</u> of loss can be reduced by increasing efficiency. For example, in Figure 6.4(a), the corporation's management team perceives a prior subjective probability distribution of possible profit outcomes which include a substantial probability of loss at seventy percent efficiency (see shaded area). In Figure 6.4(b), the contractor shifts the distribution and reduces the probability of loss to a tolerable level, with an average profit expectation. Simultaneously, he increases his efficiency to eighty percent. The pressure theory incentive is stronger with a higher perceived probability of loss, as in Figure 6.4(a).

In many ways Scherer suggests that the influence of the pressure theory is greater than the influence of the reward theory. Reward theory incentive is a function of the contractor's share ratio, and it is a constant over variations in target cost, target profit, and uncertainty. On the other hand, pressure theory incentive strength is dependent upon three variables: cost target tightness, the contractor's share ratio, and uncertainty. If mean profit expectation is greater than target profit, there is room for estimating error, as with Figure 6.4(b). However, if mean profit expectation is less than the target profit, the contractor has a

FIGURE 6.4
PRESSURE THEORY AND PROBABILITY IMPACT

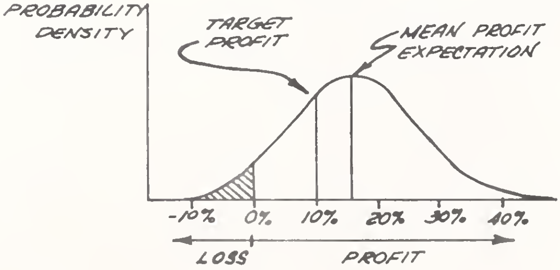
(a.)

SEVENTY PERCENT EFFICIENCY



(b.)

EIGHTY PERCENT EFFICIENCY



SOURCE: SCHERER, OP. CIT., PAGE 233.

slender margin of protection against losses from any uncertainty, and the pressure theory incentive is stronger. *Ex ante* uncertainty is the expected standard deviation of possible cost outcomes, and varies from contract to contract. Given a negotiated cost and profit target, the pressure theory incentive will be stronger with a greater expected standard deviation of possible cost outcomes because the total probability of loss is higher.

The critics of incentive contracts who say they are fundamentally poor instruments because every outcome depends on *a priori* estimates lack an understanding of the reward and pressure theories. The purpose of this section has been to demonstrate that probability applied to the negotiation process can reduce substantially the risk of either massive profits or massive overruns. The government's representative can try to negotiate contracts that incorporate degrees or reward and pressure incentive. Contracts so negotiated will be in balance.

Roberts/Sloat Thesis

A research program at Massachusetts Institute of Technology which is studying the organization and operation of research and development programs in this country has published other comments critical of the incentive contract when utilized for R&D work. These comments shall be called the Roberts/Sloat thesis after the men who conducted the specific study and published their findings.[4] The Roberts/ Sloat thesis casts a shadow on the subject of incentives; it tentatively concludes that incentive contracts used in R&D work were not effective in obtaining desirable outcomes. While the researchers had no cause for bias, the unfavorable findings obviously had an origin. It behooves us to examine the approach and methods of this study.

Five research and development contracts that were converted from cost reimbursement types to incentive types were studied for this project. The sample was extremely small by any testing standards. Furthermore, let it be noted that persons at the project level in the companies that had these contracts indicated uniformly that they opposed the idea of conversion when it was suggested initially. If one judges from the aspect of attitude and role, less than 100 percent cooperation existed because the contractors resisted the forced imposition of incentive contracts on the work that had to be performed. It does not seem comparable to a situation where both the government and the contractor greatly desire an incentive contract for the opportunities it presents.

Out of the five contracts studied, each contractor tried to avoid risk by some combination of stalling and

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[4] Edward B. Roberts and J. Barry Sloat, Effects of Incentive Contracts in Research and Development: A Preliminary Research Report. (Boston: Mass. Institute of Technology), April, 1966.

allowing time to reduce the uncertainty or by refusing to negotiate agreements that contained cost sharing possibilities. Losses, when they occurred on incentive contracts, were highly motivating in an unfavorable way: contractors threatened the government with work stoppages or began taking harmful shortcuts. Decreased technical flexibility resulted; every change had to be negotiated, which created major problems. Sometimes poor communication between top management and project management caused companies unintentionally to enter high risk incentive agreements when this risk was known at lower tiers. Contractors avoided risk by refusing to negotiate share ratios that might lead to a significant penalty (pressure theory). Administrative time allocated to changes increased in each contract; the process of negotiation reflecting many subjective variables had more influence on cost outcome, relative to target cost, than did the operation of automatic contractual incentives. Weighting of incentives to get a proper balance for those objectives that the contracting agency felt were most important was a problem. The most serious problem Roberts and Sloat found was obviously the suggestion that a contractor would take harmful measures in avoiding losses.

This one point was so prominent that they recommended, "therefore, that contractor cost-sharing ratios of more than a few percent be avoided in the sharing structures of incentive contracts designed to motivate desirable contractor behavior."[5] Nothing could be further from the truth as

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[5] *Ibid.*, p. 20.

a basic concept of incentive philosophy. In order to make an incentive which actually motivates the contractor, high share ratios are necessary, as it is the opportunity for reward that begets unusual performance.

The Roberts/Sloat study found desirable effects also. Examples were: increased contractor and government concern for control of contract changes; increased management involvement which led to better specifications on work to be performed; greater concentration on the process and mechanics of contract change negotiation; and a high level of involvement between representatives of both parties. There were other contract areas which received a skeptical treatment.

The Roberts/Sloat study recorded several dysfunctional consequences of incentive arrangements. One not cognizant with the methods of structuring incentive contracts might falsely assume that undesirable effects exist to the same degree in a carefully structured model. There is no basis for this opinion.

The study contained a false premise in that a few contracts were assumed to be representative of the entire universe. Hopefully, they were not. They also assumed that a degree of, at least, partial control existed in the sense that a control experiment is made using the scientific method. Their study covered several contracts that were originally awarded on a CPFF basis and were then converted to incentive. The researchers assumed a before and after comparison of behavioral changes was valid. However, each of the contractors had balked at the prospect of conversion. The Roberts/Sloat thesis is here rejected; the sample was too small and not representative, and the study was based upon incentive contracts structured by traditional techniques. The purpose of this paper was to collect several models that could effectively overcome the dysfunctional effects of improperly structured contracts. There is reason to presume that undesirable effects can be controlled, or perhaps would not even be present in a contract designed properly, i.e., one which tests interdependency and checks trade-off objectives.

One final word on Roberts and Sloat. Evidently the isolation of the academic world was responsible for the strong recommendation that contractor share ratios be very low. Contract administrators and negotiators with any experience know that shallow share ratios have two primary undesirable effects. First, the government is automatically inviting the contractor to maximize by overhead packing as the example in Chapter IV demonstrated. Second, the share ratio recommended of a few percent has a very shallow slope, hence it is tantamount to a CPFF contract with a horizontal share line. A weak incentive would only generate weak motivation, and incentive effectiveness would be diminished additionally.

The proponents of an integrated approach to incentive structuring are insistent with regard to compartmented incentive. This problem arises when parties negotiate separately incentive provisions for cost, performance, and schedule. Performance and schedule are a function of cost, and their relationship varies continuously at different output levels. Any model which establishes interdependency can overcome this objection. Even building overlap into an incentive agreement compensates for a deficiency of this nature. Another analytical rule states that fee should always be monotonic and should increase with effectiveness value. This insures the customer against undesirable trade-offs.

For example, in Figure 6.5(a) all incentive variables are related to total cost. Overall effectiveness is desired, and it is included at a value of zero for target cost. Fee relationship is linear and constant. The constraints in Figure 6.5(a) are minimum and maximum fee; the fee range extends over a range of incentive effectiveness bounded by minimum and maximum cost. Most of the models which do not specifically include effectiveness value are like this one.

Figure 6.5(b) represents an incentive arrangement where total fee is single valued, monotonic, and also includes effectiveness value and total cost written to specified government objectives. Both effectiveness value and total cost variables determine fee amount.[6] Incentive plans which incorporate both of these variables eliminate many problems associated with incentive contracts, such as dependent weighting of

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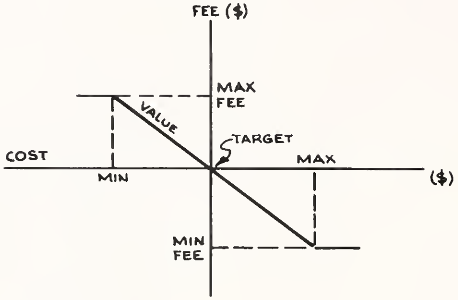
[6] DOD Incentive Contracting Guide, op. cit., pp. 109-110.

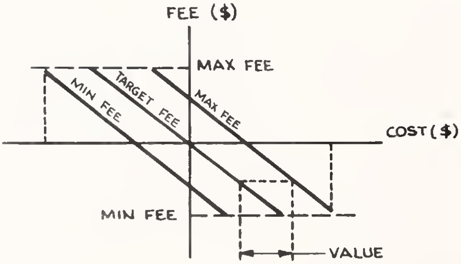
FIGURE 6.5

EFFECTIVENESS VALUE AND TOTAL COST EFFECT ON FEE

(a) OVERALL



(b) VARIABLE



SOURCE: <u>DOD INCENTIVE CONTRACTING GUIDE</u>, PAGE 109.

individual incentive variables, trade-offs which must be made when one (or more) individual incentive parameter has reached its fee plateau, etc.[7] This technique also eliminates the requirements to negotiate a separate target fee with a minimum and a maximum for each incentive; thus the negotiating requirements are not as burdensome as is the case when the parties negotiate a compartmented incentive contract.

One condition noted with level-of-effort and service contracts is that contractors are more vulnerable to the demands of organized labor. The hypothetical situation arises whereby a union whose demands are spurned by a contractor under performance and schedule incentives might use a slowdown, work stoppage, or even sabotage to force the contractor to meet demands. In effect, the contractor might be faced with the alternative of an unplanned trade-off: He might pay the increased wages demanded by the union so that a performance or schedule goal is not missed, or he might forego the cost incentive fee because of unplanned spending. There is no way to guarantee that this will not happen; however, the contractor can protect himself by having an adjustments clause which passes wage increases on to the government. The leverage-effect of labor is not restricted to incentive contractors; any contractor under a FFP contract runs the same risk of having profit dollars converted into

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[7] *Ibid.*

wage expenses by sudden union demands.

The obvious answer to this problem is that labor-management relations must not deteriorate, and contracts with unions should be negotiated for a longer period of time than incentive contract duration to provide a guaranteed cost base.

Another charge made quite frequently is that incentive contracts require greater administrative effort and cost. Claims have been made that incentive contracts require more negotiating, more auditing, more checking, and more control. Again, the rebuttal is based on empirical observation, not on scientifically tested data. Yes, the incentive contract requires all of these in greater amounts than straight fixed price contracts. No, incentive contract requirements for these services are not as demanding as they are with cost-reimbursable contracts.

The fact remains that more time and effort put into negotiation often results in much better contract definition. This must be considered an asset and not a liability of incentive contracts. As far as additional audit, reporting or checking are concerned, there does not appear to be a greatly increased requirement. In fact, proof positive exists that the government, at least, can save on audit and checking costs. The way in which this occurs will be explained.

Risk

The DOD has borne a major share of the cost risk entailed in the performance of many kinds of contracts because of the prevalence of cost-reimbursement type contracts for so many years. More recently, the burden of risk has been substantially shifting from the government back to defense contractors due to refinements in contracting techniques and greater utilization of FFP and incentive type contracts, resulting in a continuing reduction in the use of CPFF contracts. However, during the period when CPFF contracts were prevalent, or the so-called period of high government risk, many administrative, cost, and audit controls were imposed on industry. "Now that higher risk contracts are being increasingly used, it is considered desirable and practicable to measure the cost risk motivation imposed on individual contractors as evidenced by the mix of contracts, and whenever practicable to eliminate administrative controls and reasonableness overhead audits on those contractors who attain a verifiable 'weighted average share' of risk which meets a prescribed threshold."[8] A concept was developed based on the premise that good management by industry properly motivated to cost consciousness can accomplish much more effective control of costs than can detailed review, control, and overhead audit by government personnel. This concept is called "The Contractor's Weighted Average Share

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[8] Defense Procurement Circular, Department of Defense, No. 50, December 30, 1966, p. 2.

in Cost Risk" (CWAS).[9]

The objectives of CWAS are:[10]

a. to furnish a measure of an individual contractor's risk motivation, as provided by types of contracts, and to conduct his business prudently and with maximum economy.

b. to offer additional inducement to a contractor to accept higher risk type contracts.

c. to minimize the extent of government control, including controls exercised through Department of Defense prime contracts and subcontracts thereunder, thereby reducing government costs.

d. to provide a simple, uniform procedure for determining a contractor's assumption of cost risk that can be applied equitably to all defense contractors who desire to participate by voluntarily submitting pertinent data.

e. To provide a means for directing audit and other Department of Defense management efforts to those areas where they are most needed because of the greater degree of government risk.

f. To provide a basis for determining that indirect costs incurred during the applicable period by a contractor whose CWAS rating is above a predetermined threshold are reasonable and therefore reimbursable if otherwise allowable and allocable.

CWAS provides that a single-threshold level be used for all the above applications. A technique has been devised for determining and expressing numerically the degree

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[9] Ibid.

[10] Ibid., pp. 2-3.

of cost risk a contractor has assumed, based on an analysis of the mix of types of contracts which he has agreed to perform for his customers. The percentage factors to be used in determining the CWAS by type of contract are given in Table 6.1.

The contractor's weighted average share in cost risk is determined as follows. First, total dollar costs incurred for commercial work and government contracts by specific type for the fiscal year just ended are listed separately. Second, the costs incurred for each class of contract are multiplied by the approval percentage factors given in Table 6.1. This is the contractor's dollar cost risk. Notice that risk is relatively higher for CPIF, FPI and FFP contracts because the percentages are greater than those for cost-reimbursable types. For example, the CPFF contract carries a factor of zero. Third, the resulting contractor dollar cost risks for the respective types of contracts are totaled. The sum is next divided by total dollar costs incurred. The result is the contractor's CWAS rating.

Once a contractor has a CWAS rating, the government uses it to judge the reasonableness of indirect costs the contractor is claiming. To a certain extent, the allowability of an indirect cost is based on reasonableness of the nature and amount. The only way available for the government to determine reasonableness in the past has been by 100 percent audit. However, the CWAS rating substitutes

TABLE 6.1

PERCENTAGE FACTORS USED TO DETERMINE CWAS

Type of Contract	Percentage Factor
Letter Contracts	0
Time and Material	0
Labor Hour	0
Cost Only	0
Cost Sharing	share line
Cost-Plus-a-Fixed-Fee	0
Cost-Plus-Incentive-Fee	15%
Fixed-Price-Incentive (Successive)	55%
Fixed-Price Incentive (Firm)	55%
Fixed-Price Redeterminable (Retroactive)	50%
Fixed-Price Redeterminable (Prospective)	80%
Fixed-Price with Escalation	80%
Firm Fixed Price - Non-Competitive	80%
Fixed-Price with Escalation (Competitive)	100%
Firm Fixed Price - Competitive	100%
Commercial	100%

Source: *Defense Procurement Circular*, No. 50, (Washington: U. S. Department of Defense), December 30, 1966, p.7.

the investigative process, since the government has stated it will rely on the CWAS rating for reasonableness. A contractor with a profit center with a CWAS rating of 65 points or higher, 35 points or more of which rating were derived from competitive FFP contracts or commercial sales, will not be questioned on the reasonableness of his indirect costs.[11] If the profit center within which the cost is incurred has a CWAS rating of 50 or higher, but less than 65, the Administrative Contracting Officer (ACO) _may_ at his discretion consider the cost reasonable and not question it.[12] It is optional with the individual ACO and the procurement situation.

The reason the CWAS rating system has been reviewed so extensively is that it will probably achieve greater importance as contractors become familiar with it. As this occurs, there will be one more impetus to utilize incentive contracts. Both the government and the contractor will realize substantial administrative cost savings and the objection that incentive contracts require more audit and control can be laid to rest. By letting contractors manage their own affairs under incentive arrangements, there is less need for government counterparts and redundant manpower for checking.

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[11] _Ibid_., p. 11.

[12] _Ibid_.

The Booz, Allen, and Hamilton Study

This study is limited to NASA incentive contracting effectiveness only; DOD incentive contracting practices have been in existence longer and probably achieve greater sophistication. However, the NASA incentive contract experience is equally appropriate for a general description of conditions.

The Booz-Allen study is not critical of incentive contracts *per se*, but only of why they might be considered imperfect. For example, the study noted that present guidelines are inadequate for obtaining maximum benefit from performance and schedule incentives.[13] It criticized the value statement approach for establishing incentive weighting by suggesting that it is of little assistance in developing appropriate incentive structures. One of the most important influences on the effectiveness of incentive structures was extracontractual factors. Present structuring methods give no recognition to extracontractual influences. One might add that official procurement guides , such as *ASPR*, are of little benefit on the subject of extracontractual factors, regardless of contract form.

In the 15 contracts Booz-Allen reviewed, corporate pressures existed to secure new business and to maintain high performance. These "were clearly the dominant source of contractor motivation."[14] The influence of extracontractual factors often resulted in actions that reduced short-term profit under the terms of incentive agreements.

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[13] Booz, Allen, and Hamilton, op. cit., Appendix B(5).

[14] *Ibid.*, p. 14.

Examples noted were that pressure to secure a contract often outweighed considerations of incentive provisions; pressure to achieve maximum performance generally outweighed cost considerations; and, extracontractual motivation in some cases caused contractors to ignore provisions of the incentives. The Booz Allen recommendation is that new ways must be created to deal with extracontractual factors. Whether or not this is a soluble problem is uncertain; your author would not be critical of incentive agreements which are incapable of resolving impossible problems.

The report also states that there was little evidence that incentive features had been used in formal trade-off analysis.[15] The implications of this charge are quite serious. If trade-off analysis is not used by the contractor for decision making, the development of incentive contract models that emphasize this tool has been in vain. Each case contract was studied to see exactly how the performance incentive features were used in trade-off analyses against cost incentives. Other than for one exception, no evidence was found of formal analysis in which fees associated with cost and performance were systematically related in order to reach a so-called cost-effectiveness decision. The report researchers felt that trade-offs when made were neither the all significant or controlling factor used in arriving at a final decision.

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[15] _Ibid._, p. 32.

All in all, Booz-Allen study criticisms with regard to incentive effectiveness were extremely mild. The overall tone of the report is favorable and in complete agreement with incentive philosophy. It behooves us to look at the benefits they found in conjunction with incentive effectiveness. These advantages will not be expanded since several have been reviewed already.

The report presents benefits of incentives in two forms: demonstrated and potential.[16] The demonstrated benefits are:

1. Incentive contracting requires and results in better program definition.
2. Incentive features aid in communicating NASA objectives.
3. Performance and delivery incentives provide contractors with effective management tools.
4. Incentive features contribute to attainment of program objectives.
5. When incentives are applied to a prime contract, contractors are generally successful in introducing incentives with subcontractors.

Potential benefits described are those which the evaluation said existed, but benefits had not yet been fully realized. They are:

1. Incentive contracting can result in more realistic cost estimates than usually achieved under CPFF arrangements, as long as the cost incentive has included significant financial penalties for overruns.

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[16] _Ibid._, Section IV, parts 2 and 3.

2. The more rigorous change procedures resulting from incentive contracts generate better control of changes.

3. Incentives reduced the need for day-to-day surveillance.

4. The closer communication between NASA technical and administrative personnel required by incentives provided an opportunity for improved cost-effectiveness decisions.

5. The ability of incentive effects to promote cost-estimating realism was potentially very high.

Final highlights of the Booz-Allen study take the form of some specific recommendations. Among these are that: incentive contracts should continue to be used for R&D contracts and support services since the advantages far outweigh the disadvantages; present guides covering the structuring of performance, delivery, and cost incentives need revision; incentives should be structured for maximum utility as motivational device rather than as trade-off models; primary weight should be placed on cost incentives; techniques should be developed that will recognize extra-contractual influences in structuring contracts; risk factors should be assessed more closely in selecting contract type and structuring cost incentives; feasibility of employing phased incentive arrangements should be evaluated; the value and effectiveness of interdependent incentives should be studied further; CPAF techniques should be applied in more contract situations; and, studies on recent contracts for major programs should continue.

The Booz-Allen evaluation of incentive contracting practices is optimistic. Incentive contract limitations were negligible in the face of many offsetting actual and potential benefits.

Summary

All government contracts have persistent problems such as those described in Appendix C. Incentive contracts have an additional set of related problems which are peculiar to this instrument and may be of a structural or administrative nature. For example, contract changes alter the existing model and must be negotiated on a constant dollar basis, a constant percentage basis, or some variation of either method.

Negotiating target cost, profit, and related variables is more difficult than with conventional contracts but the application of probability theory is recommended as a means of making the process more objective. Furthermore, the use of other techniques, such as having single valued, monotonic fee relationships, coupled with an overall effectiveness model, can further avoid dysfunctional consequences. Some additional foresight can be added by the introduction of pressure theory, reward theory, and the Roberts/Sloat thesis. While profit can be utilized to motivate contractors, and there is positive and negative profit, the threat of losses seems to exert a disproportionate effect on contractors. Thus, the stick must be used more judiciously than the carrot.

An extensive, but as yet incomplete study by a reputable source, the Booz-Allen conclusion was that the positive aspects of incentive contracts outweighed the negative aspects, and that the additional administrative burden was justified. Emphasis was given to the point that nonfinancial benefits must also be considered. As a rule, the incentive contract resulted in greater management efficiency.

The results of all studies to date on incentive contract effectiveness are inconclusive or premature. Much has been learned for the time, from empirical observation; however, much remains unknown about the motivating process and how incentives affect it.

Some of the models described in this study have never been used. Others have found application on one major procurement. A small sample cannot accurately predict all possible features, either pro or con, of the incentive arrangement. Additional studies evaluating completed incentive contracts are required and they will probably identify good and bad features unthought of for the present.

The M.I.T. and NASA studies concerned the so-called first generation incentive contracts, those which did not relate incentive parameters to one another, and did not use models or matrices to test the interdependency effect. The next generation of incentive contracts will possibly use trade-off models, and will have fewer limitations.

The application of improved contract models, and a willingness to experiment with the structuring problem may help the incentive contract survive the fate of the CPFF contract. The CPFF contract had no flexibility and only one form. The incentive contract is a multi-faceted instrument capable of adaptation in the sense used by naturalists. Problems can be solved when they appear, as long as flexibility in model building and the will to simulate exist. The prognosis for incentive contracts is favorable.

CHAPTER VII

SUMMARY AND CONCLUSION

The use of incentive contracts for DOD procurements has escalated rapidly during the last five years. While their utilization is mandatory, the community of defense contractors has accepted this instrument with reservations. They fail to recognize the opportunity to optimize profit under incentive contracts and recall instead visions of government agencies using this contract method to their disadvantage.

The distaste for incentive contracts stems from an unfavorable first experience with this contract form. Some of the first incentive contracts became dysfunctional, that is, the final outcome was a reversal of initial expectations. The first incentive contracts were structured by negotiating cost, performance, and schedule elements separately. The parties would then tie the elements together by assigning weights on the basis of subjective priority. The weighting system was supposed to automatically ensure that goals pursued by the contractor were the same goals desired by the government. After a period of time had elapsed and the results of completed incentive contracts became available, DOD concern grew over the lack of goal congruence. Contractors faced with the decision of delivering greater performance capability while sacrificing fee would ordinarily choose to halt work and protect the fee they had already achieved, to the chagrin of the government.

The theoretical foundation of incentive contract arrangements is sound. Both parties to a contract can participate in savings if they exist. The U. S. must conserve scarce resources and that is why the DOD adopted the incentive philosophy. In order to work, however, incentive contracts must motivate a contractor to become more efficient. Furthermore, the tendency of the first incentive contracts to become dysfunctional must be eliminated.

The use of incentive contract models was proposed as a solution to this problem. The hypothesis was that an incentive contract model which recognizes and tests interdependency between elements will tend to optimize goal congruence between the government and the contractor, automatically eliminating many problem sources.

Results of Study

Investigation of methods for structuring incentive contracts led to the discovery of several existing specified models, such as PIIM, STOIC, Trade-Off Curves, or formulas. Some had the benefit of empiricism and have already been applied successfully in major procurements. Others exist in the form of theoretical concepts only. This study analyzed each model to find out how the interdependency effect between elements was tested. Hypothetical contract examples were assumed for each model.

The study's hypothesis is valid and was proved with examples developed using the models. Contractors have an opportunity to optimize profit and will automatically follow the path leading to highest total fee. Profit motivates performance and it behooves the government to negotiate from a position of strength, using this knowledge, having applied an incentive matrix that guarantees the contractor will select alternatives in the best interest of both parties because his total profit depends upon the best trade-offs. Total fee is a function of the coefficients selected for each element times that element's actual result. Goal congruence is a result of identifying and negotiating individual parameters for each element. Additionally, the buyer must decide on the value, or marginal utility, of each increment of cost, performance, and schedule. The contractor may use indifference analysis to make decisions leading to optimum profit for the situation that exists.

The role of profit in motivating contractor management is a major one. Incentive contracts should not be constrained by maximum profit limitations. Instead, this writer advocates high share ratios as long as they are justified, even though they seem exhorbitant when compared to cost. Justification consists of unusual efficiency or innovation in contract performance. High profits are consistent with incentive philosophy and lead to maximum motivation of the contractor. Present profit guides as contained in ASPR are inadequate and require revision to prevent contradiction to incentive model requirements. Results of limited studies suggest that mean incentive profits will not exceed conventional profits significantly and that slight additional government expense is justified. This writer opposed profit guides in general when they existed as a ratio of contract cost without consideration of the investment required to perform the contract.

The choice of individual elements that comprise the incentive matrix must be made selectively. Negotiated parameters should reflect the common objectives of both parties. They should also assist contractor management by orienting him towards those goals desired by the government. Therefore, elements should associate directly with the contract's objectives. A systems approach may be applied to the selection problem. Once elements have been selected, then they are structured into a contract via the model.

Incentive contracts have unique problems with respect to negotiating contract changes and also minor problems with respect to establishing targets. No greater knowledge exists beforehand with other contract forms; however, conventional contracts do not make as many assumptions regarding various probable outcomes. The writer suggested that probability theory be applied to targets to lessen the degree of risk from massive miscalculation. Most models will indicate a skewed profit pattern because the incentive emphasis is on reward rather than penalty. Each of these areas is subject matter for new study.

General Observations and Conclusions

Many of the dysfunctional incentive problems can be eliminated by using a model which interrelates the elements and tests interdependency between elements. Simulation of contract outcomes prepares both parties for subsequent events so that major obstacles can be avoided.

Existing models for structuring incentive contracts may be two-dimensional and quite simple, such as the CMI Logmill System; or three-dimensional and complex, as with PIIM. No method was found superior as each fills a specific need. Thus, a rule of structuring must be that the parties adopt or design the most appropriate model to the situation. A desirable feature of models is that they remain functional. Complexity does not automatically serve this end. For example, the contractor and his organization should be able to determine the effect future decisions have on total fee. Greater motivation will result if fee amount is determined easily. After-the-fact evaluation did not appear to have equal motivating advantages even though it must be classified as incentive in nature because it bases fee on reward. Trade-off analysis for specific contract decisions depended upon knowing the outcome, or fee effect, immediately. Both of these matters deserve continuing study.

Improved models are needed which do not require mathematical dexterity or computers. Additional research is required for these and for analysis of the substance of contract motivation, looking at the behavioral aspects along with the economic issues.

Incentive contracts which have been structured with models have not withstood the test of time. Chronic deficiencies exist in the defense contracting process. They are not insoluble; relative progress is possible. Achieving goal congruence with the application of models to incentive contracts is highly desirable and all personnel connected with the contracting process ought to be familiar with their operation and advantages. Variable incentive arrangements have the flexibility to make the profit stimulus as strong in government contracting as it is in the marketplace.

APPENDIX A

SAMPLE CPAF CONTRACT MEASUREMENT METHODS

Sample CPAF contract measurement methods used in the NASA Incentive Contracting Guide, (pages 704-712), which illustrate the evaluation problems connected with CPAF contracts. Two separate situations are presented, both of which are for service contracts. The first example is for Base Support Services. The second example is for the Maintenance and Operation of Space Tracking and Data Acquisition Networks. These examples illustrate the degree to which NASA is able to define a range of incentive effectiveness and then to decide, "objectively and consistently, where the contractor's actual performance falls within that range." These methods are not intended to reflect good or bad contract practices; they merely describe NASA's approach to CPAF contracts and after-the-fact evaluation.

EXHIBIT A

Sample Evaluation Criteria: CPAF Contract For Base Support Services

Nature of the work: Contractor to furnish all necessary personnel, equipment, and materials (other than that which NASA elects to furnish) and perform all work and services required to accomplish plant maintenance, operation, repair, overhaul, minor alterations, inspection, and other services necessary to assure that NASA base buildings, grounds, facilities, and equipment are and remain in condition to meet and effectively satisfy all operating requirements.

Comment: Most of the work under this contract is performed on the issuance of work orders for maintenance and operations tasks. Therefore, success in meeting the M&O portion of overall contractual objectives is best indicated by the cumulative level of proficiency with which individual work orders are performed; thus the criteria selected focus directly on these individual work orders. However, since there are other important aspects of the work, additional criteria are set forth under a separate heading (General Management).

Criteria (Maintenance and Operation):

Timeliness of Response (as indicated by the number of work orders completed on time, compared to the total number of work orders completed).

Quality of Work (as indicated by the number of work orders accepted on first inspection compared to the total number of work orders inspected).

Effectiveness in Controlling and/or Reducing Costs (as indicated by the number of work orders completed within the cost estimate compared with the total number of work orders completed).

Criteria (General Management):

Contract Administration. Prompt submission of accurate cost data and reports. Response to contract changes and problems. Purchasing and subcontracting policies and practices, including utilization of small business concerns. Control and effective utilization of Government Furnished Property. Control of costs such as wages, salaries, communications, and travel.

Safety. Quality of safety program.

Personnel and Labor Relations. Quality of recruitment and training program. Effectiveness of labor relations policy and programs.

EXHIBIT B

Sample Evaluation Criteria: CPAF Contract For
Maintenance And Operation Of Space Tracking
And Data Acquisition Network

Nature of the Work: Contractor to perform the following Tasks: Operate and maintain five tracking stations at various locations throughout the world. Operate and maintain a training and demonstration facility. Provide logistic support for the facilities in the above areas. Provide engineering support for the entire tracking network. Provide operations support, including the preparation of operating procedures, schedules, reports, and so forth. Operate and maintain instrumented aircraft.

Comment: The environment in which this contract is performed is that of a total mission rather than a number of discrete work orders. The evaluation criteria, therefore, are intended to focus on the maintenance of an overall high level of achievement. In some areas, however, achievement is definable in very different terms, depending on whether the time span covered is a mission or a nonmission period--that is, whether the contractor is required to perform actual tracking and data acquisition tasks or simply to remain in a state of readiness to perform.

Criteria:

Station Operations (Mission Period)

Amount of Data Acquired
Accuracy of Data Acquired

Station Operations (Nonmission Period)

General facilities
Station records and logs
Station operating manuals and drawings
Electronic equipment
Operator proficiency
Training
Cross-training
Instrumented aircraft dynamic tests
Site administration

Logistics Support

Response to requisitions
Shipping methods
Handling, packing, and storage of parts
Maintenance of depot records
Retirement of obsolete stock
Delivery dates and prices of purchased parts

EXHIBIT B (CONTINUED)

Operations Support

Preparation of operating procedures
Preparation of operations directives
Updating of manuals and drawings
Scheduling station activities
Preparation of network evaluation reports
Preparation of post-flight mission reports
Preparation of network countdown procedures
Fulfillment of special task assignments

Engineering Support

Caliber of continuous engineering support
Caliber of engineering support on individual task orders
Quality of engineering reports

Contract Administration and Cost Control

Budgetary planning
Cost control
Subcontracting
Compliance with overtime approval requirements, limitation of costs clause, property accountability and disposal procedures, patent requirements, small subcontracting programs
Accident prevention
Timely, accurate cost estimation on direction of work orders.

EXHIBIT C

Format for Field Evaluation: General Management of Base Support Services Contract

Performing Activity ____________
Date ____________
Period of ____________
NASA Technical Monitor ____________

Ratings

Excellent	(91-100)
Good	(81-90)
Satisfactory	(71-80)
Marginal	(61-70)
Unsatisfactory	(0-60)

Criteria — Average % Rating

I. Contract Administration

- A. Prompt submission of accurate cost data & reports including Disaster Plan ____
- B. Response to contract changes, anticipation & solution of contract problems ____
- C. Purchasing & subcontracting policies & practices, including utilization of small business concerns ____
- D. Control & effective utilization of Government furnished equipment, property, supplies, & facilities ____
- E. Control of costs, e.g., wages & salaries, communications, & travel ____
- F. Other (specify) ____

Avg. % Rating ____ X Weighting Factor ____ = Weighting Rating ____

II. Safety

- A. Quality of Safety Program ____
- B. Other (specify)

Avg. % Rating ____ X Weighting Factor ____ = Weighting Rating ____

III. Personnel & Labor Relations

- A. Quality of recruitment & training program ____
- B. Effectiveness of labor relations policy & programs ____
- C. Other (specify) ____

Avg. % Rating ____ X Weighting Factor ____ = Weighting Rating ____

TOTAL WEIGHTED RATING ____

COMMENTS:

NOTE: Provide supporting data and/or justification for below satisfactory or outstanding activities.

Signature (s)

EXHIBIT D

Format for Field Evaluation: Maintenance and Operation of Tracking Network

Summary Report for Station Performance*

REPORTING PERIOD

FROM: ______________________________
Station

Beginning: __________

TO:

Ending: ______________

This performance Report is submitted pursuant to requirements of the Performance Evaluation Plan. Reports covering specific areas are attached or no reportable events occurred as indicated below:

AREA		ATTACHED	NO EVENTS
PART I	General Facilities		
PART II	Records & Logs		
PART III	Operating Manuals & Drawings		
PART IV	Electronic Equipment		
PART V	Operation Proficiency		
PART VI	Cross Training		
PART VII	Instrumented Aircraft Dynamic Tests		
PART VIII	Administration		
PART IX	Other		

GENERAL COMMENTS: Station performance was satisfactory as noted during pre-mission simulations and actual mission support. No equipment malfunctions or operator errors were noted. However, use of test equipment, which was out of calibration, caused some degradation of data. Flight Control support was adequate although some time was lost, prior to recognizing the calibration problem in resolving differences between spacecraft and ground readouts.

Date: ___________

Signature: _________________

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*Sample comments included.

EXHIBIT D
(Cont'd)

Detailed Report for Part IV--Electronic Equipment*

This pertains to adequateness and status of preventive maintenance, modifications, operational readiness based on down-time recorded and unit tests of systems and sub-systems.

EVENT (+) OR (-)	TIME MISSION OR NON-MISSION	EXPLANATION
+	Non-mission	Preventive maintenance at this station has been of a superior nature. An ingenious checkout procedure was devised for the Command System that resulted in a great saving of time and effort on the part of the operators.

*Sample comments included

I. Explanation of Exhibit A

Base Maintenance and Operation

In this contract the criteria for evaluating that part of performance directly related to maintenance and operation focused on the completion of individual work orders. The criteria were: timeliness of response, quality of work, and effectiveness in controlling and/or reducing costs. As a result, it was possible to take a relatively objective approach to measurement. In other words, even though the measurement of performance on the entire contract could not be reduced to a formula, the performance on individual work orders could. Achievement could be expressed as a series of ratios (or percentages) as follows:

Timeliness of Response

$$\frac{\text{Number of work orders completed on time}}{\text{Total number of work orders}} = \begin{array}{l}\text{\%completed} \\ \text{on time}\end{array}$$

$$\frac{\text{Sum of days late (early) for all work orders}}{\text{Sum of days allowed for all work orders}} = \begin{array}{l}\text{Average \%} \\ \text{days late(early)}\end{array}$$

Quality of Work

$$\frac{\begin{array}{l}\text{Number of work orders accepted} \\ \text{on first inspection}\end{array}}{\text{Number of work orders inspected}} = \begin{array}{l}\text{\% accepted} \\ \text{on first} \\ \text{inspection}\end{array}$$

Effectiveness in Controlling or Reducing Costs

$$\frac{\begin{array}{c}\text{Number of work orders completed within } \pm 10\% \\ \text{of estimated cost}\end{array}}{\text{Number of work orders completed}} = \begin{array}{l}\text{\% completed} \\ \text{within esti-} \\ \text{mated cost}\end{array}$$

Unfortunately, the mere calculation of such ratios does not guarantee absolute quantification of a range of incentive effectiveness. There is no indication of what percentages (in the above formulas) correspond to outstanding or minimum acceptable performance. This determination must be left to the evaluator's judgment. However, the use of a quantified approach like this does permit the gradual accumulation of data that will make it possible to establish--in future contracts--precise statements regarding the RIE. On the basis of data gathered during this contract, subsequent contracts might specify an RIE for "Quality of Work" of from 75 percent to 95 percent. These contracts might still have to be CPAF, however, so that the quantitative evaluation could be tempered with the evaluator's judgment as necessary. In other words, the great variety of work orders might preclude total reliance on the quantitative measure. (As noted above, whenever it's reasonable to use the quantitative measure exclusively, the CPAF type should be replaced by a conventional formula arrangement.) Because this measurement method permits evolution toward an increasingly precise and objective set of performance standards, it should be used wherever possible.

Base Maintenance and Operation (General Management)

A number of important areas of responsibility in this contract were not covered by the evaluation of performance on work orders alone. It was also considered desirable to make work under the General Management title subject to evaluation, and to measure the contractor's proficiency with regard to contract administration, safety programs, and personnel and labor relations. A review of the subcriteria under these three headings will show that the expression of achievement, unlike the work order environment described above, defies direct quantification of any kind. Therefore, undesirable as it may be, outstanding or minimum acceptable levels of performance will be determined almost solely by the subjective standards NASA personnel apply at each step of the evaluation process. Selection of the method of measurement, then, will turn on whether application of these subjective standards is to be made primarily by the field evaluator or at some higher level. In some cases the field evaluator will be used only as a reporter of facts (see example below); in others, he will play the predominant role in determining whether the contractor's performance is minimum, acceptable, outstanding, or somewhere in between the two extremes.

In the general management category of the base support services contract, the field evaluators exercised the more predominant role. After reviewing the contractor's performance on the basis of the criteria established for his particular area of responsibility, each evaluator assigned numerical ratings according to the following scale of achievement:

Excellent	(91-100)
Good	(81- 90)
Satisfactory	(71- 80)
Marginal	(61- 70)
Unsatisfactory	(0- 60)

These separate numerical ratings, modified at higher levels only as necessary, were combined to give a total rating of from 0 to 100. This was then translated directly into an award fee in accordance with a formula set forth in the contract.[1] In this contract base fee was paid for an overall rating of 70; maximum fee for a rating of 100.

To meet the requirements mentioned earlier, of fairness and consistency in evaluating contractors' performance, two additional conditions must be met when this method of measurement is used. First, to ensure <u>fairness</u>, every evaluator must be thoroughly experienced in the kind of work being performed, since it is this experience that will determine his concept of "excellent," "satisfactory," "marginal," and so forth. Second, to ensure <u>consistency</u>, the evaluators must be required to provide narrative justification for their numerical ratings. This will enable comparison and adjustment at higher levels, thereby reducing the impact of individual differences.

II. Explanation of Exhibit B

Maintenance and Operation of Tracking Network

Since few of the criteria in this contract can be quantified, fairness and consistency, both in defining an RIE and in rating the contractor, will again depend almost exclusively on the subjective standards NASA personnel apply. The method of measurement used, however, is of interest since it places the individual evaluators in a somewhat

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[1] A second, very similar approach to measurements in the circumstances described above is to rate on the basis of the number of points earned out of a stipulated maximum possible point score for each evaluation criterion. The points earned are totaled and an award fee is paid on this basis.

different role than they had in the evaluation of general management for base maintenance and operation as discussed above. In the M&O situation, the evaluators assign numerical ratings that have a specific, arithmetic impact on the amount of fee. For the tracking network contract, on the other hand, the evaluators simply cite occurrences of conditions that they believe indicate performance "below that required for adequate support" or "superior" to it. Events in the first category are reported as minus(-), events in the second category as plus (+).[2] There is no provision whatsoever for quantifying these events although the evaluator can state his conclusions regarding their relative importance. (He is required, however, to make an overall evaluation of the contractor's general level of performance in those areas for which he is the cognizant evaluator.) Thus, the function of the field evaluators in this contract is not so much to judge the contractor as to provide higher levels of NASA management with the facts necessary to make their judgment. Below the level of the Evaluation Board, no attempt is made to translate the facts into an amount of award fee, though, of course, a considerable amount of collating and qualitative evaluation is done before the Board makes its judgments. As a result the Board has very wide latitude for determining the relative importance of the facts it receives. In the process of making this determination, it is also setting the RIE, e.g., establishing su-

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[2] To ensure consistency when this method is used, evaluators are given examples of plus and minus events for their areas.

perior and minimum acceptable performance. Consequently, as the nature of the plus or minus events changes, so changes also the basis of the RIE.

The logic behind this method of measurement can be seen by comparing this situation with the one described for general management in the base support contract. The criteria established for general management are, essentially, independent of one another. Furthermore, the entire contract is concerned with a number of individual functional categories at a single geographic location. This makes it quite reasonable to score numerically at the lowest level of evaluation and to have that score make a specific, predetermined impact on the amount of award fee. In the contract pertaining to the tracking network, on the other hand, events and conditions at one location can and do have a profound effect on the readiness or operational success of the total system. For this reason, scoring of individual events can take place only at a level that permits an overall view of network performance.

Relative Weights

After the RIE has been established, the next step in structuring a CPAF contract is to set relative weights for the various criteria against which the contractor's performance will be evaluated. Because of the kind of effort involved, i.e., the criteria used to measure, relative weighting is much less demanding under CPAF contracts than it is with formula-type incentive arrangements. Since what it actually amounts to is a subjective determination, it should be made largely on the basis of these two considerations:

(i) The relative importance to NASA of the various performance areas being evaluated. (Assigning weights on this basis should motivate the contractor to concentrate on those areas NASA deems to be of the greatest importance.)

(ii) The relative amounts of effort the contractor will have to make to attain higher than normal performance in the various categories selected for evaluation. (This determination, which is subjective in nature, should take into consideration such factors as past experience, controllable versus noncontrollable influences, and resources to be committed by the contractor.)

As mentioned previously, significant weight should always be attached to the contractor's ability to control costs.

The relative weights assigned to the evaluation criteria at the beginning are normally spelled out in the definitive contract. Whether or not these weights will remain fixed for the life of the contract, however, will depend on the nature of the effort involved and NASA's particular wishes in this respect. Under some CPAF contracts, NASA reserves the right to change the initial weightings after the work has begun. Such flexibility is often desirable to make certain that the contractor will always be motivated to direct his efforts in accordance with NASA's most current interests. In fairness to both parties, however, it is good practice to make an assessment of the contractor's performance up to the point where the relative weightings will be changed, and to make a partial fee award accordingly.

Target Cost

The definition of target or estimated cost for a CPAF contract is the same as that used with formula-type contracts. Specifically, target costs should represent the best estimate of what costs will actually be when the contract is complete. As might be expected, cost estimating for nonpersonal services contracts is difficult because of the extent of technical direction involved and the uncertainty inherent in predicting the required number of man-hours to accomplish the work. However, since evaluation of the contractor's success in controlling costs under a CPAF contract may take into account a target cost that later proves to be a poor one, an accurate target is less important than in a CPIF or FPI contract.

Base and Maximum Fees

Although, for purposes of internal management, it may be helpful to establish a target fee for normal, or "expected," performance, the CPAF contract generally contains only a base fee for minimum acceptable performance and a maximum fee for outstanding performance. A _contractually_ stated target fee is omitted, not only to prevent evaluations from gravitating towards a norm, but more important, to eliminate the need for NASA to make strongly critical statements in order to support a unilateral decision to award the contractor a lesser fee. This does not mean, however, that no adverse comments should be made about contractor performance.

In general, the contractor's investment in nonpersonal services contracts is at a minimum, so fees should be considerably lower than those on contracts involving hardware. Because few, if any, facilities have to be supplied and the contractor only provides personnel, his return on investment is normally quite substantial even with a relatively small profit percentage. Hence, it is suggested that the base fee in a CPAF contract for nonpersonal services be in the vicinity of 0 to 3 percent, and the maximum fee from 5 to 7 percent.[3] As with any incentive, a wide fee swing is essential to ensure maximum incentive impact. Payment of any award above base fee should be contingent upon substantial compliance with all contract requirements. Noncompliance with contract requirements, unacceptable work, or substandard performance should lead, as in any other contracts, to prompt and strong representations to the contractor that his failure to correct such conditions would warrant consideration of contract termination and would be reflected in the evaluation of his capabilities for future work.

The Evaluation Procedure

It is apparent from the discussion of the problem of structuring CPAF contracts that field evaluators are in an extremely sensitive position. They must be mature, well-informed individuals who have a full understanding of the

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[3] NASA PR 3.450(f) imposes an administrative limitation on maximum incentive fees of 15% of target cost in contracts for experimental, developmental, or research work, and 10% of target cost in other contracts.

work statement, otherwise the contractor will have no confidence in the integrity of a process that is inherently subjective.

The impact that each evaluator can have on the contractor's performance is substantial. His ratings and his informal comments will determine to a great extent the areas to which the contractor gives particular emphasis; in the absence of formulas for determining fee, the contractor's trade-off decisions will rest on actions taken by the evaluator. It is not necessary, therefore, for field evaluators to wait until the final fee determination to inform contractor's of deficiencies; rather, it is best to point out such problems immediately and thus speed corrective action. This, of course, is in line with the general objective of CPAF contracting to improve contract performance. Pointing out trouble spots does not mean, however, that NASA management should be substituted for contractor management. The function of evaluation is to evaluate, <u>not</u> to control.

In general, there should be only as many evaluators as are necessary to cover the contractor's work completely; moreover, all field evaluators should be persons who are normally in frequent and direct contact with the work areas for which they are responsible. Evaluators should be selected from the existing NASA administrative organization, not added to it simply to carry out the evaluation process.

III. Explanation of Exhibits C & D

Format

The format used for field evaluations is determined by the nature of the criteria employed and the method of measurement. Nevertheless, it should always be clear, concise, and no longer than absolutely necessary. Whenever possible, existing contract administration forms should be adapted to the evaluation process, or in some instances, replaced by the evaluation form, thereby holding to a minimum the additional administrative burden of evaluation.

The format used to report field evaluations of the general management area in the contract for base support services is reproduced in Exhibit C. Samples of the format used in the contract for maintenance and operation of the tracking network are shown in Exhibit D. In the second contract, evaluators were given a sheet on which to report plus and minus events for each subcriterion and a summary sheet for the major criteria heading. The summary report shown in Exhibit D is for station performance and the sample subcriterion under station performance is Electronic Equipment.

Frequency

The frequency of field evaluations will depend on the nature of the procurement and the circumstances surrounding it. A field evaluation should not be made until enough events have occurred in each area of evaluation to result in a good cross section of contractor effort. Too-frequent evaluations will impose a heavy administrative requirement and may also encourage hasty, uncoordinated corrective action by the contractor. On the other hand, if field evaluations are too widely spaced, there may be a loss of continuity in the appraisal of contractor performance. In this context, reference is being made to the compilation of reports by the field evaluators for transmittal to a higher level. The process of gathering data upon which the reports will be based is, of course, a continuous process. Only by regular accumulation of information can the evaluator ensure that his periodic report will be an accurate reflection of contractor performance over the entire period. In most cases, field evaluations should be made monthly with quarterly reviews by the Evaluation Board. Variance from this pattern is permissible in accordance with the requirements of an individual procurement.

Consolidation and Review

After field evaluation reports have been completed, they are transmitted to the cognizant project office where they are assembled, analyzed, and consolidated. The project office may draw upon technical, procurement, audit, fiscal, and other personnel, as appropriate, in performing this function. The entire review process should be part of the normal administrative procedure in any nonpersonal services contract.

IV. The Evaluation Board

When the project office has completed its review function, its findings, together with the field evaluation, are submitted to an Evaluation Board. The functions of the Board are as follows:

(i) To evaluate the significance of reported events and conduct its own review of the contractor's effort, if such a review is necessary.

(ii) To afford the contractor an opportunity to submit information on his own behalf.[4]

(iii) To make a recommendation regarding the amount of award fee to be given.[5]

Membership of an Evaluation Board may vary from the Center level to NASA Headquarters level, depending upon the dollar value, nature, and complexity of a given procurement. Board members should be familiar with the type of work being evaluated and should be able to devote enough time to perform thorough reviews. At least one NASA Center has found it advantageous to establish a permanent Evaluation Board of three members who participate in all the Center's CPAF contracts. This permanent Board is augmented on each contract by two ad hoc members whose background is particularly suitable to evaluating the kind of work involved. This arrangement ensures that the Board will perform with consistency from contract to contract and will always have available the skills necessary to make fair judgments.

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[4] Judgment must govern the extent of field evaluation detail which is furnished to the contractor in affording him an opportunity to submit information on his own behalf. Generally, a summary of the individual ratings will suffice, accompanied by brief comment as to particular areas of exceptional or deficient performance. The objective of this referral is not only to elicit information from the contractor which will support or explain the nature of his performance, but also to acknowledge meritorious work and to give notice of areas requiring correction or improvement for whatever action may be indicated.

[5] The Board should also approve the evaluation criteria and procedures before the contract is definitized.

V. Final Fee Determination

The NASA official designated to make the final incentive fee determination may be at the Center level or the Headquarters level. In most cases it will be the Center Director or his designee, though the Associate Administrator will make the designation in procurements of five million dollars or more. The designated official's function is to approve, or modify, the award fee recommended by the Evaluation Board and to see that the contractor is notified of his findings. This notification should be positive, constructive, and complete so that the contractor will be clearly aware of his deficiencies and his strengths.

APPENDIX B

SAMPLE LMI TABULAR MODEL
WITH REWARD/PENALTY MULTIPLIERS

The example is a CPIF contract for aircraft development. The purpose of presenting this example is to demonstrate how different multiplier techniques might be applied when using the Tabular Model principle. This sample was found in the DOD Incentive Contracting Guide, (pages 87-92), and was not intended to reflect good or bad contract practices; it is here only to illustrate the multiplier technique.

APPENDIX B

CPIF AIRCRAFT DEVELOPMENT CONTRACT

Contract Parameters

Target Cost:	$100 M
Maximum Fee:	$ 15 M (15%)
Minimum Fee:	- 2 M (-2%)

Range of Incentive Effectiveness:

900 to 1100 mph for performance

$80 M to $120 M for cost

21 to 27 months for schedule

The Government attaches greatest importance to cost saving and least importance to early delivery among the incentive elements. The basic incentive arrangement, therefore, should reflect this relation. Performance and schedule, however, should not be unduly sacrificed to earn the greater cost incentive; so penalty multipliers (i.e., multipliers less than one) are assigned to the lower portions of the performance and schedule ranges.

It is desired to establish increased reward for situations in which the contractor's achievement on every element is outstanding. For convenience, the midpoint of each RIE (vis., 1000 mph, $100 M, 24 Months) is called "target achievement" and outstanding achievement is defined to be achievement better than target in all elements.

Assume the negotiating parties decide to assign reward multipliers (i.e., multipliers greater than one) to performance and schedule. These reward multipliers will be used only in the event that all three incentive elements experience better-than-target achievements. In such a situation, the average of the pertinent reward multipliers is used to adjust (multiply) the unadjusted incentive fees for all three elements.

Suppose, for instance, that all elements are better-than-target, and that the reward multipliers assigned to the achievement grades attained for performance and schedule are 1.07 and 1.25. Then the average of these multipliers, ½(1.07 + 1.25) = 1.16, is used to multiply the unadjusted incentive fees for all three elements.

The specific incentive arrangement for the contract is as follows:

Basic (Unadjusted) Incentive

FOR PERFORMANCE

$0.016 M for each mph, not to exceed 200, above the minimum speed of 900 mph = $3.20 M

FOR COST

$0.233 M for each $1 M, not to exceed 40, under the maximum cost of $120 M = $9.32 M

FOR SCHEDULE

$0.3 M for each month, not to exceed 6, by which delivery precedes 27 months= $1.8 M

Target Achievement

1000 mph for performance.

$100 M for cost.

24 months for schedule.

Penalty Multipliers - to be used except when achievement is better-than-target in each of the three elements.

Assigned Perf. Multiplier	Associated Performance Range (mph)	Achievement Grade	Associated Schedule Range (Months)	Assigned Schedule Multiplier
0.60	900 thru 909	1	26.6 to 27.0	0.70
0.65	910 thru 919	2	26.1 to 26.5	0.80
0.70	920 thru 929	3	25.6 to 26.0	0.85
0.75	930 thru 939	4	25.1 to 25.5	0.90
0.80	940 thru 949	5	24.6 to 25.0	0.95
1.00	950 thru 1000	6	21.0 to 24.5	1.00

Penalty Multiplier Rule:

A penalty multiplier assigned to the level of achievement on one element is used to adjust (multiply) the unadjusted incentive fees for the other two elements. When two such multipliers are applied to the same fee, use the product of the two (e.g., 0.80 x 0.85 = 0.68).

Reward Multipliers: To be used only when achievement in every one of the three elements is better-than-target.

Assigned Perf. Multiplier	Associated Performance Range (mph)	Achievement Grade	Associated Schedule Range (Months)	Assigned Schedule Multiplier
1.00	1001 thru 1019	1	24.0 to 27	1.0000
1.02	1020 thru 1029	2	23.6 to 23.9	1.025
1.04	1030 thru 1039	3	23.1 to 23.5	1.050
1.06	1040 thru 1049	4	22.6 to 23.0	1.075
1.08	1050 thru 1059	5	22.1 to 22.5	1.100
1.10	1060 thru 1069	6	21.6 to 22.0	1.125
1.15	1070 thru 1079	7	21.0 to 21.5	1.150
1.20	1080 thru 1089	8		
1.25	1090 thru 1100	9		

Reward Multiplier Rule: The average of the multipliers assigned to the levels of achievement on performance and cost is used to adjust (multiply) the unadjusted incentive fees for all three elements (e.g. ½(1.25 + 1.15) = 1.2).

STIPULATIONS REGARDING MULTIPLIER USAGE MUST PRECLUDE THE INVOLVEMENT OF BOTH REWARD AND PENALTY MULTIPLIERS IN A SINGLE FEE CALCULATION. THE FIRST STEP IN ANY CALCULATION IS TO DETERMINE WHICH TABLE OF MULTIPLIERS APPLIES.

Hypothetical outcomes and sample fee calculations for this example follow:

Target Performance in All Elements

	A	B	C	D	E	F	G
Incentive Elem.	Achievement	Minimum Achievement	(A) - (B)	Basic Incen. Rate(s)	Unadj. Incen. Fee($M)	Mult. Appl.	Incen. Fee ($M)
Performance	1000	900	100	.016	1.60	1.0	1.60
Cost	100	120	-20	.233	4.46	1.0	4.66
Schedule	24	27	- 3	.3	.9	1.0	.90
					Minimum Fee	-	2.00
					Total Fee		5.16

Maximum Fee

	A	B	C	D	E	F	G
Incentive Elem.	Achievement	Minimum Achievement	(A) - (B)	Basic Incen. Rate(s)	Unadj. Incen. Fee($M)	Mult. Appl.	Incen. Fee ($M)
Performance	1100	900	200	.016	3.20	1.20	3.840
Cost	80	120	-40	.233	9.32	1.20	11.184
Schedule	21.0	27	- 6	.3	1.8	1.20	2.160
					Minimum Fee	-	2.000
					Total Fee		15.184 *

* $0.184 Overlap

Target Cost - Maximum Performance and Schedule

	A	B	C	D	E	F	G
Incentive Elem.	Achievement	Minimum Achievement	(A) - (B)	Basic Incen. Rate(s)	Unadj. Incen. Fee ($M)	Mult. Appl.	Incen. Fee ($M)
Performance	1100	900	200	.016	3.20	1.20	3.840
Cost	100	120	-20	.233	4.66	1.20	5.592
Schedule	21.0	27	- 6	.3	1.80	1.20	2.160
					Minimum Fee		- 2.000
					Total Fee		9.592

Worst Performance, Best Cost, Target Schedule

Performance	900	900	--	.016	0.0	1	0.0
Cost	80	120	-40	.233	9.32	.60	5.592
Schedule	24	27	- 3	.3	.9	.60	.540
					Minimum Fee		- 2.000
					Total Fee		4.132

Best Performance, Worst Cost, Target Schedule

Performance	1100	900	200	.016	3.2	1	3.2
Cost	120	120	0.0	.233	0.0	1	0.0
Schedule	24	27	- 3	.3	.9	1	.9
					Minimum Fee		- 2.0
					Total Fee		2.1

Above Target in All Elements

	A	B	C	D	E	F	G
Incentive Elem.	Achievement	Minimum Achievement	(A) - (B)	Basic Incen. Rate(s)	Unadj. Incen. Fee($M)	Mult. Appl.	Incen. Fee ($M)
Performance	1030	900	130	.016	2.08	1.0575	2.1996
Cost	86	120	- 34	.233	4.25	1.040 1.075 1.0575	7.9220
Schedule	23	27	- 4	.3	1.2	1.0575	1.2690
					Minimum Fee		- 2.0000
					Total Fee		9.3906

Best Cost - Target Performance and Schedule

Performance	1000	900	100	.016	1.6	1.0	1.60
Cost	80	120	- 40	.233	9.32	1.0	9.32
Schedule	24	27	- 3	.3	.9	1.0	.90
					Minimum Fee		- 2.00
					Total Fee		9.82

The above sample fee calculations confirm the achievement of the stated desired objectives of this Example (viz. greatest importance attached to cost saving and least importance to early delivery). Some question may exist, however, regarding the rewards paid for better than average performance in all areas. Such performance might justify higher rewards than those given. If such a decision is made, a lower weighting on the basic (unadjusted) cost element and higher multipliers assigned to performance and/or schedule would be needed. If, however, cost is the most important element and the Tabular Model is used to assure "average" performance and schedule results and provide maximum fee only for outstanding results in *all* three elements then a combination of weights similar to this Example would achieve these objectives.

APPENDIX C

CHRONIC DEFICIENCIES IN DEFENSE CONTRACTING

A sample of some chronic deficiencies found in defense contracting by an Air Force survey team and published in <u>Air Force Management Surveys</u>. This section intends to examine problems of a general nature which persist in defense contracting, especially those which might benefit from incentive contract models and incentive contract management.

CHRONIC DEFICIENCIES IN DEFENSE CONTRACTING

The discussion perspective was narrowly confined to one form of contract for the sake of study. The advantages and disadvantages of the incentive contract were aired with particular emphasis on the latter in Chapter VI. For a broadened perspective, one must determine how these special problems compare with the general problems experienced by contract managers in defense work using other contract forms. Without this comparison there might be a false tendency to condemn the incentive form. To what extent do general problems exist in defense contracting without incentives? The problems, or deficiencies referred to will pertain to contract management. The repetitive nature of deficiencies demands that government contracting authorities use more techniques that will self-actuate the contractor towards common goals.

In 1962, the USAF Inspector General and Air Force Systems Command completed surveys of a representative group of Air Force contractors.[1] The surveys were launched because of concern over steadily increasing costs for new weapon systems. The Management Surveys found many identical basic deficiencies between the contractors that were studied. A management

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[1] Air Force Systems Command, A Summary of Lessons Learned From Air Force Management Surveys, United States Air Force, AFSCP 375-2, June, 1963.

deficiency is defined as: "all occasions of omission or comission (in direction, control, conduct, and administration of necessary functions and processes) which compromise attainment of programmed costs, schedules, and product performance objectives."[2] These are recurring problems common to companies working under Air Force contracts, but are of concern to the DOD as well. Not all management deficiencies from this study are reviewed. Only those which the Air Force, or this writer, feel should benefit from improved contracting processes are presented.

Project management, a special organization form for a weapon system or contract, is commonly employed in the defense industry. Project management puts stress on an end-product or objective, and is the creation of the contract program. According to the surveys, decentralized program management usually lacked controls. Top management did not take action to insure that internal policies, procedures, authority, and responsibility were clearly defined for integrated program control. This condition created uncertainty or confusion for line organization managers as to exact responsibility and authority on program matters. Program decisions were not made in a timely manner. The deficiency was caused, in part, because of the role of vested interests in making decisions. Decisions were not made in the best interest of the program because there were no trade-offs.

Contractors have a tendency to stall when they feel a

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[2] *Ibid.*, p. 81.

firmed-up contract would not be in their favor. A frequent deficiency was that letter contracts were used far longer than necessary as the signing of formal contracts was postponed. Delays in definitizing letter contracts resulted in creation of work forces without positive direction, handicapping progress evaluation, stimulating continuous program redirection, and expending Air Force funds for tasks that did not contribute fully to achievement of program objectives. Ineffective cost controls and work were often keyed to contractor estimates rather than firm provisions. Wasted work was nearly completed under letter contract due to poorly defined requirements; disagreement on cost estimates; a desire to keep the contract open so that new work could be added (padding); and the weak bargaining position of the government when they negotiated with a sole source. These problems could not be controlled with reports. Contractors maintained detailed cost control and accounting reports that contributed to inaccurate cost estimates, unanticipated overruns, and delays in making program decisions.

Deficient cost control and accounting practices were due to: inadequate segregation of contract costs; cost controls unrelated to work accomplishment actual costs; poor utilization of cost data for program control; no formal, centralized estimating system; inaccurate allocation of costs on multiple contracts; and a lack of management information systems. Contractors are unwilling to identify and compare detailed actual costs with proposals. Therefore, cost proposals were incomplete, had unrelated elements, or were fabricated.

Delays in contract negotiation and definitization created overrun potentials which were not identified until it was too late.

A related problem was the repeated tendency to miss targets. Costs were consistently underestimated causing program decision delays, program stretch-outs, or late program terminations, all of which contributed to cost overruns, on cost reimbursement contracts. The reasons for underestimating cost so frequently were traced to incomplete product descriptions, lack of communication and mutual understanding as to acceptable estimating systems between the contractor and the Air Force, lack of management attention, and an inability to support estimating factors.

A major problem in defense contracts has always been manpower utilization. Contractors exhibited limited standards for manpower utilization, relative to that which is common for commercial work. Standards for assessing manpower utilization requirements generally were rudimentary. As a result, the contractors exercised loose control over the largest single element of cost. Manpower controls, when applied, were based on obsolete, historic employment data, and gross estimates of people needed for projected tasks. There were no established guides for supervisory-to-worker ratios (span of control); no standard hours or standard cost data for estimating manning levels, except from old contracts; and no indirect manpower standards. The cost reimbursement contract did not motivate managers to use manpower efficiently. Middle managers justified overall manpower ceilings instead of matching jobs to specific contract requirements.

Unrealistic development, engineering, and test schedules were frequent problems. Development schedules established early in a program generally prove to be optimistic and are seldom achieved. Witness the present TFX/F-111 airplane project. Contractors failed to meet original milestone dates by a wide margin, yet they showed ever-increasing achievement for concurrent milestones. This is accomplished by changing the method of recording progress as program slippage develops, and it leads to increased program costs. Schedule slippages were due to: planning that did not consider past experience; poor analysis of significant factors influencing schedules; insufficient time alloted to the development of schedules; unrealistic schedule proposals to beat competition; and contracts that imposed no penalties on contractors failing to meet schedules.

The survey team commonly found that inadequate competition and price analysis resulted in high material costs, one-sided contract terms, and a weak government position for follow-on procurements. This deficiency was related to repeated purchases from the same supplier; too many single or sole source purchases; frequent expedited procurements that justified other than the lowest bidder; cursory price analysis; delays in definitizing letter contracts; overruns on CPFF contracts; and excessive subcontract costs. Subcontract management deficiencies existed because of the failure on the part of management to audit and enforce policies, procedures, and controls governing competitive procurement; insufficient price analysis and purchase order review; and pressures to compress procurement lead time from various sources.

There was generally inadequate management of subcontractors aside from the inadequate competition and price analysis found in the award phase. Specifically, subcontractor management was deficient in the areas of price redetermination, control over expenditures, and technical progress evaluation; which resulted in unanticipated cost overruns. Prime contractors were responsible for this because they did not use the learning curve in negotiations, and did not familiarize themselves with subcontractor technical or production problems. Subcontract financial reports were unreliable, untimely, and often neglected by the prime contractor, when they deserved immediate attention. This problem had organizational origins, when responsibility for financial excesses was not isolated.

Often, deficiencies were connected in a chain reaction. For example, the last two deficiencies noted created delays in termination of subcontracts. Lack of strict procedural discipline delayed notification and settlement of terminated subcontracts, and increased costs. Subcontractor claims were not settled promptly. There was slight managerial emphasis on the contract termination function, and general inattentiveness by both the prime contractor and the government. Delays prompted additional expenses.

<u>The Management Surveys</u> uncovered many deficiencies usually blamed on poor management. This phrase is useless because it doesn't identify an underlying cause but may merely describe

an effect. The consistent, repetitious pattern of deficiencies suggests that contractor management lacked real motivation, nor had any empathy, with defense agency objectives. Millions of dollars could be saved if genuine motivation would spontaneously result from incentives and the expectation of greater rewards.

The contract form is not a cause of management deficiency and no inference should hold the contracting function responsible. Some deficiencies whatever the cause, occur because of basic management incompetence. They occurred in the companies surveyed because of imperfections in the management process. Advanced planning necessary to attain program objectives was either not recognized nor given full consideration in order to phase major operations into proper sequence. Communication imperfections existed because proper policies and procedures were not emphasized, nor were authorities and responsibilities defined sufficiently to permit middle management to control, direct, administer, or integrate overall functions and processes. Managerial discipline was lax in areas where plans, policies, and procedures were adequate. Adequate performance was the norm when the government demanded exceptional performance.

Deficiencies, the result of poor management practices, disrupt the decision-making process. In the studies, judgment was distorted and took two distinct courses: (1) cost, performance, and schedule objectives were wrongly determined from information available and could not be achieved with existing resources; or (2) wrong decisions were made in subsequent actions that jeopardized attainment of program objectives.

Problems were consistently associated with the functional areas of contracting, subcontracting, cost control, accounting, and estimating. These areas have inherent problems rarely isolated by source or cause. Incentive contracts could bring relief to these chronic problems by tieing together cost, performance, and schedule, as found in the multiple incentive models with a tested interdependency effect.

Chronic deficiencies varied in degree of seriousness as to: basic causes; or, interrelated effects. The survey team noted that some problems exist for which there are no universal criteria or norms, and perfection is relative to poor performance only. The causes are too varied to be completely eliminated. However, hope exists for general improvement if management can be educated. <u>The incentive contract can improve the learning curve of management</u>.

The <u>Management Surveys</u> gave alternatives for resolution of these problems. Suggestions and recommendations were made for new policies and procedures which might apply to all government agencies. The most frequent suggestion was, "improve existing techniques." Useful tools, such as, program definition, cost trade-off studies, systems analysis, PERT/cost, etc., were mentioned. Special recognition was given to training and education programs in cost estimating, PERT, and incentive contracting.

Conclusion

Some chronic deficiencies in the defense contracting process will never be completely eliminated. However, greater efficiency could be obtained by concentrating on improved performance. Greater use of the incentive contract was frequently suggested as a means towards that goal.

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BIOGRAPHICAL SKETCH

Martin Irwin Veiner was born in Boston on January 10, 1938. He graduated from Millis High School, Millis, Massachusetts, in 1956. He received the Bachelor of Science in Business Administration degree from Babson Institute in 1959, and the Master of Business Administration degree in 1960. His undergraduate major was economics; his graduate major was finance; and his terminal major included management. From 1961, to 1962, he was employed by an investment banking firm active in corporate and municipal issues. From 1962, to 1964, he worked as a financial analyst for an aerospace firm. In 1964, he joined the Directorate of Contractor Evaluation at Patrick AFB, Florida. Since the latter part of 1964, Mr. Veiner has pursued work towards the Doctor of Philosophy degree at the University of Florida. In January, 1967, he became a member of the graduate faculty for Florida State University at the Graduate Center located at Patrick AFB.

Mr. Veiner is married to the former Joyce Sher of Marlboro, Mass., and lives with his four children in Indialantic, Florida. He is a member of: the American Economic Association; the American Finance Association; the Southern Economic Association; the Southern Finance Association; the Academy of Management; the American Society for Training and Development; and Omicron Delta Epsilon National Honorary Society in Economics.

This Dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Business Administration and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

March 1968

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